DONG-WOOK SONG
PHOTIS M PANAYIDES

MARITIME LOGISTICS

2ND EDITION

A GUIDE TO CONTEMPORARY SHIPPING AND PORT MANAGEMENT

The Chartered Institute of Logistics and Transport

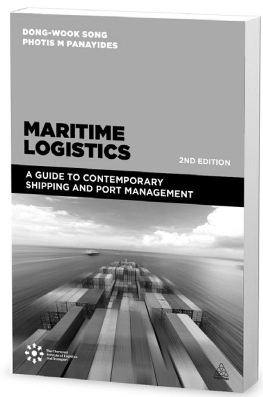
KoganPage

Maritime Logistics

Dong-Wook Song dedicates this book
to his beloved family members Sung-Hee,
Jee-Young and Jee-Hoon.

Photis M Panayides dedicates this book
to his wife Marina and his sons Michalis,
Ioannis and Aristotelis.

SECOND EDITION



Maritime Logistics

A guide to contemporary shipping and port management

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PREFACE TO THE 2ND EDITION

At the end of the preface to the first edition of *Maritime Logistics*, we expressed our hope that 'the present volume trains the next generation of maritime logistics specialists and initiates the further progression of this fascinating sub-discipline of logistics and supply chain management over the years to come. The editors would love to hear from you on any area for improvement and inclusion for the future edition.'

When writing the preface slightly over three years ago, we had not expected such enthusiastic and tremendous responses from virtually every single part of the world. Students and professionals new to the field sent appreciative messages that they were better guided to the subject with the contents and context of the book. Researchers, especially those in the early stage of research, seemed to have benefited from having read the book and subsequently located their positional stance in the field; that is, they were able to see the field as a whole without losing sight of the individual components that make up the entirety of the discipline. Finally, fellow academics, lecturers and teachers conveyed to us their welcoming messages and at same time pointed out a number of areas for further inclusion, improvement and even clarification.

Having really appreciated that encouraging and postive feedback as well as being urged by the publisher Kogan Page to respond to those requests, the editors decided a year ago to take the feedback on board by producing the second edition of the book. As was the case for the first edition, we first cross-checked which chapters were to be updated and revised and which new chapters were to be developed in line with comments and feedback received and with recent developments and trends. We called on the previous contributors to make the necessary changes and also asked a series of known scholars to contribute chapters on the newly identified areas. Fortunately, we received an equally enthusiastic reaction from new authors and contributors whose work features in this second edition.

Those who read the first edition will find that the second edition has been substantially enlarged in volume and contents but the three parts of the book remain intact. We believe that these enlargements and changes will enrich the knowledge horizon of the field in a more logical manner. In the pages that follow, you will find the fruits of those individual and collective efforts.

As was the case for the first edition, we are extremely grateful to all the contributors and reviewers for their academic professionalism. Julia Swales from Kogan Page deserves our special thanks: her encouragement

and patience throughout the journey turned out to be a crucial instrument in this rewarding process.

We would still love to hear more from you as we believe that you are the main figures shaping the academic discipline of maritime logistics over the years to come. Thus, hold the book firmly and read the chapters herein with a critical mind and forward thinking and send us your thoughts and views.

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PREFACE TO THE 1ST EDITION

Every book has a reason why it ought to be prepared and published. The book you are holding now is no exception. For over 50 years both editors have been collectively researching and teaching the subjects of shipping, port and logistics management. Over the years, we observed an evolution in discipline development with the convergence of two distinct fields of shipping and port management; a convergence that occurred with the use of another field of study: logistics and supply chain management. This change has raised concerns as to the effectiveness of teaching the subjects in a traditional sector-oriented approach which does not offer the comprehensive all-round knowledge required for the next generation of students. However, apart from the pedagogic value that this endeavour obviously brings, the book serves as a stimulant to further research in this emerging field of maritime logistics. Judging from the subjects that the contributors to this volume chose to research and analyse, it is evident that there is an ample opportunity for empirical investigations that will guide future practice in maritime logistics.

We are grateful to all the contributors and reviewers for their professionalism to ensure the quality of all the chapters has been up to the standard that was set right at the outset. A special thanks goes to Martina O'Sullivan, a commissioning editor for Kogan Page, for her wonderful support and synchronization throughout this arduous but thoroughly rewarding process.

Last but not least we feel obliged to acknowledge the publishing house, Kogan Page. The decision to publish this volume by Kogan Page is testament to the innovativeness that has made them a leading publisher in the transport and logistics field.

It is our hope that the present volume trains the next generation of maritime logistics specialists and initiates the further progression of this fascinating sub-discipline of logistics and supply chain management over the years to come. The editors would love to hear from you on any area for improvement and inclusion for future editions.

Dong-Wook Song
Photis M Panayides
August 2011

PART ONE
Introduction

Introduction to maritime logistics

01

DONG-WOOK SONG AND PHOTIS M PANAYIDES

Background

Globalization and the technological revolution in the transport sector including containerization, logistics integration and the consequent expansion of the maritime industry have redefined the functional role of shipping and ports in global logistics and supply chains and have generated a new pattern of freight distribution. The rapid increase in world trade in the past decade has restructured the global maritime industry, having brought about new developments, deregulation, liberalization and increased competition. There have been dramatic changes in the mode of world trade and cargo transportation, characterized by the prevalence of business-to-business and integrated supply chains. These changes have been embodied in the increasing demand for value-added logistics services and the integration of various transportation modes such as inter- or multi-modal transport systems. As a consequence, the business stability and sustainability of the industry is largely subject to how well it adapts to such a dynamic environment. Therefore, high-quality logistics services and the effective and efficient integration of transport and logistics systems offered by a maritime operator (ie a shipping company or port/terminal operator) has become an important issue.

Maritime logistics has been traditionally regarded as the primary means of transporting parts and finished goods (viz outbound logistics) on a global scale and has recently attracted considerable attention from academics and practitioners alike. However, the term 'maritime logistics' is not easy to define and its precise definition, scope and role within global supply chains are yet to be established (Song and Lee, 2009). The first edition of the present book *Maritime Logistics* (2012) is considered to be the first formative approach towards the establishment of maritime logistics as an academic discipline by setting up a disciplinary boundary, scope and contents.

Historically, however, the initial attempt to define maritime logistics was made by Panayides (2006), who suggests that, for a better understanding and ultimate definition of the term, the starting point should be to consider the underlying scope and characteristics of the two areas making up the term (ie 'maritime transport' and 'logistics and supply chain management'). On the one hand, maritime transport (ie shipping and ports) is clearly concerned with the transportation of goods and/or passengers between two or more seaports by sea; on the other hand, logistics is the function responsible for the flow of materials from suppliers into an organization, through operations within the organization and then out to customers. A supply chain is composed of a series of activities and organizations that materials (eg raw materials and information) move through on their journey from initial suppliers to final customers. Supply chain management involves the integration of all key business operations across the supply chain. In general, logistics and supply chain management relate to the coordinated management of the various functions in charge of the flow of materials from suppliers to an organization through a number of operations across and within the organizations, and then reaching out to its consumers (Harrison and van Hoek, 2011).

Based on this clean-cut understanding, Panayides (2006) further elaborates on the issue of convergence of maritime transport and logistics. These two terms are largely attributed to the physical integration of modes of transport facilitated by containerization and the evolving demands of end-users that require the application of logistics concepts and the achievement of logistics goals. At the centre of maritime logistics is, therefore, the concept of integration, be it physical (intermodal or multimodal), economic/strategic (vertical integration, governance structure) or organizational (relational, people and process integration across organizations) as an ongoing attempt to create a greater value for shareholders (Lee and Song, 2015).

In this process, a number of issues still require further elaboration and explanation. This book brings together the key contributions in the field of 'maritime logistics' from leading academics and researchers from across the globe.

Outline of the book

Part One of this book consists of six chapters introducing the topics of maritime logistics and establishing a foundation upon which the discipline of maritime logistics is developed. In Chapter 2, Veenstra introduces the role of maritime transport and logistics as a trade facilitator, having examined a number of issues in a retrospective as well as prospective manner. More specifically, this chapter addresses the relationship between ocean shipping and trade by examining to what extent shipping facilitates trade. With regard to this purpose, the chapter briefly introduces the 'trade facilitation' school of thought in shipping and port management and then describes the mechanism of international trade and the specific role of shipping within this mechanism.

In Chapter 3, Yercan and Yildiz focus on developments in international maritime transport by emphasizing the developments in global trade. They offer a broad idea of logistics and its interaction with international trade, by providing general characteristics of logistics and the interrelation of various business areas. They build a background to the interaction between logistics and the transport industry within the global economy, followed by a more in-depth discussion on the developments in the global economy and the maritime transport industry in relation to international trade.

In Chapter 4, Lee, Nam and Song provide a precise understanding of the concept of maritime logistics and a guideline for value creation of maritime logistics systems. The chapter addresses such issues as the importance of maritime transportation in an entire logistics system, the definition of maritime logistics and maritime logistics value, the main activities of maritime logistics, and the process of maritime logistics, as well as the significance and strategic implications for maritime logistics operators.

Bergqvist in Chapter 5 deals with hinterland logistics. Some of the load units arriving at seaports are transhipments for other seaports, while others have inland destinations. The hinterland transportation system enables load units to be transhipped between seaports and inland destinations. The term 'hinterland' is often referred to as the effective market or the geo-economic space in which the seaport sells its services. The logistics related to the hinterland involve many actors and activities, and require intense collaboration and coordination to work effectively and efficiently. Hence, hinterland logistics and transportation have become a crucial part of ensuring an efficient supply chain.

Finally, Österman and Osvalder in Chapter 6 deal with the human element of maritime operations, arguing that mechanization, automation, information and communications technology have made many manual tasks redundant, enabling ship and cargo-handling operations with a minimum of manpower. However, there is still an area of potential to acknowledge and develop in the effort to improve maritime logistics – the role of the human element and the interface between human and technology in the various man–machine systems in the global supply chain. The chapter puts forward a number of ideas to be seriously considered in the industry for the present and future.

Part Two covers topics related to the management of logistics for the shipping sector. Chapter 7 by Hayashi and Nemoto analyses the global intermodal transport that combines maritime and other transport modes, explaining the concept of intermodal transport and its components and characteristics, discussing the function of containers in the development of intermodal freight transport and logistics, and introducing typical global intermodal transport services with some examples in North America, Europe and Asia. They discuss the role of intermodal transport facilitators and their services, and review and predict the development factors affecting intermodal transport.

In Chapter 8, Ducruet and Notteboom analyse liner service networks as configured by container shipping lines. They discuss the drivers of and decision variables in liner service design as well as the different liner service types. Next, the chapter provides a global snapshot of the worldwide liner shipping network based on vessel movement data. The changing geographic distribution of main inter-port links is explored in light of recent reconfigurations of liner shipping networks. They move on to the position of seaports in liner shipping networks referring to the concepts of centrality, hierarchy and selection factors. They conclude by elaborating on the interactions and interdependencies between seaport development and liner shipping network development notably under current economic changes.

The growth of world container trade during the last decades reflects the coalescent markets in the world. The geographic separation of supply and demand has raised the expectations towards transportation services. Keeping up with the growth of global container traffic was considered as one of the biggest challenges. In addition, customers expect fast and reliable services in a wide geographical network. Vessel capacity and utilization provide only one possibility for competitiveness. Vertical and supply chain integration are characterizing the modern transport industry, as transport businesses are gearing up towards global logistics services based on the principle of the ‘one-stop-shop’. In order to accomplish this goal, it is necessary to integrate port, hinterland transportation and logistics management services. It follows that strategic aspects of supply chain integration and diversification are of significant importance in the contemporary shipping industry. In Chapter 9, Panayides, Wiedmer, Andreou and Louca, after having conceptually explained the basic concepts of diversification and supply chain integration, analyse the recent trends, developments and current situation in the maritime shipping industry and carry out an empirical investigation into the relationship between supply chain integration and shipping firm performance.

Chapter 10 by Baird seeks to analyse container shipping line strategy relating to the provision of added-value logistics services. The chapter aims to identify, analyse and compare/contrast the logistics strategies of container shipping lines. The study entailed the administration of a short questionnaire to survey the top 20 container shipping lines to help investigate these questions. The results of the survey, plus supporting information, are analysed to provide a summary of container line strategy with respect to the provision of logistics services. This analysis includes several brief case studies which seek to review and analyse the specific logistics activities and strategies within several of the top 20 container lines. The case studies offer a more detailed insight into the different approaches adopted by major global container lines with respect to the development and provision of logistics services. The purpose of the overall study is to help develop a wider picture concerning what/how liner shipping competitors are doing with regard to provision of logistics and value-added activities, to assess the extent of these activities in terms of logistics services provided, and to offer an indication as to how this might evolve in the future.

Desrosiers in Chapter 11 focuses on the transfer of bulk petroleum at fixed terminal facilities and introduces the reader to the logistics of bulk liquid. Three major components of petroleum movement are introduced (ie the petroleum per se, the cargo terminals and the ships), followed by the practical steps involved in transferring this valuable liquid. In addition to the physical movement of petroleum, contractual aspects of petroleum movement and custody transfer are discussed to add context to the need for careful monitoring and proactive efforts by all parties on the scene to prevent both fiscal and cargo loss. It is argued that knowledge of the legal procedures and processes involved in the transfer of bulk petroleum is important to understanding the constraints and problems that can and do arise. This knowledge will allow the practitioner to not only plan more effective operations, but will enable comprehensive action to improve the processes and make more effective and informed decisions.

Finally, Chapter 12 by Comtois and Lacoste covers dry bulk shipping logistics. The globalization of economic activities has led to a profound mutation in the dry bulk trade. The growth in the amount of dry bulk carried by sea and the mutation in the direction of flows are some of the major phenomena. The steady growth in the volume of dry bulk shipments has resulted in intense demand, thereby increasing the competitiveness of bulk logistics. Bulk commodities have a low value/weight (or volume) ratio implying that the efficiency of land and marine transport has an impact on value added. The handling conditions of dry bulk materials are influenced by a wide range of factors such as size and weight. Handling equipment is often custom-designed for specific dry bulk commodities. There are various types of contractual arrangements used for the shipment of dry bulk commodities. The command centre of dry bulk trade is not always commensurate with dry bulk port location. Ships and consignment size vary enormously. These conditions raise a series of key issues which are fully discussed and analysed in the chapter.

Part Three covers the topic of logistics management for ports and associated sectors. Roso and Rosa in Chapter 13 focus on the concept of dry ports. Dry ports are regarded as a means to increase port throughput, hinterland reach, and transfer parts of port operations to inland terminals by relying on intermodal transport. A dry port is defined as an inland intermodal terminal directly connected by rail to seaport(s) where customers can leave/pick up their units as if directly to a seaport. In addition, the dry port is also a means to rationalize transport in and out of a port by bundling the flows and transferring container transport from road to rail, thus reducing congestion in the proximity of the port – typically relevant for port cities – and bringing about other environmental benefits. They argue that, in order to fully discuss the dry port concept, it is useful to mention intermodal services and review a number of different shapes that an inland freight terminal may take.

In Chapter 14, Valantasis-Kanellos and Song examine an emerging concept applicable to a port/terminal and its hinterland logistics – port-centric logistics. The notion that ports are generators of trade and commerce can be traced back to the era of the Phoenicians. Ports have been recently characterized as business networks. Within these networks companies are interdependent. In the context of a holistic system inter-firm relationships are of high importance. This chapter focuses on ports in a logistics environment, thus a relevant definition must be employed. Under the definition of ports being 'the interface between land and sea providing facilities and services to commercial ships and their cargo, as well as the associated multimodal distribution and logistics activities', this chapter commences a series of discussions associated with the scope of ports in a maritime logistics environment as part of a system and goes on to examine the latest practices taking place in the field with the concept of port-centric logistics.

Since the hub-and-spoke concept was introduced to the aviation market after the US airline deregulation in the late 1970s, it became a primary distribution model employed by leading international logistics companies. This pattern drives the companies to consolidate shipments on a large scale at major terminals (ie hub) and to redistribute the smaller scale of shipments to their respective destinations via radial links (ie spoke). In the field of logistics and supply chains, however, the hub concept has been often introduced in various terms in accordance with functionality, such as logistics centre, logistics zone, freight terminal, distribution centre and warehouse. Such heterogeneous terminology on the concept of logistics hubs still seems to be used by practitioners and academics alike. Having recognized this rather ambiguous concept and definition in the literature, Nam and Song in Chapter 15 attempt to define the logistics hub concept that is applicable to the maritime industry by synthesizing existing studies/perspectives and examining its possible implications.

Chapter 16 by Parola aims to provide a comprehensive overview of the container port business state of the art and evolution by depicting mainstream trends and common managerial practices. For this purpose, the chapter conceptualizes the nature and typology of the stevedoring services, enlightening the differences between dedicated and multi-user facilities in line with business models of leading market players. Interestingly, the chapter analyses the spatio-temporal dimensions of container port multinational enterprises (MNEs) and their internationalization, illustrating the timing and the geographic scope of overseas expansion in a number of visual illustrations. The chapter goes on to depict firms' most common entry patterns and expands understanding of inter-firm partnerships.

Lam, Parola and Panayides in Chapter 17 examine an ever-more challenging aspect of maritime logistics business – that is, financing port development and expansion. Developing and operating ports is a highly capital-intensive business. The rapid pace of technology advancement has seen tremendous growth in vessel sizes in various shipping sectors including container ships, dry bulk carriers and tankers. In order to handle these vessels, ports have to expand their capacity as well as equip these facilities with a new generation of cargo-handling system designed to achieve greater productivity and efficiency from a logistical perspective. Pursuit of greater handling capacity does, however, require enormous financial resources and professional expertise. Ports have been seeking private sector participation through various forms of public–private partnership (PPP) schemes. This chapter adds value to the body of literature in view of the growing trend in port PPPs by performing an exploratory investigation into the impact of PPP on port logistics performance through the discussion of examples from the port industry and the respective countries' situation.

Chapter 18 by Cetin discusses the organizational aspect of port logistics with a conceptual framework established. The changes in the traditional role of ports put responsibility on port authorities as the administrative bodies of port organizations. Their landlord, regulator and operator roles are shifted towards a 'coordinator, facilitator and integrator role in port clusters, international transport, logistics and supply chains'. As the roles and functions change, so too do the goals. The changing goals also change the organizational effectiveness criteria. It appears that in today's port business circumstances, commonly used port performance measures such as efficiency, profitability and growth are not enough to assess a port organization's success at all points. With respect to the developments in logistics chains, the chapter covers a wide range of related matters such as port logistics chain integration, adaptability to the changes in the environment, customer orientation and satisfaction, information and communication management, service quality and provision of value-added and intermodal services, innovation and resource acquisition.

Chapter 19 by Woo, Pettit and Beresford aims to investigate the effect of supply chain integration of seaports on port performance by examining the causal relationships among the integration strategies of seaport terminals along the supply chain, and the antecedents and consequences of the integration strategies. The integration strategy is termed Port Supply Chain Integration (PSCI) and the antecedents of PSCI are identified as port supply chain orientation. Logistics performance of ports is considered as consequences of PSCI because it is suggested that a traditional performance measure such as cargo throughput is not sufficient for a proxy of port performance in the global supply chain era.

Finally, in Chapter 20, Part Four, Panayides and Song provide an overall conclusion to the book by considering in particular how the topics discussed can drive further research and development for the maritime logistics area.

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Maritime transport and logistics as a trade facilitator

02

ALBERT W VEENSTRA

Introduction

In the last decade, international trade agreements and regional trade integration initiatives have significantly reduced the tariff-based barriers to trade. Substantial barriers to trade remain, however. These remaining barriers are often termed 'non-tariff barriers'. In many bilateral and multilateral negotiations, attempts are also made to reduce these barriers, but this turns out to be much more difficult than reducing import and other tariffs. The reason for this is that a number of these so-called non-tariff barriers are closely related to, or caused by, the main conduit of international trade, namely logistics and international transportation, and the non-fiscal government supervision in the international movement of goods.

Ocean transportation has always been connected with trade. This relationship goes back hundreds, perhaps thousands, of years. During the period of the great explorations of the world, trading and transport was always one operation. This practice continues, with the large trading houses in the world – Glencore, Cargill, Vitol, Trafigura, ADM, Noble Group, Louis Dreyfus, Bunge and some lesser known (but not smaller) companies such as Koch, Gunvar, Mercuria, Wilmar International, Arcadia, Mabanaft – controlling a large part of the world bulk fleet, mainly through long-term and short-term charter contracts.

In the mid-19th century, however, ocean shipping also became a business activity on its own. The advent of the steam engine brought reliability and predictability far beyond what sailing vessels could offer. This separation of shipping and trade, however, brought a host of new challenges. One that is still debated to this day is the exemption of cartel legislation for liner shipping that originates from the beginning of the 20th century. In Europe and the USA, these exemptions have only recently been abolished.[1]

Another topic that has been hotly debated among maritime economists is the way in which shipping and ports facilitate trade. Perhaps the biggest supporter of this idea was United Nations Conference for Trade and Development (UNCTAD). This United Nations initiative started in 1964 with the ambition to change global trade by providing the poorer countries with an independent role in trade and in transportation (Taylor and Smith, 2007). Its golden years were the 1960s and 1970s, when, among others, the Code of Conduct for Liner Conferences saw the light (see, for instance, Neff, 1980 or Sturmey, 1986). This Code of Conduct was a typical instrument to (re-)forge the link between trade and transport: one of the provisions said that transport companies from two trading countries should be allowed to carry equal parts of the trade and leave a limited trade volume to be carried by third parties. This idea later became known as the 40/40/20 rule. The implied result of this rule was that any trading country should thus form its own transport capacity, in order to carry the allotted 40 per cent of its own trade.

Trade facilitation has developed from a narrow idea about the possibility to move goods between countries through ports to a much more extensive concept, encompassing the general trade environment in countries and between countries (Wilson *et al*, 2005). As a result, it is no longer the simple opportunity of moving goods that defines trade facilitation, but also the ease with which this can be done.

This chapter addresses the relationship between ocean shipping and trade, by examining to what extent shipping nowadays still is a facilitator to trade. For this purpose, we first briefly introduce the trade facilitation school of thought in shipping and port management. We then describe in some detail the mechanism of international trade, as well as the specific role of shipping within this mechanism. We aim to connect this to the ongoing work on non-tariff barriers, both theoretical and empirical, that has taken flight in recent years. We finish with some concluding remarks and an outlook on further research.

Ports and shipping as facilitators of trade

Theoretical considerations on the relationship between trade and shipping in maritime economics go back to Koopmans (1939), who observed that without the analysis of seaborne trade, the analysis of shipping markets cannot succeed. He also introduces the notion that seaborne trade is inelastic to prices in shipping. Tinbergen (1959) proposed the idea that demands for shipping could be measured by the actual tonnage carried by ships. Their perspective was mainly to find sources for cyclicality in shipping. Trade was such a source, although shipping also creates its own cyclicality (see Zannetos (1966) for an early source on this).

In later studies and publications, the relationship between trade and transportation was developed more, and the element of transport costs was introduced as a variable in classic trade models. The classic approach to model global bilateral trade patterns is a gravity model (for a formal derivation of the gravity equations, see Anderson, 1995). Such a model normally relates bilateral trade flows to national income, population and distance. Distance is often taken to represent transport costs, although this is certainly not a one-to-one correspondence.

Various authors have tried to estimate more elaborate (maritime) transport cost functions, in order to gain a better understanding to what extent high transport costs are a determinant of (ie a barrier to) trade. Clark *et al* (2004) estimate a maritime transport function that includes determinants for distance, product specific requirements (including value), directional imbalance, total trade volume on a route (to represent increasing returns to scale), technological innovation, anti-competitive practices, and the quality of port and cargo handling infrastructure. They find that seaport efficiency is an important determinant for transport costs. From their analysis, they also conclude that transport costs are potentially a barrier to trade, and need to be considered by policy makers. Arvis *et al* (2013) also analyse trade costs, which they derive as an implication of the pattern of bilateral international trade.

The point that ports play an important role in facilitating trade has been made for years. For example, Haralambides and Veenstra (1996) analyse the interaction between ports and the development of trade. They observe that countries' ambitions to follow an export-led growth strategy has resulted in government retrenchment from ports, and port reform, with both negative and positive consequences. On the one hand, ports have become more efficient, largely due to the involvement of international operators, while on the other hand, liberalization in many countries has resulted in large redundancy programmes for port workers. The authors argue that the efficiency of port operations is not the only relevant indicator, but the entire economic context of a port should be considered: the competitive environment, access infrastructure by land, and the way in which a government or port authority attempts to recoup some of the port reform costs (for the redundancy of port workers, among others) from other parties.

Wilson *et al* (2003) put port efficiency in a broader framework of four indicators for trade facilitation:

- port efficiency;
- customs environment;
- regulatory environment;
- service sector infrastructure.

Port efficiency is a measure for the quality of transport infrastructure. Customs environment measures direct customs-related costs and transparency of customs as well. Regulatory environment measures a country's approach to regulation and the service sector infrastructure measures the level of national business service levels.

Much of this conceptualization of trade facilitation is very location- or country-based. The modelling of trade flows with gravity models is also rather one-sided in the sense that flows are explained by variables representing exporting and importing countries individually (for a classic source, see Anderson, 1979). The only variable that represents relationships between countries is usually transport cost, for which distance or the CIF/FOB price ratio are used as proxies (Carrère, 2002). As a result, the trade facilitation contribution of the link between any pair of export and import countries is not made explicitly in much of the trade economics literature.

An exception is the work of Hummels *et al* (2009) who investigate the trade diminishing effect of the market power of shipping companies. Their work confirms the difference in the way shipping lines treat developing and developed countries in terms of transport prices. In other words, shipping lines present themselves differently in different parts of the world, depending on product value, high import and export tariffs and lack of competition on a trade route. Carrying this line of thinking further, it could be that some of the unfavourable treatment of developing countries by shipping lines carries over to the developed countries. There is a case where this mechanism seems to be at work: the import of fresh fruit from South America to Europe, via the Port of Rotterdam. This is a classic CIF trade, where the exporters book the transport. Shipping lines apparently invest very little in their local liner agents in South America, which results in a lot of physical paperwork. The paperwork is then sent to the receiving parties in Europe, who cannot benefit from the higher level of digitization that shipping lines usually offer in Europe.[2] This leads to the transfer of some of the inefficiencies on one side of a trade lane to the other side of the trade lane.

In the next section, we will explore in some more detail how transportation by means of ships also brings complexities to international trade that could be interpreted as trade barriers.

The practice of international shipping

International trade is made up of commercial transactions between buyers and sellers. These can be complete strangers to each other, or part of the same enterprise. For the commercial transaction this does not make much difference, since in many cases, even sister companies need to trade with each other as if they are separate companies. This is called arm's-length trading, and it has primarily a fiscal background: tax authorities in both import and export countries demand a transaction in which the value of the product is established in a market setting.

The commercial transaction determines the specification of the goods, the price and the number of goods. The transaction usually also contains an arrangement of who takes responsibility of the shipment of the goods. For this purpose, the International Chamber of Commerce has established some standard trade terms that divide the responsibilities of transportation, ownership and insurance among buyer and seller. These trade terms are called Incoterms. Currently there are 11 Incoterms, which range from the one extreme of the seller taking care of everything (delivery duty paid) to the other extreme of the buyer taking care of everything (ex-works). Important intermediate points where transfers of responsibility can take place are the ocean ports in an international transport chain.

A second important issue in international trade transactions is the relationship between delivery and payment. In an international context, where parties may not know and trust each other, payment and delivery has to take place more or less at the same time. The international transport operator plays an important role in this mechanism. The way this works is that the ocean transport operator can declare that goods were taken on board of the ship, by signing a so-called bill of lading (B/L). This is proof that transportation is taking place, and that payment can be transferred. A copy of the B/L is therefore shared with the bank of the seller, who sends it to the bank of the buyer, who then transfers payment on behalf of the buyer. As a result of this mechanism, the B/L is also a document of title that gives the holder rights to the cargo. This greatly facilitates trading of goods that are in transit.

In cases where the buyer and seller are part of the same enterprise, this process can be simplified. In those cases, a simplified version of the B/L is used – the so-called Seaway Bill – which is basically the same as a B/L, except it is not a document of title.

For container shipping, which is the most relevant part of shipping for the purpose of this chapter, some further issues need to be considered. For a large part, these issues are related to the container.

First of all, the container shipping line generally owns the containers in which goods are shipped, and needs to provide these containers to the shippers who want to ship cargo. This mechanism is fraught with problems. The containers need to be available for the shipper. A shipper does not want to wait too long, and wants a container that is suitable for its needs. There are different types of containers: 20-foot containers, 40-foot containers, 40-foot high cube containers, 45-foot containers, open-top containers, flat beds, foldable containers, refrigerated containers. All these containers conform to the ISO 668 2013 (revised) standard. In addition, commercially, containers may have a five-step scale of cleanliness. The highest level, so-called food grade containers, is the only level that is acceptable for the transportation of food products.

Second, customs authorities consider containers to be packing material that requires, in many countries, some type of temporary import licence. This licence may restrict the time the empty containers can stay in a country. If the container stay too long, VAT and other levies may become payable.

Third, after delivering a container to a destination country, the shipping line would like to return a container as quickly as possible to a paying customer. For this purpose, the shipping lines all charge fees if the receiver of goods takes too long to pick up the full container, or deliver the empty container back. The first fee is called demurrage (not to be confused with demurrage in bulk shipping), and the second fee is called detention. These two fees are in the range of a few euros per day to as much as 75 euros per day, chargeable after a so-called free period of several days. Of course, the fees and free days are negotiable, so no shipping line's customer will pay the same as another customer. How the demurrage and detention fees are established will depend on the party who books the transport, and their negotiating power. For transport, this can be either the buyer or the seller.

Because of the need to keep track of containers in countries, formal obligations to report unloaded containers to customs authorities in the destination countries, and the need to only provide the goods in the container to the rightful owner, the shipping line maintains an administrative process in ports in which some fees need to be paid, information for the party who will pick up the container is exchanged, and the empty depot in which the container needs to be returned is recorded. In many ports, this exchange between the agent of the shipping line and the representative of the buyer of the goods is a cumbersome process that takes time and effort. Only when this process is completed can a transport be booked to pick the container up in the port. Often this process cannot take place or be completed until the container is physically unloaded. The buyer's agent needs to track a terminal's website to find the unloading confirmation of the container, and then verify all relevant information, take care of payments, and book transport. The degree to which this process is supported with IT – usually a port community system – differs strongly from port to port and from shipping line to shipping line. RSM (2010) has estimated that in Rotterdam, the cost related to these processes can range between 5–25 euros per container. For a customs or freight forwarding agent, who gets 35–50 euros for the administrative handling of a container, this is a substantial cost driver. This is the fourth issue.

A fifth issue is the overall performance of international container lines. Vernimmen *et al* (2007) have reported on the impact of delays of ocean carriers on logistics variables such as safety stock. Their figures, together with the more recent analysis of Chung and Chiang (2011), result in an average delay for shipping lines of 1.5 days. This delay translates into higher safety stock levels, which are an additional cost for business. Obviously, there are differences between shipping lines, and therefore, the countries that are served by shipping lines with relatively more delays are at a disadvantage compared to countries that are primarily served by carriers with fewer delays.

A sixth issue is that customs authorities tend to use ship manifest data for their initial risk assessment. Countries differ in the time at which they require this information to be submitted. The United States and Europe require this type of data to be submitted before departure from the origin country, and in Europe more or less the same data needs to be submitted again a few days before arrival in the port of destination. Other countries receive this data shortly before arrival of the ship, or use it to verify imports and exports after loading and unloading has taken place. This formal obligation means that shipping lines and their agents have had to set up a process to gather this data at the right time from their clients or the clients' agents. To indicate that this imposes costs on the logistics chain, shipping lines charge US$ 25 for submitting pre-departure declarations to European customs authorities in destination countries for every container. Another potential bottleneck is the different ways in which shipping companies facilitate their agents in different countries. In some countries, the information exchange between customers' agents and the shipping lines' agents is fully digitized, while in some countries, the information exchange is still with paper documents. The latter is not only a problem for that country, but also for all the other countries to which the ships are sailing to unload cargo. All errors and other problems related to paper-based information exchange are transferred to these destination countries as well.

A final point deals with the pricing structure of container shipping. The complicated tariff structure of container shipping is well documented in the maritime economics literature. It is well known that, apart from a base transport tariff, shipping companies may charge a bunker adjustment factor (BAF), a currency adjustment factor (CAF), port congestion charges, piracy risk charges, terminal handling charges, war risks, security surcharges, winter surcharges, dangerous goods and refrigeration surcharges, and document fees. Cariou and Wolff (2006) looked into the BAFs and the underlying bunker price developments, and found that these charges do not accurately reflect the underlying cost development. In other words, some of these surcharges are used to raise the price for transport. These surcharges can easily raise the total transport bill by 50 per cent or more, and they make the transport cost for ocean shipping complex and difficult to interpret. The chosen Incoterms determine which party books ocean transport. This can also have an effect on the height of certain charges, as well as the basic transport tariff.

In summary, current shipping line operations result in time delay and costs for logistics chains, either due to administrative processes, formalities the shipping line has to carry out, or enforcement measures to increase the circulation of containers. Hummels and Schaur (2012) estimate the impact of time delays on trade, and find that each day's delay reduces the probability of trade by 1–1.5 per cent. Time delay really is a trade barrier, and ocean shipping, which causes structural delays, can be seen as the cause of this.

In addition, other complexities of container shipping may also cause a barrier to trade. This is confirmed by Nordas *et al* (2006), whose analysis builds on Hummel's work, and includes logistics services. In their analysis, poor logistics services also translate into time delays, which have a negative effect on trade.

Some of the issues mentioned above exhibit a 'transfer effect'. This is the case for the quality of information in the shipping documents, and, under specific conditions, for demurrage and detention. For the former, the provision of information by the seller or his/her agent to the shipping line may be so poor that the buyer will run risks of additional customs inspection, delays and addition costs. For the latter, the condition is that the seller books transport under the chosen Incoterms. This is common practice, for instance, in the trade of fresh fruit originating from the southern hemisphere. In these cases, the seller may choose to limit demurrage and detention free time in the port of destination, since this is costly for him. The buyer will then be very limited in his or her options to transport containers out of the port, or run a high risk of incurring demurrage or detention fees.

To investigate to what extent this type of thinking has been recognized in current efforts to measure non-tariff barriers to trade, in the next section we look in some detail at these measurement efforts.

International trade research and non-tariff barriers

Definition of non-tariff barriers

Through the initiatives of the Global Agreement on Trade and Transport (GATT) and the World Trade Organization (WTO) negotiation rounds, trade tariffs, ie the duties paid on imported or exported goods, have generally decreased worldwide. (For more details, see the historical overview of trade policy measures in the World Trade Report (WTO, 2013).)

As a result, the attention of WTO and other trade policy bodies has shifted to non-tariff barriers. Defined narrowly, these are all trade barriers that are not tariffs (Deardorff and Stern, 1997). However, almost always what is meant is that the non-tariff barriers are actively engineered by policy-makers. This means that non-tariff barriers that are studied by academics and trade policy analysis can always be traced back to some policy goal of one or a group of countries.

Carrère and de Melo (2011) provide a useful classification of non-tariff barriers that refers to the UNCTAD 2006 classification of non-tariff barriers. We have reproduced their list in Table 2.1. (See also UNCTAD (2013) for a more detailed list.)

Observe that pre-shipment inspection and other formalities are listed as a non-tariff barrier. The pre-shipment declaration to customs in Europe (and the US) – the so-called entry summary declaration or ENS – could therefore be characterized as a non-tariff barrier. Since this is a policy driver, this really is a non-tariff trade barrier.

Some of the fees charged by shipping lines, as well as the limitations put on containers (demurrage and detention) could fall under the headings 'distribution restrictions', if they were part of some country's policy. But since they are measures put forward by business, these restrictions are usually not considered to be non-tariff barriers.

TABLE 2.1 Classification of non-tariff barriers

Import measures	Technical measures	Sanitary and phytosanitary measures Technical barriers to trade
	Non-technical measures	Pre-shipment inspection and other formalities Price-control measures Licences, quotas, prohibition and other quantity-control measures Charges, taxes and other para-tariff measures Finance measures Anti-competitive measures Trade-related investment measures Distribution restrictions Restrictions on post-sales services Subsidies Government procurement restrictions Intellectual property Rules of origin
Export measures		Export-related measures (including export subsidies)

SOURCE Carrère and de Melo (2011)

To broaden our understanding of the way in which shipping-related restrictions are considered as non-tariff barriers, in the next section we will describe some of the recent efforts to measure trade and business barriers on a global scale.

Global trade barrier measurement

In this section, we will describe several global efforts to measure barriers to trade, or to doing business internationally. We will concentrate on the following three measurement efforts:

- World Bank: Logistics Performance Index;[3]
- World Bank and International Finance Corporation: Global Doing Business report;[4]
- World Economic Forum: Enabling Trade Report.[5]

Logistics Performance Index (LPI)

The LPI was developed around 2005–2006, and aims to measure the performance on trade logistics of all countries in the world. It is compiled on the basis of freight forwarder and express carrier surveys, supplemented by quantitative data on measurable aspects of logistics performance. It was compiled for the years 2007, 2010, 2012 and 2014.

The LPI consists of six components (LPI, 2014):

- the efficiency of customs and border clearance;
- the quality of trade and transport infrastructure;
- the competence and quality of logistics services;
- the ease of arranging competitively priced shipments;
- the ability to track and trace consignments;
- the frequency with which shipments reach consignees within scheduled or expected delivery times.

In 2014, the LPI was published for 160 countries. In Table 2.2 we provide a summary of the top five and bottom five countries for 2014.

Note that the first three items could be seen as inputs for logistics performance (customs, infrastructure, competence), and the last three (shipments, tracking, timeliness) as output, effectively measuring time, cost and reliability. The first three items are subject to policy-making.

The six components of the LPI are based purely on perception of respondents. The LPI also has a 'national' variant, where countries can evaluate themselves, which is based on targeted questions for each of the six components. For instance, quality of trade and transport infrastructure distinguishes between ports, airports, roads, rail, warehousing and telecommunication infrastructure, as well as quality of transport services for various modes and logistics activity types. The outcomes of the national and the general LPI are not compared for consistency.

While the analysis of the LPI is very country-oriented, the detailed data per country do, in principle, allow a bilateral generalized distance analysis on items that might provide some further insight in the way maritime transport contributes to logistics performance, eg quality of port infrastructure, quality of maritime transport, maritime transhipment delay on some major trade lanes. Such a generalized distance measure could also be used to represent the transfer effect of ocean shipping, in the sense that a bigger gap may result in a larger transfer effect.

Global Doing Business report (GDB)

The GDB report (GDB, 2014) focuses on benchmarking regulation that affect private sector firms. Eleven areas of business regulation are reviewed for 189 countries. These 11 areas are: 1) starting a business; 2) dealing with construction permits; 3) getting electricity; 4) registering property; 5) getting credit; 6) protecting investors; 7) paying taxes; 8) trading across borders; 9) enforcing contracts; 10) resolving insolvency; and 11) employing workers. Based on these 11 areas, an overall ranking of countries is also constructed. The GDB report has been published 11 times between 2004 and 2014.

TABLE 2.2 Summary of LPI top and bottom five countries

Country	LPI overall	Rank					
		Customs	Infrastructure	Competence	Shipments	Tracking	Timeliness
Germany	4.12	2	1	3	4	1	4
Netherlands	4.05	4	3	2	11	6	6
Belgium	4.04	11	8	4	2	4	2
United Kingdom	4.01	5	6	5	12	5	7
Singapore	4.00	3	2	8	6	11	9
Eritrea	2.08	153	159	136	157	153	122
Congo, Rep.	2.08	160	157	146	148	147	142
Afghanistan	2.07	137	158	152	156	159	149
Congo, Dem. Rep	1.88	158	156	158	160	151	159
Somalia	1.77	147	160	160	159	160	160

SOURCE LPI (2014)

TABLE 2.3 GDP top five summary

Country	Overall GDB rank	Trading across borders rank
Singapore	1	1
Hong Kong SAR	2	2
New Zealand	3	21
United States	4	22
Denmark	5	8

SOURCE GDB (2014)

For this chapter, the section on 'trading across borders' is the most relevant. This area is characterized by the following items:

- number of documents for export;
- time to export in days;
- cost to export in US$ per container;
- number of documents to import;
- time to import in days;
- cost to import in US$ per container.

In Table 2.3 we summarize the overall value and the score on the trading across borders category for the top five countries in the GDB index.

The focus of the GDB is very much on regulation. Within the trading across borders category of the index (right-hand column of Table 2.3), there is therefore a lot of attention on the customs-related impact on documents, time and costs. This is not exclusively so, however. The time component of the index also contains port and terminal handling and inland transport and handling time, while the cost component contains costs related to port and terminal handling and inland transport and handling. However, there is no way to differentiate between customs-related documents, time and costs, and transport-related documents, time and costs

Similar to the LPI, based on the trading across border indicators, a generalized distance measure could be obtained for combinations of countries, but this measure would represent a combination of customs- and transport-related items.

Enabling Trade report

The Enabling Trade (ET) report studies supply chain-related barriers to international trade (ET, 2014). The ET Index is based on four sub-indices, and seven pillars. These are:

1. Sub-index A: Market access
   - Pillar 1: Domestic market access
   - Pillar 2: Foreign market access
2. Sub-index B: Border administration
   - Pillar 3: Efficiency and transparency of border administration
3. Sub-index C: Infrastructure
   - Pillar 4: Availability and quality of transport infrastructure
   - Pillar 5: Availability and quality of transport services
   - Pillar 6: Availability and use of ICT
4. Sub-index D: Operating environment
   - Pillar 7: Operating environment

Market access basically measures a country's tariff regime. Border administration reflects quality and efficiency of the customs and other supervision processes in a country. Infrastructure assesses the availability and quality of transport infrastructure, services and IT. Operating environment measures institutional factors that impact import and export.

Within these pillars, data on 56 indicators are gathered from proprietary datasets at the World Bank, WTO, UNCTAD, International Trade Centre and various other partners in the project. Some of these indicators, 23 in total, originate from the World Economic Forum Executive Opinion Survey, which gathers 13,000 responses from 148 countries. Apart from the ET Index, these data are also used to compute the Global Competitiveness Index, the Networked Readiness Index and several other indices.

A summary of the ET Index and its sub-indices is provided in Table 2.4.

The ET report, under the title *The Road Ahead*, explicitly addresses the measurement of non-tariff barriers, which it considers inadequate. There is ongoing research by the International Trade Centre to collect data on non-tariff barriers, both for cross-border measures and for behind-the-border measures.

Another interesting area for further research, according to the authors of the ET report, is that the infrastructure sub-index should be strengthened with connectivity indicators that might replace simple indicators such as available transport capacity. For international ocean transport such indicators already exist – the UNCTAD Liner Shipping Connectivity Index and the Transhipment Connectivity Index – which are included in the ET Index. For air transport such an index is still being developed, while for domestic connectivity, no index exists yet.

The UNCTAD Liner Shipping Connectivity Index (see www.unctad.org) is derived from characteristics of the maritime transport link for specific pairs of countries: the number of ships visiting that country, the total container carrying capacity of those ships, the maximum vessel size, the number

TABLE 2.4 Summary of the Enabling Trade (ET) Index

Country	ET Index	Rank			
		Market access	Border administration	Infrastructure	Operating environment
Singapore	5.9	2	1	1	2
Hong Kong SAR	5.5	37	11	2	1
Netherlands	5.3	75	4	3	8
New Zealand	5.2	22	6	25	7
Finland	5.2	75	2	14	3
United Kingdom	5.2	75	7	4	11
Switzerland	5.2	71	12	11	5
Chile	5.1	1	26	44	25
Sweden	5.1	75	3	17	9
Germany	5.1	75	13	6	12

SOURCE ET (2014)

of services and the number of companies offering these services. The data is available per country, but also for all country pairs.

To further illustrate that there is a relationship between some of the transport-related indicators and trade, we present some results from Arvis *et al* (2013). They derive a measure of trade costs from bilateral trade patterns, and then test the impact of various determinants from the global trade barrier measurement efforts and other sources on these trade costs. Their analysis includes: the cost of starting a business (GDB), the LPI overall index, the air and liner shipping connectivity indices, exchange rates, regional trade agreement membership, tariffs, same country, common border, common colonizer, common language (official and ethnographic), common border and distance. They find that distance, tariffs and the costs of doing business impact trade costs positively (in other words, they increase trade costs), while all other measures decrease trade costs. This is clear evidence for the development of further measures that help identify barriers to trade.

Summary and conclusion

In this chapter, we have repositioned shipping in the debate on trade facilitation. Shipping and ports facilitate trade, but researchers are recognizing more and more that transport or trade costs are an important factor in explaining bilateral trade patterns and that factors that impact these trade costs negatively can be considered a barrier to trade.

We then provided an overview of some of the operational bottlenecks caused by or associated with container shipping: demurrage and detention, pre-shipment declarations to customs, the operations and formalities related to the container, the structural delay of container ships, the complicated tariff structure of container transport and the low quality of data on shipping documents. These items translate into costs and time loss, which translate directly as barriers to trade. In addition, since shipping connects countries, we also argued that the way a pair of countries differ on specific variables may be a determinant for the level of trade costs and the level of trade between those countries. We have argued that through these items, current ocean shipping operations are also a barrier to trade.

We have discussed a general classification of non-tariff barriers to trade, and various global attempts to measure non-tariff trade barriers. Most of these efforts are based on collecting information for individual countries. These efforts do provide good basic data to develop measures that represent gaps between countries, such as the LPI. These gap measures could be used to explain the quality of transport links, that could be measures, for instance by the data underlying the UNCTAD Liner Shipping Connectivity Index. As far as we know, such an analysis has not been conducted.

Thinking in terms of relationships between countries, the Enabling Trade Index seems to be ahead of the other two efforts considered here. It contains elements that represent transport connectivity, which are based on measures of transport capacity and transport service level on routes between countries. However, the index and the data of the ET Index are still represented at an individual country level.

The global measurement efforts (LPI, GDB, ET) do not reflect barriers to trade related to container shipping. All these indices concentrate on collecting information at country level, and not on the country-to-country relationship. There are two positive points, however. The first is that with the consistent measurement of trade barriers and the indexing of countries, gap measures for pairs of countries can be constructed more easily. Second, the ET Index contains elements from the UNCTAD Liner Shipping Connectivity Index, which is an effort to include information on bilateral transport relationships between countries. This index, however, still concentrates on transport capacity and connectivity, and not on operational bottlenecks that we have identified.

We leave for further research the incorporation of bottlenecks related to container shipping operations into formal trade barrier measurement efforts such as the ET Index. An extension of the UNCTAD Liner Shipping Connectivity Index seems to provide a good basis for this. We also suggest the development of gap measures for pairs of countries based on the LPI, GDB or ET, and the use of these gap measures as determinants for trade patterns or trade costs. In particular, gap measures based on some of the detailed transport-related elements of the LPI should shed some light on the way the quality of transportation between countries plays a role in explaining trade patterns or trade costs between those countries.

Notes

1 The Transatlantic Rate Fixing Agreement (TAA) was abolished in 1994, its follow-up, the Transatlantic Conference Agreement (TACA), was eventually terminated in 2003, and in 2006, the block exemption for liner conferences was repealed altogether. In the USA, the Ocean Shipping Reform Act of 1998 also effectively abolished conferences, even though it still allowed rate discussion agreements between liner companies.

2 Private communication with a representative of the industry association of fruit importers in the Netherlands, Frugi Venta.

3 http://lpi.worldbank.org/ [accessed 6 July 2014].

4 http://www.doingbusiness.org/ [accessed 6 July 2014].

5 http://www.weforum.org/reports/enabling-trade-valuing-growth-opportunities [accessed 6 July 2014].

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International maritime trade and logistics

03

FUNDA YERCAN AND TURKAY YILDIZ

Introduction

The concept of logistics has been used in business for more than two decades. Logistics management, as an earlier and limited version of supply chain management until the beginning of the 2000s, covers the physical process of planning, organizing and controlling the flow of materials and services from the supplier's point to the customer's as the end point. In addition to these aspects, the concept of supply chain management also includes customer satisfaction, customer relations, financial flow and information flow by making logistics functions a more integrated and complex group of activities. Therefore, logistics support and the interaction of logistics and supply chain management with local and global trade cannot be disregarded. Indeed, as approximately 85 per cent of international trade is carried out by maritime transport (eg ocean transport, seaways and inland waterways), the role of maritime transport is considered to be crucial for global trading.

This chapter of the book focuses on developments in international maritime transport by emphasizing developments in global trade. The first section of this chapter broadly discusses logistics and its interaction with international trade. This section provides the general characteristics of logistics and its interrelations with various business areas. The second section builds a background to the interaction between logistics and the transport industry in the global economy. The third section then discusses more in-depth developments in the global economy and the maritime transport industry in relation to international trade.

The objectives of this chapter are to:

- describe logistics;
- identify and address global economic growth and integrate it with maritime trade;

- bring forward global trade volumes;
- position international and maritime trade within logistics;
- identify the developments in international maritime trade within international trade;
- enhance the contribution of commodity sectors in order to develop the effectiveness of developed and developing countries as well as transition economies; and
- review international maritime trade networks.

In order to achieve the above-specified objectives, the methodology in this chapter includes a conceptual description of the interrelation of international and maritime trade within global logistics services, using world economic data and a review of developments in the global economy, of international maritime transport by cargo type and of liner shipping connectivity data. The overarching purpose is to explicate the background to international competitiveness in maritime trade routes and cargo types between countries in maritime networks.

Logistics and supply chain management

This section of the chapter provides a general background to logistics and supply chain management. The characteristics and functions in logistics are reviewed and described in order to emphasize its interrelation with international trade.

The crucial importance of logistics and supply chain management has been highlighted by businesses focusing on the needs and wants of customers, owing to the competition stemming from globalization, specialization and developments in information communication and technology at the beginning of the 2000s. Therefore, in addition to these concepts, functions and stages, concepts of information flow, financial flow and customer relations and functions have also been covered within the supply chain management concept (Croom *et al*, 2000; Bowersox *et al*, 2007).

Supply chain management is a chain management process as long as its links stay connected. Although the strength of each link is sufficient to hold another, the strength of the whole chain depends on the connectivity between all the links. Similarly, suppliers, including their suppliers, manufacturers, wholesalers, retailers, transporters, distributors and consumers, rely on one another to supply and consume goods and services. Therefore, each link is linked heavily to another in the chain.

Logistics and supply chain management are integrated among various business functions and progresses, with the aim of minimizing costs, maximizing benefits and profit and thus generating customer satisfaction (Burt *et al*, 2003). The links within this chain focus on management, planning, the supply of raw materials and/or semi-finished goods, production planning, the processing of raw materials and/or semi-finished goods, manufacturing, packaging, storing, warehousing, inventory management, distribution, transportation, wholesaling, retailing, marketing, selling and reaching customers as the final consumers (Bowersox *et al*, 2002). Hence, logistics and supply chain management not only coordinate the activities of finished goods, they also facilitate communications, information technology, humanities and social sciences.

In parallel to developments in international trade, logistics and supply chain management can rapidly transform and develop businesses. Each link within logistics activities and supply chains must be integrated in order to meet the globalization challenge as well as exploit the market conditions domestically and internationally. Based on the foregoing, the next section reviews the role of the transport industry in international trade and global logistics services.

Logistics and transport

This section first describes logistics and then summarizes the challenges in the transport industry within logistics services against the background of a volatile global economy.

Global production, transport, distribution and logistics all require the setting of appropriate freight management strategies. Logistics concerns all the activities required for goods to be made available to markets, principally purchase, order processing, inventory management and transport (Rodrigue and Browne, 2007). It is taking an increasingly important role in the global economy by supporting a wide variety of commodity chains (Hesse and Rodrigue, 2004). Transport and logistics activities have always been essential since firms started to know and use them. The movement, storage, handling and delivery of goods from one point to another occur until they reach the final user. Transport is more than cars, trains, ferries, vessels, aeroplanes and other vehicles. Each raw material needs to be moved until it becomes a semi-finished product and all physical products need to be moved to the points where they are consumed. Transport, which plays a vital role in logistics and supply chain management activities, also has a crucial place within international trade, which relies on the movement of goods from one point to another.

Recently, growing demand for transport and trade has led to globalization and the development of the global economy, which has directly affected transport and trade facilitation. The period of the late 2000s, and 2008 in particular, was a milestone for the global economy. The global financial crisis ended a period of unprecedented growth in both trade and market demand, and its subsequent effects on the transport and maritime industries have been severe. All actors involved in the maritime industry, shipping, ports and intermodal transport have been forced to reshape their business development models to prepare for the future.

However, these difficulties have been accompanied by considerable opportunities to develop corrective actions that address pre-existing misallocations. The main players in the transport and maritime industries now consider it to be the time to review established practices, streamline prevailing theories and integrate shipping and ports into intermodal transport systems. The next section reviews and analyses global trade, especially in the maritime industry.

Global trade and the maritime industry

This section discusses in depth the developments in the global economy and in global trade together with the significance of maritime transport and its interrelations. In this regard, various data on global trade and international maritime trade are presented and reviewed.

After the global financial crisis in late 2008, 2009 witnessed the worst global recession in over seven decades since World War II. Global GDP shrank by 2.2 per cent, with an approximately 13 per cent decline in the total volume of global trade in 2009 and only a 1.8 per cent increase in global economic output between 2007 and 2010 (see Tables 3.1 and 3.2; UNCTAD, 2010, 2013). During these crisis years, the trade patterns in both developed and developing countries altered. In parallel, the import and export volumes of developed economies remained below their pre-crisis levels. On the other hand, imports and exports from emerging market economies were 26 and 22 per cent respectively above their pre-crisis levels.

The global economy continues to struggle to return to a strong position. World output growth was just 2.2 per cent in 2012, and this remained approximately the same in 2013, with 3 per cent expected in 2014 (UNCTAD, 2013). Moreover, the total volume of merchandise exports dropped seven times more rapidly than global GDP. These changes were related to globalized production processes and the increased trade in parts and components, the deepening and widening of global supply chains, the product composition of the fall in demand for consumer goods and durables and limited trade finance. Rapid declines in trade volumes also resulted from the trade in goods dropping faster than that in services. Further, weak consumer confidence depressed the retail industry, while the low level of capital investments and slowdowns in the real estate and housing sectors continued in advanced economies.

A global recovery took place by early 2010, with an expansion of 4.1 per cent in GDP and a growth of 9.5 per cent in the total volume of trade based on World Trade Organization estimates of 180 economies around the world. The annual increase in exports from developed economies was about 13 per cent in volume terms in 2010, while the annual increase in shipments from developing economies, Asian countries (14.7 per cent) and China (29.1 per cent) in particular, rose by 16 per cent as the world started to emerge

TABLE 3.1 Global economic growth 2005–2014 (annual percentage change)

Region/Country	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
World	**3.5**	**4.1**	**4.0**	**1.5**	**–2.2**	**4.1**	**2.8**	**2.2**	**2.1**
Developed countries	**2.4**	**2.8**	**2.6**	**0.0**	**–3.8**	**2.6**	**1.5**	**1.2**	**1.0**
of which:									
Japan	1.3	1.7	2.2	–1.0	–5.5	4.7	–0.6	1.9	1.9
United States	3.1	2.7	1.9	–0.3	–3.1	2.4	1.8	2.2	1.7
European Union (EU-27)	2.1	3.3	3.2	0.3	–4.3	2.1	1.6	–0.3	–0.2
of which:									
Euro area	1.7	3.3	3.0	0.4	–4.4	2.0	1.5	–0.6	–0.7
France	1.8	2.5	2.3	–0.1	–3.1	1.7	2.0	0.0	–0.2
Germany	0.7	3.7	3.3	1.1	–5.1	4.2	3.0	0.7	0.3
Italy	0.9	2.2	1.7	–1.2	–5.5	1.7	0.4	–2.4	–1.8
United Kingdom	2.8	2.6	3.6	–1.0	–4.0	1.8	0.9	0.2	1.1
South-east Europe and CIS	**6.5**	**8.3**	**8.6**	**5.2**	**–6.6**	**4.5**	**4.5**	**3.0**	**2.7**
South-east Europe	4.7	4.8	5.5	3.7	–4.3	0.0	1.1	–1.4	0.3
CIS	6.7	8.7	8.9	5.3	–6.8	4.9	4.8	3.4	2.9
of which:									
Russian Federation	6.4	8.2	8.5	5.2	–7.8	4.5	4.3	3.4	2.5
Developing countries	**6.8**	**7.6**	**7.9**	**5.3**	**2.4**	**7.9**	**5.9**	**4.6**	**4.7**
Africa	5.8	5.9	6.2	5.2	2.8	4.9	1.0	5.4	4.0
North Africa, excl. Sudan	5.1	5.4	4.7	4.6	3.2	4.1	–6.1	7.8	3.6

(Continued)

TABLE 3.1 Global economic growth 2005–2014 (annual percentage change) (*Continued*)

Region/Country	2005	2006	2007	2008	2009	2010	2011	2012	2013[a]
Sub-Saharan Africa, excl. South Africa	6.7	6.5	7.7	6.6	4.9	6.4	4.8	5.3	5.4
South Africa	5.3	5.6	5.5	3.6	–1.5	3.1	3.5	2.5	1.7
Latin America and the Caribbean	4.5	5.6	5.6	4.0	–1.9	5.9	4.3	3.0	3.1
Caribbean	7.4	9.4	5.8	3.1	–0.1	2.6	2.4	2.5	2.7
Central America, excl. Mexico	4.8	6.4	7.0	4.1	–0.2	4.1	5.2	5.0	4.1
Mexico	3.2	5.2	3.3	1.2	–6.0	5.5	4.0	3.9	2.8
South America	5.0	5.5	6.6	5.5	–0.2	6.4	4.6	2.5	3.2
of which:									
Brazil	3.2	4.0	6.1	5.2	–0.3	7.5	2.7	0.9	2.5
Asia	7.8	8.6	9.0	5.8	3.9	8.9	7.1	5.0	5.2
East Asia	8.6	9.9	11.0	6.9	5.9	9.5	7.7	6.0	6.1
of which:									
China	11.3	12.7	14.2	9.6	9.2	10.4	9.3	7.8	7.6
South Asia	8.0	8.3	8.9	5.2	4.7	9.4	6.6	3.0	4.3
of which:									
India	9.0	9.4	10.1	6.2	5.0	11.2	7.7	3.8	5.2
South-east Asia	5.8	6.1	6.6	4.3	1.2	8.0	4.5	5.4	4.7
West Asia	6.8	7.0	4.6	3.8	–1.7	7.0	7.1	3.2	3.5
Oceania	3.4	2.9	3.5	2.7	2.3	3.6	4.3	4.1	2.7

SOURCE UN/DESA-Department of Economic and Social Affairs, 2013; UN, 2010, 2013; UNCTAD, 2010, 2013

NOTES

a. Partly estimated.

TABLE 3.2 Growth in the volume[a] of merchandise trade, by geographical region, 2007–2012 (annual percentage change)

Exports							Imports					
2007	2008	2009	2010	2011	2012	Countries/regions	2007	2008	2009	2010	2011	2012
5.8	3.0	–13.3	13.9	5.2	1.8	**WORLD**	6.6	2.2	–13.6	13.8	5.3	1.6
3.9	2.8	–15.5	13.0	4.9	0.4	**Developed countries**	3.7	0.0	–14.6	10.8	3.4	–0.5
						of which:						
6.8	4.9	–24.8	27.5	–0.6	–1.0	Japan	0.8	–0.9	–12.2	10.1	4.2	3.7
6.8	5.5	–14.0	15.4	7.2	4.1	United States	1.1	–3.7	–16.4	14.8	3.8	2.8
3.2	2.5	–14.9	11.6	5.5	–0.2	European Union (EU–27)	4.8	1.1	–14.5	9.6	2.8	–2.8
8.6	0.8	–14.4	11.3	4.2	1.0	**Transition economies**	26.1	16.0	–28.2	15.9	15.7	3.9
8.7	4.2	–9.7	16.0	6.0	3.6	**Developing countries**	10.6	5.3	–10.2	18.8	7.4	4.5
						of which:						
4.8	–2.8	–9.5	8.8	–8.3	5.7	Africa	11.2	11.6	–6.2	8.4	2.8	8.0
2.4	–0.6	–7.4	8.3	4.6	2.2	Latin America and the Caribbean	11.6	8.6	–17.9	22.5	10.8	2.5
15.0	7.3	–10.9	24.1	10.4	5.2	**East Asia**	10.2	0.6	–5.3	22.7	7.4	4.3
21.8	14.9	–14.1	29.1	13.0	7.2	*of which:* China	14.1	2.4	–1.1	25.4	10.3	5.9
6.3	10.7	–6.1	10.0	8.8	–10.2	**South Asia**	10.9	7.2	–5.5	14.0	6.0	2.0
15.2	2.1	–6.8	14.0	14.2	–2.5	*of which*: India	16.9	10.4	–0.9	13.8	9.1	5.8
6.9	7.4	–10.0	18.6	4.4	2.2	**South–east Asia**	6.7	8.0	–15.8	22.0	6.7	6.0
2.0		–4.8	5.7	6.5	6.9	**West Asia**	16.7	8.4	–14.2	8.4	8.1	5.8

SOURCE UNCTAD, 2013; UNCTAD, 2010

NOTE

a. Data on trade volumes are derived from international merchandise trade values deflated by UNCTAD unit value indices.

from recession. This recovery played a crucial role in the expansion of the total volume of global trade and improvements in the global economy.

However, the global recovery was slower than previous post-recession recoveries, and it was particularly challenged by the uncertainties, fragile economic conditions and political problems and transformations taking place in several Middle Eastern countries at the beginning of 2011. As a result, the annual increase in exports from developed economies dropped to 0.4 per cent in volume terms in 2012, while that from developing economies (Asian countries 1.5 per cent, China 7.2 per cent) was up 3.6 per cent (UNCTAD, 2013).

A growth in international trade positively affects the growth in international transport services – the second largest category of commercial services after the tourism sector – because of the movement and carriage of goods from suppliers and producers to customers as end-users. Maritime transport services are directly driven by global economic growth and the need to carry goods internationally, and thus they are subject to developments in the global economy. In other words, global economic growth directly influences international trade, which, in turn, directly affects transport services and therefore the world's seaborne trade volumes (as a measure of demand for shipping, port and logistics services). Maritime trade is the most commonly used transport mode in international trade, representing about 85 per cent of total transport volume. As demand for both maritime transport services and logistics services derives from global economic growth and the need to carry out international trade, the global shipping industry and maritime transport activities (notably seaborne trade) could not escape from the contractions in global GDP and international trade volumes in 2009.

In parallel with these economic declines and following the collapse in economic growth and international trade, the total volume of international seaborne trade shrank by 4.5 per cent in 2009. The total volume of goods loaded was only 7.8 billion tons in 2009 compared with 8.2 billion tons in 2008. Similar to merchandise trade, however, world trade in commercial services grew in 2012, and the total volume of goods loaded by using maritime transport services increased to 9.1 billion tons in 2012 (see Table 3.3). Developing countries continued to have the largest share of global seaborne trade with approximately 61 per cent of all goods loaded and 55 per cent of all goods unloaded, reflecting their increasingly leading role in driving global trade. The share of developed economies in global goods loaded and unloaded was 32 and 44 per cent respectively, while transition economies accounted for only 6.4 and 0.8 per cent respectively (UNCTAD, 2010).

After the recession in 2008, world shipments of tanker trade volumes, including crude oil, petroleum products and liquefied natural gas (LNG), fell by 3 per cent in 2009. As also illustrated in Table 3.3, total tanker cargoes loaded amounted to 2.73 billion tons in 2008 and this dropped to 2.64 billion tons in 2009, before slightly increasing to 2.83 billion tons in 2012. The major oil producers including the OPEC countries of western Asia were the largest loading areas for crude oil together with transition economies, with

TABLE 3.3 Development of international seaborne trade 1970–2012 (millions of tons loaded)

Year	Oil	Main bulks[a]	Other dry cargo	Total (all cargoes)
1970	1,442	448	676	2,566
1980	1,871	796	1,037	3,704
1990	1,755	968	1,285	4,008
2000	2,163	1,288	2,533	5,984
2006	2,698	1,849	3,135	7,682
2007	2,747	1,972	3,265	7,983
2008	2,732	2,079	3,399	8,210
2009	2,642	2,085	3,131	7,858
2010	2,772	2,335	3,302	8,409
2011	2,794	2,486	3,505	8,784
2012	2,836	2,665	3,664	9,165

SOURCE Compiled by the UNCTAD secretariat on the basis of data supplied by reporting countries as published on the relevant government and port industry websites, and by specialist sources. The data for 2006 onwards have been revised and updated to reflect improved reporting, including more recent figures and better information regarding the breakdown by cargo type.

NOTE

a. Iron ore, grain, coal, bauxite/alumina and phosphate. The data for 2006 onwards are based on *Dry Bulk Trade Outlook* produced by Clarkson Research Services Limited.

South-east Asia, Central Africa, the northern and eastern coasts of South America, North and West Africa and Central America the major producers and consumers of oil and gas. The major unloading areas included North America, Europe, Japan and South-east Asia. With the strong demand in oil from China, India, western Asia and Latin America, crude oil shipments to these regions started to grow rapidly. In terms of the total volume of cargoes loaded regardless of their type, global seaborne trade loaded dropped from 8.2 billion tons in 2008 to 7.8 billion tons in 2009, before rising to 9.17 billion tons in 2012 (UNCTAD, 2013). The total volumes of world seaborne trade by type of cargo loaded and unloaded together with country groups between 2006 and 2012 and world merchant fleet tonnage surplus by main type of vessel in the maritime transport industry are illustrated in Tables 3.4 and 3.5 respectively.

The year 2009 was the most challenging in the history of the container industry with dramatic declines. Container trade volumes declined sharply by 9 per cent, totalling 124 million 20-foot equivalent units (TEU)

TABLE 3.4 World seaborne trade volumes by type of cargo and country group 2006–2012

Country group	Year	Goods loaded (millions of tons)				Goods unloaded (millions of tons)			
		Total	Crude products & gas		Dry cargo	Total	Crude products & gas		Dry cargo
World	2006	**7,682.3**	1,783.4	914.8	4,984.1	**7,885.9**	1,931.0	894.2	5,060.8
	2007	**7,983.5**	1,813.4	933.5	5,236.6	**8,136.1**	1,995.5	904.3	5,236.3
	2008	**8,210.1**	1,785.2	946.9	5,478.0	**8,272.7**	1,942.1	964.1	5,366.5
	2009	**7,842.8**	1,724.5	924.6	5,193.6	**7,908.4**	1,877.8	957.3	5,073.3
	2010	**8,408.9**	1,787.7	983.8	5,637.5	**8,443.8**	1,933.2	979.2	5,531.4
	2011	**8,784.3**	1,759.5	1034.2	5,990.5	**8,797.7**	1,896.5	1,037.7	5,863.5
	2012	**9,165.3**	1,785.4	1050.9	6,329.0	**9,183.7**	1,928.7	1,054.9	6,200.1
Developed economies	2006	**2,460.5**	132.9	336.4	1,991.3	**4,164.7**	1,282.0	535.5	2,347.2
	2007	**2,608.9**	135.1	363.0	2,110.8	**3,990.5**	1,246.0	524.0	2,220.5
	2008	**2,708.5**	129.0	394.3	2,185.1	**4,007.9**	1,251.1	523.8	2,233.0
	2009	**2,540.1**	118.6	355.0	2,066.5	**3,499.8**	1,149.8	529.4	1,820.6
	2010	**2,865.4**	135.9	422.3	2,307.3	**3,604.5**	1,165.4	522.6	1,916.5
	2011	**2,982.5**	117.5	451.9	2,413.1	**3,632.3**	1,085.6	581.3	1,965.4
	2012	**3,162.9**	121.6	447.3	2,594.0	**3,678.8**	1,097.7	573.7	2,007.5

Transition economies	**2006**	**410.3**	123.1	41.3	245.9	**70.6**	5.6	3.1	61.9
	2007	**407.9**	124.4	39.9	243.7	**76.8**	7.3	3.5	66.0
	2008	**431.5**	138.2	36.7	256.6	**89.3**	6.3	3.8	79.2
	2009	**501.8**	151.3	41.6	309.0	**60.5**	6.1	3.0	51.4
	2010	**515.7**	150.2	45.9	319.7	**122.1**	3.5	4.6	114.0
	2011	**505.0**	132.6	42.0	330.5	**156.7**	4.2	4.4	148.1
	2012	**542.1**	136.6	41.1	364.4	**149.2**	3.8	4.0	141.4
Developing economies	**2006**	**4,811.5**	1,527.5	537.1	2,747.0	**3,650.6**	643.4	355.5	2,651.6
	2007	**4,966.6**	1,553.9	530.7	2,882.0	**4,068.9**	742.2	376.8	2,949.8
	2008	**5,070.2**	1,517.9	515.9	3,036.4	**4,175.5**	684.7	436.5	3,054.3
	2009	**4,800.8**	1,454.6	528.0	2,818.2	**4,348.1**	721.9	424.8	3,201.3
	2010	**5,027.8**	1,501.6	515.6	3,010.5	**4,717.3**	764.4	452.0	3,500.9
	2011	**5,296.8**	1,509.4	540.4	3,247.0	**5,008.8**	806.7	452.1	3,750.0
	2012	**5,460.3**	1,527.2	562.5	3,370.6	**5,355.7**	827.3	477.2	4,051.2
Africa	**2006**	**704.0**	353.8	86.0	264.2	**357.4**	41.0	39.9	276.5
	2007	**708.9**	362.5	81.8	264.6	**375.9**	45.5	45.0	285.3
	2008	**741.9**	379.2	83.5	279.3	**366.1**	44.8	44.2	277.0
	2009	**682.1**	335.0	82.8	264.4	**365.6**	43.7	42.7	279.2
	2010	**754.0**	351.1	92.0	310.9	**416.9**	42.7	40.5	333.7
	2011	**723.7**	338.0	68.5	317.2	**378.2**	37.8	46.3	294.1
	2012	**787.3**	370.1	72.6	344.6	**407.7**	35.9	51.7	320.1

(*Continued*)

TABLE 3.4 World seaborne trade volumes by type of cargo and country group 2006–2012 (*Continued*)

Country group	Year	Goods loaded (millions of tons)				Goods unloaded (millions of tons)			
		Total	Crude products & gas		Dry cargo	Total	Crude products & gas		Dry cargo
Americas	**2006**	**1,030.7**	251.3	93.9	686.5	**373.4**	49.6	60.1	263.7
	2007	**1,067.1**	252.3	90.7	724.2	**415.9**	76.0	64.0	275.9
	2008	**1,112.2**	234.6	93.0	784.6	**433.8**	74.2	66.9	292.7
	2009	**1,050.6**	219.4	89.6	741.7	**387.0**	74.2	65.4	247.5
	2010	**1,172.6**	241.6	85.1	846.0	**448.7**	69.9	74.7	304.2
	2011	**1,239.2**	253.8	83.5	901.9	**508.3**	71.1	73.9	363.4
	2012	**1,287.2**	250.7	91.6	944.9	**538.5**	77.5	79.4	381.6
Asia	**2006**	**3,073.1**	921.2	357.0	1,794.8	**2,906.8**	552.7	248.8	2,105.3
	2007	**3,187.1**	938.1	358.1	1,890.8	**3,263.6**	620.7	260.8	2,382.1
	2008	**3,211.8**	902.7	339.3	1,969.9	**3,361.9**	565.6	318.3	2,477.9
	2009	**3,061.7**	898.7	355.5	1,807.5	**3,582.4**	604.1	313.1	2,665.2
	2010	**3,094.6**	907.5	338.3	1,848.8	**3,838.2**	651.8	333.1	2,853.4
	2011	**3,326.7**	916.0	388.2	2,022.6	**4,108.8**	697.8	328.0	3,082.9
	2012	**3,376.7**	904.7	397.5	2,074.5	**4,396.2**	713.8	341.5	3,340.9
Oceania	**2006**	**3.8**	1.2	0.1	2.5	**12.9**	0.0	6.7	6.2
	2007	**3.5**	0.9	0.1	2.5	**13.5**	0.0	7.0	6.5
	2008	**4.2**	1.5	0.1	2.6	**13.8**	0.0	7.1	6.7
	2009	**6.3**	1.5	0.2	4.6	**13.1**	0.0	3.6	9.5
	2010	**6.5**	1.5	0.2	4.8	**13.4**	0.0	3.7	9.7
	2011	**7.1**	1.6	0.2	5.3	**13.5**	0.0	3.9	9.6
	2012	**9.0**	1.6	0.8	6.6	**13.3**	0.0	4.6	8.6

SOURCE UNCTAD, 2013

TABLE 3.5 World merchant fleet tonnage surplus, by main type of vessel, selected years[a] between 1990 and 2010 (in millions of dwt or millions of cubic meters)

	1990	2000	2004	2005	2006	2007	2008	2009	1 Apr 2010
World tanker fleet (dwt)	266.2	279.4	298.3	312.9	367.4	393.5	414.04	435.25	438.33
Idle tanker fleet (dwt)	40.9	13.5	3.4	4.5	6.1	7.8	14.35	8.51	9.42
Share of idle fleet in tanker fleet (%)	15.4	4.8	1.1	1.4	1.7	2.0	3.47	1.96	2.15
World dry bulk fleet (dwt)	228.7	247.7	325.1	340.0	361.8	393.5	417.62	452.52	458.63
Idle dry bulk fleet (dwt)	19.4	3.8	2.1	2.0	3.4	3.6	3.68	2.64	4.00
Share of idle fleet in dry bulk fleet (%)	8.5	1.5	0.6	0.6	0.9	0.9	0.88	0.58	0.87
World conventional general cargo fleet (dwt)	63.6	59.3	43.6	45.0	44.7	43.8	44.54	42.53	40.54
Idle conventional general cargo fleet (dwt)	2.1	1.1	0.7	0.7	0.6	0.7	0.97	0.83	1.01
Share of idle fleet in general cargo fleet (%)	3.3	1.9	1.6	1.6	1.4	1.6	2.18	1.95	2.49
World ro-ro fleet (dwt)	..	..	..	..	..	..	11.37	10.93	10.21
Idle ro-ro fleet (dwt)	..	..	..	..	..	..	0.89	0.73	0.67
Share of idle fleet in ro-ro fleet (%)	..	..	..	..	..	..	7.83	6.68	6.56

(*Continued*)

TABLE 3.5 World merchant fleet tonnage surplus, by main type of vessel, selected yearsa between 1990 and 2010 (in millions of dwt or millions of cubic meters) (*Continued*)

	1990	2000	2004	2005	2006	2007	2008	2009	1 Apr 2010
World vehicle carrier fleet (dwt)	..	..	..	..	..	..	11.27	11.20	10.72
Idle vehicle carrier fleet (dwt)	..	..	..	..	..	..	0.24	0.55	0.42
Share of idle fleet in vehicle carrier fleet (%)	..	..	..	..	..	..	2.13	4.91	3.92
World LNG carrier fleet (m3)	..	..	..	..	..	..	44.43	46.90	49.29
Idle LNG carrier fleet (m3)	..	..	..	..	..	..	5.87	1.29	0.77
Share of idle fleet in LNG fleet (%)	..	..	..	..	..	..	13.21	2.75	1.56
World LPG carrier fleet (m3)	..	..	..	..	..	..	11.56	18.50	19.05
Idle LPG carrier fleet (m3)	..	..	..	..	..	..	0.94	0.10	0.13
Share of idle fleet in LNG fleet (%)	..	..	..	..	..	..	8.13	0.54	0.68

SOURCE Compiled by the UNCTAD secretariat, on the basis of data from Lloyd's Shipping Economist (various issues).

NOTE

a. End-of-year figures, except for 1990 and 2000, which are annual averages. This table excludes tankers and dry bulk carriers of less than 10,000 dwt and conventional general cargo/unitized vessels of less than 5,000 dwt.

TABLE 3.6 Cargo flows on the major east–west container trade routes 2008–2012 (millions of TEUs and annual percentage change)

Years	Asia–North America	North America–Europe	North America–Asia	Asia–Europe	Europe–Asia	Europe–North America
2008	13.4	3.3	6.9	13.5	5.2	3.3
2009	10.6	6.1	11.5	5.5	2.8	2.5
% change 2008–2009	**−20.9**	**84.8**	**66.7**	**−59.3**	**−46.2**	**−24.2**
2010	12.3	6.5	13.3	5.7	3.2	2.7
2011	12.4	6.6	14.1	6.2	3.4	2.8
2012	13.3	6.9	13.7	6.3	3.6	2.7
% change 2011–2012	**7.3**	**4.5**	**−2.8**	**1.6**	**5.9**	**−3.6**

SOURCE www.containershipping.com, April–June 2013; European Liner Affairs Association, 2010 *Containerization International*, August 2010

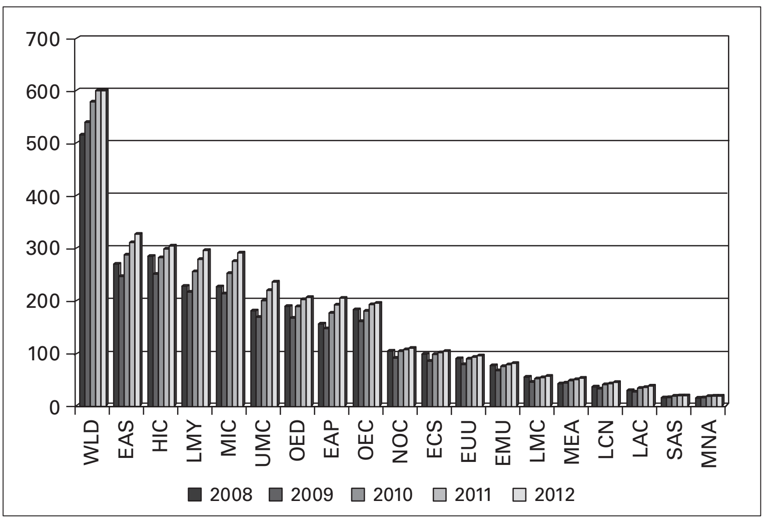
TABLE 3.7 Container port traffic 2004–2012 (million TEU)

Economies/Regions	2004	2005	2006	2007	2008	2009	2010	2011	2012
East Asia & Pacific (developing only)	102.4	96.2	114.8	139.5	155.73	147.75	175.33	192.52	205.67
East Asia & Pacific (all income levels)	174.2	193.8	217.8	250.2	269.31	247.67	287.16	311.36	325.57
Europe & Central Asia (all income levels)	71.1	75.8	81.3	91.6	98.30	83.99	94.54	101.49	104.18
Euro area	56.4	60.3	64.6	72.7	76.75	66.68	73.76	79.15	80.69
European Union	67.9	71.5	76.0	85.0	90.01	78.01	86.63	92.82	94.89
High income	194.4	232.7	246.5	265.2	286.15	253.49	284.38	299.70	305.10
Latin America & Caribbean (developing only)	19.4	21.9	24.8	27.5	29.24	27.11	32.76	34.99	36.38
Latin America & Caribbean (all income levels)	22.3	24.8	28.0	30.8	35.63	32.63	40.10	41.48	43.12
Lower middle income	105.8	100.4	119.9	144.4	44.58	44.67	51.87	55.05	56.91
Low & middle income	144.0	143.5	170.3	202.3	229.78	218.51	257.65	280.10	296.40
Middle East & North Africa (all income levels)					41.99	42.55	46.52	49.93	51.43
Middle income	143.3	142.7	169.4	201.3	226.59	215.34	254.05	276.28	292.30
High income: non-OECD	50.7	80.0	84.5	89.0	103.46	91.97	102.93	106.93	109.65
High income: OECD	143.7	152.7	162.0	176.2	182.69	161.51	181.45	192.77	195.46
OECD members	150.2	159.8	170.5	186.6	191.22	168.91	190.72	202.84	205.93
South Asia	8.5	9.9	11.9	13.7	14.44	14.77	17.32	17.94	18.10
Upper middle income	37.5	42.3	49.4	56.9	182.01	170.67	202.18	221.23	235.40
World	338.4	376.3	416.8	467.5	515.94	471.99	542.03	579.80	601.51

SOURCE World Bank Data Bank 2013; 2010 or 1.19 billion tons in 2009. The global financial crisis and economic recession contracted demand for consumer and manufactured goods and durables. Table 3.6 illustrates the cargo flows on the major East–West container trade routes in the world. The annual percentage changes between 2008 and 2009 illustrate the declines on most major trade routes, with the dramatic increase of 84.8 per cent in Atlantic container trade between the USA and Europe one notable exception. Another was the annual increase of 66.7 per cent in container trade between North America and Asia. These dramatic changes settled down at the end of 2012 with percentage changes between 2011 and 2012 from 1.6 to 7.3 per cent, mostly in trans-Pacific container trade (with the exception of a decline of -2.8 per cent in container trade between North America and Asia).

More specifically, Table 3.7 and Figure 3.1 give an idea of the recent container port traffic in total number of TEU as 20-foot-equivalent units by

FIGURE 3.1 Container port traffic 2008–2012 (million TEU)



NOTE

Country Code	**Country Name**	**Country Code**	**Country Name**
WLD	World	EUU	European Union
EAS	East Asia & Pacific (all income levels)	EMU	Euro area
HIC	High income	LMC	Lower middle income
LMY	Low & middle income	MEA	Middle East & North Africa (all income levels)
MIC	Middle income		
UMC	Upper middle income	LCN	Latin America & Caribbean (all income levels)
OED	OECD members		
EAP	East Asia & Pacific (developing only)	LAC	Latin America & Caribbean (developing only)
OEC	High income: OECD		
NOC	High income: non-OECD	SAS	South Asia
ECS	Europe & Central Asia (all income levels)	MNA	Middle East & North Africa (developing only)

region between 2004 and 2012. In this table, the development of container port traffic is specified by different regions East Asia and the Pacific, the European Union, Europe and Central Asia, Latin America and the Caribbean, the Middle East and North Africa, OECD members and South Asia) and different income levels. In terms of the total number of TEU, container traffic in East Asia and the Pacific reflects that to and from its leading ports, such as Hong Kong and Singapore.

Despite these challenging developments, container shipping and international maritime trade had started to recover from the global economic downturn by 2010. By mid-2010, gradual growth had emerged and increases in total trade volumes had started to be recorded, especially to and from China.

By the beginning of 2010, the total world merchant fleet had expanded by an impressive 7 per cent to reach 1.276 billion deadweight tonnes (dwt). In addition, world container throughput declined by about 9 per cent to 465 million TEU in 2009, while total container trade in world seaborne trade was forecast to increase by 11.5 per cent by the end of 2010.

Liner shipping is defined as a vessel carrying passengers and cargo that operates on a route with a fixed schedule (Hinkelman, 2009). Liner shipping emerged from the establishment of regular steamship lines on regular schedules, calling at many ports at specific dates and times. The main advantages of liner companies are their regularity and organization at a wide range of ports regardless of the existence of cargoes (Pamuk, 2000). Liner shipping is used for general cargo on fixed trade routes and on a fixed timetable. The United Nations Conference on Trade and Development (UNCTAD) notes that access to high-frequency, reliable and low-cost liner shipping services largely determines a country's connectivity to overseas markets and thus its competitiveness globally (Hoekman, 2006; World Bank, 2007).

The configuration of liner shipping networks is important not only to shipping lines, but also for the structure of such networks. The relative position of a port on the network has a significant impact on the level of transport costs (Marquez *et al*, 2006; Wilmsmeier and Hoffmann, 2008; Wilmsmeier and Notteboom, 2009a). Therefore, the location of a port within the network becomes strategic to ensure trade competitiveness, which raises important questions about the determinants that lead to the configuration of current networks and about how these could be influenced (Wilmsmeier and Notteboom, 2009a).

Demand for containerized transport also affects the development of liner shipping networks. The routing of containerized trade flows depends on the strategies of shipping companies and demand of shippers for specific service characteristics. As such, the location of a port or a region within the global liner shipping network is determined by the density of trade flows to and from a specific port or region (Wilmsmeier and Notteboom, 2009b).

The Liner Shipping Connectivity Index scores from 2004 to 2013 presented in Table 3.8 suggest how well countries are connected to global shipping networks. This index is based on five components of the maritime transport sector: number of ships, container-carrying capacity of ships,

TABLE 3.8 Liner shipping connectivity values – ordered by 2013 rankings

Rank	Country Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1	China	100.00	108.29	113.1	127.85	137.38	132.47	143.57	152.06	156.19	157.51
2	Hong Kong SAR, China	94.42	96.78	99.31	106.2	108.78	104.47	113.60	115.27	117.18	116.63
3	Singapore	81.87	83.87	86.11	87.53	94.47	99.47	103.76	105.02	113.16	106.91
4	Korea, Rep.	68.68	73.03	71.92	77.19	76.40	86.67	82.61	92.02	101.73	100.42
5	Malaysia	62.83	64.97	69.20	81.58	77.60	81.21	88.14	90.96	99.69	98.18
6	United States	83.30	87.62	85.80	83.68	82.45	82.43	83.80	81.63	91.70	92.80
7	Germany	76.59	78.41	80.66	88.95	89.26	84.30	90.88	93.32	90.63	88.61
8	United Kingdom	81.69	79.58	81.53	76.77	77.99	84.82	87.53	87.46	84.00	87.72
9	Netherlands	78.81	79.95	80.97	84.79	87.57	88.66	89.96	92.10	88.93	87.46
10	Belgium	73.16	74.17	76.15	73.93	77.98	82.80	84.00	88.47	78.85	82.21
11	France	67.34	70.00	67.78	64.84	66.24	67.01	74.94	71.84	70.09	74.94
12	Spain	54.44	58.16	62.29	71.26	67.67	70.22	74.32	76.58	74.44	70.40
13	Italy	58.13	62.20	58.11	58.84	55.87	69.97	59.57	70.18	66.33	67.26
14	United Arab Emirates	38.06	39.22	46.70	48.21	48.80	60.45	63.37	62.50	61.09	66.97
15	Japan	69.15	66.73	64.54	62.73	66.63	66.33	67.43	67.81	63.09	65.68
16	Saudi Arabia	35.83	36.24	40.66	45.04	47.44	47.30	50.43	59.97	60.40	59.67
17	Egypt, Arab Rep.	42.86	49.23	50.01	45.37	52.53	51.99	47.55	51.15	57.39	57.48
18	Morocco	9.39	8.68	8.54	9.02	29.79	38.40	49.36	55.13	55.09	55.53
19	Turkey	25.60	27.09	27.09	32.60	35.64	31.98	36.10	39.40	53.15	52.13
20	Malta	27.53	25.70	30.32	29.53	29.92	37.71	37.53	40.95	45.02	49.79
21	Oman	23.33	23.64	20.28	28.96	30.42	45.32	48.52	49.33	47.25	48.46

(Continued)

TABLE 3.8 Liner shipping connectivity values – ordered by 2013 rankings (*Continued*)

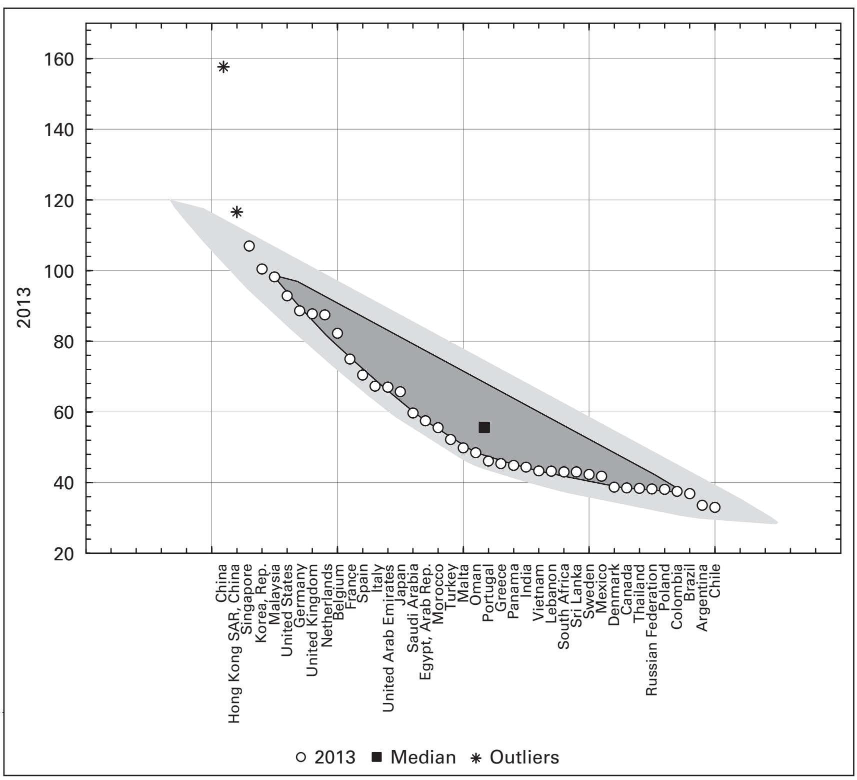
Rank	Country Name	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
22	Portugal	17.54	16.84	23.55	25.42	34.97	32.97	38.06	21.08	46.23	46.08
23	Greece	30.22	29.07	31.29	30.70	27.14	41.91	34.25	32.15	45.50	45.35
24	Panama	32.05	29.12	27.61	30.53	30.45	32.66	41.09	37.51	42.38	44.88
25	India	34.14	36.88	42.90	40.47	42.18	40.97	41.40	41.52	41.29	44.35
26	Vietnam	12.86	14.30	15.14	17.59	18.73	26.39	31.36	49.71	48.71	43.26
27	Lebanon	10.57	12.53	25.57	30.01	28.92	29.55	30.29	35.09	43.21	43.16
28	South Africa	23.13	25.83	26.21	27.52	28.49	32.07	32.49	35.67	36.83	43.02
29	Sri Lanka	34.68	33.36	37.31	42.43	46.08	34.74	40.23	41.13	43.43	43.01
30	Sweden	14.76	26.61	28.17	25.82	30.27	31.34	30.58	30.02	49.45	42.32
31	Mexico	25.29	25.49	29.78	30.98	31.17	31.89	36.35	36.09	38.81	41.80
32	Denmark	11.56	24.25	25.39	22.10	26.49	27.68	26.76	26.41	44.71	38.67
33	Canada	39.67	39.81	36.32	34.40	34.28	41.34	42.39	38.41	38.29	38.44
34	Thailand	31.01	31.92	33.89	35.31	36.48	36.78	43.76	36.70	37.66	38.32
35	Russian Federation	11.90	12.72	12.81	14.06	15.31	20.64	20.88	20.64	37.01	38.17
36	Poland	7.28	7.53	7.50	7.86	9.32	9.21	26.18	26.54	44.62	38.03
37	Colombia	18.61	19.20	20.49	21.07	21.64	23.18	26.13	27.25	37.25	37.49
38	Brazil	25.83	31.49	31.61	31.64	30.87	31.08	31.65	34.62	38.53	36.88
39	Argentina	20.09	24.95	25.58	25.63	25.70	25.99	27.61	30.62	34.21	33.51
40	Chile	15.48	15.53	16.10	17.49	17.42	18.84	22.05	22.76	32.98	32.98

SOURCE World Bank Data Bank (2013)

maximum vessel size, number of services and number of companies that deploy container ships to a country's port. The index is fixed in 2004 to the value of 100 (ie the country with the highest score). China leads the connectivity index with a considerable gap to its nearest countries, namely Hong Kong and Singapore. Table 3.8 presents the liner shipping connectivity values of the top 40 countries.

Countries actively involved in trade have the highest liner shipping connectivity values. For instance, the export-oriented economies of China and Hong Kong are ranked first, with the transhipment hub of Singapore third. Large traders such as Korea (4), Malaysia (5), the USA (6), Germany (7), the UK (8) and Japan (15) are also ranked among the top 15. Countries such as France (11), Spain (12), the United Arab Emirates (14), Saudi Arabia (16), Egypt (17), Morocco (18) and Turkey (19) also rank high because of the major transhipment functions performed by their ports, as also illustrated by Figure 3.2. As shown in this figure, China, Hong Kong and Singapore are the outlier countries of the index because they have significantly higher scores than their nearest followers.

FIGURE 3.2 Bag plot of the liner shipping connectivity index (2013)



Transport connectivity is the main determinant of countries' access to world markets, especially as regards regular shipping services for the import and export of manufactured goods (UNCTAD reviews, 2013). Based on UNCTAD reports on liner shipping connectivity indices, companies that operate container shipping are considered to be less likely to provide services to and from the seaports of least developed countries (LDCs), because national trade volumes tend to be lower and a lower level of development will often make ports less attractive for the transhipment and transit of cargo. UNCTAD's Liner Shipping Connectivity Index shows that the average ranking of LDCs in 2010 was 111 compared with 78 for other developing countries and 64 for developed countries. This rating shows that LDCs remain isolated from major or frequently used shipping routes.

In summary, after falling global demand following the contractions in global GDP, world seaborne trade volumes started to improve in 2008, with reflections of the emerging recovery in the global economy in 2009 and 2010, reaching 9.165 billion tons in 2012 (UNCTAD, 2013).

Discussion and conclusion

The global economy continues to recover from its worst crisis since World War II. After a slowdown in 2008, positive growth rates returned to some developed and developing economies in 2009. Moreover, global GDP expanded by about 4.1 per cent in 2010, meaning a return to pre-crisis growth rates in most regions and an exit from recession. The annual increase in GDP remained at 2.2 per cent in 2012 and 2.1 per cent in 2013.

International transport, maritime transport services in particular, has direct relationships with the overall performance of the global economy as well as with the total volume of trade. Seaborne trade in the international maritime transport industry, which comprises approximately 85 per cent of global trade, directly reflects the developments in the global economy and in international trade. In parallel, the industry continues to face problems in order to keep employed its rapidly growing capacity of very large ships during economic crisis periods.

This chapter described maritime logistics services and the interrelation of international maritime trade within global trade. More specifically, it reviewed developments in global trade and international seaborne trade within the maritime transport industry, as the most common way of transporting goods through the supply chain, by providing a background to the carriage of commodity goods in developing and developed economies. Global economic growth and integration with maritime trade were also emphasized and analysed by reviewing the shipping connectivity index of shipping networks and major maritime trade routes around the world.

In summary, maritime trade within international trade and logistics services has always been directly affected by the global economy because the majority of goods traded internationally are carried and transported by maritime transportation. Therefore, global demand and the total volume of world trade are influenced by the world's current economic status.

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04

Defining maritime logistics and its value

EON-SEONG LEE, HYUNG-SIK NAM AND DONG-WOOK SONG

Introduction

Maritime transportation, as a central integrated component of global logistics systems, is enforced to provide not only transport-related services but also other related and wider logistical services in a more efficient and effective manner. The maritime transport system which is deeply involved in the entire logistics flows is often referred to as 'maritime logistics'. The main value of maritime logistics has been recognized as achieving a high rate of both operational efficiency (such as reducing lead-time and business costs) and service effectiveness (such as flexibility, responsiveness and reliability in the service). Maximizing the maritime logistics value and successfully integrating its value into global logistics, therefore, become critical strategic objectives of the maritime industry. Despite its importance, however, a systematic approach towards defining maritime logistics and its value creation from the perspective of industry professionals remains relatively untouched.

This chapter aims to provide a precise understanding of the concept of maritime logistics (including definition and main activities of maritime logistics) and a guideline for the value creation of a maritime logistics system. The chapter will address mainly the following:

- the importance of maritime transportation in an entire logistics system;
- a definition of maritime logistics;
- the main activities of maritime logistics;

- the process of maritime logistics;
- a definition of maritime logistics value and its significance; and
- strategic implications for maritime logistics operators.

As the main purpose of this chapter is to systematically clarify the current situation which is being thoroughly discussed in the maritime transport and logistics industry, this study is an exploratory research which is underpinned by a comprehensive literature review.

Maritime logistics in concept

Maritime logistics definition

Logistics has been embedded into every type of businesses, from the largest corporations down to the smallest corner shops on your street. It can easily be assumed that no business can run without some use of logistics (Accenture Annual Report, 2002, p 4).

Logistics has become a significant area of interest in global business and management, and is seen as a means to enhance firms' performance and outcomes (Grant *et al*, 2006). The importance of logistics has dramatically increased, as evidenced by the significant amount of attention paid to it by practitioners and academics alike, due in large part to the internal and external environmental factors affecting firms, such as globalization, changing customer demands, advances in technology and industrial deregulation. Managing logistics and supply chains is necessary in order to control the flow of material, goods, information and other resources with cyclic relations between the source of production and the source of consumption in response to the requirements and needs of customers.

Since the concept of logistics was first introduced in the early 1960s, its role, as a main centre for a firm's cost reduction activities and consequently improving its competitive market position, has become ever more important to the business world (Rushton *et al*, 2006). The logistics concept provided by the Council of Supply Chain Management Professionals (2010) is one of the most popular, in which logistics is defined as the part of supply chain management that plans, implements, and controls the efficient and effective forward and reverse flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers' requirements. This definition implies all the relevant activities of the flow of goods from the origin to ultimate destination, including transportation, warehousing, purchasing, distribution etc. The primary goal of logistics is to minimize firms' costs and maximize customer satisfaction by coordinating the flows of materials and information in the most efficient way, and by providing a service to customers at a speedy rate and with a reasonable price (O'Leary-Kelly and Flores, 2002; Coyle *et al*, 1999).

Maritime transportation, one of key components of a logistics system, is responsible for carrying and handling cargoes across the ocean and consequently connects widely dispersed transportation linkages between consigners and consignees. It also plays a bridging role in connecting all the entities in logistics (eg customers, suppliers, plants, warehouses and other channels). If maritime transport is not well integrated into the whole logistics flows, additional costs, unnecessary delays and accidents may arise, thus distorting the smooth flows of logistics (O'Leary-Kelly and Flores, 2002). Hence, maritime transportation should handle cargoes in a highly integrated manner by keeping pace with other logistics components (O'Leary-Kelly and Flores, 2002). Refining maritime operations so that they can be successfully integrated into the overall logistics system contributes to better outcomes for all logistics entities (Huybrechts *et al*, 2002; Misztal, 2002). In this respect, maritime transportation can be regarded as a strategically crucial part of the logistics integration system.

The integrated demand for maritime transport has delivered a 'maritime logistics' concept (Panayides, 2006). Maritime logistics is referred to as the process of planning, implementing and managing the movement of goods and information which is involved in ocean carriage. Maritime logistics can be distinguished from maritime transportation in both its focus point and the managerial function. Table 4.1 summarizes a comparison of maritime logistics and maritime transportation. With reference to the focus point, maritime transportation emphasizes individual functions relating to sea transportation and pursues its own competitiveness of transport terminal

TABLE 4.1 Maritime logistics vs maritime transportation

	Maritime logistics	Maritime transportation
Concept	The process of planning, implementing and managing the movement of goods and information which is involved in the ocean carriage.	The process of carrying and handling cargoes across the ocean.
Focusing point	Maritime logistics is concerned with not only individual functions relating to sea transportation, but also an effective logistics flow as a systematic entity of the logistics integration system.	Maritime transportation emphasizes individual functions relating to sea transportation. Each function pursues its own aims or competitiveness.

(*Continued*)

TABLE 4.1 Maritime logistics vs maritime transportation (*Continued*)

	Maritime logistics	Maritime transportation
Managerial function	Sea transportation activities: eg contracting, shipping, sea voyage, moving cargo, and loading/unloading. Additional logistics services: eg stripping/stuffing, storage, warehousing, offering a distribution centre, quality control, testing, assembly, packaging, repacking, repairing, inland connection, and reuse.	Sea transportation activities: eg contracting, shipping, sea voyage, moving cargo, and loading/unloading.

SOURCES Lu (2000), Notteboom and Winkelmans (2001), Robinson (2002), Bichou and Gray (2004), Carbone and De Martino (2003), Panayides (2006), World Bank (2006)

operators; while maritime logistics, as a systematic entity of the logistics integration system, is largely concerned with an efficient and effective flow of the entirety of the logistics system. With regard to the managerial functions, maritime logistics involves not only the activities relating to maritime transportation, eg contracting, shipping, sea voyage, moving cargo, and loading/unloading, but also other logistics services, eg stripping/stuffing, storage, warehousing, inventory management, offering a distribution centre, quality control, testing, assembly, packaging, repacking, repairing, inland connection, and reuse (World Bank, 2006).

As maritime logistics is a concept developed from the study of maritime transportation within the context of logistics, the following three key players of maritime transportation make up the maritime logistics system: shipping, port/terminal operating, and freight forwarding. Table 4.2 presents the main and supportive logistics functions that maritime operators should provide.

The major function of the shipping system is moving the goods of shippers from one port to another. Shipping also provides other logistics services in order to successfully support the shipping and logistics flow, eg pick-up service, delivery notification, a special handling service for customers who require particular services, inbound/outbound bill of lading (B/L), container tracking and information, and intermodal services (Lu, 2000; Heaver *et al*, 2000; Notteboom and Winkelmans, 2001; Robinson, 2002).

TABLE 4.2 Main function and supportive activities of maritime logistics

	Shipping	Port/Terminal operating	Freight forwarding
Main function	Moving cargoes between ports.	Shipping reception; Loading/unloading cargoes; Stevedoring; Connecting to inland transportation.	Booking vessels; Preparing for requisite documents for ocean carriage and trade, on behalf of shippers.
Supportive logistics activities	Documentation relating to sea trade; Container tracking and information; Intermodal service.	Warehousing; Offering a distribution centre; Testing; Assembly; Repairing; Inland connection.	Inventory management; Packaging; Warehousing.

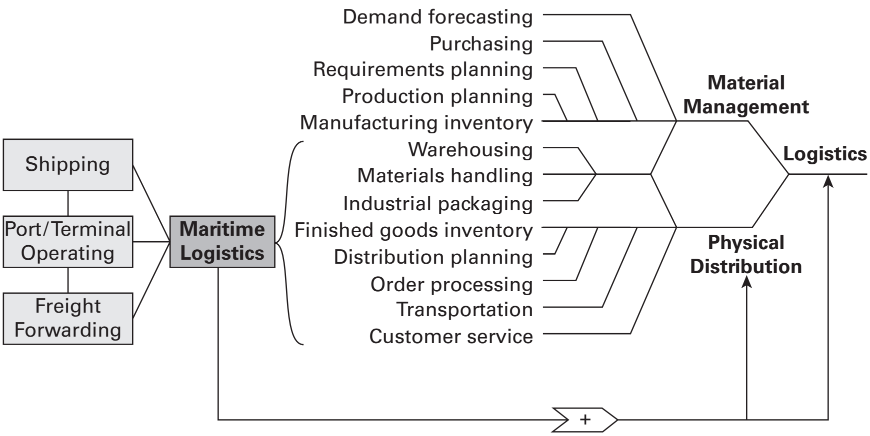
SOURCE Lu (2000); Heaver *et al* (2000); Robinson (2002); Notteboom and Winkelmans (2001); Carbone and De Martino (2003); Bichou and Gray (2004); Roh *et al* (2007); Murphy and Daley (1992); Bernal *et al* (2002)

The key function of port/terminal operation is loading/discharging cargoes into/from a vessel, and making preparations for the cargoes to be ready to be delivered to the final destination of the consumer via inland transportation. In order to ensure that the cargoes be passed smoothly and quickly to the next stage of the logistics system, port/terminal operations in modern logistics systems involve not only loading/off-loading cargoes to/from a vessel, but also various value-adding services including warehousing, storage and packing and arranging inland transportation modes (Carbone and De Martino, 2003; Bichou and Gray, 2004; Roh et al, 2007).

Sometimes, a third intermediate party is engaged in the process of sea transportation for arranging the complex processes of international trade. For example, freight forwarders reserve a vessel on behalf of shippers, or prepare for requisite documents for ocean carriage (eg B/L) and other documents required for customs clearance and/or insurance requirements. They also arrange other logistics services, eg inventory management, packing and warehousing (Murphy and Daley, 1992; 2001).

Figure 4.1 shows the interaction of maritime logistics with other activities in a whole logistics chain. As indicated in Table 4.2, maritime logistics is involved in sea transportation service as well as additional logistics services.

FIGURE 4.1 Maritime logistics in the whole logistics system



SOURCE Extended from Coyle *et al* (1999)

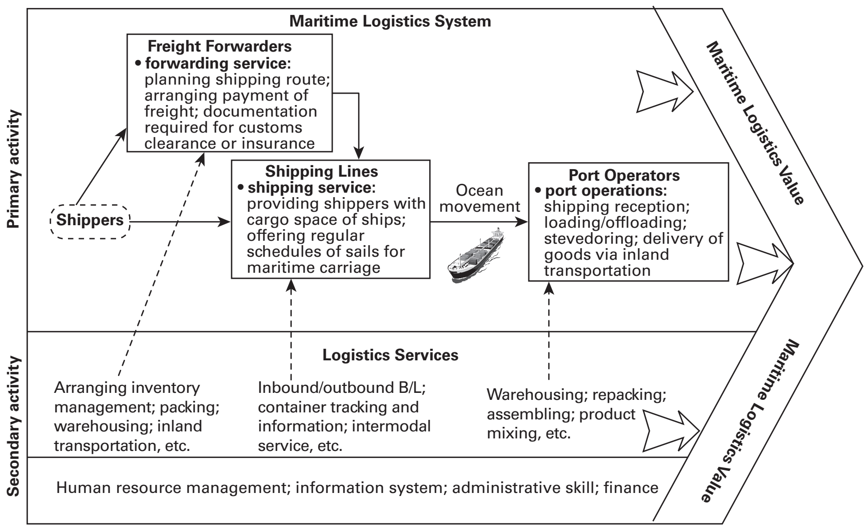
Those additional logistics services are a major part of physical distribution activities, eg warehousing, material handling, packaging, goods inventory, distribution planning, order processing, transportation, and customer service. Therefore, the performance of maritime logistics activities does inevitably affect the overall performance of physical distribution management. As physical distribution is one of the two pillars of the whole logistics chain, successful management of maritime logistics has a direct impact on the overall management and operations of both physical distribution and logistics management.

The process of maritime logistics

The concept and key activities of maritime logistics have been identified in the previous section. Figure 4.2 shows the process of the maritime logistics system and its value creation. This model is built on from Porter's value chain model (Porter, 1985). The model disaggregates a maritime logistics system into primary and secondary activities. The primary activities consist of the major functions of the maritime operators (ie shipping lines, port/terminal operators and freight forwarders). The secondary activities are those which support the primary activities by helping them to run more effectively. Additional logistics services of the maritime operators and their organizational capability, ie human resource management, information systems, administrative skills and financial support, are essential in supporting the primary activities.

The primary activities which are performed by freight forwarders, shipping lines and port operators are inter-linked with each other as suppliers or buyers. For example, shipping lines, who choose a port in which to anchor

FIGURE 4.2 Process of maritime logistics



their vessels, are the main customers of port/terminal operators; freight forwarders, who work for shippers, are the customers of shipping lines. The maritime logistics system generated from these inter-linked primary activities can be reinforced by being supported by the additional logistics services of the secondary activities. The maritime logistics services can then be offered at a time when all the operators in the system are well coordinated as a single team (O'Leary-Kelly and Flores, 2002). If the maritime logistics system can prove that the services are valuable enough for their customers to willingly purchase the services, the maritime logistics value is created (Anderson and Narus, 1991).

The maritime logistics value would be increased by satisfying customers' needs with a higher quality of services (Rutner and Langley, 2000). As a result, the highly valued maritime logistics service leads to the high performance of individual operators and the entire logistics system. The concept of maritime logistics value and its effectiveness is discussed in the following section.

Maritime logistics value defined

The term 'value' is an abstract and intangible concept and is often defined in a different form according to the views of managers (Rutner and Langley, 2000). Value is, however, commonly understood as 'the perceived worth in terms of the economic, technical, service and social benefits received by a customer firm in exchange for the price paid for a product offering' (Anderson and Narus, 1991). Although firms provide differentiated goods or services, unless customers are satisfied with the goods or services offered, those goods or services may not be valuable. Therefore, the maritime logistics value should reflect how well the system fulfils customer needs. In this sense, this paper defines the maritime logistics value as the extent to which the maritime logistics system responds to customer demands by successfully managing the flow of goods, services and information in maritime logistics.

The value can be discussed from a customer's or a service provider's point of view. This paper focuses on the latter, since the value of a service could be assessed by customers (Anderson and Narus, 1991). For example, even though the service provider (ie a firm) regards their service as valuable, if the service cannot be perceived as valuable by their customers, the service ultimately could not be regarded as valuable. When examining the elements that constitute the maritime logistics value, firms should initially identify who their customers are and what they demand. Customers in maritime logistics would primarily be shippers who are in demand for shipping and freight forwarding services, and shipping lines are the customers of port/terminal operators. However, since all of the activities in a logistics system are inter-connected with each other and their operations are directly or indirectly affected by others, the quality of maritime logistics services may also affect the behaviours of all the players in an integrated logistics system. For instance, delays in shipping or carrying cargoes may cause serious problems not only with processing other successive works but also with delivering goods on time to the final consumers. Such problems may lead to serious dissatisfaction among final consumers and others in the entire logistics system. Therefore, the boundary of maritime logistics would not be limited only to shippers or shipping lines. Rather, all the entities in the whole logistics flow should be included as the customers of the maritime logistics system.

As far as the customer needs of maritime logistics system are concerned, the overall demands from all the customers in a logistics system should be taken into account. Today's customers seek a service that is quick, reliable, flexible and yet also offers the lowest price. These components are associated with organizational efficiency and effectiveness. Thus, maritime logistics value can be also reflected in the operational efficiency and effectiveness of services offered (Lai *et al*, 2002).

Having suggested that 'efficiency measures how well the resources are utilized, and effectiveness concerned with the extent to which goals are accomplished', Lai *et al* (2002) measure operational efficiency and service effectiveness widely used in transport logistics such as costs, assets, reliability and responsiveness/flexibility. The first two criteria are about efficiency-related indicators of a firm, while the other two are effectiveness-related criteria. Table 4.3 indicates measurements representing the efficiency and

TABLE 4.3 Measurement of efficiency and effectiveness in transport logistics

Supply chain process	Measurement criteria	Performance indicators
Efficiency-related (Internal facing)	Cost	Total logistics management costs Productivity Return processing cost
	Assets	Cash-to-cash cycle time Inventory days of supply Asset turns
Effectiveness-related (Customer facing)	Reliability	Delivery performance Order fulfilment performance Perfect order fulfilment
	Flexibility and Responsiveness	Response time Production flexibility

SOURCE Lai *et al* (2002)

effectiveness in the context of transport logistics. Since maritime logistics is a part of transport logistics, the framework can be applicable to assessing maritime logistics value.

Bearing the above points in mind, this chapter suggests two major indicators of maritime logistics value: 1) reduction of lead-time and business costs; and 2) improvement in service quality (eg flexibility, responsiveness and reliability). The first is concerned with efficiency-related elements of maritime logistics value, whilst the second relates to effectiveness. The current research considers the reduction of lead-time as an important factor for the efficiency of maritime logistics, although it was not included in Lai *et al* (2002). The reason for its inclusion is that a lead-time occurred in the maritime logistics system does significantly affect the overall cargo movements and associated costs. For example, cargoes not delivered on time may have repercussions, such as shipping congestion, inefficient utilization of transport equipment, delays in handling cargoes, and customer dissatisfaction. However, this chapter excludes the 'asset' factor of Lai *et al* (2002) from maritime logistics value. This is because, in the context of maritime logistics value, customers may be much more concerned about service quality and price than about the degree of asset utility of service providers, since the service quality and price may have a direct influence on the costs and degree of satisfaction of the customers in regard to the maritime logistics service.

Strategic significance of maritime logistics value

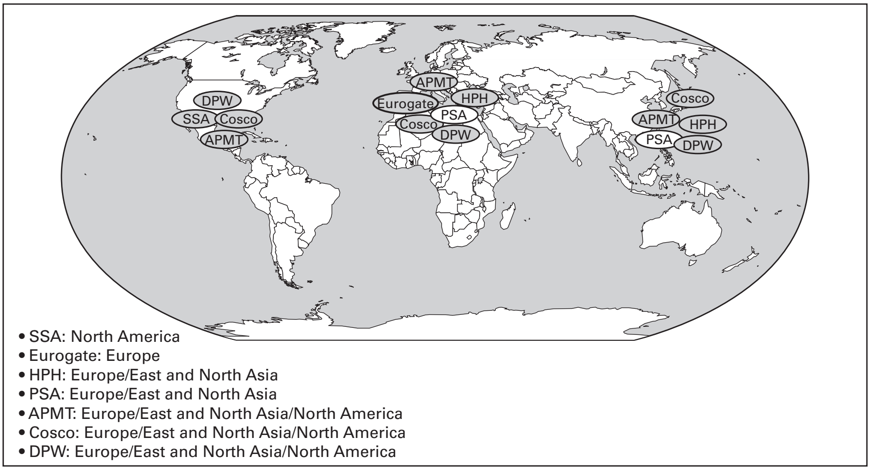
As discussed in the previous sections, the maritime logistics value can be created by maritime operators, eg shipping lines, port terminal operators and freight forwarders. Today, the maritime operators are involved in global business through moving goods across the world. Shipping lines navigate on a regional and/or global scale carrying cargoes to a variety of destinations. Large enterprises such as Maersk Line, MSC or APL have their own subsidiaries in almost every country to and from which they transport products. Currently, they are also expanding their business scope by establishing their own dedicated terminals across the world (Oliver, 2005). Small and medium-sized shipping lines whose geographical coverage is relatively small are more likely to specialize in a few shipping routes. However, most of them do also have branches or agencies in countries at which their vessels call, with the aim of reducing the uncertainty of the foreign market and offering a more diversified service.

As one of the players in maritime logistics operations, freight forwarders need to process a number of documents related to international trade on behalf of shippers, and to handle logistics activities such as warehousing, inventory management and inland transportation in both domestic and foreign countries. Therefore, freight forwarders should be well versed in the foreign countries where their businesses are involved. A great number of freight forwarders proactively establish foreign branches and/or collaborate with local companies in overseas markets so as to provide their customers with more agile and differentiable services (*Korea Shipping Gazette*, 2009).

Port/terminal operators are also engaged with global operations. For example, leading terminal operators, such as DP World, PSA Corporation and Hutchison Port Holdings, are all actively expanding their business boundaries across the world. Figure 4.3 shows the latest developments in the global coverage of major port/terminal operators. As a consequence, their operational scope inevitably overlaps with each other on a regional basis, thus creating a situation where they compete against each other in those markets (Janelle and Beuthe, 1997).

In the discussion so far, maritime operators are considered as global business units whose operations are involved in more than one country (Hill, 2001). Their operations are globally inter-connected with each other and the activities of one may inevitably affect the activities and performance of another; as a result, this may have an impact on the performance of an entire logistics system and supply chain. For example, unforeseen delays in loading cargoes in Busan Port – cargoes which are supposed to be moved to Sydney Port – may cause unavoidable delays in shipping and freight forwarding operations, which in turn results in the decline in performance of the entire logistics flows by delaying delivery of the product to the final customer.

FIGURE 4.3 Global coverage of port/terminal operators



Therefore, the common and fundamental requirements for the maritime operators may be improving operational efficiency and service effectiveness so that they can realize greater customer satisfaction. As a result, the higher maritime logistics value may facilitate the higher performance of both individual maritime operators and the entire logistics system. In this sense, enhancing the maritime logistics value may be regarded as a significant strategic consideration that maritime logistics operators should take on board in their daily operations and management. Today's maritime operators, who are at present facing many business environmental challenges, should be in search of a new strategic option which enables them to develop their capability to realize a more efficient operation and more effective service, while at the same time diminishing the environmental uncertainty.

Concluding remarks

This chapter outlines the concept of maritime logistics and its value, and discusses strategic significance of maritime logistics value in today's maritime operations within the context of global logistics and supply chains. As reviewed in this chapter, maritime logistics is a system which encompasses all the activities involved in both maritime transport and logistics management. The maritime logistics value, the value created from the maritime logistics system, can be maximized when maritime logistics operators offer their services in the most efficiency and effective manner. As it may contribute to the higher performance of both individual maritime operators and entire logistics system, maximizing the maritime logistics value has become one of the most significant strategic goals which maritime operators want to achieve.

In conclusion, this study can provide a meaningful insight into what constitutes a maritime logistics system and maritime logistics value, and the question of how maritime logistics value can be enhanced, by systematically defining those phenomena. However, despite the considerable research underpinning this study, its impact must be limited, as the concepts defined in this chapter have not been empirically tested. Future studies will need to rigorously analyse the validity of these concepts by collecting data from the maritime logistics field and statistically testing their appropriateness.

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Hinterland logistics and global supply chains

05

RICKARD BERGQVIST

Introduction

The hinterland transportation system enables load units to be transhipped between seaports and inland destinations. Some of the load units arriving at seaports are transhipments for other seaports, while others have inland destinations. The term 'hinterland' is often referred to as the effective market or the geo-economic space in which the seaport sells its services (Slack, 1993). A similar definition is presented by van Klink and van den Berg (1998) who define hinterland as the interior region served by the port. The logistics related to the hinterland involves many actors and activities, and requires intense collaboration and coordination to work effectively and efficiently. Hence, hinterland logistics and transportation have become a crucial part of ensuring an efficient supply chain.

From a seaport perspective, the nature and number of available hinterland services depends on its location and overall infrastructure. Some seaports enjoy possibilities for inland waterways, while others are limited to land-based modes of transport. Containerization, in combination with intermodal transport possibilities, has enabled the ports' hinterland to expand (Song, 2003). The increased hinterland of many ports has led to an intensified inter-port competition (Bergqvist *et al*, 2013; Cullinane and Wilmsmeier, 2011; Notteboom and Winkelmans, 2001). The complexity of hinterland logistics in combination with inter-port competition requires ports to be more proactive in their hinterland strategies. Hinterland connections have become part of the ports' distinct value propositions. Van Klink (2000, p 134) describes the importance of increased hinterland rail transport from a port perspective:

> Another way in which ports can exploit know-how in order to pursue their strategic goals is to participate in the development of a network of inland terminals within Europe. (…) By investing in inland terminals and participating in their operation, a sea port can establish itself in inland regions.

Hinterland logistics incorporates the hinterland transportation system and related logistics activities. Hinterland logistics should not be dealt with in isolation from the overall supply chain; rather, hinterland logistics has an important role in effectively and efficiently connecting large and more global, primarily sea-based transport networks with hinterland transport systems (Jensen and Bergqvist, 2013). Expansion of ports' hinterlands and potential for more effective and efficient hinterland systems, associated with better collaboration and coordination among actors in the supply chain, gives hinterland logistics an obvious role in designing and managing global supply chains. In order to better understand the current hinterland logistics systems, a short exposé of the history of hinterland transport is needed.

Before the 19th century, hinterland transport primarily consisted of sailing ships and horse-drawn wagons. During the 19th century, barge canal operations combined with horse or rail became more common, and there were even some early experiences with ITUs (intermodal transport units). One of the first experiences of ITU was in England where it was used for the transport of coke between road carts, barges and railcars.

By the early 20th century, rail wagons were put on seagoing vessels and trucks on rail wagons. Intermodal transport began, but there were still a few systems that could carry a standardized load unit suitable for intermodal transport.

By the mid-20th century, the carrying of road vehicles by railcar, known as piggyback transport or trailers-on-flatcars (TOFC), became more widespread (see Figure 5.1). This method of transport was previously introduced in 1822 in Germany, and in 1884 the Long Island Railroad started a service of farm wagons from Long Island to New York City (APL, 2011). As TOFC caught on during the 1950s, the use of boxcars declined. One reason why TOFC become popular was the improved efficiency of cargo handling and the end of break-bulk handling. From the years 1957 to 1992, the number of boxcars in the United States decreased from about 750,000 to fewer than 200,000 (APL, 2011).

Parallel to the development of piggyback transport, a huge revolution had begun in maritime transport that would entirely change the world of shipping, namely, the introduction of the container.

FIGURE 5.1 TOFC, piggyback transport

SOURCE APL (2011)

The container revolution

The entrepreneur Malcolm McLean is often referred to as 'the father of containerization'. During the 1930s, he had the idea to rationalize the loading and unloading of ships. At this time he was a small hauler in the Port of Hoboken, New Jersey (GDV, 2011). His first ideas regarded loading complete trucks onto ships. The implementation of trailers and containers that could be handled by tractors enabled only the load unit to be transported, thus saving space and costs. Gradually the trailer was abandoned in favour of the container.

McLean met with great scepticism from the shipping community. As a result, he decided to become a ship-owner himself and started the company Sea-Land Inc. He sold his company during the late 1990s and the company now lives on as part of Maersk Sealand.

The first ship-to-transport container, often referred to in the literature, was McLean's ship *Ideal X*. This ship carried a transport of 58 containers from Newark to Houston on 26 April 1956 (GDV, 2011). Two years after McLean's innovation, the Matson Navigation Company's ship, the SS *Hawaiian Merchant*, introduced container shipping in the Pacific, carrying 20 x 24-foot-long cargo holders from Alameda to Honolulu (Raine, 2006; Matson, 2011). It took another decade before the first container shipping was introduced in Europe. Matson Navigation Company (Matson) was also

FIGURE 5.2 Matson Navigation Company Inc (Matson)

NOTE Founded in San Francisco, Matson developed an intermodal container freight system including trucks, trains and ships. The picture above illustrates a container on flatcar service (COFC). Reproduced courtesy of Matson Navigation Company Inc.

one of the first companies to systematically transport containers to hinterland destinations (see Figure 5.2). The development started during the late 1950s, and by the beginning of the 1960s, Matson constructed intermodal transport systems, including ships, trucks and trains.

The shipping community took notice of Matson's and McLean's initiatives, and containerized shipping increased and soon transatlantic container services were introduced. Since the US container size standers were difficult to apply in Europe, an agreement was eventually reached following intense negotiations. The results were ISO standards with lengths of 10-, 20-, 30- and 40-foot containers with a fixed width of 8 feet and a height of 8 feet and 8 feet, 6 inches.

From the beginning of the late 20th century until the present, there have been small innovations in technology and processes, refining initiatives during the mid-20th century. The main trends and innovations during this time have been:

- double-stacking of containers;
- trucks on rail wagons and associated techniques for loading and unloading;
- increased modal cooperation;
- development of inland terminals;
- unprecedented growth.

From this historical review, we can conclude that innovations can have a profound effect on the hinterland transportation system. At the same time, their impact can be hard to predict at first.

The next section introduces key concepts, definitions and characteristics related to hinterland transport. After the conceptual framework, the hinterland transport system is described in three sections related to design, strategy and management. A case study follows the hinterland transport system descriptions relating to the case of the Scandinavian Railport System. Reflections and analyses based on existing literature and the case study is then the basis for the following section on hinterland logistics and its influence on global supply chains. The final section summarizes key observations related to hinterland logistics and hinterland transport systems.

Conceptual framework

The design of hinterland logistics systems can be based on a number of concepts and technologies. This section introduces the most common concepts, definitions and technologies used in hinterland logistics. Transportation has a major role to play in the effective and efficient performance of the system right along the entire supply chain. The main components of the transportation system are:

- Modes of transportation. The most frequently used modes of transport in hinterland transportation systems are inland waterways, road and rail. The cost structure, operational characteristics and environmental impact of each mode of transport will be presented later in this section.
- Intermodal transportation. Intermodal transportation is defined by OECD (OECD, 2008) as: 'Movement of goods (in one and the same loading unit or a vehicle) by successive modes of transport without handling of the goods themselves when changing modes.'

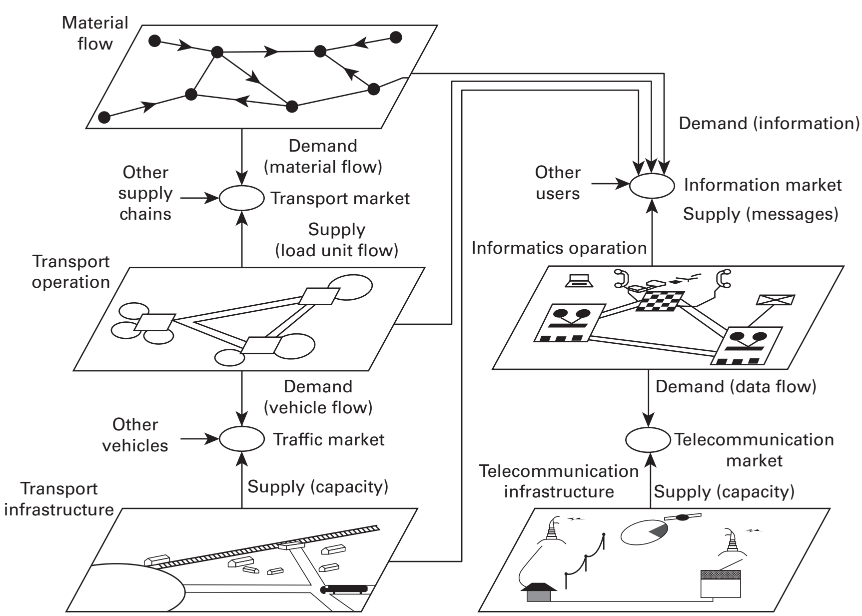
Other common terms within the concepts of intermodal transportation are:

- Multimodal: when more than two modes are used.
- Bimodal: strictly two modes of transport.
- Combined: the European Conference of Ministers of Transport (ECMT) defines this as 'Intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final leg carried out by road are as short as possible' (OECD, 2008).
- Rolling motorway systems: accompanied lorries on rail wagons, eg Eurotunnel.

- Piggyback transport: unaccompanied articulated semi-trailers on rail.
- Load units: a standardized unit for the consolidation of goods.
- Terminals: transport nodes for transhipment of goods.

The hinterland transportation system can be described with the help of the conceptual model developed by OECD (1992). According to this model, the transportation system consists of five layers: material flow, transport operation, information operation, transport infrastructure and telecommunication infrastructure (see Figure 5.3). In short, the material flow is consolidated and operated by appropriate means of transportation. In the traffic market, connections are made between vehicle flows, logistics service providers, and infrastructure capacity. The coordination and operation of material flows are supported by information exchange using telecommunication infrastructure. This model has been used by Bergqvist (2007), Hansen (2002) and Wandel and Ruijgrok (1993), for example, as a framework for analysing logistics structures and functions. The efficiency and accessibility of the transport system is determined by the efficiency of layers and the interconnections between layers.

FIGURE 5.3 The 5-layer model of a transportation system



SOURCE Modified from OECD (1992)

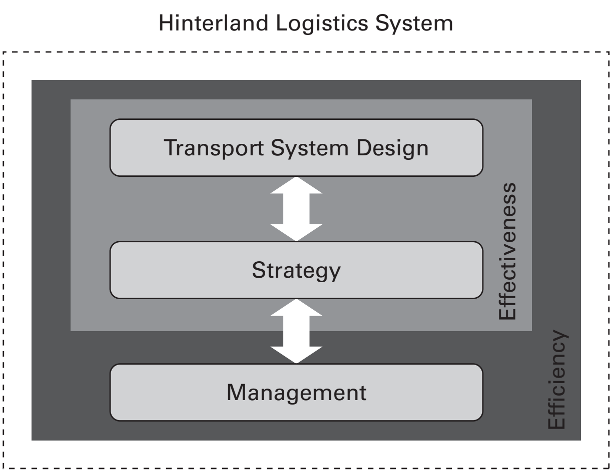
While OECD (1992) provides a conceptual model of the different layers of the transport system from a system perspective, it does not capture the actors' perspectives relating to the activities of design, strategy and management of the hinterland transport system. For that purpose, the following conceptual model (see Figure 5.4) has been developed (Notteboom and Rodrigue, 2005; Roso *et al*, 2009):

- transport system design: the infrastructure needs to be well developed and the transport system design and structure must fulfil the basic needs of the users;
- strategy: the services offered must be attractive to customers and correspond to the needs for movement;
- management: the actors in the system need to be well coordinated and the services well managed.

In summary, the issues of design and strategy determine the accessibility and effectiveness of the hinterland system. Adding the component of management to the system determines the overall efficiency.

Even though there are three separate activities, they are highly interdependent. The three components need to be developed simultaneously to ensure the overall efficiency and effectiveness of the system. If well developed, the system offers effective and efficient hinterland accessibility. Continued discussions related to hinterland transport systems in this chapter will relate to both conceptual models presented here.

FIGURE 5.4 Hinterland logistics systems: A conceptual framework



Hinterland transport systems and modes of transport

The goal of the hinterland transportation system is to achieve accessibility and overall cost-efficiency at required logistics quality. The transport system comprises modes of transport, in isolation or in combination. The achievement of cost-efficiency and logistics quality is very much dependent upon

TABLE 5.1 Cost structures and operational characteristics of different transport modes

Mode	Cost structure and operational characteristics
Air	Relatively low fixed costs and high variable costs. Variable costs include fuel, maintenance, security, airport fees, etc. The main operational characteristics are high speed and limited loading capacity. Furthermore, intermodal combinations are required to reach shippers and receivers.
Road	From an infrastructure perspective, fixed costs are high, but from an operational perspective, road transportation is characterized by a high share of variable costs. Other significant characteristics are high flexibility, availability, speed, and frequency, but limited loading capacity compared with other modes of transport. It enables door-to-door transport and direct access to shippers and receivers.
Water	Medium level of fixed costs and low variable costs. Fixed costs include vessels, handling equipment, etc. Examples of variable costs are costs for staff, bunker fuel and maintenance. It's a high capacity mode of transport, and due to its high fixed costs, it is characterized by economies of scale. It usually does not offer door-to-door possibilities, and compared to other modes of transport, it can be regarded as slow.
Rail	High fixed costs and relatively low variable costs. High fixed costs are locomotives, wagons and handling equipment. Variable costs are mainly staff, fuel and maintenance. General operational characteristics are good speed, frequency and capacity. Intermodal combinations to reach shippers and receivers are usually required.
Pipeline	Very high share of fixed costs due to construction. Variable costs are mainly security inspections and maintenance. High reliability and capacity, but limited to special circumstances.

the possibilities for a good match between demand characteristics of the material flows and the design components of the hinterland transportation system; therefore, it is important to understand the characteristics of the different modes of transport. Each transport mode has different inherent cost structures and operational characteristics, as illustrated in Table 5.1.

Besides the general generic characteristics of the different modes of transport, it is also important to understand from a hinterland transport perspective that different geographical regions have substantially different prerequisites for the respective mode of transport. There are, therefore, substantial differences between regions and countries when it comes to the usage of the different modes of transport. Some of the differences can be explained by geographical conditions, but other important facts are regulatory aspects, status of infrastructure, and occasionally technology.

From a transport work (tkm) perspective, EU–27 extensively uses road transport. Japan has a similar situation, but compared to EU–27, Japan's geographical conditions make it more reliant on road transportation. The use of the double-stacking of containers, and hence more loading capacity, is one reason why the US has a larger share of rail transport compared to the EU–27. Various types of electrical systems, signalling systems etc in the European Union are other reasons why rail has a lower market share in the EU compared to other regions. Geographical conditions are, of course, a key for explaining the situation illustrated in Figure 5.5. However, the characteristics of the different modes of transport described in Table 5.1 apply for all regions. This emphasizes that the situation in the EU–27 would be very different if the transport system within the Union could be better harmonized.

Besides cost-efficiency, the importance of the environmental friendliness of transportation systems is increasing. The trend towards less-polluting transport solutions and the quest for sustainable transport is caused by a combination of customer demand and regulatory frameworks. The transport sector is one of the largest polluters, and stakeholders, especially policy-makers, aim to construct regulatory frameworks that will facilitate the growth of sustainable transport solutions. Figure 5.6 illustrates the share and development of CO_2 emissions among different sectors within the EU.

The demand for more environmentally friendly transport solutions has had a great impact on the design of the hinterland transportation system, both in terms of technology used and modes of transport applied. Inland waterways and rail-based transport have inherited economies of scale and usually perform better over longer distances, in terms of environmental impact, than the road-based transport system, given current technology and truck fuel. The environmental performance of rail-based transport is especially difficult to generalize since it varies greatly depending on the circumstances. As an example, the double-stacking of containers on rail is possible, commonly used in North America, and to some extent in China (Meng and Niemeier, 2000), while the infrastructure limitations of bridges and electricity lines makes this difficult in other parts of the world. Electrified railways are another key component for the environmental performance of rail. An

FIGURE 5.5 Freight transport in different regions

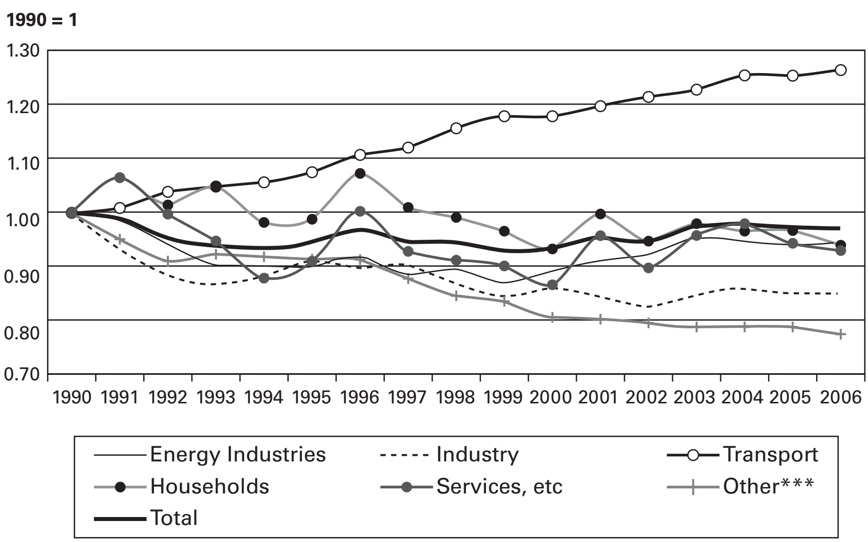
	FREIGHT TRANSPORT				
	EU-27	USA	JAPAN	CHINA	RUSSIA
billion tkrn	2011	2009	2010	2011	2011
Road	*1734.1*	1929.2	333.2(7)	5137.5	223.0
Rail	420.0	2309.8(6)	20.4	2946.6	2128.0
Inland waterways	141.1	406.6		2606.9	61.0
Oil pipeline	*118.6*	829.8		202.2(8)	2422.0
Sea (domestic / intra-EU-27)	*1407.7*	286.6	179.7	4935.5	77.0

NOTES

(1) **Japan:** data for passenger car, bus+trolley bus+coach and waterborne are from 2009.
(2) **USA:** including light trucks / vans.
(3) **Japan:** including light motor vehicles and taxis.
(4) **China:** including buses and coaches.
(5) **Japan:** included in railway pkm.
(6) **USA:** Class rail.
(7) Jt**apan:** 2009.
(8) **China:** oil and gas pipelines.

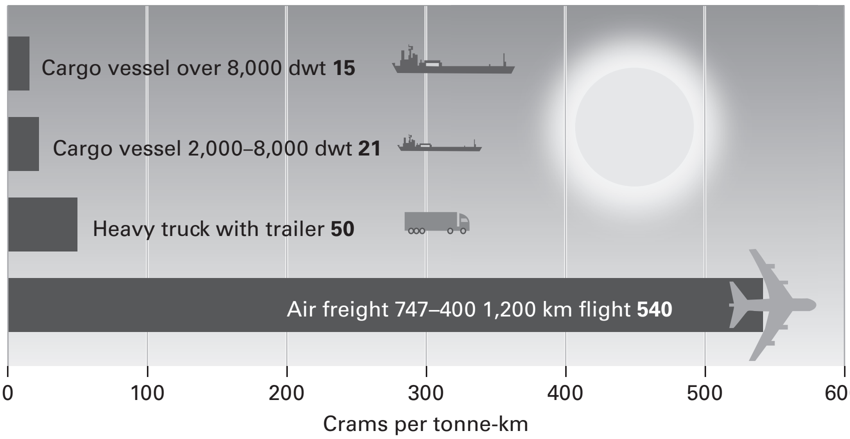
SOURCE European Commission (2013)

FIGURE 5.6 Emissions of CO_2 by sector



SOURCE European Commission (2010)

FIGURE 5.7 Emissions of CO_2 by transport mode



SOURCE Maritime International Secretariat (2006)

NOTE Rail is not included in this figure but would be similar or lower (depending on whether it is electrified or not) than the 8,000 dwt cargo vessel.

issue related to electrified railways is the source and production of electricity. Given the most favourable circumstances, where railways are electrified and electricity is produced with renewable sources of energy, the CO_2 emissions of traditional diesel-based rail are many times more than for electrified rail (g/tonkm) (Green Cargo, 2010; SJ, 2010). However, this does not mean that trucks are more environmentally friendly than diesel-based rail. On the contrary, trucks emit more CO_2, and more importantly, from a local and regional perspective, trucks emit more particles and NOx per tonkm. Figure 5.7 illustrates the environmental impact of different modes of transport.

Rail is not included in the comparison in Figure 5.7 but would be similar or lower (depending on whether it is electrified or not) than the 8,000 dwt cargo vessel.

Hinterland transport system design

The design of a transportation system aims at matching demand (material flows) with supply (infrastructure) by means of transportation. Choosing which transportation mode(s) to use is based on characteristics such as freight volumes, distance, time restrictions, product value, availability of services etc (Mangan *et al*, 2008). Consequently, the hinterland transport system design can be defined through its service components. The most important service components are described in Table 5.2.

TABLE 5.2 Service components of hinterland transport systems

Service component	Characteristics
Capacity	The amount of goods that can be shipped over a period of time.
Capability	The range of skills and abilities of the transport provider: available modes of transport, customs clearance, access to inland clearance deports, handling possibilities for load units such as refrigerated containers, bulky shipments etc.
Transit time	Transit time is a key component since it is determined at the time an order is placed and continues until the transport activity is completed. Transit time affects the overall lead time, and thus costs as well (tied-up capital etc). It also affects customer satisfaction when the transit time is part of the lead time for customers' orders.
Frequency	The frequency determines the overall availability of the service. The frequency, in combination with transit time and reliability, is often of special interest, since it influences the turnaround time for products and load units, and hence the number of load units needed and products tied up in transportation. The turnaround capabilities are especially important for reverse logistics.
Reliability	How reliable are the services based on variables such as time accuracy, frequency, downtime etc?
IT and communication	Another important issue is the available information technology and related interfaces for information exchange. When overlooked, it can have a substantial effect on the overall efficiency through decreased transparency of information and hence of the supply chain.
Value adding	Dry ports, ICD etc, warehousing, assembly and packaging.
Security	Traceability, fencing (geo-fencing).
Reverse logistics	How well does the system support reverse flows of products and package?

By combining different means of transport, intermodal transport chains are created. The rationale for connecting different modes of transport is that the inherited advantages of the modes can be safeguarded at the same time as the disadvantages are minimized. Road–rail intermodal transport chains, for example, can achieve cost-efficient and environmentally friendly transport over long distances, while road transport enables more flexible routing and final transport to the end-customer. In some instances the design of the intermodal transport chain is even more complex. Given the same example of the road–rail intermodal transport chain, there can be a parallel direct road-based door-to-door transport chain for transporting suitable volumes of door-to-door shipments. After completion of the direct door-to-door mission, the resources are used for pick-up and delivery from the terminal to the final customers. By doing so, an intelligent transport system design is created that applies the most suitable mode of transport with regard to the characteristics of the transport link.

Hinterland logistics: Strategy

The strategic component in the hinterland logistics system is characterized by the actors involved in the system and the logistics services they provide.

Logistics service providers

The logistics service providers involved in hinterland movements depend on the structure of the hinterland transport chain. In Table 5.3, three common hinterland transport chains are described based on the actors involved.

TABLE 5.3 Hinterland transport chains and involved actors

Hinterland transport chain	Actors involved
Barge-road	• Forwarder • Seaport operator • Barge operator • Inland port operator • Truck operator (Road hauler) • Shipper • Consignee
Railroad	• Forwarder • Seaport operator • Rail operator

(*Continued*)

TABLE 5.3 Hinterland transport chains and involved actors (*Continued*)

Hinterland transport chain	Actors involved
	• Intermodal terminal operator • Railroad authority/company • Infrastructure manager (eg for the inland terminal) • Truck operator (Road hauler) • Shipper • Consignee
Direct road	• Forwarder • Truck operator (Road hauler) • Shipper • Consignee

SOURCE van der Horst and de Langen (2008)

From Table 5.3 above, it is evident that intermodal transport services are more complex, since they require coordination with more actors than, for example, direct road services.

Openness and transparency

When evaluating hinterland logistics design, it is often necessary to choose either what is offered by logistics service providers in the market or construct one's own hinterland transportation system. There are several aspects to consider before making this choice.

The characteristics associated with services offered by existing logistics service providers are:

- *Open system*. The system might enjoy economies of scale as a result of many users. Many users may also contribute to the reliability of the system, since it is generally more robust against changes in the marketplace.
- *Easy implementation and start-up*. As a first-time user, it is very easy to begin using the service since it has previously been operational. There are well-developed routines and documentation for quality aspects such as transit times, reliability, security issues, etc (ie low risk)

- *No long-term contractual requirements*. The service can begin without being strategically bound to the provider for a long period of time. Overall, a larger degree of freedom exists to switch logistics service providers compared to a hinterland transportation system managed in-house.
- *Pricing*. The hinterland transport solution might have very low marginal costs due to, for example, economies of scale; however, this does not necessarily translate into marginal pricing. Given the nature of the business and transportation needs, this might be an incentive for managing one's own hinterland transportation system.
- *Power of negotiations*. The selection and choice of logistics service providers greatly influences the power of negotiations, a characteristic that can be skilfully utilized by clever strategies and negotiations. One strategic consideration to analyse is the number of carriers used and how they complement/compete with each other.

The advantages associated with designing and managing one's own hinterland transportation system are:

- *Closed system*. The choice can be made to open up the system for other users or not. This option can be very valuable when the strategic advantages of the hinterland transportation system are so large that it has a significant impact on the overall competitiveness and the distinct value proposition of the product/service.
- *Long-term commitments*. This solution often requires large investments in rolling stock, vehicles, locomotives, barges etc, which implies that it is a long-term commitment. There are exit possibilities through secondary markets, but these are often associated with significant exit costs. Furthermore, the investments made in human resources for designing, implementing and managing the system often generate a significant payback time.
- *Control/risk*. When a person manages a hinterland transportation system, he/she is in total control of costs, which can be crucial in a number of situations, such as if there is a significant risk of higher market prices of the hinterland services or if there are imbalances between supply and demand. The risks of highly fluctuating costs/prices for hinterland transportation can be limited if the owner controls the system and costs personally. Another important aspect is that the owner is able to control the issue of capacity.

The system can be totally tailored to one's specific needs. A self-managed system can be tailored according to timetables, load units, handling techniques, storage facilities, IT systems, etc. The option also allows for greater flexibility, eg frequency.

Hinterland logistics: Management

Only a few studies exist on coordination and management in hinterland transport (eg van der Horst and de Langen, 2008). However, the supply chain management literature has, for a long time, recognized the need to address challenges of coordination in inter-organizational settings such as hinterland transport systems. Van der Horst and de Langen (2008, p 3) identify four general factors that lead to coordination problems:

1. Unequal distribution of costs and benefits of coordination. If actors believe that there is an imbalance between contributions to the collaboration, eg in risk, investments etc as compared to the experienced benefits, there might be a lack of incentive for coordination and collaboration.
2. Lack of resources or willingness to invest. In collaborations where small firms are involved, it might be difficult to get the necessary financial commitment for investments which hinder coordination.
3. Strategic considerations. If competitors also gain benefits from improved coordination, actors might become reluctant to participate.
4. Risk-averse behaviour and short-term focus. If the implementation cost and efforts of the collaboration are high and the benefits uncertain, actors might be reluctant to engage.

These are important factors to keep in mind when setting up a logistics collaboration and relationship, such as designing and implementing a hinterland transport system, both in an informal and formal context, such as contractual agreements. Van der Horst and de Langen (2008) identify some general and mode-specific coordination problems in hinterland chains (see Table 5.4).

After identifying the important factors behind coordination problems and the common coordination problems in the hinterland transport chain, it is possible to link them together in order to identify suitable solutions for addressing the issues of coordination. A number of concepts can be applied for dealing with the most common coordination problems (van der Horst and de Langen, 2008; Bergqvist and Pruth, 2006):

- *Incentives*. By introducing incentives, the balancing of the collaborative structure is formalized, eg bonuses, penalties, tariff differentiation, warranties, capacity regulations, deposit arrangements, tariffs linked to cost drivers.
- *Formalization*. By formalizing the cooperation and linking the actors closer together, communication, trust and commitment are facilitated. Formalization of the cooperation limits risk on how uncertainties will be addressed by the actors in the cooperation. Examples of formalization include subcontracting, project specific contracts,

TABLE 5.4 Examples of coordination problems in hinterland transport chains

Coordination problem	Actors involved
General. Insufficient information exchange regarding container data makes planning more difficult	Shipping line, terminal operator at the seaport, forwarder, hinterland transport operator, inland terminal operator
General. Long-term planning horizon for hinterland terminal investments and development	Forwarder, inland terminal operator, hinterland transport operator
General. Introduction of new hinterland transport services requires a basic volume to which 'cargo-controlling' parties are unwilling to commit	Forwarder, shipping line, shippers
General. Insufficient planning on transporting and storage of empty containers	Forwarder, shipping line, customs, hinterland transport operator, inland terminal
General. Limited customs declarations, physical and administrative inspection causes delay	Forwarder, customs, hinterland transport operator
General. Limited planning for physical and administrative inspection between customs and inspection authorities causes delay	Customs and inspection services
General. Insufficient information about customs clearance of a container	Forwarder, customs, shippers
Truck. Peak load in arrival and departure of trucks at deep-sea terminals causes congestion and delays	Terminal operator at the seaport, trucking company, infrastructure manager
Truck. Lack of information of truck drivers leads to insufficient pick-up process at terminals	Forwarder, inland terminal operator, trucking company

(*Continued*)

TABLE 5.4 Examples of coordination problems in hinterland transport chains (*Continued*)

Coordination problem	Actors involved
Barge. Insufficient planning coordination of terminals and quays with respect to sailing schedules of barge and deep-sea vessels (increases crane utilization)	Barge operator, terminal operator at the seaport, forwarder, inland terminal operator
Rail. Peak loads on terminals, few terminal slots available	Rail operator, terminal operator at the seaport, forwarder, inland terminal operator, infrastructure manager
Rail. Limited exchange of traction and marshalling/shunting recourses	Rail operator

SOURCE van der Horst and de Langen (2008)

defined standards for quality and service, formalized procedures, offering a joint product/service, and a joint capacity pool.

- *Creating collective action*. Introducing public governance by a government, port authority, public–private partnership, branch associations, etc facilitates long-term focus and stability in a context that normally might be uncertain and unstable.

The next section provides a case study describing how the hinterland logistics system in Scandinavia, related to the functions of the Port of Gothenburg, was developed.

CASE STUDY Scandinavian Railport system

The development of integrated hinterland transport has been extensive in Scandinavia over the last decade. The Port of Gothenburg is the principal port in Scandinavia, and early on the port authorities recognized the importance of a well-developed hinterland transport system. The possibilities for transport using inland waterways are limited in Scandinavia, so focus was put on rail-based intermodal transportation. Currently, the hinterland transport system comprises 24 direct rail shuttles to inland terminals in Scandinavia (see Figure 5.8). The rail shuttles are operated by eight different rail operators, proof that competition exists in the system. Over the years, the number of shuttles and the frequencies of the shuttles have varied over time. Most services operate five to seven days a week, and the most frequent one, which supports H&M's central warehouse in Eskilstuna, operates 14 times a week in each direction. As the system has developed, so have the inland terminals. Some have developed sophisticated systems for information sharing, customs clearance, etc, and can be regarded as dry ports (similar functions are offered inland directly at the seaport).

FIGURE 5.8 Port of Gothenburg and its hinterland transport system as of March 2014

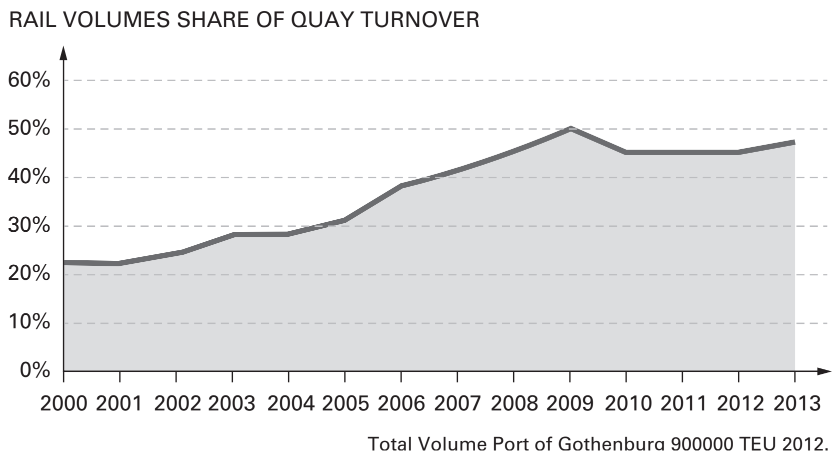
SOURCE Port of Gothenburg (2014)

Similar to the rail operations, the inland terminals are often operated by independent terminal operators, especially the largest inland terminals. The small terminals are generally operated by local logistics service providers.

Most rail shuttles operate over distances of 250–450 km. The shortest shuttle, about 10 km from the port, connects the port with a stuffing and stripping terminal.

The hinterland transport system moved approximately 400,000 20-foot equivalent units (TEU) in 2012 (see Figure 5.9), with a turnover of about €60 million (Bergqvist, 2009). The system originates from a decision by the board of directors at the Port of Gothenburg, stating that half of the growth in the container segment should enter or leave the port by rail. The system has developed beyond this goal. In 2012, the Port of Gothenburg handled about 900,000 TEU, which means that the hinterland transport system of rail shuttles has a market share of about 45 per cent. Containers dominate the systems, but there is a strong market interest in developing and incorporating more semi-trailers into the system.

FIGURE 5.9 Market share of hinterland transport system related to rail shuttles



SOURCE Port of Gothenburg (2014)

The system of rail shuttles is estimated to decrease the transport costs by approximately 10 per cent as compared with direct road transport (Bergqvist, 2009). The system also relieves congestion in the city of Gothenburg and decreases the carbon dioxide (CO_2) emissions by about 51,000 tons every year (Port of Gothenburg, 2011a). Furthermore, the system employs about 400 persons (Bergqvist, 2009). For their achievements and innovations related to the rail shuttle system, the Port of Gothenburg received the Schenker Award in 2008. The award is one of the most prestigious prizes related to the logistics industry in Sweden. The most recent development is the introduction of a five-level grading system of the inland terminals, managed by the Port of Gothenburg, to illustrate the assortment and level of services they offer. The rating is based on four parameters: conditions and geographical location, range of services, safety and security and physical layout (Port of Gothenburg, 2014).

The Port of Gothenburg expects the volumes and market share of the rail shuttle system to grow even further. Nevertheless, with a wider and denser geographical coverage of the hinterland, the hinterland transport system, with its rail shuttles and inland terminals, is running out of potential destinations. Until now, the Port of Gothenburg has been able to develop the hinterland transport system without any real competition from other ports. However, as ports in northern Europe look for ways to expand their hinterlands, the competitive interface of the hinterland may change.

Hinterland logistics and its influence on global supply chains

As already established early in this chapter, hinterland logistics and hinterland transport systems have become an important and integrated part of global supply chains. As shippers put more focus on logistics service providers and their ability to design not only efficient but also environmentally efficient supply chains with high logistics quality, the focus has expanded from the seaports to the hinterland. Well-designed hinterland transport systems alone are not sufficient. It is the hinterland transport system, in combination with the level of integration with the port, that is shaping hinterland logistics. This observation has far-reaching consequences for actors in the transportation system, especially the seaport. The competitive landscape is rapidly changing as the distinct value proposition of ports increasingly incorporates its hinterland transportation possibilities and capabilities. For the seaport, there are numerous strategic issues to address. What is desired by port customers in terms of hinterland transport services? What is their willingness to pay? What is offered by third parties in terms of services, and what should be offered by the seaport? Is it necessary to secure critical infrastructure and nodes? If so, what means are available and desirable, such as investments, ownership, franchise, mergers, acquisitions etc? The last question is especially interesting from a competitive point of view, as seaports, to a larger extent than before, engage themselves in inland affairs related to infrastructure investments, intermodal terminals, dry ports etc (Bergqvist and Monios, 2014).

From a societal point of view, this perspective is quite different to that of the seaports. On the one hand, increased interest in hinterland transport will probably lead to more investments, and an overall improvement in integration and coordination. However, the quest for competitive advantages in the hinterland may lead to decreased competition, if some seaport dominates, for example, intermodal transhipment possibilities by means of ownership and exclusive rights to using those transhipment terminal resources. Since the development in hinterland logistics is rapid, it is important that the regulatory framework, through its legislation and incentives, is designed so that both efficiency and accessibility are secured. Accessibility could, for example, be addressed by legislations allowing for third-party access, if any financial support for infrastructure is given by national or supra-national bodies (eg the EU). Individual countries address this issue differently, which is alarming since the effects are far more widespread than for an individual country. As seaport competition knows no country-specific boundaries, and hinterland transport has become a greater part of the seaports' competitiveness, there is an obvious risk that the hinterland regulatory framework affects the competitive interface and competitive equity between seaports.

Conclusions

As a shipper, the hinterland transport system is a crucial part of your supply chain. The modes you select, the supplier choice and the long-term perspective of your strategy are all important considerations when designing an effective and efficient hinterland transport system and supply chain strategy. In order to make the right considerations, it is important as a shipper to understand that hinterland logistics have unique characteristics and dynamics.

As a logistics service provider, the hinterland transport system is no longer an isolated part of the supply chain, but an integrated part of your total network and total offerings. An attractive logistics service provider must be able to manage both horizontal and vertical coordination and collaboration in the supply chain. Horizontal coordination is done by offering single, multiple and combinations of transport modes; vertical coordination is carried out by integrating different actors in the supply chain, such as hauliers, shipping lines, ports, terminals, infrastructure manager etc. Only by doing so is it possible to manage the inherent advantages and disadvantages of individual transport modes and manage the coordination challenges between actors.

In conclusion, hinterland logistics have become an integrated part of global supply chains and their management. An in-depth understanding and knowledge of hinterland logistics, and its unique conditions in each situation, are a crucial part of effective design and strategy regarding transport systems, and ultimately of efficient global supply chain management.

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Human elements in maritime logistics

06

CECILIA ÖSTERMAN AND ANNA-LISA OSVALDER

Introduction

Adventure and a will to engage in foreign trade have stimulated and advanced development, building and utility of ships and ports since time immemorial. Improved design of hull, propulsion and cargo-handling systems have continuously increased speed, capacity and reliability of sea transports. Simultaneously, efforts have been made to perfect manning both for onboard and onshore operations in order to optimize transportation costs (Ding and Liang, 2005; Stopford, 2009). Mechanization, automation, information and communications technology have made many manual tasks redundant, enabling ship and cargo-handling operations with a minimum of manpower. A striking example of the technological development is the world's largest container vessel, the *Emma Maersk*, which is 397 metres long and normally operated by a crew of only 13 people. She has a capacity equivalent of about 15,000 20-foot containers that can be moved at a crane rate of 30–40 containers an hour at leading container terminals.

However, there is an area of potential to acknowledge and develop in the effort to improve maritime logistics: the role of the human element and the interface between human and technology in the various man–machine systems in the global supply chain. As technological systems increase in complexity, the gap between the human operator and the system tends to increase as well. Operators have difficulties in understanding what the technological system does and correctly detect and assess problems (Osvalder and Ulfvengren, 2008). The gap between human and machine has led to a number of incidents and accidents over the years. One example is the container vessel *Savannah Express* whose collision with a linkspan at Southampton Docks in 2005 after an engine failure was caused by the operators not fully understanding the complex electronic control system for the main engine (MAIB, 2006). A similar incident occurred in 2006, when the product tanker *Prospero*'s loss of control of the podded propulsion system led to heavy contact twice with the jetty in Milford Haven; once forward and once aft (SHK, 2007). Neither of the incidents led to human injuries or loss of lives. While the *Savannah Express* needed only paintwork, the linkspan had to undergo major repair work before it could be utilized again, thus disrupting service at Southampton Docks. The *Prospero* was taken out of service for 10 days for subsequent investigations and repairs. The jetty was declared to be unusable and was closed for repairs. Due to the extent of the damage, a long-term restriction limited the berth's capacity from 165,000 to 100,000 deadweight tonnage. Further, the charterer subsequently declined to charter *Prospero* and her sister vessels again.

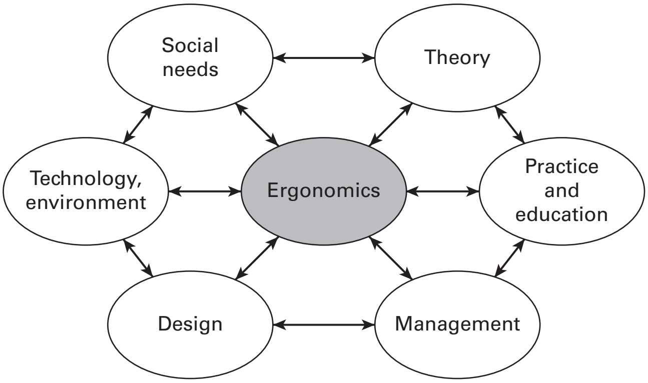
The area for potential improvements in maritime transport systems is also shown by the fact that despite significant changes of work – where many manual and physically demanding tasks have been replaced by more monitoring and operating of automated systems and machinery and more administrative work – the maritime domain still suffers from a high level of occupational accidents. Cargo handling in ports is considered one of the most dangerous tasks (HSE, 2008; AV, 2011) and work-related mortality for seafarers remains among the highest of all occupations (Roberts and Marlow, 2005). This high incidence of occupational accidents and injuries means that many individuals are afflicted with aches, pains and sometimes lifelong disability and relegation from the labour market, but it also means disruptions of output and heavy expense to businesses and the community.

Traditionally, the regulatory regimes surrounding maritime transport have focused on improving technical aspects of shipping, often driven by maritime disasters rather than through a proactive systems approach (O'Neil, 2003). The *Titanic*, *Herald of Free Enterprise*, *Estonia* and *Erica* are but a few of the catastrophes that have resulted in prescriptive measures, principally in the area of ship design and equipment. But, in November 1997, the International Maritime Organization (IMO) adopted a resolution acknowledging the human element as a complex multi-dimensional issue that affects maritime safety and the protection of the marine environment (IMO, 1997). Partly spurred by society's increased concern for sustainable development in terms of safety, well-being of people and a minimized impact on the environment, this resolution represents a move towards a more holistic approach to maritime transports. In this resolution, the human element involves every human activity performed by ships' crews, shore-based management, regulatory bodies, recognized organizations, shipyards, legislators and other relevant parties, all of whom are required to cooperate to ensure that human element issues are addressed effectively (IMO, 1997).

The human element in science and theory

The science of human activity and interaction with systems (machines, products, artefacts) is called 'ergonomics'. The aim is to fit systems, tools, machines and environments to the physical and mental abilities and

FIGURE 6.1 General dimensions of ergonomics



SOURCE Karwowski (2005)

limitations of people (Chapanis, 1996). As illustrated in Figure 6.1, ergonomics is a multi-disciplinary science, including a variety of dimensions such as social needs, theory, practice and education, management, design and technology/environment (Karwowski, 2005).

The word ergonomics derives from the Greek words *ergos* (work) and *nomos* (law) and can be translated as the science of work. Ergonomics as a scientific discipline was introduced in 1857 by the Polish scientist Wojciech Jastrzebowski (Karwowski, 2005), who proposed a broad scope of human activity, including labour, entertainment, reasoning and dedication (Jastrzebowski, 2006). Contemporary ergonomics is a fusion between the North American human factors and engineering psychology developed from military problems during World War II, and the European industrial applications for design of workstations and industrial processes (Helander, 1997).

The International Ergonomics Association (IEA) defines ergonomics (or human factors) as:

> the scientific discipline concerned with the understanding of interactions among humans and other elements of a system, and the profession that applies theory, principles, data and methods to design in order to optimize human well-being and overall system performance.
>
> IEA, 2011

With this definition, IEA calls attention to a holistic and systems-oriented approach embracing every aspect of human activity: physical, cognitive and organizational. The definition indicates both a social aim (human well-being) and an economic aim (overall system performance). Although there is no generally agreed definition of employee well-being, theory and research have focused on topics such as physical and mental health, job satisfaction, employee morale, stress, motivation, organizational commitment and climate (Grawitch *et al*, 2006).

Thus, ergonomics can be seen as an approach to ensure goals of improved system effectiveness, productivity, safety, ease of performance and the contribution to overall human well-being and quality of life (Karwowski, 2005). The systems view constitutes an established analytical view with some definite characteristics. A common core is that a system consists of a number of parts that are coordinated to achieve certain goals. The essence is not to know all there is about the studied system, but rather to understand the possible implications of our lack of comprehensive knowledge (Churchman, 1968). It is because we never know enough that understanding and critical judgement becomes essential, from an intellectual as well as a moral point of view. A core component of any system is people acting as users, operators, maintainers and so forth. Even a highly automated system requires people – in any case to start, stop and monitor the system. Often, users and operators also perform service and maintenance on the machines.

The term 'socio-technical system' refers to the inter relatedness of social and technical aspects when viewing an organization as an open system. The point of departure is a said lack of mutual understanding of the technical society. Engineers are said to ignore the social concerns of their work, and social scientists to ignore technology. In this respect, a systems model can be a tool to bring both sides together and portray both social and technical phenomena: the technization of society and the socialization of technology (Ropohl, 1999).

The areas of ergonomics

Within ergonomics, domains of specialization represent deeper competencies, often grouped in physical, cognitive and organizational ergonomics (IEA, 2011).

Physical ergonomics refers to anatomical, physiological, anthropometric and biomechanical characteristics related to human activity. Relevant topics include working postures, manual handling, repetitive movements, work-related musculoskeletal disorders, workplace layout, product design, safety and health. Physical ergonomics is also concerned with the physical work environment and how it might affect human performance, such as noise, vibration, light, climate, air pollutants and hazardous materials. These physical factors can interact with and aggravate risks of musculoskeletal disorders and have an adverse effect on mental health. Noise, for example, causes not only impaired hearing. Lower levels of noise can cause accidents when vital information is lost; noise is also closely linked to stress. Similarly, bad lighting conditions can lead to impaired vision and cause accidents due to an operational error, like pushing the wrong button. Poor lighting can also cause musculoskeletal disorders when having to compensate by assuming an unfavourable work posture.

Knowledge of the effects physical ergonomic factors have on humans is important when designing tools, machines, work tasks and environments to avoid harm and ensure necessary prerequisites for good performance. The human body is made for variation and motion, so an appropriate mixture of movements, loads and recovery is needed to sustain the functions of the body. While it is readily understood that heavy loads can have destructive effects on body tissue, it is equally important to avoid too low and static loads. Sedentary work, such as monitoring for a prolonged period, is unfavourable for the circulation and locomotor organs.

Cognitive ergonomics is concerned with mental processes such as perception (the process of interpreting information from our senses), cognition and motor response, as they affect interactions among humans and other elements of a system. The relevant topics include mental workload, decision making, mental performance, human error, human reliability, work stress and training. All these relate to the performance of the operator in a specific human–machine system. For example, when driving a car a driver has to look out through the windscreen, keep an eye on the mirrors and monitor the speedometer and GPS (the perceptive tasks). All this information has to be processed, interpreted and understood so that the driver can make appropriate decisions that then have to be performed (the cognitive tasks). In order to aid the driver – or any operator of a system – it is important to design tasks and machines to highlight the perceptual cues and minimize the cognitive load, but also to ensure adequate training and work schedules.

Organizational ergonomics is concerned with the optimization of socio-technical systems, including their organizational structures, policies, cultures and processes. The relevant topics include communication, crew resource management, teamwork, design of working schedules, participatory design, cooperative work, organizational culture, telework and quality management.

Effects on system performance and well-being

The effects of human element issues on overall system performance and well-being can be seen in several respects. Poor working conditions annually lead to negative monetary and non-monetary effects for individuals, companies and the society as a whole. In the EU member states it is estimated that costs due to work-related accidents vary from 1 to 3 per cent of gross national product (Mossink and De Greef, 2002). A number of models and methods have been developed to estimate the effects of ergonomics on company level. Some models and methods are generic, others designed for a special industry in mind; none however explicitly concerns the maritime domain (Österman *et al*, 2010). The studied effects mainly originate from improvements in productivity, efficiency and quality, as well as personnel costs associated with accidents, injuries and labour turnover.

In order for an organization to adequately plan operations and identify and prioritize strategies for performance improvements, it is important to monitor performance and discern the impact of decisions made and the level of goal achievement. Traditionally, performance measurements for management control are based on financial results, which assess historical outcome rather than assist in predicting future outcomes or identify underlying causes to variations in performance. In addition, financial performance measurements tend to be affected by economic trends. In this context, it is valuable to balance the financial measurements with non-financial measurements for productivity, efficiency and quality. These operative quantities should be measured together to make sure that improvements in one area have not occurred at the expense of another. And, returning to the twofold aim of ergonomics, the dimension of well-being should also be added.

Acknowledging that productivity losses can be caused by events outside the control of the ship or cargo-handling operator (eg force majeure, strike or war), three main causes for lost productive time at sea or in port are considered to be under the influence of the operating management in a logistics system:

- accidents or injuries;
- operational disturbances of machinery and equipment;
- inspections and potential subsequent detentions.

Accidents and injuries are always likely to have a disruptive effect on operations, both at the time of the accident or injury, and in the aftermath with potential subsequent internal and external investigations, repairs, replacement of personnel, training and familiarization of new personnel. According to the European Maritime Safety Agency (EMSA), loss of life and the number and cost of accidents remain significantly higher than 3–5 years ago. During 2008, 754 vessels were involved in 670 accidents, and 82 seafarers lost their lives on ships operating in and around EU waters (EMSA, 2009). The high occurrence of occupational injuries compared to other industries and the high costs for incidents involving crew members suffering from mental ill-health (NEPIA, 2006) indicate significant potential for improvements in this area.

Leading stakeholders within the maritime domain have stated that eroding knowledge and competence across the industry is a major cause for increasing accident tolls (Richardsen, 2008; Spencer, 2009). Supposedly, the reasons for insufficiently educated and trained seafarers are that competence is sacrificed for less expensive labour, but also lack of suitable mechanisms to ensure a globally implemented minimum standard for maritime training and control of competence (Ding and Liang, 2005). Lower manning levels on board do not necessarily pose a problem per se. However, in addition to the worldwide shortage of competent seafarers (estimates suggested a shortfall of 30,000 in 2010; Drewry, 2010) there is a risk that subsequent lower retention and faster promotion result in an eroded level of experience. At the same time, new technical solutions have been introduced that have resulted in increased complexity and reduced transparency of many operations. Complacency, automation-induced errors, out-of-the-loop unfamiliarity, behavioural adaptation and loss of skills are but a few commonly described problems with automation in the literature on ergonomics (Lee, 2006). These problems and their effects on safety have also been observed within the maritime domain (Lützhöft, 2004). Other important ergonomic factors known to cause accidents and injuries at sea include fatigue, situation awareness, communication, decision making, team work, health and stress (Hetherington *et al*, 2006).

Operational disturbances of machinery and equipment due to unplanned maintenance or breakdowns are costly both in direct costs for repairs and loss of available time for port, ship and technical and administrative functions ashore. According to the International Union of Marine Insurance (IUMI), machinery damage remains the primary cause for major partial losses of vessels, accounting for 35.5 per cent between 2004 and 2008 (IUMI, 2009). The Hanseatic Marine Underwriters state that the value of machinery claims doubled between 2004 and 2009 although the number of insured ships was stagnant. Among insurers, the causes for this trend include poor fuel quality, crew skills deficiencies, neglect of technical inspection by owners and managers, and the complexity of modern onboard systems that are not always fully understood, maintained or repaired.

Inspections by various constituents are frequent occurrences in maritime logistics operations. Depending on the executor, a failed vessel inspection can result in the ship, or ship operator, being disqualified for certain business opportunities, detention of ship, conditions or withdrawal of class, or a ban to enter certain ports. Coastal states around the world have founded regional cooperation groups, for instance the Paris and Tokyo Memorandum of Understanding (MoU), in which port state control officers (PSCOs) are authorized to inspect and under certain circumstances detain ships. During an inspection, a ship's various certificates are examined, but also the general condition of the ship, its engine room, accommodation and hygienic conditions. It is further checked that operations and procedures are conducted safely and in accordance with the various IMO Conventions; that the crew demonstrates sufficient proficiency and are familiar with critical procedures; and that crew members are able to communicate with each other and with other persons on board (Paris MoU, 2010). Deficiencies hazardous to safety, health or the environment can cause a ship to be detained, or only be permitted to proceed to the nearest repair yard until the deficiencies are rectified. In 2008, deficiencies were reported in 58 per cent of the inspections within the Paris MoU, and the detention rate amounted to 4.95 per cent. A major category of deficiencies were related to working and living conditions, representing almost 12 per cent of the deficiencies (Paris MoU, 2009).

Detention has several commercial implications, not only in possible loss of revenue and schedule disturbances, but also because necessary unplanned repair work undertaken at short notice is more expensive. Deficiencies and detentions within the Paris MoU are regularly made public in the web information system Equasis. Thus, even when the ship is not actually delayed, a failed port state control can reflect poorly on both ship and companies involved and can have commercial consequences for future employment for the ship. Ships with deficiencies get an increased ‘target factor’, which in turn leads to increased likelihood for future inspections. Potential charterers can assess the likelihood of the ship being inspected during their charter, and assess the cost of possible delays. Likewise a sub-standard ship may have difficulties obtaining insurance cover (Paris MoU, 2010).

Generally, quality is concerned with meeting specified requirements or standards and in order to improve quality, a company can focus either on the product (or service) or on the production process. Service quality is often described as a function of technical and functional quality and corporate image (Grönroos, 1984) and relates to how the service is delivered and to the customer’s confidence in those providing the service, including access, communication, credibility, empathy, reliability and responsiveness.

The impact of service quality varies across the different segments of sea transport services. Roughly, the technical quality of a ship depends on the quality of its design and build, along with the maintenance it has received since construction. The functional quality depends on how reliable the transport service is and how it is executed. Large shipping companies have developed beyond the pure sea transport service to become a one-stop-shop for logistics solutions.

Over the years, the public response to maritime accidents and marine pollution indicates an increased public interest in environmental and safety policies of companies. Consumer awareness can be turned into a powerful marketing tool for ship operators, contributing towards the quality of shipping. When it comes to environmental issues there are already mechanisms in place. The Clean Shipping Index, for example, is used by over 20 of Sweden’s largest cargo owners in their procurement processes in order to evaluate the environmental performance of shipping companies (Clean Shipping Project, 2011). The network includes for instance ABB, Ericsson, HandM and Volvo.

Human element issues relevant for the maritime domain

Table 6.1 illustrates how a number of human element issues relevant for the maritime industry can affect the outcome in terms of maritime and occupational accidents, injuries, operational disturbances and employee well-being. The analysis does not, however, pose as an absolute account, nor are the issues ranked in order of importance.

TABLE 6.1 Human element issues and their effects from a maritime perspective

Human element issues		Causes and effects	Outcomes		
			Accidents/ injuries	Operational disturbances	Well-being
Physical environment	Chemicals	Exposure to toxic and carcinogenic materials causing deaths as well as acute and chronic illnesses.	+	+	–
Physical environment	Noise	Noise-induced hearing loss.	+	+	–
		Non-auditory health effects interfering with sleep, communication and mental tasks requiring attention and concentration.	+		–
Physical environment	Vibrations	Ship motions causing slips, trips and falls (STF).	+	+	–
		Whole-body vibrations causing reduced cognitive performance and fatigue.	+	+	–
		Hand-arm vibrations causing vascular, neurological and musculoskeletal disorders (MSD).	+	+	–
Physical environment	Workplace layout	Poor design is a common cause of STF.	+	+	–
Physical load	Work postures	Strenuous working postures, manual handling etc, causing MSD.	+	+	–
Cognitive	Automation	Complex technology leading to increased attentional and cognitive demands.	+	+	–
		Over-reliance on machines leading to less effective monitoring.	+	+	
		Poor judgement in use of technological aids contributes to maritime accidents.	+	+	

(*Continued*)

TABLE 6.1 Human element issues and their effects from a maritime perspective (*Continued*)

Human element issues		Causes and effects	Outcomes		
			Accidents/ injuries	Operational disturbances	Well-being
Cognitive	Mental health	Psychosocial factors contributing to poor performance, accidents and mental disorders.	+	+	–
		Suicide rates found high for seafarers.	+	+	–
Cognitive	Work stress	Work at sea is associated with considerable stress; especially regarding relationships with others and the home/work interface.	+	+	–
		Many female seafarers experience sexual harassment and feel unsafe.			–
Organizational	Communication	Lack of situation awareness and poor team working.	+	+	–
		Social relationships, on board and ship–shore.	+	+	–
		Language problems.	+	+	–
		Lack of common language can contribute to feelings of isolation.	+	+	
Organizational	Work experience	Inadequate training and short–term contracts contribute to operational disturbances and high accident rates.	+	+	–
Organizational	Work organization	Poor organization of work and rest hours causing fatigue and alone work tasks.	+	+	–

An inherent potential for improvement can be found within the workplace layout and technical design. Many human element issues regarding the physical environment and physical loads are believed to be best solved if addressed early in the planning and design phase of a vessel, ensuring that the workplace design matches the tasks, capabilities and limitations of the expected users. Slips, trips and falls are common types of occupational accidents believed to be caused largely due to poor design of ladders and stairways with steep and various angles (Anderson, 1983; Hansen *et al*, 2002; Jensen *et al*, 2005).

Noise-induced hearing loss is one of the most recognized occupational diseases in the European Union (EU-OSHA, 2005), in seafaring (Kaerlev *et al*, 2008) and among dockworkers (AV, 2011). These rates have not declined over time. Importantly, noise is further known to cause non-auditory health effects, such as interfering with sleep, communication, and mental tasks that require attention and concentration. However, regulations for noise levels only take the auditory health affects into account, neglecting the change in work tasks that has taken place in shipping, where many physically demanding tasks have been replaced by more cognitively demanding and administrative tasks. Similarly, whole-body vibrations on board caused by wind, sea and propulsion – and in onshore operations from driving large cargo-handling vehicles – are known to cause fatigue in both ship structures and in the human body, leading to musculoskeletal disorders and reduced cognitive performance.

The workforce in contemporary sea transport services has largely altered from manual workers to knowledge workers, demanding a high level of concentration during planning, operation, monitoring and administration of work. With long working hours and the watch systems on board involving few hours of rest, there is a need for good quality sleep in order to recuperate. A systematic approach towards reduced noise and vibration levels in working and living quarters on board is believed to yield fewer personal injuries, but also contribute to efficient operation with less risk of use errors and accidents by stressed or fatigued operators losing concentration.

The increased use of complex shipboard technology for automation, navigation and communication has brought new cognitive and attentional demands for the human operators on board. Studies from aviation suggest that poorly designed automation may reduce workload under routine conditions, but can actually increase workload during stressful operations (Wiener, 1989). This phenomenon has also been seen in shipping where poor judgement in use of technological aids has contributed to several maritime accidents (Perrow, 1999). Over-reliance on machines can lead to less effective monitoring on the bridge (Lützhöft and Dekker, 2002), and poor design of advanced radars may even have increased the likelihood of collisions (Lee and Sanquist, 2000).

Stable crews returning to the same ship show reduced risk for accidents (Bailey, 2006; Carter, 2005; Hansen *et al*, 2002). These findings are consistent with research from other industry sectors covering a wide range of blue

TABLE 6.2 Indicators for personnel, productivity, efficiency and quality

Area	Examples of indicators
Personnel	Personnel composition such as age, education, certification, form of employment, length in service in company and in profession
	Working hours, overtime hours
	Personnel turnover
	Absence from work
	Work-related accidents and diseases
	Sick leave
	Rehabilitation cases
	Employees who have not been ill for a long period of time
	Training
	Job satisfaction, motivation
	Physical and psychosocial work environment
Productivity	Maritime and occupational accidents
	Incidents
	Operational disturbances, breakdowns
	Inspections
	Deficiencies
	Detentions
	Ban from port
Efficiency	Quantity (how much gets done)
	Quality (how well it gets done)
	Timeliness
	Multiple priorities (how many things can be done at once)
Quality	Customer satisfaction
	Damage to cargo
	Damage to vessel or cargo-handling equipment
	Corporate image

and white collar occupations, such as construction, healthcare, telecommunications and mining (Quinlan *et al*, 2001). Negative effects of poor work organization and crew composition include work stress, fatigue, mental ill-health, and a sense of social inequality that in turn can lead to increased risk for accidents, reduced performance and well-being (Carter, 2005; Hetherington *et al*, 2006, Parker *et al*, 2002). Essentially, most functions and work tasks at sea can be viewed as safety critical. Hence, poor performance, irrespective of cause, leads to increased risk for loss of lives and damage to environment and property.

Economic outcomes at company level

Both costs and revenues in a company are affected by human element issues. Costs traceable to human element issues include direct costs accrued from maritime and occupational accidents or injuries, such as medical costs, compensation payments and fines. In addition, there are also indirect costs related to damage to environment, cargo or equipment such as overtime, training and supervision of new tasks or new staff, employee turnover, reworking, and lost production time due to cautiousness and time spent discussing the accident with other employees. Conversely, revenues are positively affected by increased knowledge of the interplay between the human operator and the technical systems. In addition to the augmentation of the productive time that would follow a decrease in accidents and injuries, there is also a potential for increased efficiency of operations in terms of resource usage measurable in work hours, fuel, equipment and spares.

Substantial savings may be gained through proper design for maintenance of technological systems since as much as 80 per cent of a maintainer's time is spent in diagnosing a difficulty (Chapanis, 1996).

Table 6.2 exemplifies measurable indicators in the suggested areas of personnel, productivity, efficiency, and quality in the maritime domain. The suggested indicators can be further subdivided into quantifiable dimensions of absolute or relative numbers, percentage, time or value, but also in qualitative terms for perceived job or customer satisfaction, work environment or corporate image, for instance. Operationalized performance indicators such as these act as evaluation tools and information bearers, and signal a need for remedial measures, ergonomic or other, and constitute the foundation of business decisions.

Concluding remarks

The present chapter has addressed overall system performance and well-being in a maritime context. Further, the chapter has theoretically explored how these concepts can be operationalized and related to human element issues.

It is believed that increased knowledge of ergonomic principles can contribute to increased productivity, operational efficiency, service quality, and operator well-being in the maritime domain. The productive time at sea can be improved by addressing ergonomic factors that contribute to a minimum of unproductive days due to maritime and occupational accidents, operational disturbances of machinery and equipment, time-consuming inspections and potential subsequent detentions, or loss of business opportunities. Operational efficiency can be improved by addressing the organizational ergonomic factors that contribute to crew efficiency, such as organizational and managerial structures, communication, design of working times, and knowledge-creating processes. Technically, operational efficiency would benefit from a ship design that allows for more than just operability, and also takes into account the ship's maintainability, working conditions, habitability and survivability for a safe and efficient ship operation over time. Maritime service quality can largely be equated with safety. It is assumed that the self-regulating quality management systems in place today, especially within the liquid bulk segment, will continue to develop within other shipping markets. It is further assumed that the public awareness and pressure on shipping to deal with environmental issues will expand to encompass social and ethical issues such as fair working conditions.

The outcome can be measured in terms of individual, organizational and societal benefits. Individual benefits include reduced risk for occupational injuries, improved physical and mental health, and job satisfaction. Organizational benefits include improved productivity, efficiency, quality, personnel concerns – such as recruiting and retaining, reduced absenteeism and labour turnover – and liabilities. On a societal level, benefits include reduced costs for ill-health and accidents, and in a larger perspective a contribution towards an economically, environmentally and socially sustainable sea transport system and society as a whole.

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PART TWO
Shipping logistics

Intermodal freight transport and logistics

07

KATSUHIKO HAYASHI AND TOSHINORI NEMOTO

Introduction

As a consequence of containerization, maritime transport became integrated with land transport, and resulted in the provision of efficient intermodal transport. Intermodal transport that links factories and warehouses in many parts of the world in a door-to-door manner has become a crucial service for shippers such as multinational manufacturing companies that operate globally. Shippers believe that concentrating business resources on their area of expertise is competitively advantageous, and logistics outsourcing has increased. Intermodal transport is the focal service in the wide range of logistics services including storage, inventory control and packaging, and has produced added value to maritime services which makes it an important field in maritime research.

This chapter analyses global intermodal transport that combines maritime and other transport modes. The first section explains the concept of intermodal transport and its components and characteristics. The next section discusses the function of containers in the development of intermodal freight transport and logistics. The third section introduces typical global intermodal transport services with some examples in North America, Europe and Asia, followed by a section explaining the role of intermodal transport facilitators and their services. Finally, prospects and future issues are discussed by reviewing and predicting the development factors affecting intermodal transport.

Characteristics of intermodal transport

Transport using several modes has been called, almost synonymously 'intermodal transport', 'multimodal transport' and 'combined transport'.

The following discussion will describe the definition and the background from which each term emerged.

Definitions of multimodal transport

The responsibilities of shipping companies in international maritime transport are regulated by the Carriage of Goods by Sea Act enacted in each country, which was based on the Hague Convention, the Hague–Visby Rules, and the Hamburg Rules over a long period of history. As global intermodal transport developed, international agreements that include transport responsibilities during transit by land transport have likewise been expanded. The Convention on International Multimodal Transport of Goods (MT Convention) adopted in 1980 by the United Nations is one of these agreements (United Nations Conference on Trade and Development, 2001).

The MT Convention defines 'multimodal transport' as follows (Article 1 (1)):

> 'International multimodal transport' means the carriage of goods by at least two different modes of transport on the basis of a multimodal transport contract from a place in one country at which the goods are taken in charge by the multimodal transport operator to a place designated for delivery situated in a different country ...
>
> The main features of a multimodal transport are (1) the carriage of goods by two or more modes of transport, (2) under one contract, one document, and (3) one responsible party for the entire carriage, who might subcontract the performance of some, or all modes, of the carriage to other carriers. United Nations Conference on Trade and Development, 2001: 5

Definition of intermodal transport

In Europe, where there have been continued efforts over the years for regional integration, 'multimodal transport', 'intermodal transport' and 'combined transport' are introduced as follows:[1]

> Multimodal transport: Carriage of goods by two or more modes of transport.
>
> Intermodal transport: 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.
>
> Combined transport: Intermodal transport where the major part of the European journey is by rail, inland waterways or sea and any initial and/or final legs carried out by road are as short as possible. United Nations Economic and Social Council, 2000: 4

Furthermore, multimodal transport and intermodal transport might also be defined by comparing differences in their level of integration:

> Multimodal transport is characterized by essentially separate movements involving different transport modes, intermodal transport is the integration of shipments across modes. Intermodal transport may be defined as being those integrated movements involving at least two different modes of transport under a single through rate. Slack, 2001: 142

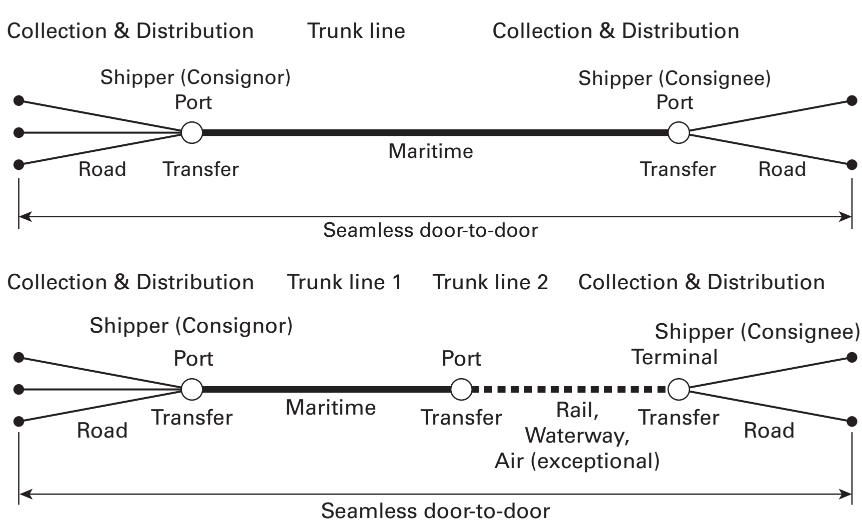
As shown above, the term multimodal transport was used originally in international maritime transport. However, in recent years the term intermodal transport has been used extensively, aimed at the integration of systems. In this chapter, intermodal transport is defined as seamless door-to-door operations using at least two different modes in an integrated manner.

Components of intermodal transport

In general, intermodal transport is composed of: 1) collection; 2) trunk line; and 3) distribution using standardized containers. The movement of goods takes place using different networks and at least two different transport modes. Maritime transport is the typical transport mode for trunk line while collection and distribution take place by road.

In cases of long-distance continental rail transport, the trunk line segment might use rail transport and inland water transport. In North America, efficient double stack train (DST) networks are utilized to transport containers from the ports on the West Coast to the inland areas and the East Coast.

FIGURE 7.1 Components of intermodal transport by sea, road, and another mode



In Europe, the use of rail transport and inland water transport, which are environmentally efficient, are being promoted. Recently in China an intermodal transport system using DST and inland water transport has been partially started (Figure 7.1).

The intermodal transport route might be significantly shorter than the maritime transport route depending on geographic location. When compared to the Asia/East Coast sea route that navigates through the Panama Canal, the Asia/East Coast mini-land bridge route passing the West Coast using the transcontinental trains can be shorter in terms of haul distance and transport time. Similarly, the haul distance of the Siberia land bridge using the Trans-Siberian Railway is shorter than that of the Asia/Europe sea route that navigates through the Suez Canal.

There is a special type of intermodal transport that combines air and sea transport which has distinctive characteristics. Because the air freight container can only be used between airports, transhipment of freight at airport facilities is necessary. This is different from other types of intermodal transport because common transport equipment is not utilized. During the time when air freight rates were much higher compared to sea freight rates, various combined air and sea services were seen between Asia and Europe. However, combined sea and air services have declined due to reductions in air freight rates brought about by intense competition among airline companies and the proliferation of large airplanes. At present, they are partially being used for emergency transport, and in cases when other airports are used to avoid airport congestion (ie Chinese cargo headed for Europe is transported by sea to Incheon Airport and transhipped there because of congestion at Beijing Airport).

Advantages of intermodal transport

For the shipper, the greatest advantage of intermodal transport is the possibility to easily employ seamless door-to-door transport. It is quite troublesome to arrange the use of separate and different transport modes, especially in foreign countries. For intermodal transport, even when an accident happens, the intermodal transport operator takes responsibility regardless of the transport segment. For non-intermodal transport, it is necessary to claim compensation from the transport company according to each segment.

One of the advantages of using intermodal transport is in consolidation, particularly in the longer-distanced trunk line move (OECD, 2002). Consolidation leads to economies of scale and the possibility to transport goods more economically. Figure 7.2 shows an example of costs for intermodal transport by sea and road. The cost for container vessels per ton-mile is generally lower than that for traditional vessels, and therefore, the slope of the line representing container vessels between ports (VC_i) is smaller than that for traditional vessels (VC_t). Furthermore, at container terminals, costs for loading and unloading containers (TC_i) are far lower than costs for traditional handling by manpower (TC_t).

The relationship of such traditional vessels with container vessels is very similar to the relationship between small and large-sized container vessels on transport costs, and between small and large-scale terminals on transhipment costs. Shipping companies introduce competitively large-sized container ships to reduce operational costs. On the other hand, container

FIGURE 7.2 Costs for intermodal transport by sea and road

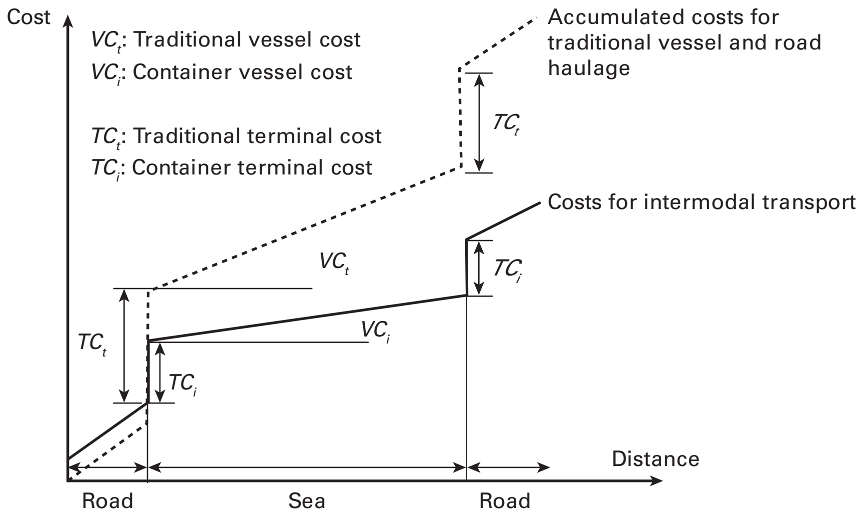
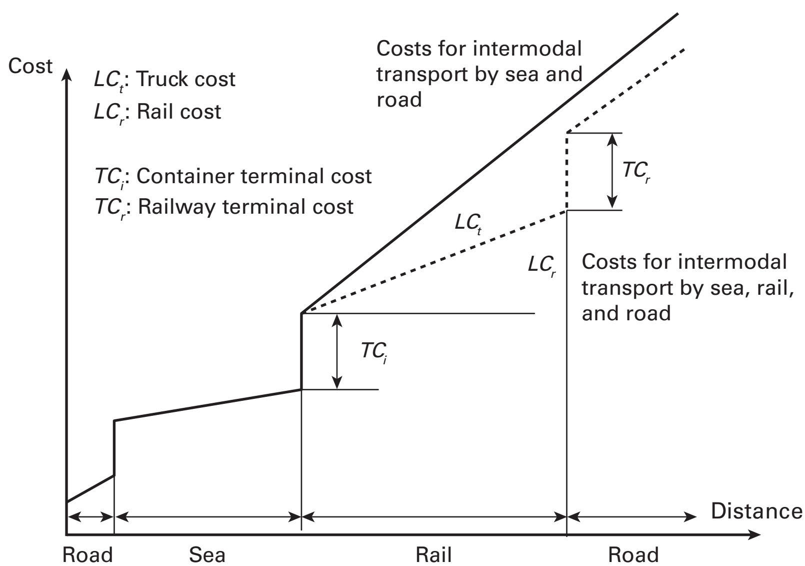


FIGURE 7.3 Costs for intermodal transport by sea, rail and road



terminals in many parts of the world compete to accommodate large-sized ships by expanding their berths and by introducing the latest large-scale gantries and mechanical handling equipment.

For longer inland transport distances, the use of rail and inland water transport becomes advantageous as both have lower transport costs. As shown in Figure 7.3, rail cost (LCr) is lower than truck cost (LCt). If the transport distance is adequate enough to accrue a saving which is more than the railway terminal cost (TCr), then a shift from road/sea/road to a combination of road/sea/rail/road becomes more economical. This shift has been proven to effectively reduce CO_2 emissions and improve the environment, which has become an important policy issue.

Containerization and intermodal transport

Introduction of ISO container

Historically, intermodal transport using liner ships started as a bypass route using land transport before the opening to traffic of the Suez Canal in 1869 and the Panama Canal in 1914. Compared with the Cape of Good Hope (Africa) sea route, the British shipping company, Peninsular Steam Navigation Company, greatly reduced the number of days travel by way of the Mediterranean Sea, then transhipment at Alexandria (Egypt), then by land transport to Suez and by sea transport from Suez to Bombay (India). Similarly, the US shipping company Pacific Mail Steamship Corporation connected the various ports along the Pacific Coast and the West Coast of North America by using land transport between Panama and Colon.

Embarking on a modern intermodal transport system needed transport devices which followed international standards. Although various transport devices were already developed like transport containers and trailers, the pioneer who introduced the container connected with today's internationally standardized containers was Malcolm McLean, who was president of a trucking company. McLean conducted a transport experiment using containers, trailers, and a remodelled ship *Ideal X* to and from New York and Houston in 1956. Soon afterwards, Sea-Land Services Inc was established, regular container transport began, and intense competition took place because other shipping companies like Matson Line started similar services. They also began to ply container ships along international routes, and containerization of international maritime transport started. The world's major liner companies began to acquire container vessels and containerization began to spread rapidly (Levinson, 2006).

The most important benefit of containerization is in the reduction of terminal costs. Machine loading and unloading by gantry crane and straddle carrier has become possible by standardizing the size of the container. Manpower was greatly reduced, and loading and unloading was converted from a labour-intensive industry to a capital-intensive industry. As a consequence, dockworkers were deeply affected by unemployment.

The cellular structure of container ship has been designed to accommodate and load/unload the containers. It takes about one day to complete loading and unloading with the gantry crane, compared to about one week in a traditional cargo vessel. Economies of scale have dictated an upward trend in sizes of container ships. The first full container vessel at the end of the 1950s could load only 166 containers of 35 ft length. At the end of the 1970s, the maximum size of the full container vessels became the Panamax type container vessel – the maximum vessel type that can be navigated in the Panama Canal. Towards the latter half of the 1980s, the maximum vessel size became the 4,400 TEU class, which could not be navigated in the Panama Canal. At present, ultra-large container ships of the 14,000 TEU class have emerged, which have imposed the provision of large-depth quays and the installation of large-sized cranes.

International standards have been advanced through ISO (International Organization for Standardization). In 1961, the United States proposed as international standard the 8 ft width by 8 ft height by 10/20/30/40 ft length container dimensions. On the other hand, European countries proposed a height dimension that reflects local transport conditions of door-to-door transport and a standard of 6–7 ft in width. In 1964, the United States' proposal was approved as the international standard for intercontinental transport, and the European proposal was approved as the international standard for transport within the European continent. The basic standard dimensions were established during this time, although minor revisions were introduced afterwards. The dimensions of containers generally used today are the 8 ft width by 8 ft height by 8.5/20/40 ft length containers.[2] It can be stressed that the provision of an international standard in the early stages is one of the major reasons why containerization had developed so rapidly afterwards.

ISO containers on the road

The ISO container began to diffuse from sea to land. In the United States where the standard size of domestic road transport was the same as the ISO container, there were no serious problems in transporting maritime containers to inland areas. Although the heavier maritime containers had caused damage to roads, which required additional policy measures, intermodal transport expanded well compared with other countries.

On the other hand, adjusting the domestic standards to the ISO container size became a big issue in European and Asian countries. The benefits of intermodal transport cannot be achieved if the trucks with ISO containers cannot pass through on domestic routes. Cargo has to be transported from/to the container terminal in a smaller truck after/before container de-vanning/vanning there. In Europe, they deregulated the maximum dimensions of trucks and improved the major road network in order to accommodate trucks with an ISO container.

The road infrastructure in Japan at the beginning of containerization lagged behind compared with that in the United States, and vehicle standards were smaller and lighter. Moreover, customs clearance was carried out in the bonded area adjacent to the ports. Because of this, vanning and devanning of containers were performed at the ports. However, high-standard highways to accommodate larger trucks loading an ISO container have been gradually developed, and bonded transport became possible through the installation of inland bonded areas and other improvements in the customs clearance system.

Industrialization advanced rapidly in Asian countries mainly through export expansion, where the number of containers handled has been increasing faster than in other parts of the world. Along with it, most governments seem eager to develop port-related infrastructure. In China, for example, they developed new container terminals and expressway networks to the terminals, and they are also planning to combine railway systems. In other Asian countries, there are many cases in which infrastructure development cannot catch up with economic growth, and congestion at ports and on roads has become a chronic problem.

Development of intermodal transport

North America

From the initial stages of containerization, intermodal transport using railway had remained limited even in North America because of severe restrictions by the Interstate Commerce Commission (ICC) and competition with truck companies. However, when railway regulation was eased by the Staggers Rail Act in 1980, railway and shipping companies began to work cooperatively on intermodal transport. Shipping companies started to reserve spaces from the railway company, stack up two levels of containers on the train (double stack train), and began transporting them from the West Coast to inland areas. The DST may reach as much as one mile in total length with a capacity of about 400 TEU with excellent transport efficiency. Compared with the old train system, transport costs are reduced by about 35–40 per cent.

Intermodal transport using DST takes pride in its perfectly seamless, door-to-door transport system. DST is reserved according to a specific day of the week of the ship's arrival, operated and loaded in a short time using large-sized loading machines at the on-dock freight station adjacent to the port. To resolve trade friction with the United States in the 1980s, Japanese automotive companies located their factories in inland areas, and intermodal transport using DST was utilized to transport imported auto-parts.

TABLE 7.1 Main intermodal transport to North America

Service	Route	Transit time (days)
MLB (mini-land bridge)	Asia == west coast port – east coast/ Gulf (vessel) (rail)	15–18
IPI (interior point intermodal)	Asia == west coast port – inland (vessel) (rail, truck)	22
RIPI (reversed point intermodal)	Asia == east coast port – inland (vessel) (rail, truck)	24

SOURCE Ocean Commerce (2009) *International Transport Handbook*

This intermodal transport has been called the 'belt conveyor that stretches across the sea', and is an advanced transport service to realize international just-in-time (JIT) transport.

Intermodal transport services offered by shipping companies include MLB (mini-land bridge), IPI (inland point intermodal) and RIPI (reverse inland point intermodal). MLB is a service that provides freight transport to the US East Coast using transcontinental railway after having been transported to the various ports of the US West Coast by container ships. Transport distance to New York is reduced by 2,200 miles compared with via the Panama Canal, and the number of days for transport can also be shortened to about 7–10 days. MLB is the oldest service started in 1972, and DST has been in operation since 1984. Each shipping company introduces exclusive DST matched to the specific ship and competes by reducing transhipment and transport time (Ocean Commerce, 2009).

For freight going into the inland areas of the United States, there is the IPI, which passes through the US West Coast, and the RIPI, which passes through the US East Coast. In 1980, the West Coast shipping alliance started IPI, and in retaliation, the East Coast shipping alliance started RIPI. As the size of most ships is getting larger and over-Panamax, which cannot navigate through the Panama Canal, IPI occupies the majority of transport to inland areas at present.

Europe

In Europe, intermodal transport using railway or inland waterway was limited in the earlier stages of containerization. Before the integration of the market in Europe, rail freight transport had been exclusively carried out by the national railways of each country. International transport of ISO containers was conducted by the international rail company (Intercontainer) jointly managed by the national railways. However, with the implementation of railway reforms due to regional integration, it became possible for private freight railway companies to use the rail infrastructure and conduct operations. In addition, the EU has promoted the provision of the Trans-European Network (TEN), and the implementation of support policies for intermodal transport under the Marco Polo Programme in order to address environmental problems (EC, 2009).

These policies have helped improve intermodal freight transport using rail. In Rotterdam port, which is the biggest gateway in Europe, 200 shuttle services a week arrive and depart from/to various parts of Europe including East and Central Europe, and 11 per cent of the handled containers is transported by rail. Through the support of the EU, a German industrial zone was directly connected with a cargo-exclusive line that was opened in 2007. In Hamburg port, which is the second major port in Europe, 200 shuttle services a week arrive and depart and 18 per cent of handled containers travel by rail transport. One of the operators is the subsidiary railway company of Hamburger Hafen und Logistic AG (HHLA), which is the operator of the container terminal. Although it is difficult to introduce DST because of overhead wirings and tunnels in Europe, intermodal transport to inland areas has progressed by establishing efficient railway shuttles.

Inland water transport using rivers and canals also became an important intermodal transport mode in Europe. Promoting the utilization of inland water transport was regarded as important in the TEN infrastructure plan and the Marco Polo Programme. In the Port of Rotterdam, river transport using the Rhine has been vibrant and inland water transport accounts for 30 per cent of the handled containers. In other major container ports located in the mouth of rivers, inland water transport has become an important intermodal transport mode. Connecting the Rhine and Danube by canals is being examined as a future transport route to East and Central Europe.

Asia

For rail freight transport in Japan, because the original 12-ft standard container was being adopted, it was necessary to provide infrastructure that accommodates the large-sized ISO containers, together with wagons and handling equipment. Even though they made some efforts to transport ISO containers at the major arterial networks, traffic volume has not increased that much. One reason why it is difficult to achieve modal shift is that there is not sufficient demand for long-distance transport because of limited land area. Some other reasons include contradictory policies with negative impacts on intermodal transport such as the eradication of railroad crossings going to the ports to ease road congestion.

In China, railway plays an important role as a transport mode for long-distance inland transport, while they face stringent capacity constraints because of huge transport demands for oil, coal, minerals and grains. The Chinese government concentrates on container transport using railway, arranges the container stations in the whole country, provides five fixed-freight trains (with fixed arrival and departure stations, railway routes, operation numbers, arrival and departure times and fares), and constructs railway infrastructure along the major routes. Since 2004, the DST operation of a 160 TEU per train has begun on the arterial network to increase the transport capacity of each train.

Inland water transport has been actively used in China. Its applicability is especially high in the Yangtze River and Pearl River Delta, and the provision of container terminals at inland areas is being promoted. Along the Yangtze River they can transport over 2,000 km to inland Chongqing and Sichuan using small container ships. A stable service has become possible with the completion of the Three Gorges Dam. Intermodal transport using the Yangtze River has become an important transport mode to the companies located in the inland areas.

Because there are only a few rivers that can be used and rail infrastructure is insufficient in other Asian countries, intermodal transport using these systems is quite limited. However, demand for intermodal transport in the region is expected to increase due to the regional integration of Asia and industrialization of inland areas in the future, although industries have been concentrated at the coastal areas until now. Therefore, the provision of an international intermodal transport in other Asian countries is now being explored.

Combined transport operators and their services

Intermodal transport facilitators

The company who presides over intermodal transport is defined in the MT Convention as the MTO (multimodal transport operator) although it can also be called the CTO (combined transport operator). Various companies including shipping companies, forwarders, consolidators, shipping associations, terminal operators, railway companies and truck companies provide intermodal transport services. However, it is the shipping companies and forwarders who develop large-scale intermodal transport globally.

Today, intermodal transport has become an important factor in the integrated logistics services of shipping companies. The shipping company ties up with the railway company to construct a seamless intermodal transport system using DST in North America. This effort is an example of vertical integration through capital tie-up or strategic partnership. With the easing of railway regulations in Europe, shipping companies have begun to invest in railways to expand intermodal transport.

Forwarders use the VOCC (vessel operating common carrier) space and perform maritime transport as a NVOCC (non-vessel operating common carrier). NVOCC is a business concept that was born out of deregulation in the United States, which allows the selling of sea transport services to shippers even if the ship is not owned. Forwarders provide various integrated services by freely combining sea and land transport. Even among the shipping companies, there are many cases in which they have established forwarders as subsidiaries to flexibly use the sea transport of other companies.

The main feature of this arrangement is in fulfilling the needs of shippers by flexibly combining the transport services of the shipping company and the land transport company. It is difficult for even large-scale shipping companies with land transport subsidiaries to fulfil all the complex needs of shippers only through the transport services the group companies could provide. On the other hand, it is likely that forwarders have higher communication costs with many companies, so they should be careful to monitor the whole intermodal process in order to avoid unnecessary further coordination.

Logistics services

As a response to the globalization of shippers, shipping companies and forwarders often set up in foreign countries. Through these overseas networks of logistics bases, intermodal transport services were developed all over the world. Important routes in terms of freight volume are from China and ASEAN to Europe and America. Various transport services have been developed according to shippers' demand, resulting in a global-scale intermodal transport network.

For instance, Nippon Express, one of larger global forwarders, has established foreign operations bases in more than 200 cities and developed many intermodal transport services to and from these bases. In order to manage these services as an organized network, the company has set up a special intermodal transport department that develops new services and information system such as cargo tracing and inventory management.

Shipping companies and forwarders offer not only intermodal transport services, but have provided various services as well such as packaging, warehousing and logistics processing. Furthermore, some of them are trying to provide third-party logistics (3PL) services responding to the advanced outsourcing needs of shippers. 3PL services consist of consulting and planning as well as offering comprehensive services from the shipper's point of view in partnership with the shipper.

In the case of procurement logistics services for global manufacturers, for example, 3PL providers could propose and manage the whole process of procurement. It collects parts from suppliers, packs them into containers, clears customs, transports containers to distribution centres abroad, manages inventory, and delivers to their factory just-in-time. In the case of services for the apparel industry, 3PL providers could inspect the products thoroughly, check remaining needles, and perform other logistics processing activities such as ironing and price tagging.

Towards the innovative intermodal transport

Development factors of intermodal transport

Shipping companies and forwarders have offered various intermodal transport services which link many parts of the world by means of different transport modes. The following summarizes the factors in the development of intermodal transport from both supply and demand sides.

From the supply side, it can be learned from history that containerization was the greatest factor in the spread of intermodal transport. Transhipment costs and time were reduced with standardized transport devices and intermodal transport became more efficient than single-mode transport. In addition, the increase in the size of container ships and improvements in port loading facilities have also contributed to the development of intermodal transport. Likewise, the provision of high-standard highways had expanded the transport coverage of large-sized trailers. For railways in the United States, DST and block trains were introduced and transport efficiencies to inland areas have been greatly improved. Inland water transport networks have also been built in Europe and China. For example, with the completion of the Three Gorges Dam in Yangtze, stable container transport to inland areas has become possible.

From the institutional aspect of the transport industry, deregulation penetrated the major countries which allowed easy entry of carriers and forwarders. The collapse of the Shipping Conference also introduced free entry and rate setting. Through efforts on service trade liberalization of WTO and FTA (Free Trade Agreement)/EPA (Economic Partnership Agreement), shipping companies and forwarders have likewise been positively affected as they can now enter the market abroad more freely and can also establish their own collection and delivery facilities in many parts of the world.

On the demand side, the locations of shippers have expanded to inland areas and their transport demands have extended from port-to-port to door-to-door. In Europe and the United States, foreign firms have located in inland areas in order to resolve trade frictions and penetrate the local market. Multinational companies pursue the best in locating their bases around the world and aspire for the most efficient transport between procurement, production, and sales bases. Moreover, accurate and prompt transport service is required in a JIT manner in order to reduce stocks. Intermodal transport which links inland bases suits such needs.

The future of intermodal transport

Let us now examine future of intermodal transport from the viewpoints mentioned above.

On the supply side, intermodal transport using the present ISO container is anticipated to grow, while revolutionary technological improvements such as 'containerization' are not expected to take place. As for the infrastructure for intermodal transport in the United States and Europe, improvements to accelerate further intermodality will be encouraged. For example, it is expected that transhipment facilities will be improved and bottlenecks such as missing transport links eliminated. In Asian countries, the provision of infrastructure corresponding to ISO containers which are larger than local standards is still a big problem. Although rapid infrastructure improvements have been observed in China and South Korea, immediate response is necessary in other countries.

From the institutional aspect, an open business environment has almost been provided in the major developed countries. In the developing countries restrictions on foreign direct investment and other non-tariff barriers including cross-border transport regulations remain, partly in order to protect the local logistics industry.

Cooperation among concerned countries including developing countries is indispensable to establish global intermodal transport. A consensus has been established in Europe on a common regional transport policy. Even in the United States, a common transport policy in the region is being proposed under the NAFTA cooperation framework. On the other hand, in Asia under the ASEAN cooperation framework, discussions on a common transport policy in the region are underway, although cooperation across a larger region that includes Japan, China and South Korea has remained limited in scope. It might be important among Asian countries to 'decide on an international transport infrastructure and intermodal transport system in a pan-Asian scale, upgrade logistics functions, reduce negative environmental impacts of traffic, and promote logistics security and transport safety' (Ono and Fukumoto, 2008: 35).

From the demand side, increasing sophistication of shippers' needs will dictate the future development of intermodal transport. Under a globalized environment, more varied alternative intermodal transport routes with a variety of costs and qualities (ie frequency) are required to meet the advanced shippers' needs. The shippers intend to optimize the widespread global supply chain, so that the solution should be logistics planning and operations from the viewpoint of 3PL where intermodal transport will play an important role in providing logistics alternatives.

Notes

1 These definitions are intended for the work of the three inter-governmental organizations, namely the European Community, the European Conference of Ministers of Transport (ECMT) and the UN/ECE.

2 The number of containers converted into 20-foot containers is called TEU (twenty-foot equivalent unit). A 40-foot container is equivalent to 2 TEU.

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Developing liner service networks in container shipping

08

CÉSAR DUCRUET AND THEO NOTTEBOOM

Introduction: Background on liner shipping

Container liner shipping has a relatively short history. In 1956 Malcolm McLean launched the first containership *Ideal X*. Ten years later the first transatlantic container service between the US East Coast and North Europe marked the real start of long-distance scheduled container liner services. The first specialized cellular containerships were delivered in 1968. In the 1970s the containerization process expanded rapidly due to the adoption of standard container sizes and the awareness of industry players about the advantages and cost savings containerization brought (Rodrigue and Notteboom, 2009; Levinson, 2006). Although container shipping occupies a relatively minor share of the whole maritime fleet (about 12 per cent), it is the fastest growing sector and currently concentrates more than half of world trade value, regularly expanding to other commodities (eg neo-bulks).

The world container traffic, the absolute number of containers being carried by sea, increased from 28.7 million TEU in 1990 to 152 million TEU in 2008 or an average annual increase of 9.5 per cent. Worldwide container port throughput increased from 36 million TEU in 1980 and 88 million TEU in 1990 to about 535 million TEU in 2008. A comparison between world container traffic and world container port throughput reveals a container on average was handled (loaded or discharged) three-and-a-half times between the first port of loading and the last port of discharge in 2008. In 1990 this handling figure had been three times. The rise in the average number of port handlings per box is the result of more complex configurations in liner service networks as will be explained later in this chapter. Furthermore, the centre of gravity of these liner service networks has shifted to Asia. The dominance of Asia is reflected in world container port rankings. In 2009, 14 of the 20 busiest container ports were in Asia, mainly in China. In the mid-1980s there were only six Asian ports in the top 20, mainly Japanese load centres. The emerging worldwide container shipping networks helped to reshape global supply chain practices and supported the globalization in production and consumption. New supply chain practices in turn increased the requirements on container shipping service networks in terms of frequency, schedule reliability/integrity, global coverage of services and rate setting.

This chapter analyses liner service networks as configured by container shipping lines. In the first section we discuss the drivers of and decision variables in liner service design as well as the different liner service types. Next, the chapter provides a global snapshot of the worldwide liner shipping network based on vessel movement data. The changing geographic distribution of main inter-port links is explored in the light of recent reconfigurations of liner shipping networks. Third, we zoom in on the position of seaports in liner shipping networks referring to concepts of centrality, hierarchy, and selection factors. The chapter concludes by elaborating on the interactions and interdependencies between seaport development and liner shipping network development notably under current economic changes.

Configuration and design of liner shipping services

The configuration of liner shipping services and networks

Liner shipping networks are developed to meet the growing demand in global supply chains in terms of frequency, direct accessibility and transit times. Expansion of traffic has to be covered either by increasing the number of strings operated, or by vessel upsizing, or both. As such, increased cargo availability has triggered changes in vessel size, liner service schedules and in the structure of liner shipping.

When designing their networks, shipping lines implicitly have to make a trade-off between the requirements of the customers and operational cost considerations. A higher demand for service segmentation adds to the growing complexity of the networks. Shippers demand direct services between their preferred ports of loading and discharge. The demand side thus exerts a strong pressure on the service schedules, port rotations and feeder linkages. Shipping lines, however, have to design their liner services and networks in order to optimize ship utilization and benefit the most from scale economies in vessel size. Their objective is to optimize their shipping networks by rationalizing coverage of ports, shipping routes and transit time

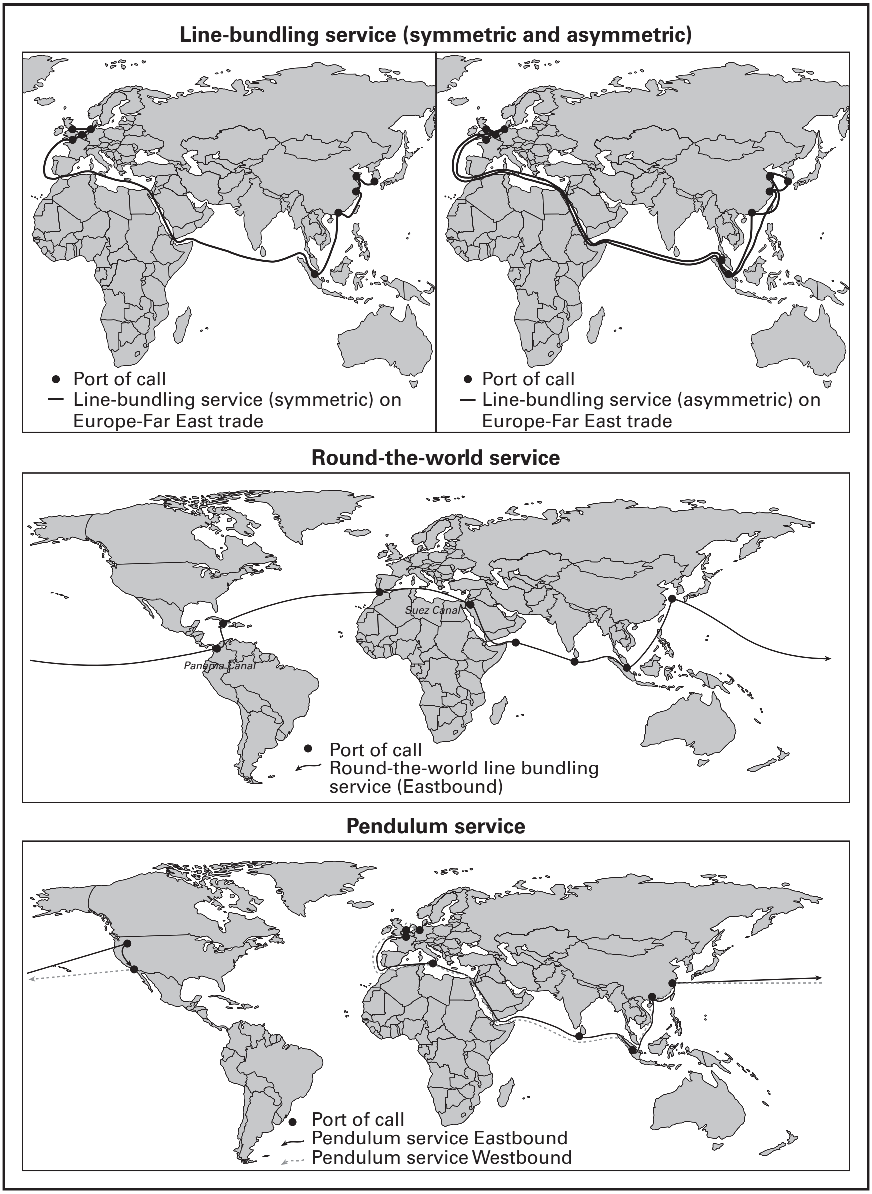
(Zohil and Prijon, 1999; Lirn *et al*, 2004). Shipping lines may direct flows along paths that are optimal for the system, with the lowest cost for the entire network being achieved by indirect routing via hubs and the amalgamation of flows. However, the more efficient the network from the carrier's point of view, the less convenient that network could be for shippers' needs (Notteboom, 2006).

Bundling is one of the key drivers of container service network dynamics. The bundling of container cargo can take place at two levels: 1) bundling within an individual liner service: and 2) bundling by combining/linking two or more liner services.

The objective of *bundling within an individual liner service* is to collect container cargo by calling at various ports along the route instead of focusing on an end-to-end service. Such a line-bundling service is conceived as a set of x roundtrips of y vessels each with a similar calling pattern in terms of the order of port calls and time intervals (ie frequency) between two consecutive port calls. By the overlay of these x roundtrips, shipping lines can offer a desired calling frequency in each of the ports of call of the loop (Notteboom, 2006). Line-bundling operations can be symmetric (ie same ports of call for both sailing directions) or asymmetric (ie different ports of call on the way back) (Figure 8.1). Most liner services are line-bundling itineraries connecting between two and five ports of call scheduled in each of the main markets. The Europe–Far East trade provides a good example. Most mainline operators and alliances running services from the Far East to North Europe stick to line-bundling itineraries with direct calls scheduled in each of the main markets. Notwithstanding diversity in calling patterns on the observed routes, carriers select up to five regional ports of call per loop. Shipping lines have significantly increased average vessel sizes deployed on the route from around 4,500 TEU in 2000 to over 8,000 TEU in early 2011. These scale increases in vessel size have put a downward pressure on the average number of European port calls per loop on the Far East–North Europe trade: 4.9 ports of call in 1989, 3.84 in 1998, 3.77 in October 2000, 3.68 in February 2006, and 3.35 in December 2009. Two extreme forms of line-bundling are round-the-world services and pendulum services.

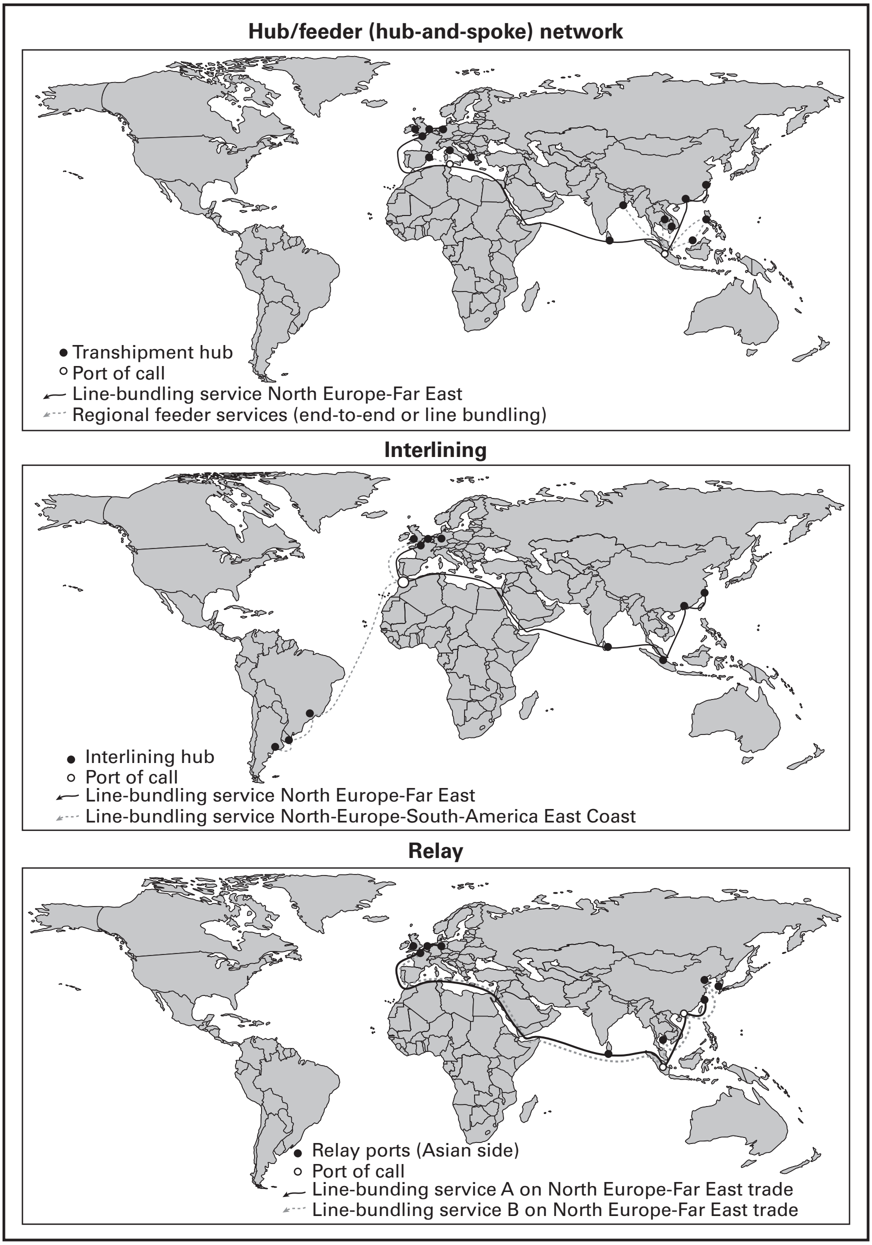
The second possibility is to *bundle container cargo by combining/linking two or more liner services*. The three main bundling options in this category include a hub-and-spoke network (hub/feeder), interlining and relay (Figure 8.2). The establishment of global networks has given rise to hub port development at the crossing points of trade lanes. Intermediate hubs emerged since the mid-1990s within many global port systems: Freeport (Bahamas), Salalah (Oman), Tanjung Pelepas (Malaysia), Gioia Tauro, Algeciras, Taranto, Cagliari, Damietta and Malta in the Mediterranean, to name but a few. The role of intermediate hubs in maritime hub-and-spoke systems has been discussed extensively in recent literature (see, for instance, Baird, 2006; Fagerholt, 2004; Guy, 2003; McCalla *et al*, 2005). The hubs have a range of common characteristics in terms of nautical accessibility, proximity to main shipping lanes and ownership, in whole or in part, by carriers

FIGURE 8.1 Bundling within an individual liner service



or multinational terminal operators. Most of these intermediate hubs are located along the global beltway or equatorial round-the-world route (ie the Caribbean, South-east and East Asia, the Middle East and the Mediterranean). These nodes multiply shipping options and improve connectivity within the network through their pivotal role in regional hub-and-spoke networks and in cargo relay and interlining operations between the carriers'

FIGURE 8.2 Bundling container cargo by combining/linking two or more liner services



East–West services and other inter- and intra-regional services. Container ports in northern Europe, North America and mainland China mainly act as gateways to the respective hinterlands.

Two developments undermine the position of pure transhipment/interlining hubs (Rodrigue and Notteboom, 2010). First of all, the insertion of hubs often represents a temporary phase in connecting a region to global shipping networks. Hub-and-spoke networks would allow considerable economies of scale of equipment, but the cost efficiency of larger ships might not be sufficient to offset the extra feeder costs and container lift charges involved. Once traffic volumes for the gateway ports are sufficient, hubs are bypassed and become redundant (see also Wilmsmeier and Notteboom, 2010). Second, transhipment cargo can easily be moved to new hub terminals that emerge along the long-distance shipping lanes. The combination of these factors means that seaports which are able to combine a transhipment function with gateway cargo obtain a less vulnerable and thus more sustainable position in shipping networks.

In channelling gateway and transhipment flows through their shipping networks, container carriers aim for control over key terminals in the network. Decisions on the desired port hierarchy are guided by strategic, commercial and operational considerations. Shipping lines rarely opt for the same port hierarchy in the sense that a terminal can be a regional hub for one shipping line and a secondary feeder port for another operator. For example, Antwerp in Belgium and Valencia in Spain are some of the main European hubs for Mediterranean Shipping Company (MSC) while they receive only few vessels from Maersk Line. Zeebrugge and Algeciras are among the primary European ports of call in the service network of Maersk Line while these container ports are rather insignificant in the network of MSC.

The liner service configurations in Figures 8.1 and 8.2 are often combined to form complex multi-layer networks. The advantages of complex bundling are higher load factors and/or the use of larger vessels in terms of TEU capacity and/or higher frequencies and/or more destinations served. Container service operators have to make a trade-off between frequency and volume on the trunk lines: smaller vessels allow meeting the shippers' demand for high frequencies and lower transit times, while larger units will allow operators to benefit from economies of vessel scale. The main disadvantages of complex bundling networks are the need for extra container handling at intermediate terminals and longer transport times and distances. Both elements incur additional costs and as such could counterbalance the cost advantages linked to higher load factors or the use of larger unit capacities. Some have suggested that the most efficient East–West pattern is the equatorial round-the-world, following the beltway of the world (eg Ashar, 2002 and De Monie, 1997). This service pattern focuses on a hub-and-spoke system of ports that allows shipping lines to provide a global grid of East–West, North–South and regional services. The large ships on the East–West routes will call mainly at transhipment hubs where containers will be shifted to multi-layered feeder subsystems serving North–South, diagonal and regional routes. Some boxes in such a system would undergo as many as four transhipments before reaching the final port of discharge. The global grid would allow shipping lines to cope with the changes of trade flows as it combines all different routes in a network.

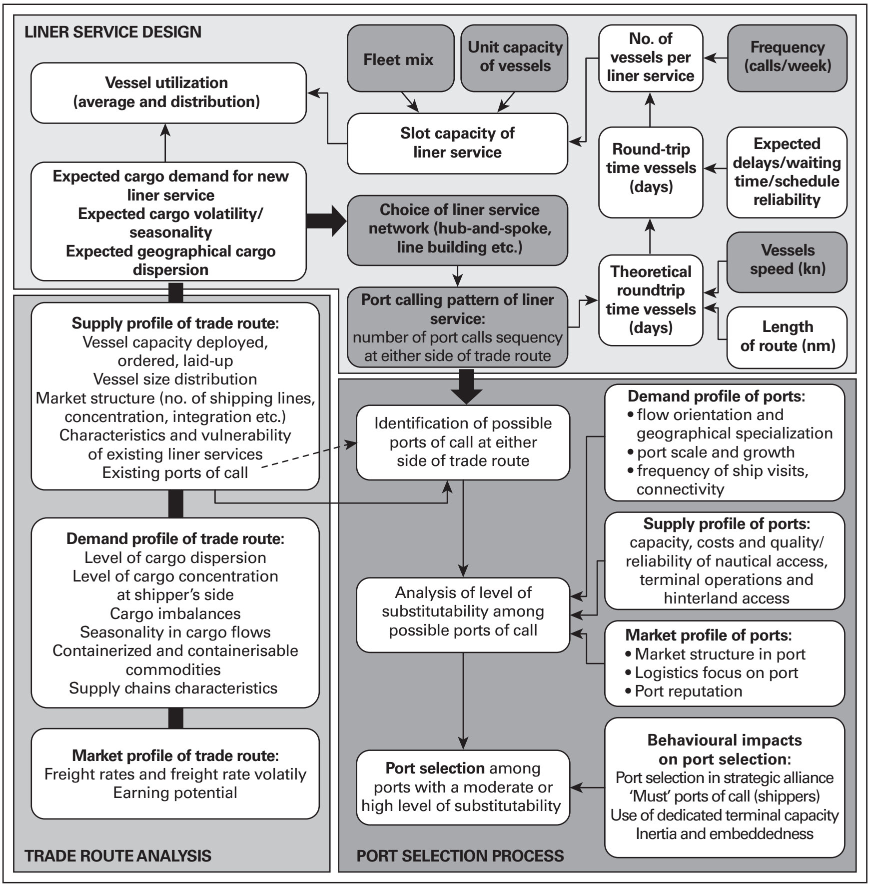
Existing liner shipping networks feature a great diversity in types of liner services and a great complexity in the way end-to-end services, line-bundling services and transhipment/relay/interlining operations are connected to form extensive shipping networks. Maersk Line, MSC and CMA-CGM operate truly global liner service networks, with a strong presence also on secondary routes. Maersk Line especially has created a balanced global coverage of liner services. The networks of CMA-CGM and MSC differ from the general scheme of traffic circulation through a network of specific hubs (many of these hubs are not among the world's biggest container ports) and a more selective serving of secondary markets such as Africa (strong presence by MSC), the Caribbean and the eastern Mediterranean. Notwithstanding the demand pull for global services, a large number of individual carriers remain regionally based. Asian carriers such as APL, Hanjin, NYK, China Shipping and HMM mainly focus on intra-Asian trade, trans-Pacific trade and the Europe–Far East route, partly because of their huge dependence on export flows generated by the respective Asian home bases. MOL and Evergreen are among the few exceptions frequenting secondary routes such as Africa and South America. Profound differences exist in service network design among shipping lines. Some carriers have clearly opted for a true global coverage, others are somewhat stuck in a triad-based service network forcing them to develop a strong focus on cost bases. Alliance structures (cf Grand Alliance, New World Alliance and CYKH) provide its members easy access to more loops or services with relatively low-cost implications and allow them to share terminals.

The process of designing a liner service

Figure 8.3 summarizes the liner service design process. Before operators can start with the actual design of a regular container service, they will have to analyse the targeted trade route(s). The analysis should include elements related to the supply, demand and market profile of the trade route. Key considerations on the supply side include vessel capacity deployment and utilization, vessel size distribution, the configuration of existing liner services, the existing market structure and the port call patterns of existing operators. On the demand side, container lines focus on the characteristics of the market to be served, the geographical cargo distribution, seasonality and cargo imbalances. The demand vs supply balance on the trade route results in fluctuations in the freight rate and overall earning potential on the trade.

The ultimate goal of the market analysis is not only to estimate the potential cargo demand for a new liner service, but also to estimate the volatility, geographical dispersion and seasonality of such demand. These factors will eventually affect the earning potential of the new service. Once the market potential for a new service has been determined, the service planners need to take decisions on several inter-related core design variables. These design variables are indicated in dark grey/shaded boxes in Figure 8.3 and mainly concern: 1) the liner service type; 2) the number and order of port calls in combination

FIGURE 8.3 The process of liner service design



NOTE Dark grey/shaded areas are decision variables in liner service design.
SOURCE Author's elaboration based on insights from Notteboom (2009) and Notteboom and Vernimmen (2009)

with the actual port selection process; 3) vessel speed; 4) frequency; and 5) vessel size and fleet mix. The array of liner service types and bundling options available to shipping lines was discussed in the previous section.

Limiting the number of port calls shortens round-voyage time and increases the number of roundtrips per year, thereby minimizing the number of vessels required for that specific liner service. However, fewer ports of call mean poorer access to more cargo catchment areas. Adding port calls can generate additional revenue if the additional costs from added calls are offset by revenue growth. The actual port selection is a complex issue. Traffic flows through ports are a physical outcome of route and port selection by the relevant actors in the chain. The most relevant service-related and cost factors explaining port selection by the main players of the transport chain (eg shippers, ocean carriers, and forwarders) are identified in the scientific literature on port choice: eg Murphy *et al* (1992); Murphy and Daley (1994); Malchow and Kanafani (2001); Tiwari *et al* (2003); Nir *et al* (2003); Chou *et al* (2003); Song and Yeo (2004); Guy and Urli (2006) and Wiegmans *et al* (2008). Port choice has increasingly become a function of the overall network cost and performance. Figure 8.3 incorporates the approach of Notteboom (2009) to group port selection factors together in the demand profile of the port, the supply profile of the port, and the market profile of the port. Human behavioural aspects might impede carriers from achieving an optimal network configuration. Incorrect or incomplete information results in bounded rationality in carriers' network design, leading to sub-optimal decisions. Shippers sometimes impose bounded rational behaviour on shipping lines, eg in case the shipper asks to call at a specific port. Wiegmans *et al* (2008) argue that port selection by shipping lines can also be heavily influenced by the balance of power among the shipping lines of the same strategic alliance, or the carrier's objective to make efficient use of its dedicated terminal capacity in specific ports.

The choice of vessel speed is mainly affected by the technical specifications of the vessel deployed (ie the design speed), the bunker price (see Notteboom and Vernimmen, 2009), environmental considerations (eg reduction of CO_2 through slow steaming) and the capacity situation in the market (ie slow steaming can absorb some of the vessel overcapacity in the market – eg Cariou and Notteboom, 2011 and Notteboom *et al*, 2010).

The number and order of port calls, the total two-way sailing distance and the vessel speed are the main determinants of the total vessel roundtrip time. The theoretical/optimal roundtrip time will seldom be achieved in practice due to delays along the route and in ports giving rise to schedule reliability problems. Low schedule integrities can have many causes ranging from weather conditions, delays in access to ports (pilotage, towage, locks, tides) to port terminal congestion or even security considerations (Notteboom, 2006). A shipping line can insert time buffers in the liner service to cope with the chance of delays. Time buffers reduce schedule unreliability, but increase the vessel roundtrip time.

When it comes to the service frequency, carriers typically aim for a weekly service. The service frequency and the total vessel roundtrip time determine the number of vessels required for the liner service. Carriers have to secure enough vessels to guarantee the desired frequency.

Given the number of vessels needed and the anticipated cargo volume for the liner service, the shipping line can then make a decision on the optimal vessel size and fleet mix. As economies of vessel size are more significant on longer distances, the biggest vessels are typically deployed on long and cargo-rich routes.

Decisions on all of the above key design variables will lead to a specific slot capacity offered by the new liner service. The resulting slot capacity should be in line with the actual demand so as to maximize average vessel utilization (given expected traffic imbalances, cargo dispersion patterns and cargo seasonality and volatility).

Shipping routes, network patterns and port centrality

The aforementioned services altogether form a global maritime network within which local, regional and global links among ports become interconnected through the establishment of hub, interlining and relay ports.

The distribution of container flows

The weight and growth of major trade routes measured in TEUs provides evidence about the imbalanced structure of the global liner shipping network based on the offer of services (Table 8.1). Their distribution confirms the predominance of the Europe–Asia link both in terms of weight and growth, closely followed by Asia–USA but with lower growth, while other links lag far behind in terms of the capacity deployed. This confirms the study by Frémont and Soppé (2005) of the global container shipping network through the mapping of the top shipping lines' service offers among world regions. They explain the dominance of Asia by the role of the Newly Industrialized Countries (NICs) that provide consumer goods to industrialized countries, thus intensifying trans-Pacific flows at the expense of transatlantic flows. They also calculated that in 2002, such relations among the main economic poles of the 'Triade' concentrated about 67 per cent of total service capacity, 22 per cent only remaining for North–South relations with these poles, and South–South relations being negligible in size.

A more precise method for measuring the weight of links is to trace the worldwide circulation of container vessels (Table 8.2). Each time a vessel calls at one port, its capacity in deadweight tonnage (dwt) is added to the port and to the inter-port link. The yearly total is thus an expression of the frequency and capacity of the links formed on various levels (ie ports,

TABLE 8.1 World's major trade routes in 2007

	Transpacific		Europe–Asia		Transatlantic	
Main route	Asia–USA	USA–Asia	Asia–Europe	Europe–Asia	USA–Europe	Europe–USA
Cargo flows (million TEUs)	15.4	4.9	17.7	10.0	2.7	4.5
Growth 2006–2007 (per cent)	2.8	3.0	15.5	9.0	7.3	1.6

SOURCE *Containerisation International*

TABLE 8.2 Distribution of inter-regional flows in 1996 and 2006 (million dwt)

Region	Oceania		South Europe		Latin America		Africa		North Europe		South & East Asia		North America	
Year	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006	1996	2006
Middle East	3	6	53	180	3	20	9	55	70	166	212	759	24	75
Oceania			8	24	4	27	8	16	16	46	116	336	18	62
South Europe					69	341	149	286	269	582	248	973	95	296
Latin America							23	102	177	418	111	570	282	737
Africa									142	154	78	269	11	38
North Europe											793	1439	316	461
South & East Asia													905	1707

SOURCE Author's elaboration based on LMIU data
NOTE Calculated based on direct and indirect calls between regions.

regions, continents) in an origin–destination matrix. One important aspect of the methodology is to have considered all ports of the same vessel voyage being interconnected, should they be or not adjacent calls in the sequence. This allows for a better view of the distribution of links and traffics.

The polarizing role of Asia appears even more explicitly, since most regions have their largest flow link directed to it at both years (Middle East, Oceania, North Europe, North America), or only in 2006 (Africa, South Europe, Latin America). In fact the latter regions have shifted their main traffic flow from North Europe, North America and South Europe respectively (in 1996) to Asia (in 2006), thereby illustrating the continuous influence of Asia on world trade patterns. Links can also be differentiated by their traffic growth rate in a descending order, confirming the faster growth of South–South linkages versus North–North and North–South linkages (albeit in smaller volumes than main routes):

- *Very fast growth* (over 500 per cent): Latin America–Oceania, Latin America–Middle East, and Middle East–Africa;
- *Fast growth* (over 250 per cent): Latin America–South Europe, Latin America–Africa, Latin America–South and East Asia, South Europe–South and East Asia, South and East Asia–Middle East;
- *Significant growth* (over 100 per cent): South Europe–Middle East, South Europe–Oceania, North Europe–all regions, South and East Asia–Oceania, South and East Asia–North Europe, North America–all regions;
- *Moderate growth* (100 per cent or less): Africa–Oceania, Oceania–Middle East, Africa–South Europe, North America–South and East Asia, South and East Asia–North Europe, North America–North Europe.

The importance of intra-regional traffic is estimated based on the sequences of calls that are internal or external to LMIU (Lloyd's Marine Intelligence Unit) regions. Such distinction provides a rough estimate on the extent to which different regions have different shipping dynamics. The intensity of intra-regional traffic in total traffic (Table 8.3) can be explained by various factors such as coastal morphology, the presence of hub ports, and the level of trade integration within the region. For instance, the low share of Africa and the Middle East in 1996 clearly reflects the lack of internal cohesion and integration, but the figure has changed dramatically in 2006, due to greater interdependency among regional ports. Shipping networks are thus a good indicator of trade and regionalization dynamics (Lemarchand and Joly, 2009). Regions with high internal connectivity through the extensive use of hub-and-feeder systems often have a high share of intra-regional traffic, such as Asia and North Europe, but also Latin America, which includes the Caribbean port system, whereas for North America, it is more the increase of multiple calls along the east and west coasts, notably with the shift of major container traffic and intermodal facilities to the South-east (eg Hampton Roads, Jacksonville, Miami).

TABLE 8.3 Share of intra-regional traffic in total regional traffic (% dwt)

Region	1996	2006
South & East Asia	69.8	70.6
Oceania	49.8	53.9
Latin America	59.1	57.1
North Europe	48.4	52.2
World average	**46.7**	**48.6**
Africa	34.7	46.5
South Europe	47.1	43.2
Middle East	32.4	33.3
North America	32.2	32.1

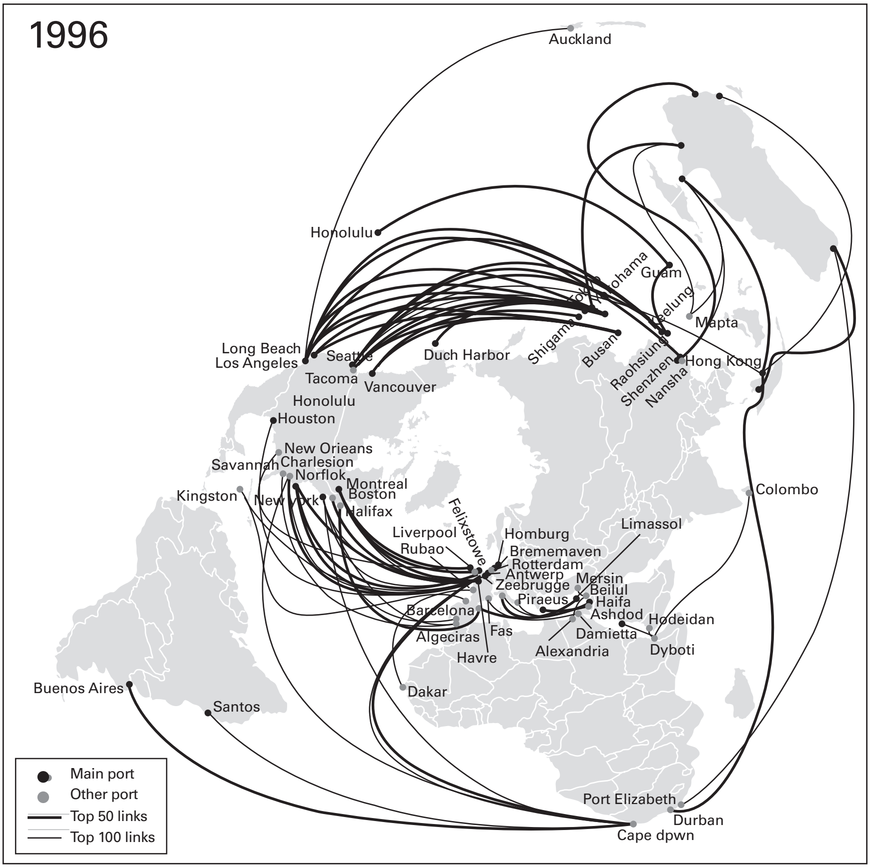
SOURCE Author's elaboration based on LMIU data

Topology and the role of distance

Although maritime transport does not use an infrastructure of tracks as in road or rail transport, Ducruet and Notteboom (2012) calculated that the overall length of the network using orthodromic distance doubled between 1996 and 2006, from 5 to 10 million kilometres. The length of the longest inter-port link has remained constant (10,000 km) but the average length has slightly increased from 1,000 to 1,200 km, as well as the traffic density from 331 to 407 TEU per kilometre. Such evidence validates the fact that shipping networks have constantly expanded geographically during this period. Although it goes beyond the boundaries of this chapter, it is important to note that 67 per cent of inter-port links made by container vessels also carried bulks or other commodities in recent years, thus illustrating the fact that the spatial distribution of liner shipping networks is not random or unique but very much path-dependent (Ducruet, 2013).

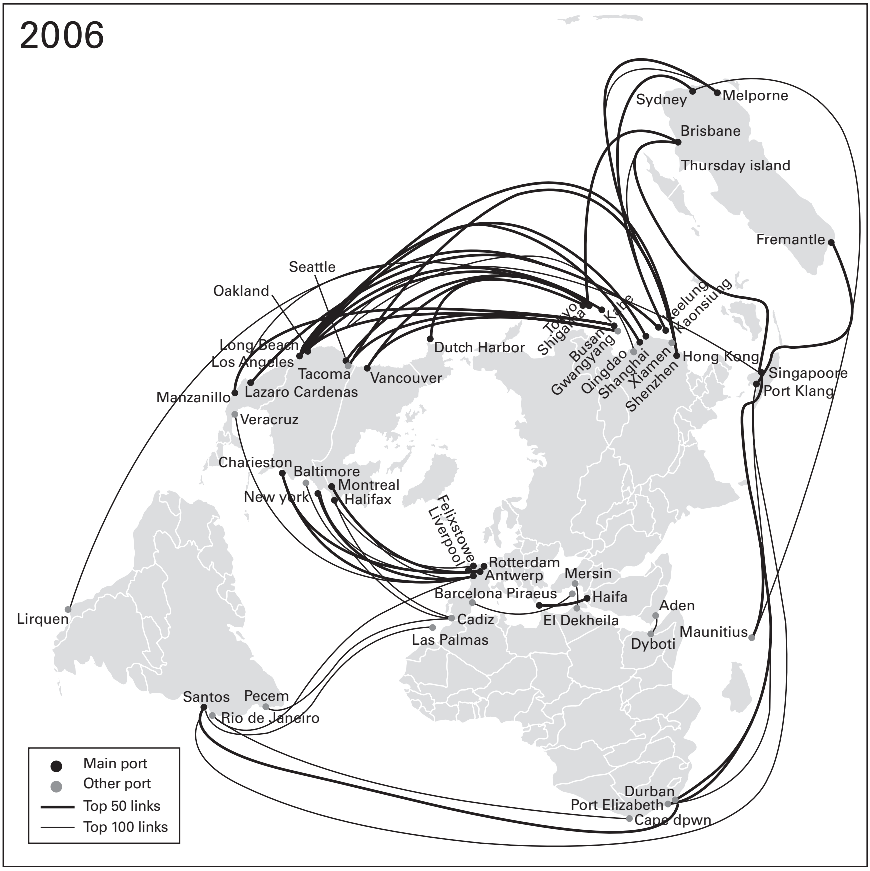
In addition to these results, Ducruet and Notteboom (2012) also underline the influence of distance on traffic concentration. They show that most traffic occurs across relatively short distances: about 80 per cent of total worldwide traffic is concentrated over direct links of 500 km or less, while links of 100 km or less support more than half. Besides the influence of coastal morphology and the necessity of following successive calls in relative proximity, such figures can be explained by some local service configurations, as in the case of adjacent seaports serving shared hinterlands (eg Le Havre–Hamburg range) or acting as dual hubs (eg Busan and Gwangyang), which often receive multiple calls for the same vessels or liner services. The noticeable increase of the longest links can be explained by stronger

FIGURE 8.4 Top 100 inter-regional traffic links in 1996 and 2006



SOURCE Author's elaboration based on LMIU data

trans-Pacific ties and also by rapid technological progress in the shipping industry, allowing longer sailing distances between two ports: links of over 5,000 km concentrated 7 per cent and 10 per cent of worldwide traffic in 1996 and 2006 respectively. Overall, it could be calculated that the top 100 direct inter-port links in terms of traffic volume represented no less than 52 per cent and 39 per cent of worldwide container traffic in 1996 and 2006, respectively, thus confirming a trend of de-concentration due to the multiplication of links. The spatial distribution of these top links also shows the dominance of intra-regional relations, with the exception of trans-Pacific links. The maps in Figure 8.4 retain only inter-regional inter-port (direct) links based on the definition of large world regions by the United Nations (ie Europe, Americas, Asia, Oceania, and Africa). We clearly observe a reduction and simplification of transatlantic and trans-Mediterranean links together with the appearance of new links in the top 100 such as Europe–Brazil and



Asia–Mexico. There is, however, also some continuity, since Le Havre–New York is the heaviest direct link connecting Europe with the world in both years, and trans-Pacific links remain at centre stage, but with a shift of main links from Japanese to Chinese ports.

The extent to which the strategies of shipping lines are reflected in the topological structure of the network can also be verified by applying some measures from graph theory and complex networks. On a world level, Hu and Zhu (2009) were the first to confirm that container shipping networks belong to the category of so-called 'scale-free' and 'small-world' networks, ie where a limited number of nodes have the majority of links, the latter's frequency being distributed along a power-law, and with high cluster densities among smaller nodes outside hubs. Although Kaluza *et al* (2010) contradict Deng *et al* (2009) about the extent to which the global maritime network is more or less 'efficient' (ie low average number of stops between two nodes) than other transport networks such as airlines, Ducruet and Notteboom (2012) underlined an increase in efficiency between 1996 and 2006, which is attributed to the expansion of the network as well as to the emergence of new hub ports. Another important trend topologically speaking is the decreasing hierarchical structure of the network, as observed by Ducruet and Notteboom (2012) on a world level and by Ducruet *et al* (2010a, 2010b) in North-east Asia and the Atlantic regions. Such a trend results from the combination of various factors such as regional integration processes (multiplication of intra-regional links, opening of new direct call and multi-port services), dis-economies of scale in large gateway and hub ports, and competition between existing and emerging hub ports.

The centrality of container ports

The impact of a liner shipping network's operation on container ports is often analysed in terms of throughput, the most widely available indicator of port performance in official statistics. Table 8.4 shows the classic port hierarchy with regard to the number of containers (TEUs) handled by top ports since the 1970s, regardless of the function of ports in the network. However, the network perspective allows for calculating the connectivity of ports, which is critically lacking in the related literature (de Langen *et al*, 2007). Two main measures of centrality in networks can be obtained based on the configuration of inter-port links in a binary port-to-port matrix (ie presence or absence of links between two given ports). First, *betweenness centrality* counts the number of positions of a node on the possible shortest paths among all nodes in the entire network (Ducruet and Lugo, 2013). It is a measure of accessibility or reachability. Second, *degree centrality* is the number of adjacent neighbours, which simply counts the number of ports connected to a given port. These are two very classic measures in network analysis across all fields of investigation from physics to sociology (Wasserman and Faust, 1994), which can provide answers to theoretical configurations, notably provided by Fleming and Hayuth (1994) on the centrality and intermediacy of transportation hubs. When it comes to ports, these measures can reveal other dimensions than sole throughput, with which they can be highly correlated.

A first look at the top 25 central ports in the worldwide network provides some evidence about the usefulness of the measures and how they characterize the position of ports in the network. Unlike airline networks where anomalous centralities depict the peculiar position of very central airports (betweenness) with few direct connections (degree) (Guimerá *et al*, 2005), liner shipping shows a good fit between betweenness and degree (Deng *et al*, 2009). Thus, very central ports in the entire liner shipping network are also those multiplying their connections towards other ports. This would mean that hub ports have many connections while being very central, unlike relay hubs in airline networks (eg Anchorage). Some exceptions, however, are visible in the results about ports, in light of the overall drop in the linear

TABLE 8.4 Top 25 container ports 1970–2009 (thousand TEU)

Rank	1970		1980		1990		2000		2009	
1	Oakland	336	New York	1947	Singapore	5224	Hong Kong	18098	Singapore	25866
2	Rotterdam	242	Rotterdam	1901	Hong Kong	5101	Singapore	17040	Shanghai	25002
3	Seattle	224	Hong Kong	1465	Rotterdam	3667	Busan	7540	Hong Kong	20983
4	Antwerp	215	Kaohsiung	979	Kaohsiung	3495	Kaohsiung	7426	Shenzhen	18250
5	Belfast	210	Singapore	917	Kobe	2596	Rotterdam	6280	Busan	11955
6	Bremen/Br.	195	Hamburg	783	Los Angeles	2587	Shanghai	5613	Guangzhou	11190
7	Los Angeles	165	Oakland	782	Busan	2348	Los Angeles	4879	Dubai	11124
8	Melbourne	158	Seattle	782	Hamburg	1969	Long Beach	4601	Ningbo	10503
9	Tilbury	155	Kobe	727	New York	1872	Hamburg	4248	Qingdao	10260
10	Larne	147	Antwerp	724	Keelung	1828	Antwerp	4082	Rotterdam	9743
11	Virginia	143	Yokohama	722	Yokohama	1648	Shenzhen	3994	Tianjin	8700
12	Liverpool	140	Bremen/Br.	703	Long Beach	1598	Port Klang	3207	Kaohsiung	8581
13	Harwich	140	Baltimore	663	Tokyo	1555	Dubai	3059	Port Klang	7310
14	Gothenburg	128	Keelung	660	Antwerp	1549	New York	3050	Antwerp	7310
15	Philadelphia	120	Busan	633	Felixstowe	1418	Tokyo	2899	Hamburg	7010
16	Sydney Harbour	118	Tokyo	632	San Juan	1381	Felixstowe	2853	Los Angeles	6749

(*Continued*)

TABLE 8.4 Top 25 container ports 1970–2009 (thousand TEU) (*Continued*)

Rank	1970		1980		1990		2000		2009	
17	Le Havre	108	Los Angeles	621	Bremen/Br.	1198	Bremen/Br.	2752	Tanjung Pelepas	6000
18	Anchorage	101	Jeddah	563	Seattle	1171	Gioia Tauro	2653	Long Beach	5068
19	Felixstowe	93	Long Beach	554	Oakland	1124	Melbourne	2550	Xiamen	4680
20	Kobe	90	Melbourne	513	Manila	1039	Durban	2497	Laem Chabang	4622
21	Hamburg	72	Le Havre	507	Bremerhaven	1030	Tanjung Priok	2476	New York	4562
22	Zeebrugge	70	Bordeaux	453	Bangkok	1018	Yokohama	2317	Dalian	4552
23	Montreal	68	Honolulu	441	Tacoma	938	Manila	2292	Bremen/Br.	4536
24	Hull	59	San Juan	428	Dubai	916	Kobe	2266	Jawaharlal Nehru	4061
25	Tokyo	54	Sydney Harbour	383	Nagoya	898	Yantian	2148	Tanjung Priok	3800
Total 25 ports		3552		19482		49168		120820		242417
World total		4423		34806		84642		235569		432018
Share 25 ports (per cent)		80		56		58		51		56

SOURCE *Containerisation International*

TABLE 8.5 Centrality of top 25 ports in 1996 and 2006

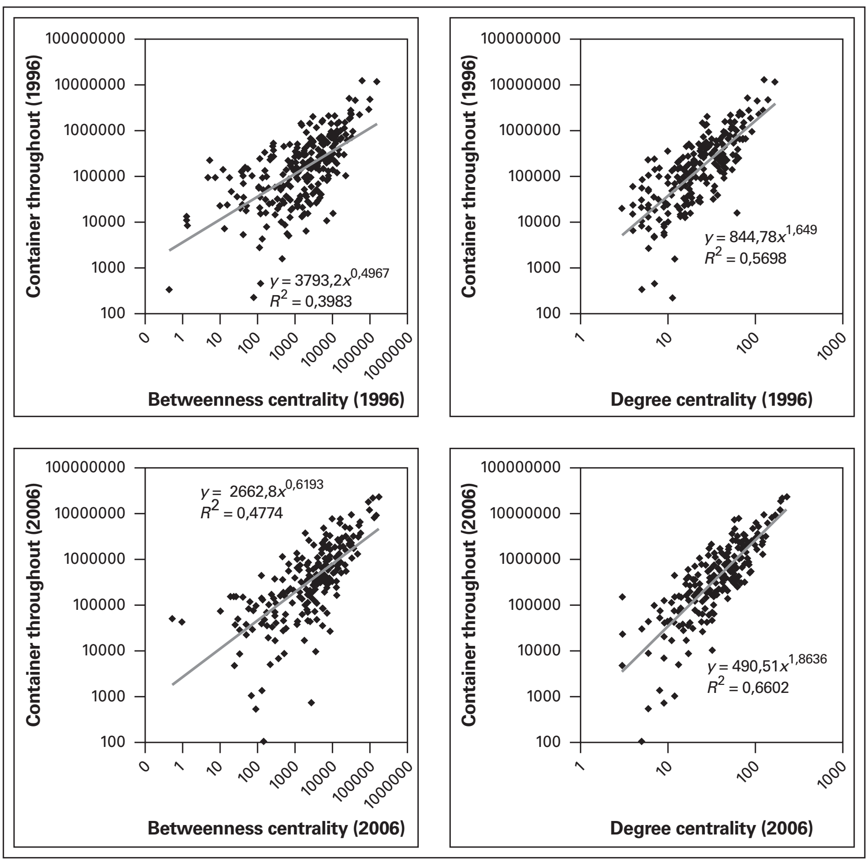
1996			2006		
Port	Betweenness centrality	Degree centrality	Port	Betweenness centrality	Degree centrality
Singapore	150,240	165	Singapore	174,516	226
Rotterdam	97,875	140	Rotterdam	146,454	167
Hamburg	90,978	124	Hamburg	127,733	150
Hong Kong	61,839	126	Hong Kong	117,675	203
Antwerp	50,513	112	Busan	96,257	190
Busan	39,943	105	Shanghai	92,838	193
Le Havre	34,593	90	Bremerhaven	56,219	105
Houston	32,841	71	Antwerp	53,766	137
New York	32,536	70	Port Klang	52,191	148
Yokohama	31,090	83	Gioia Tauro	47,971	120
Los Angeles	30,726	66	Marsaxlokk	45,183	120
Felixstowe	27,606	88	Surabaya	39,030	50
Kaohsiung	27,551	82	Kingston(JAM)	37,495	104
Piraeus	24,827	71	Algeciras	36,846	130
Melbourne	22,516	44	Valencia	33,688	120
Philadelphia	21,867	44	Miami	32,963	83
Bremerhaven	21,661	56	Barcelona	32,462	118
Algeciras	20,373	72	Le Havre	31,623	98
Port Klang	19,782	58	Kaohsiung	31,419	125
Bilbao	19,549	60	New York	30,607	93
Valencia	17,380	78	Jebel Ali	28,785	97
Port Everglades	16,176	67	Felixstowe	28,216	92
Colombo	16,043	62	Durban	27,708	82
Izmir	14,854	55	Santos	26,306	92
Shanghai	14,719	59	Shenzhen	25,582	107

SOURCE Author's calculation based on LMIU data

correlation among betweenness and degree from 0.84 in 1996 to 0.72 in 2006. This change suggests a more complex relationship between the two variables. Indeed in 2006, the peculiar position of some ports having less degree than betweenness appears with Surabaya and Miami. Those ports thus tend to have a role as regional hubs, with fewer connections to local ports that are not well connected to the rest of the network, and have no option but to go through Surabaya and Miami, such as several Indonesian and Caribbean ports. Surabaya and Miami thus benefit from their bridge position towards such smaller ports to raise their centrality in the global network. Such a trend is also visible in the work of Ducruet *et al* (2010a) showing how Busan has increased its centrality within North-east Asia but has simultaneously seen its centrality lowering in the worldwide network.

The extent to which network position relates to the hierarchy of container throughput is a crucial question that can be tested in Figure 8.5. Interestingly, the correlation with betweenness and with degree has increased between 1996 and 2006, showing a better fit with container throughput. In

FIGURE 8.5 Centrality in liner shipping networks and container throughput



SOURCE Author's elaboration based on LMIU data
NOTE Analysis based on the graph of adjacent calls between ports.

terms of variance, betweenness centrality explains 40 per cent and 47 per cent of total throughput, while degree centrality explains 57 per cent and 66 per cent at respective years. This would suggest that network indicators are very good tools for understanding overall port performance, although they do not include land-based dimensions of hinterland connectivity, coverage, and other aspects of performance such as technical standards and the availability, quality, size, and cost of terminal handling facilities and services. Overall, betweenness is less related with throughput than is degree, with regard to correlation levels and to the slope of the power-law line. Degree centrality scales super-linearly with throughput, which means that the number of connections is highly concentrated at large throughput ports. At the top of the hierarchy, large gateway ports such as Shenzhen and Yokohama may have less betweenness centrality than transhipment hubs, while ports combining both functions may rank high in the three indicators. Further analyses may better explain the role of network position on throughput performance. Overall, the position of ports in shipping networks seems to explain a large part of their overall activity.

Conclusions

The extensive worldwide container shipping networks are key to globalization and global supply chains. The requirements on container shipping service networks have tightened in terms of frequency, schedule reliability/integrity, global coverage of services and rate setting. The evolutionary path of liner shipping networks and port operations is characterized by drastic changes as well as permanencies. Shipping lines have embraced a wide range of bundling concepts and liner service configurations to drive container service network dynamics. As global trade expands in economic and geographic terms, despite difficult conjunctures such as the global financial crisis, new ports and new shipping networks are regularly created to cope with demand. Shipping lines logically adapt to such trends as well as influence them, sometimes by refining their services through rationalization or by creating new service configurations through a combination of line-bundling itineraries and transhipment/relay/interlining operations at pivotal ports of the network.

This chapter provided evidence about the increasing complexity and number of cargo movements that occur in parallel with increased concentration and polarization, depending on the measures and methodologies applied for revealing such trends. It discussed some fundamental aspects, such as the economic and geographic dimension of the variety of services offered by the industry, as well as the strong and growing interdependency between maritime centrality and port throughput for container ports, although in this simple equation, hinterland connectivity and port efficiency are not included. Looking at the distribution of main trading routes as well as disaggregated inter-regional and inter-port shipping links, the latter being compared with kilometric distance, we observed that the overall network is growing in size and length notably thanks to a catching-up of South–South linkages versus North–North and North–South linkages. However, most worldwide traffic is still concentrated over very short distances that are more specific to maritime transport than to air transport, due to adjacent calls between ports.

In light of our results, further research on container shipping networks should go deeper into an analysis of the causal relationship between throughput and centrality for container ports, while better identifying specific cases and outliers. Another avenue of future research would be to test the impact of the global financial crisis on the overall structure of regional and global liner shipping networks, as well as on the position of individual container ports, which would complement the classic view of shipping based on aggregated cargo flows among major trade routes. The global database on vessel movements is being expanded to other years and other types of vessels so as to better appreciate the linkages between port hierarchy, global/regional trade patterns, and the evolution of network structure. Last but not least, the analysis of the situation of ports and cities within combined maritime and land-based networks would prove helpful for the study of logistics chains, the hinterland–foreland continuum, intermodal transport systems, and port competitiveness.

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Supply chain integration of shipping companies

09

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Introduction

The integration of shipping companies in the transportation supply chain may be regarded as a significant strategy in the effort to fulfil demand requirements and maintain the viability of the companies in the contemporary environment.

The growth of seaborne trade during the last decades reflects the coalescent markets in the world. The geographic separation of supply and demand has raised the expectation towards transportation services. Keeping up with the growth of global seaborne commodity demand was considered as one of the biggest challenges. In addition to the satisfaction of demand, shippers and consignees have become more sophisticated and thus more demanding with respect to the quality of the transportation service. Users of freight transportation services provided by shipping companies expect fast and reliable service at a competitive cost and covering a wide geographical network. The consequent growth of shipping companies, either organic or through mergers and acquisitions, aimed at meeting the demand and fulfilling the aforementioned requirements.

The downside of this development could be observed in the 2009 economic crisis when the global maritime service industry suffered a sharp decline in demand. Suddenly, the period of growth with huge investments in vessels and service expansion had to be changed into capacity adjustment due to the market decline. This has reminded companies and professionals of the key characteristics of the freight transport industry, viz competitive intensity, market volatility and cash-flow uncertainty.

Integration and consolidation have characterized the container shipping industry primarily as a means to gain economies of scale and cost efficiencies. In previous years, liner companies invested in increasing vessel capacities in order to maintain profit margins. Considering the large investments in container vessels, only a high utilization of the companies' assets guarantees profitability. Consequently, the slump in maritime trade affects the profitability of liner shipping companies.

Vessel capacity and utilization provides only one possibility for competitiveness. Possible ways to elude this situation are to minimize investments in capital-intensive vessels or to avoid a high dependency on liner services by diversification of a company's service portfolio and the integration of logistics services respectively. Vertical integration is characterizing the modern transport industry, as transport businesses are gearing up towards global logistics services based on the principle of the 'one-stop shop'. In order to accomplish this goal, it is necessary to integrate port, hinterland transportation and logistics management services. It follows that strategic aspects of vertical integration are of significant importance in the contemporary shipping industry.

The aim of this chapter is to theoretically explain the importance of vertical integration in the supply chain by maritime companies and to investigate the performance outcomes of integration through an empirical investigation between supply chain integration and firm value.

The chapter is organized as follows. By referring to the theoretical literature on supply chain management, the first section explains the concept of supply chain integration. For supply chain integration to be achieved, a number of challenges must be overcome. More so in the maritime context as highlighted in the sections that follow after. Next, the chapter focuses on the benefits of supply chain integration and particular reference is made to the performance outcomes of shipping firms that have made moves towards greater supply chain integration using case examples. An empirical investigation is then carried out to test the relationship between supply chain integration and shipping firm performance.

Supply chain integration in the maritime shipping industry

Supply chain integration

The Council of Supply Chain Management Professionals (CSCMP Glossary of Terms, 2010) describes supply chain management as a function that:

> …encompasses the planning and management of all activities involved in sourcing and procurement, conversion, and all logistics management activities. Importantly, it also includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers,

> and customers. In essence, supply chain management integrates supply and demand management within and across companies.

Supply chain integration is a key component of supply chain management and thus an internal–external perspective is necessary to understand it (Chen *et al*, 2009). Since supply chain management is a boundary-spanning activity, both cross-functional and inter-organizational management efforts are important (Day, 1994; Bowersox *et al*, 1999).

Stevens (1989) emphasized that true supply chain integration includes both upstream and downstream players, while internal integration provides the foundation for both. Supply chain integration was analysed as internal and external integration by a variety of studies (Morash and Clinton, 1998; Stanley and Wisner, 2001; Ragatz *et al*, 2002; Pagell, 2004; Petersen *et al*, 2005), while in more recent studies, it was assigned multiple dimensions (Stank *et al*, 2001a, 2001b; Narasimhan and Kim, 2002; Vickery *et al*, 2003; Droge *et al*, 2004; Gimenez and Ventura, 2005; Koufteros *et al*, 2005).

Bowersox *et al* (1999) proposed a comprehensive framework and categorized supply chain integration into the following types: customer integration, internal integration, material service supplier integration, technology and planning integration, measurement integration, and relationship integration. Alternatively, Fawcett and Magnan (2002) asserted that there are four types of integration in supply chain management:

1. internal, cross-functional integration;
2. backward integration with valued first-tier suppliers and as a consequence with second-tier supplier;
3. forward integration with valued first-tier customers;
4. complete forward and backward integration, where integration exists from the suppliers' supplier to the customers' customer.

Handfield and Nichols (1999, p 5) list the following as the main drivers of integration: the information revolution; the increased levels of global competition, which create more demanding supplier- and customer-driven markets; the emergence of new types of inter-organizational relationships. Their study describes an integrated supply chain model, which encompasses information systems (management of information and financial flows), inventory management (management of product and material flows), and supply chain relationships (management of relationships between trading partners (Power, 2005). Lummus *et al* (1998) point out that the ascending global competition forced companies to seek supply chain efficiencies. In addition, the increasing specialization of products and processes has created inefficiencies arising from the lack of integration.

Vickery *et al* (2003) emphasize two aspects in their conceptualization of an integrative supply chain strategy. The first is the existence of integrative information technologies, and the second is the existence of practices that strengthen linkages between companies occupying different positions in the supply chain (vertical linkages as in supplier partnering and closer customer relationships and horizontal linkages as in forming intra-firm linkages using cross-functional teams).

A key characteristic of supply chain integration is the presence of integrative information technologies that increase the flow of relevant information amongst process participants to facilitate the integration of processes that transcend functional and firm boundaries (Bowersox and Daugherty, 1995; Lewis and Talalayevsky, 1997).

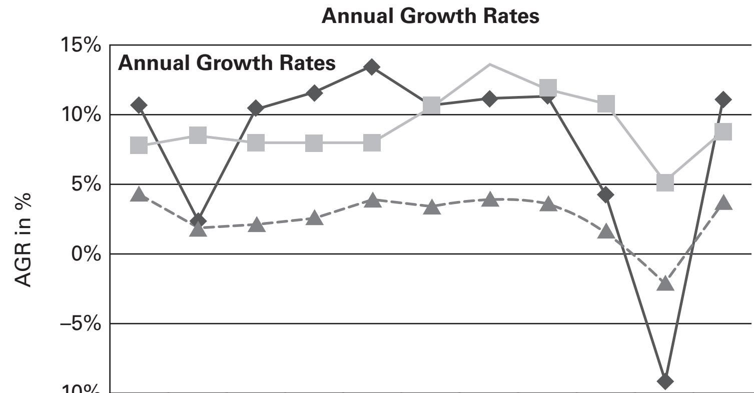
The literature acknowledges that the higher the degree of integration across the supply chain the better a firm performs (Narasimhan and Jayaram, 1998; Johnson, 1999; Frohlich and Westbrook, 2001) whereas there are dangers if suppliers and customers are not fully integrated in terms of their business processes (Armistead and Mapes, 1993; Lee and Billington, 1992; Frohlich and Westbrook, 2001).

Challenges for integrated maritime logistics systems

For a number of decades after containerization was extensively adopted in the 1960s, the containerized shipping industry was characterized by liner conferences. These agreements created a market of well-balanced service patterns which guaranteed stability in freight rates. The situation continued until some liner companies, for example Evergreen, questioned the situation in the mid-1980s (Notteboom, 2004). The liner shipping industry was progressively liberalized firstly with the US Ocean Shipping Reform Act and lately with the abolition of the exemption of liner conferences from European Union antitrust law. The increasing liberalization of the container shipping market led to a financially underperforming industry. Although the competitive environment intensified, the industry remained a capital-intensive industry (Notteboom, 2002). High fixed costs challenge the owners to achieve high and stable asset utilization. Especially under the influence of lower profit margins, the shipping lines always had the need to find creative answers to a highly variable transportation market that is characterized by highly inelastic demand, market volatility and cash-flow uncertainty. Consequently, in a weak economic environment, container liners have had to accept whatever price is offered in the market.

The challenge of balancing supply and demand in the container shipping industry is illustrated in Figure 9.1. The demand for container shipments moves parallel to the global GDP. However, container traffic grows disproportionately fast in comparison to country development. Therefore, the capacity has to be adjusted by a higher amount than what the actual economy grows. This challenge is illustrated in Figure 9.1 by the fact that the demand changes faster than the supply of container capacity. On the other hand, the slowing of the global economy has had a major impact on the container shipping industry. During the economic recession of 2009, the manufacturers and retailers realized that too much inventory had been built up. The consequent bullwhip effect led to the inventory overhang effect (Datamonitor, 2010). Especially at times of sharp declines in demand, the high fixed costs in the maritime freight industry increase the degree of competition.

FIGURE 9.1 Annual growth of demand and supply in container shipping (2000–2010)



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010 e
Demand	10.7%	2.4%	10.5%	11.6%	13.4%	10.6%	11.2%	11.4%	4.3%	–9.1%	11.1%
Supply	7.8%	8.5%	8.0%	8.0%	8.0%	10.5%	13.6%	11.8%	10.8%	5.1%	8.8%
World GDP	4.4%	1.8%	2.1%	2.6%	3.9%	3.4%	4.0%	3.7%	1.7%	–2.1%	3.7%

SOURCE Authors, based on data from UNCTAD (2010)

Due to the market pressures, shipping lines have had to expand the range of their services. The need arises primarily for managing the high volatility in the container liner business but in addition for fulfilling customers' expectations. The pressure of geographically growing competitors forces liner companies to find new solutions. Solutions included among others the organization in strategic alliances of different forms (see Panayides and Wiedmer, 2011) and mergers and acquisitions (see Alix *et al*, 1999; Fusillo, 2006; Heaver *et al*, 2000). Horizontal alliances were extensively studied in the literature (eg Evangelista and Morvillo, 1999; Midoro and Pitto, 2000; Slack *et al*, 2002; Song and Panayides, 2002). Slot charters, mergers and acquisitions and alliance agreements are popular ways in which to provide services in new geographic areas (Heaver, 2001). The vertical integration of shipping lines has been less studied. The impact of introducing new logistics services through vertical integration on firm success or performance has not received the requisite attention.

The benefits of maritime supply chain integration

Supply chain integration in a maritime context has been mostly studied in the field of container liner shipping. This is a logical consequence of the fact that the goals, operations and activities of shipping lines have been more relevant to those of logistics.

Casson (1986) conducted one of the first studies related to integration in the shipping industry. According to that analysis, shipping companies are seeking 'arm's length' relationships by offering a broad range of services. However, Casson (1986) underpins that existing contractual arrangements should not be jeopardized by untried innovations. This especially refers to existing relations with partners that work as freight forwarders. The conclusion is based on theoretical analysis and is supported empirically. Demand complementarities exist if, for example, a liner company becomes a customer of a port and vice versa. By controlling both segments, port logistics and shipping services, a company can match service formation and pricing in the most efficient way (Casson, 1986).

Heaver (2001) specifically addresses the possible economies of scope for carriers as a result of vertical integration. In addition to the expansion of the fleet deployed, corporate strategies for different services were integrated into a liner company. The integration of terminal operations is value-adding if sufficient container traffic is available on offered routes. Nevertheless, customers expect that the terminals are run independently. Therefore, the integration of intermodal services does not require ownership but a consistent management (Heaver, 2001). Only in this way, efficient and effective door-to-door services are provided. Heaver (2001) concludes that the satisfaction of customers is not dependent on the ability to offer a wide range of logistics services, but rather on the actual quality of the container transportation service.

With respect to the container handling business, in Europe leading handling companies developed independently of the liner industry, whereas in North America shipping liners aim to integrate ports services (Slack and Frémont, 2005). It is important to realize that transport integration and port performance influence each other. Port performance is affected by added-value services and port characteristics such as accessibility and hinterland size (Ducruet and van der Horst, 2009). These beneficial port features influence the willingness of container liners to integrate additional logistics services.

In a competitive, deregulated market, corporations try to simplify and control supply chains. As stated by Robinson (2002) the integration of modes, service and networks is crucial for successful transportation chains. In addition, firms try to 'seek advantage and value' (Robinson, 2002, p 22). In this manner, value is not only related to operating or technical efficiency. More precisely, the degree of integration of business processes and of the effectiveness of alliances and inter-firm arrangements is a contributor to a company's value chain. In summary, Robinson (2002, pp 20–21) identifies six key drivers that influence the value addition in an integrated supply chain:

- operational efficiency and capacity matching (intra-firm);
- real-time information and the integration of business processes (intra-firm);

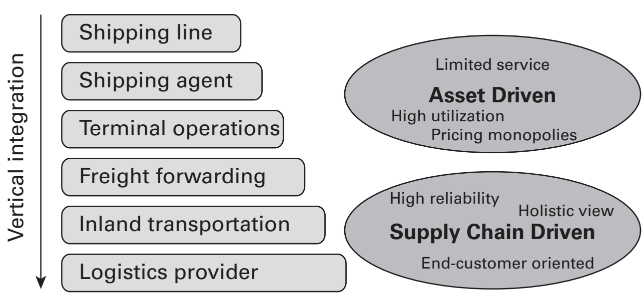
- alliances and coalitions (intra-firm);
- chain structures and value chain constellations (inter-firm);
- market settings (macro level);
- policy setting (macro level).

Especially at times of increased demand, integrated firms are able to take advantage of their own service portfolio. Externalities can be controlled more effectively (Notteboom, 2002), hence, volumes and transportation times are balanced more effectively. Inefficiencies might arise if core competencies are not developed in each field of business activity. Heaver (2005, p 206) states that 'customers are reluctant to use a logistics service if they feel that logistics services are only offered as a means to feed another business'.

A widely described advantage for vertical integration refers to the reduction of transaction costs (Panayides, 2002). Integrating logistics services may result in gained efficiency by realizing synergies (Panayides and Cullinane, 2002). In this manner, information flow between different logistics services can be improved. An improved exchange of information and business knowledge enhances logistics service quality. Better supply chain management enables the reduction of cycle times, inventories and improved flexibility, which especially holds for the competitive container shipping industry (Casson, 1986).

It is widely recognized in the literature that the future of containerization will be shaped by inland transportation systems (Notteboom and Rodigue, 2009). Figure 9.2 illustrates potential steps for transport chain integration. The scenario is developed from the shipping line perspective. The suggested steps of integration are not necessarily linear. Nonetheless, shipping liners implement those services into their business portfolios that are closely connected to their own services in the transportation chain. In this way, it is most beneficial for shipping lines to control terminal operations first. Following this, the connection to inland transportation can be worth considering.

FIGURE 9.2 Steps of supply chain integration



SOURCE Based on Frémont (2009a) and Fransoo and Lee (2013)

Furthermore, higher expectations in the production chains force transportation companies to offer services just-in-time. By offering integrated transportation services, the shipping lines have closer relationships with the customer and can reduce their dependence on third-party logistics. In many cases, in order to offer such door-to-door services, subsidiaries are mandated to integrate the transportation chain under the supervision of the shipping line. It must also be noted that inland logistics represent one of the most attractive parts of the transportation chain for reducing costs. More specifically, inland costs account for 40 to 80 per cent of the total costs. In contrast to fixed-cost-driven ocean logistics, inland transportation turns out to be much more variable, respectively cost-driven. Notteboom (2002, p 92) states that inland transportation costs are 5 to 30 times higher than long-distance liner shipping rates.

Notteboom (2009, p 21) provides a positive picture by summarizing: 'What will take place inland, will shape the future of containerization in terms of its potential to further accommodate the growth of international trade.' Nevertheless, since the shipping company moves away from its core business, new problems might be encountered. Competition between the different inland transportation modes is not a given anymore which might result in inefficiencies (Frémont, 2009a, p 11).

Supply chain integration of shipping companies and performance outcomes

It is widely accepted that the relationship between supply chain integration of shipping companies and performance has not been given the requisite attention in the literature. Hence, to provide a basis for further empirical support this section makes inferences by examining specific case examples. Many container lines choose to widen their role by offering global logistics services. Non-asset services are developed (eg freight forwarding) in order to reduce the dependence on investment intensive operations. In this way, freight forwarding can help to streamline fluctuating freight volumes. Furthermore, companies aim to implement 'one-stop' service by developing and combining various value-added activities. In many cases, these activities are already performed within the in-house logistics group of the company.

Many container lines can be considered as subsidiaries of bigger transportation groups. As illustrated in Table 9.1, the majority of fleet operators offer transportation services for cargo, liquid and solid bulks and reefer cargo. In addition, logistics management services like freight forwarding complement the activities' portfolio. Due to capacity constraints in many container terminals around the world, liner companies try to increase their influence on ports by acquiring shares in major ports. In this way, logistics activities can be streamlined while the bottleneck 'port' is controlled. In the same manner, the financing of major investments can be supported by being involved in the finance industry.

TABLE 9.1 Liner companies and their subsidiaries

	Company	Shipping lines (container)	Terminal activities	Tankers and other shipping activities	Logistics/ Multimodal	Shipyard/ Container production	Others
1	AP Möller Group	Mearsk Line Safmarine og MCC Damco	APM Terminals	Maersk Tankers Maersk Drilling Maersk LNG Maersk FPS Svitzer (towing)	Mearsk Logistics	The Odense Steel Shipyard group Container Industry	Maersk Oil Supermarked Group Danske Bank Star Air Danbor Service
2	Mediterranean Shipping Company (MSC)	MSC Cargo					MSC Cruises
3	CMA CGM Group	Delmas ANL Mac Andrews OT Africa Line CNC Line Comanav U.S. Lines			River Shuttle Cont. LTI France Progeco CMA Rail CMA CGM Logistics TCX Multimodal Logistics		Compagnie du Ponant Partir en Cargo Tapis Rouge Int. The Traveller's Club (all tourism related)
4	Evergreen Line	EG Marine Corp. Italia Marittima SpA EG Marine (UK) Ltd. EG Marine (Hong Kong) Ltd. EG Marine (Singapore) Pte Ltd.	4 transhipments hubs 3 terminals operated				

(*Continued*)

TABLE 9.1 Liner companies and their subsidiaries (*Continued*)

	Company	Shipping lines (container)	Terminal activities	Tankers and other shipping activities	Logistics/ Multimodal	Shipyard/ Container production	Others
5	Hapag Lloyd AG	Hapag-Lloyd	Holding with minor shares in container terminals in Hamburg and Montreal				
6	CSAV Group	CSAV Norasia Container Lines Ltd. Companhia Libra de Navegacao/Navegacion CSAV Panama	COSAN SAAM	Transportation of vehicles, reefer cargo, solid and liquid bulks SAAM (tugboats)	SAAM (logistics activities)		
7	NOL Group	American President Line (APL)	APL Terminal Activities		APL Logistics APL Log Transp. Management Serv. APL Log Wh Management Serv. Vascor, Ltd.		
8	COSCO Group	COSCO Shipping Lines	COSCO Pacific Co.	Xiamen (bulk) Cosco Bulk Carrier Dalian (tanker) Guangzhou Ocean Shipp (specialized)	COSCO Logistics China Ocean Shipping Agency	COSCO Shipyard Group Nantong COSCO KHI Ship Eng. Co Dalian COSCO Shipbuilding CIMC (container manufacturing)	passenger shipping: Tianjin Jinshen Ferry Sino-Japan Int. Ferry Yingkou COSCO COSCO Finance Co COSCO Int. ship trading China Marine Bunker

9	Hanjin Shipping	Hanjin Shipping	Hanjin Pacific Corporation (13 terminals) Hanjin New Port Company Hanjin Kerry Logistics Total Terminal Int.	Hanjin Overseas Bulk Hanjin Overseas Tanker Pte.	Hanjin Shipmanagement Hanjin Logistics HJLK (Transport. Agency) Shandong Hanjin Log. (ODCY)	ZESCO (ship repair yard)	Samol Co. (renewable energy)
10	CSCL	China Shipping Container Lines ShanHai Puhai Shipping Xiang Zhu	China Shipping Terminal Development Dalian Int. Container Terminal various other terminals	China Shipping Refrigeration Universal Shipping Co. Shanghai HaiXin YuanCang Int. Log. Various cargo agencies	Shanghai Yanshan Storage and Transportation Co. Dalian Vanguard Int. Logistics Universal Logistics		CSCL (Dalian) Data Processing International Computer Co. (IT)
11	Mitsui O.S.K. Line	Mitsui O.S.K. Liner Utoc Corp.	International Container Terminal	MOL Bulk Shipping - Tankers MOL LNG Transport Co. MOL Car Carriers	MOL Ship Management MOL Ferry Blue Sea Network (ferry and domestic transport) Tug-Boat and Towing	Minaminippon Shipbuilding Co.	MOL Information Systems MO Tourist Co. MO Marine Consulting MOL Finance
12	NYK Line	NYK Liner Trade	Yusen Terminals Inc.	Bulk Shipping	NYK Logistics Nippon Cargo Airline Co.		Yusen Real Estate Crystal Cruises Inc. NYK Cruise Co. Monohakobi Technology Inst. (Research)

(*Continued*)

TABLE 9.1 Liner companies and their subsidiaries (*Continued*)

	Company	Shipping lines (container)	Terminal activities	Tankers and other shipping activities	Logistics/ Multimodal	Shipyard/ Container production	Others
13	Hamburg Süd Group	Hamburg Süd Alianca		Alianca Bulk Hamburg Süd Tramp Shipping	Columbus Logistics Service GmbH (CLS) Columbus Shipmanagement GmbH		Hamburg Süd Travel Agency Columbus Tours Event Business GmbH Alianca Consulting
14	OOIL Group	OOCL Logistics Ltd.	associated companies: Ningbo Yuan Dong Terminal Tianjin Port Alliance Int. Container Terminal Co.	OOCL Logistics Ltd. (cargo) Reefer Service	Maritime Delivery Services Inc. (trucking) OOL Logistics Warehousing and Transportation Intermodal Service		E-services Orient Overseas Building (real est.) investment: Kenwake Ltd. Soberry Investments Ltd. Wall Street Plaza Wayton Wealth Cap. Corp.
15	K Line	K Line America, Inc. K Line	International Transportation Service	RoRo services Bulk shipping Tanker services LNG transport	intermodal services, land transportation Century Distribution Systems		K Line Travel Ltd. K Line Accounting and Finance Co.
16	Zim	Zim Integrated Shipping Services Reefer Containers		OOG & Project Cargo Tanker			

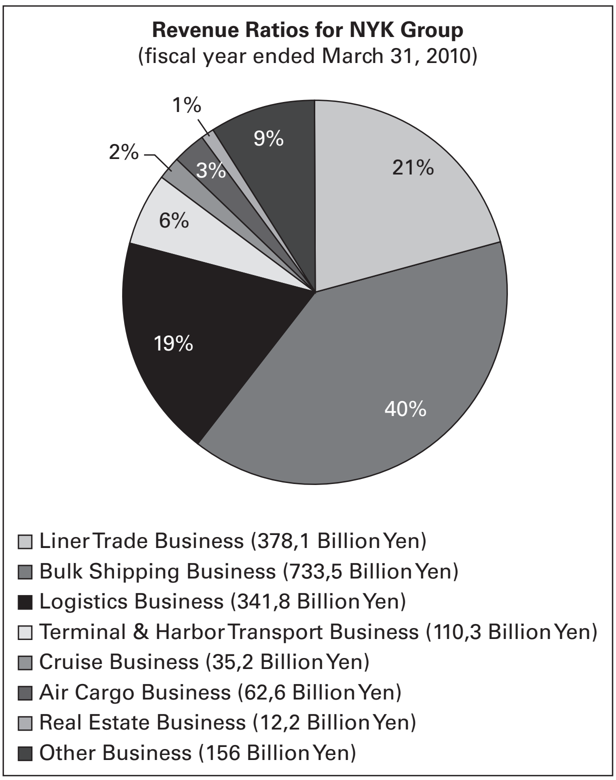
17	Yang Ming Group Corp.	Yang Ming Marine Transport Corp.	Kao Ming Container Terminal Corp. Honming Terminal & Stevedoring Co.	Kuang Ming Shipping Corp. (bulk)	Jing Ming Transport Co. Yes Logistics Corp.		Ching Ming Investment Corp.
18	Hyundai M.M.	HMM Container Lines	Investment on 5 terminals	Cargo Service Wet Bulk Dry Bulk Tanker Heavy-Lift Service			
19	Pacific International Line	PIL container liner	Port and terminal business in Singapore and Thailand		PIL Logistics (SCM solutions)	Singama Container Holdings Ltd. (container manufac.)	IT services
20	UASC	UASC liner service		Shipping Agencies Tankers	Freight Forwarding Land Transportation Air Cargo Storage	Container Repairs Ship Repair	

SOURCE Authors, companies' web pages, annual statements

The integration of logistics-related subsidiaries has influenced the revenue structure of shipping companies. Figure 9.3 illustrates the revenue ratios of NYK subsidiaries. While the shipping business of dry and liquid bulks counts for almost 40 per cent of NYK's business, the liner trade business is the second strongest business division within the group. Although NYK Line operates the 12th largest container fleet in the world, the revenue of the liner division is almost as big as the revenue of related logistics services. Moreover, the significance of port activities has increased for shipping companies as they have realized the chances of increasing influence on the supply chain. In 2008 over 40 per cent of the container terminal capacity among the top 12 operators was managed by shipping companies. The remaining 60 per cent of terminal capacity was operated by terminal managers without shipping services (NYK Annual Report, 2010).

With over 800 vessels, 42 terminals worldwide, 308 distribution centres in 33 countries in 2010 as well as an air cargo fleet, NYK reflects the

FIGURE 9.3 Revenue ratios NYK Group for the fiscal year 2009–2010



SOURCE NYK Annual Statement (2010)

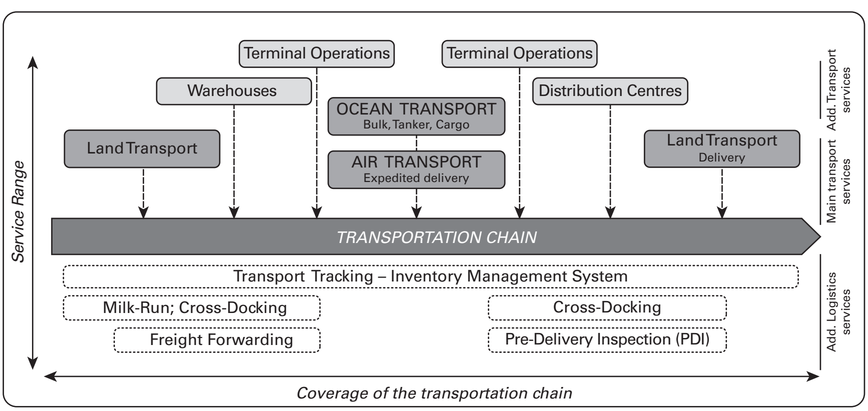
changes in the liner industry. Integrated companies promise more stability and more customer-oriented logistics services. Only in this way logistics service providers can fulfil the high expectations of globalized manufacturing companies.

A major goal of liner companies is an overall optimization of the supply chain. This ranges from land, sea and air transportation, in-transport inventories and optimized warehousing along the value chain of a company to the delivery to customers. In this manner, service providers must extend the geographical coverage, the range of services and the solution capabilities for every served industry (NYK Annual Report, 2009, p 15). The set of possible solutions is illustrated in Figure 9.4.

Frémont (2009b) conducted a survey among container lines in order to understand their definition of logistics and the relations with forwarding agents. Annual reports do not give a complete understanding of the subsidiaries' role. The turnovers of divisions are generally aggregated. Therefore, it is difficult to distinguish between the importance of inland transportation, consolidation activities etc. Although a broad portfolio of services is offered, shipping lines improve financial performance by providing maritime transportation. Inland transport is often outsourced to partners. Furthermore, shipping lines do not want to compete with forwarding agents that have been close partners and customers for the liner company. This customer might be lost if the shipping lines enter the forwarding market.

Although Figure 9.4 provides a picture of advanced service integration, the maritime groups that develop logistics capabilities remain limited. NYK, the AP Möller Group and the NOL Group with APL are exceptions. Frémont (2009b) indicates that many other shipping lines use logistics activities as labels for publicity reasons.

FIGURE 9.4 Portfolio of integrated service for a shipping company



The impact of supply chain integration on shipping firm performance

Concept

As indicated above, container liner shipping companies may choose to integrate vertically in order to offer logistics services. The empirical question which arises is whether vertical integration transcends into higher firm value. In the existing maritime literature, no quantitative studies have been conducted in this direction. On this basis the impact of vertical integration on a firm's market value is hereby examined.

In the spirit of Berger and Ofek (1995), segment-level data are used to estimate the valuation effect of vertical integration by imputing stand-alone values for individual business segments. Specifically, the actual value of a vertically integrated firm is compared to the sum of its imputed stand-alone segment values. Imputed stand-alone values are calculated using a portfolio of singe-business-segment firms, which by nature are non-vertically integrated.

It is hypothesized that vertical integration in the shipping industry pays off. Based on the abovementioned discussion regarding the shipping industry, liner companies integrate in order to be more resilient in a difficult industry environment that is characterized by high demand fluctuations, low profit margins and extensive capital (vessel) investments. Integration in the value chain supports the firm's service quality and service range, and should therefore create a higher market value.

Dataset

The sample consists of all firms listed in Compustat Industrial Segment and Compustat Industrial Annual databases during the period 1986–2008. The focus is on single- and multi-(business) segment firms that belong in the deep-sea freight transportation industry (SIC code 4412). We further restrict the multi-segment firms into those which generate more than 50 per cent of their segment sales from supply chain-related industries (SSIC1 codes 4011, 4212, 4213, 4214, 4215, 4412, 4424, 4449, 4481, 4499 and 4731). This approach resulted in multi-segment firms with the greatest chunk of sales belonging in the firm's supply chain. As a consequence we infer that multi-segment firms are more likely to be integrated across the supply chain. The final sample consists of 45 firms with 265 firm-year observations.

Methodology

In this section we describe the measurement of three sets of variables used in the analysis: valuation effects from vertical integration, as the dependent variable; vertical integration measures, as the key explanatory variables; and determinants of firm value, as control variables.

The dependent variable is constructed following the valuation approach of Berger and Ofek (1995). Specifically, 'excess value' (EV) is used to investigate whether supply chain integration creates firm value or not. EV compares a firm's market value to its imputed value if each of the business segments operates as single-segment companies. Market value is the sum of the market value of equity (equal to stock price at the fiscal year end multiplied by the number of shares outstanding) and the book value of debt. Imputed value is the sum of the segments' imputed values, obtained by multiplying each segment's sales with the median of the market value-to-sales ratio computed using only the single-segment firms in the same industry. The industry definition is based on the narrowest SIC grouping that includes at least five single-segment firms and sufficient data for computing the ratios. EV, in this setting, is the natural logarithm of the ratio of the company's market value to its imputed value and measures the gain or loss from supply chain integration.

The main independent variables are as follows: Supply Chain Integration-1 'SCI-1' describes a dummy variable that takes the value of one for multi-segment firms and zero otherwise. In addition, Supply Chain Integration-2 'SCI-2' is a firm's entropy index and aims to capture the breadth of supply chain integration of a firm's operations with respect to the number and relative size of segments. The entropy index is computed as $\Sigma Pi\ ln(1/Pi)$ where Pi is the sales attributed to segment i, and $ln(1/Pi)$ the logarithm of the inverse of sales, is the weight for each segment i.

The control variables are known determinants of firm market value. The natural logarithm of total assets (Log TA) accounts for the company size. Other variables control for the investment activity as the capital expenditures over sales (CAPX/SALES), and profitability represented by earnings before interest and taxes over sales (EBIT/SALES). The choice of the control variables is based on Berger and Ofek (1995). Furthermore, following Campa and Kedia (2002), lagged firm size (lag 1 and lag 2 of logarithm of total assets), lagged profitability (lag 1 and lag 2 of EBIT/SALES) and past investments (lag 1 and lag 2 of CAPX/SALES) are considered to control for past firm performance. In addition, the ratio of long-term debt to total assets (LEV) is taken into account, while 'ASS2' controls for possible non-linear effects of firm size as captured by the squared term of firm size.

Empirical results

Table 9.2 presents EV regression estimates. Regression model (1) replicates the Berger and Ofek (1995) analysis using the freight transport sample. In this sample, multi-segment firms as identified by SCI-1 should capture the value of supply chain integration. In contrast to expectation, results show that multi-segment firms are valued lower by 16.7 per cent relative to single-segment firms (p-value<0.05). The results also demonstrate that profitable firms, larger firms and firms with higher investment activity are valued higher (p-value<0.01, p-value<0.05, p-value<0.01, respectively).

TABLE 9.2 The relation between supply chain integration and firm value

Deep Sea Freight Transportation Firms			
	Excess Value – single and multi-segment firms		
	(1)	(2)	(3)
Const.	Yes	Yes	Yes
SCI-1	–0.167** (0.0843)	0.09677 (0.09927)	
SCI-2			0.1399* (0.0804)
Log TA	0.059** (0.0284)	0.9766*** (0.2855)	0.9874*** (0.2697)
CAPX/SALES	0.084*** (0.0175)	0.0378 (0.0363)	0.03498 (0.0363)
EBIT/SALES	0.786*** (0.1703)	–0.0055 (0.2617)	–0.0046 (0.26256)
Log TA lag1		–0.2353* (0.1311)	–0.2386* (0.12818)
CAPX/SALES lag1		0.0248 (0.04082)	0.0226 (0.0412)
EBIT/SALES lag1		–0.1448 (0.2263)	–0.1379 (0.2242)
Log TA lag2		–0.0586 (0.1543)	–0.05395 (0.1524)
CAPX/SALES lag2		0.00846 (0.0218)	0.0067 (0.0214)
EBIT/SALES lag2		0.1365 (0.1213)	0.145 (0.123)
LEV		0.614* (0.20932)	0.6154* (0.209)
ASS2		–0.0554* (0.0204)	–0.0555*** (0.01798)
Year/Firm fixed effects	No	Yes	Yes
Clustered standard errors	No	Yes	Yes
No of firms	45	45	45
No of observations	246	216	216
R^2	0.2643	0.8805	0.8812

Campa and Kedia (2002) suggest that a proper investigation of the impact of organizational structure on firm value should take into account the endogenous nature of a firm's decision to alter its organizational structure. That is, firms with higher or lower firm value relative to single-segment firms may be more likely to subsequently change their organizational structure. To address such concerns, following Campa and Kedia (2002), regression model (2) presents results after controlling for past firm performance. In addition, the model also includes year and firm fixed effects to capture time-invariant year- and firm-specific effects. Finally, standards errors were adjusted for clustering at the firm level to control for potential bias into the standard errors estimates when residuals correlate across time and/or across firm-year observations (Petersen, 2009). The results, as expected, show that the coefficient of determination increases substantially to 88.05 per cent. Interestingly, the coefficient estimate of SCI-1 turns positive, as expected, albeit statistically insignificant. Most of the control variables obey the expected sign, although some of them are statistically insignificant.

Regression model (3) is similar to model (2), but includes the entropy index (SCI-2) rather than SCI-1. SCI-2 should better capture variation of the (multi-segment firm) supply chain integration relative to the SCI-1. The results show that coefficient of SCI-2 is 13.99 per cent, larger than the SCI-1 coefficient, as expected, and statistically significant ($p\text{-value}<0.10$).

Overall, the empirical results support the presented conjectures of the preceding sections, and suggest that supply chain integration is value-creating.

Conclusion and further research

The integration of supply chains has been among the most significant issues to be discussed in the context of transportation in recent years. The question of whether integration adds value is of high scientific and practical value. There are many potential benefits that supply chain integration can bring about at strategic, economic and operational level, and these benefits have been recognized in the maritime sector and more so in the liner shipping sector that has been gradually liberalized. This liberalization has forced companies to adapt in order to ensure their viability in an environment characterized by intense competition, market uncertainty and cash-flow volatility. In addition, the increasingly sophisticated and demanding customer requirements forced companies to extend their service portfolio and geographical scope by vertically integrating in the supply chain. However, the relationship between supply chain integration and financial performance in maritime supply chains has not been entirely clear. On the basis of this motivation, this paper sought to provide empirical evidence of this relationship.

This study has provided preliminary, albeit novel, evidence of the relation between supply chain integration and performance in the maritime logistics context; evidence which indicates a positive relationship and upon which further studies can be based, in order for practitioners and managers to gain the support of the scientific community when they take key decisions. The field of liner shipping and maritime logistics develops at a very high pace and it is important for empirical research to be carried out in order to keep up with the developments.

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Logistics strategy in container shipping

10

ALFRED J BAIRD

Introduction

Globalization and increases in competitive pressures have led to many businesses developing logistics as a key part of their corporate strategy in order to achieve cost and service advantages (McGinnis and Kohn, 2002). Effective management of the supply chain demands equally effective linkages with other firms for the coordination of logistical flows of goods (Christopher, 1998).

The emergence of specialized total logistics providers and contractors, also known as 'integrators', particularly since the 1990s, signalled the start of 'complete logistics solutions and seamless origin–destination services' provided on a global basis, and with far greater customer focus (Doganis, 1991, p 320). The integrator considers its main advantage to be an ability to operate on a door-to-door basis, with conditions of carriage structured in order to permit a seamless shipper-to-consignee service (Forster and Regan, 2001).

This raises the question for ocean carriers, namely: should container shipping lines become active in providing added-value logistics services? Or, alternatively, would ocean carriers do better to remain with a focus on what arguably they know best – liner shipping? This paper seeks to analyse container shipping line strategy relating to provision of added-value logistics services. The aim is to identify, analyse and compare/contrast the logistics strategies of container shipping lines.

The study involved a short questionnaire survey of the top 20 container shipping lines to help investigate these questions. The results of the survey, plus supporting information, are analysed to provide a summary of container line strategy with respect to provision of logistics services. The study extends and updates the author's earlier work in this area (Baird, 2006), including reference to and discussion of more recent theoretical contributions on the subject of ocean liner shipping operators' logistics activities.

The study includes several brief case studies which seek to review and analyse the specific logistics activities and strategies within several of the top 20 container lines. The case studies offer a more detailed insight into the different approaches adopted by major global container lines with respect to development and provision of logistics services.

The purpose of the overall study is to help develop a wider picture concerning what/how liner shipping competitors are doing with regard to the provision of logistics and value-added activities, to assess the extent of these activities in terms of logistics services provided, and to offer an indication as to how this might evolve in future.

Literature review

In maritime transport, the theoretical evaluation of supply chain management has emphasized the power exercised by dominant firms in logistics towards control of assets, technology and markets (Robinson, 2002). In liner shipping there has been more focus on the industry integration of companies and networks (Bergantino and Veenstra, 2001). The outsourcing of an increasing number of activities perceived as not being strategic has occurred at the same time as the general trend for firms to focus on what they regard as their core business (Hamel and Prahalad, 1990). Heaver (2001) nevertheless cautioned that, due to the essential spatial dimension of transport, the provision and control of transport and logistics by a single enterprise is unlikely.

In the context of liner shipping, within an international market that is becoming ever larger and more complex, growth and diversification has presented opportunities and challenges for companies (Carbone and Gouvernal, 2007). In liner shipping, the level of logistical integration and the level of organizational integration constitute two variables which can be analysed to help assess the degree of supply chain integration (Evangelista and Morvillo, 2000). In this regard, vertical logistical integration objectives can be achieved directly through vertical (organizational) mergers and acquisitions, and indirectly through horizontal mergers; this in turn results in the creation of larger organizations which tend to enjoy more bargaining power and easier access to financial resources (Panayides, 2001). A further consequence of this trend is that larger liner shipping companies develop greater market power vis-a-vis other service providers, such as port authorities and terminal operators (Meersman *et al*, 2005).

Liner operators therefore started providing logistics services in order to meet demands from shippers for integrated supply chain solutions, for service and price differentiation reasons and revenue stabilization, as well as to increase long-run profitability and market share (Haralambides and Accario, 2010). Nevertheless, it is only relatively recently that some liner operators have established their own logistics operations (Midoro and Parola, 2006).

Much of the theoretical analysis into strategic management and integration in liner shipping businesses revolves around a focus on three main operational elements: the operation of vessels, of terminals, and of inland transport services (Musso *et al*, 2001). Analysis of strategic cooperation between liner shipping companies and various actors has been extended to include freight forwarding (Frankel, 1999) yet, generally, there seems to be rather limited analysis looking into more specific 'logistics' activities that container liner shipping operators may be involved in, aside from the main transport operational functions noted – ie vessels, ports, and inland transport.

It is argued that maritime transport operators could enhance their 'logistics value' by fulfilling more of their customers' logistical needs (Lee and Song, 2010). Moreover, it is further argued that the need for liner operators to continuously collect valuable information about their suppliers, customers, cooperative partners and business environment in order to help identify ever-changing market situations and demand can result in liner operators acquiring valuable knowledge via cooperative/co-opetive networks.

But there still remains a 'dearth' of analysis in the existing literature concerning the provision of logistics services by liner shipping operators (Hwang *et al*, 2010). While some shipping lines appear to have diversified into the wider logistics market beyond ships, terminals and inland transport, in an apparent effort to secure greater levels of profitability (Evangelista, 2004), the extent of this activity is not well known. This, it seems, is linked to a desire by shipping lines to capture the container trade further back along the supply chain, perhaps even at source (Cullinane *et al*, 2004).

However, overall there has been limited research analysis into the role of liner shipping operators in terms of their provision of logistics services. This especially relates to the extent of these services, any specific industry focus, or geographic coverage, and the extent of logistics activities in relation to overall turnover and profit. Hence the aim of this study is to address these questions, beginning in the next section with some reflections obtained via a brief survey on the logistics activities of container lines.

Container line logistics activities

Top 20 container lines

A questionnaire survey was used to investigate the following aspects of logistics strategy in respect of the top 20 liner shipping companies:

- ownership and/or relationship of logistics operations to liner shipping company;
- global/regional coverage for provision of logistics services;

- types of logistics services offered;
- any specific industry focus;
- future development of logistics activity.

Revenue and profits derived by carriers from logistics activity was also considered, but to a limited extent. It was found that detailed information on these aspects was not readily available. However, secondary sources coupled with several liner operator responses has allowed for some approximate assessment of operator revenues derived from logistics activities, as distinct from liner shipping services.

The survey of top 20 carriers achieved a 50 per cent response rate. The top 20 liner container shipping companies are estimated to account for approximately 70 per cent of all container traffic on the major East–West arterial trades, plus the majority of North–South trade. The top 20 carriers, in terms of fleet capacity and number of ships as of April 2011, are shown in Table 10.1.

TABLE 10.1 Top-20 container operators and world fleet (as of 24 April 2011)

		Total Fleet		Order Book	
Company	**Rank**	**TEU**	**Ships**	**TEU**	**Ships**
Maersk	1	1,899,969	417	416,890	48
MSC	2	1,881,690	435	388,634	39
CMA CGM	3	1,035,911	264	245,603	25
Hapag-Lloyd	4	596,737	136	134,758	11
COSCON	5	591,414	148	296,536	36
Evergreen Line	6	586,130	158	160,000	20
APL	7	582,005	142	185,400	20
Hanjin	8	494,135	107	147,762	12
CSCL	9	479,944	123	127,100	15
OOCL	10	384,159	87	150,134	15
CSAV	11	382,680	112	6,316	1
MOL	12	381,324	92	19,020	3
NYK	13	371,435	87	45,600	8
Hamburg Sud	14	335,424	96	175,694	31
K Line	15	331,639	78	42,412	9
YML	16	329,987	81	89,900	14

Company	Rank	Total Fleet		Order Book	
		TEU	Ships	TEU	Ships
HMM	17	316,546	68	1,888	1
Zim	18	282,469	72	155,418	14
PIL	19	232,143	105	34,404	8
UASC	20	202,642	51	104,800	8
Total top-20		11,698,383	2,859	2,928,269	338
World Fleet		16,603,736	9,669	4,104,975	721
% top-20		70%		71%	

SOURCE http://www.ci-online.co.uk/

The largest of the top 20 carriers is Maersk Line with 417 ships accounting for 1.9 million TEU capacity. That company is followed by MSC, which has 435 ships totalling just under 1.9 million TEU capacity. In third position is CMA-CGM with 264 ships and just over 1 million TEU capacity.

Below the top three carriers, all of the other top 20 carriers fall into the 200,000–600,000 TEU fleet-capacity range. This suggests that quite a gap has now opened up between the leading three operators and the rest. This gap is expected to widen further in future, taking into account new vessel orders that have been placed for delivery over the next few years.

Logistics and value-added services offered

In terms of logistics services offered, all top 20 liner shipping companies offer inland transport services, with 80 per cent also providing documentation and attending to customs formalities (Figure 10.1). Some 60 per cent of carriers offer warehousing and supply chain planning, with 70 per cent providing vendor management. About half of carriers offer to provide logistics activities at customers' and suppliers' premises. A relatively high 25 per cent of carriers claim to provide financial services. In terms of 'other' logistics activities, carriers mostly mention 'ocean transport'.

The data suggest that, while some carriers offer an extensive range of logistics services, others actually provide few services.

Industry focus

All liner companies surveyed have a focus on the retail and electrical/electronic sectors, with a strong focus also on consumer durables, automotive, chemicals and consumer packaged products (Figure 10.2). There is rather

FIGURE 10.1 Logistics activities offered by container liner operators

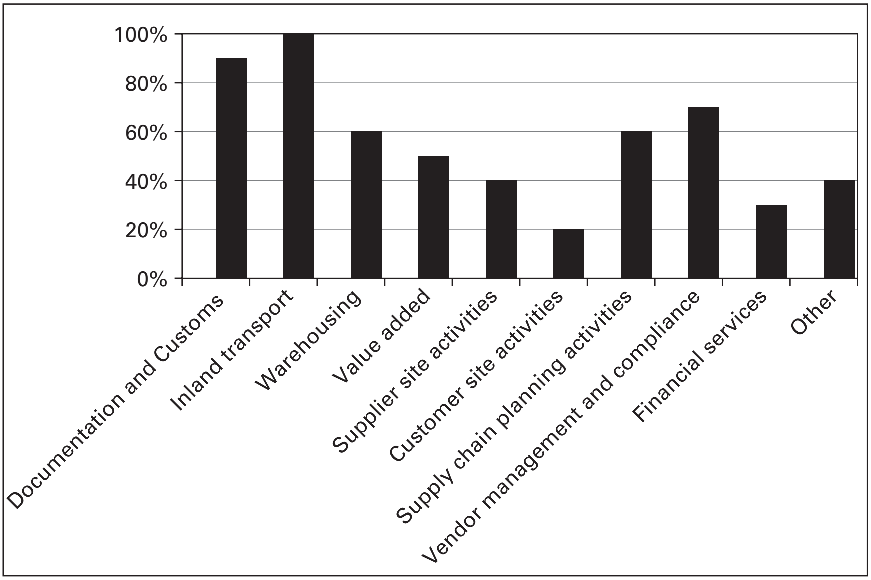
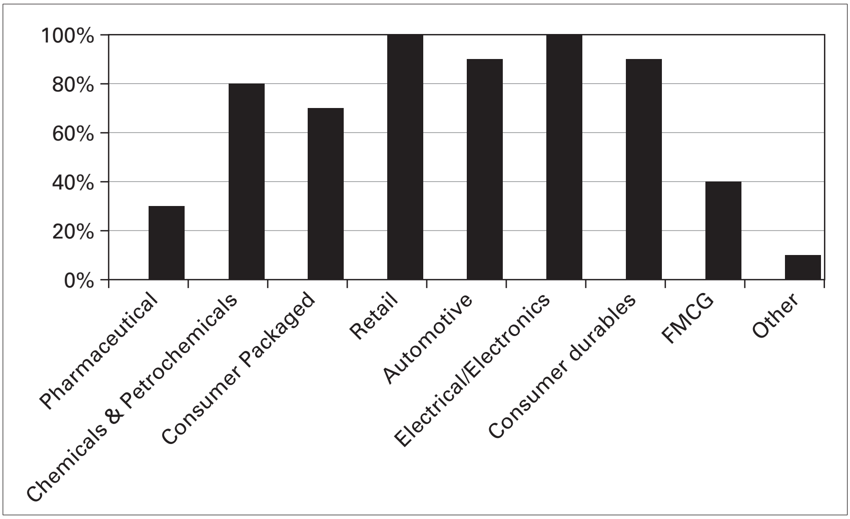


FIGURE 10.2 Industry focus for container liner operators offering logistics services



less emphasis on pharmaceutical and FMCG (fast-moving consumer goods). In regard to 'other' sectors, one respondent claimed to deal with 'all industries', though this is probably also the case for most operators to a significant degree.

Geographic focus

Development of lines' logistics services has tended to focus, at least initially, on the home market region and then to expand outwards from this base. For Maersk, logistics services were initially introduced for the benefit of European shippers, while at APL the early focus was on US shippers, and for the three main Japanese lines the emphasis was on Japanese industries to begin with.

A number of lines started to view offering value-added services in logistics as adding faster growth and better profitability potential than basic shipping, and hence these activities were expanded internationally. However, this was also due to the changing demands brought about through industry globalization (Heaver, 2002).

Virtually all carriers (90 per cent) stated that they now have a global focus covering more or less all trading regions, and most of these lines further suggested they have the capability to provide specific logistics services almost anywhere in the world (Figure 10.3). Only one of the lines appeared to have retained a distinct regional focus (ie Hamburg-Sud, primarily towards Latin America), but even with this carrier other regions are now being targeted.

FIGURE 10.3 Geographic focus of container liner operators offering logistics services

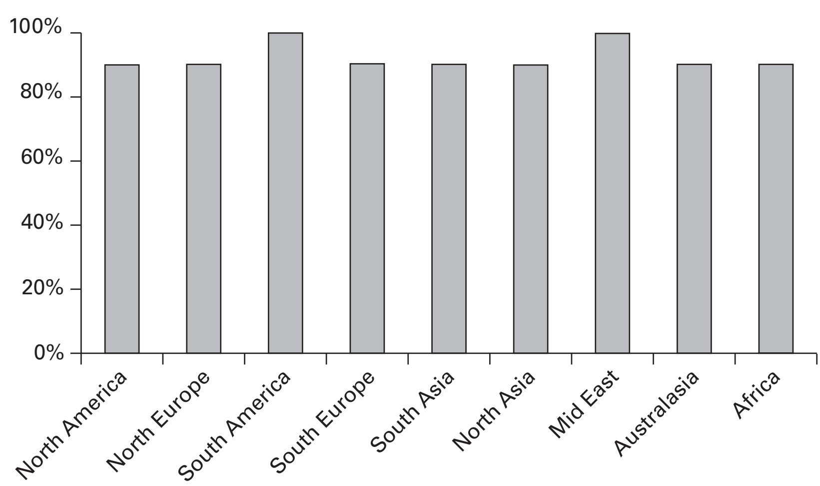
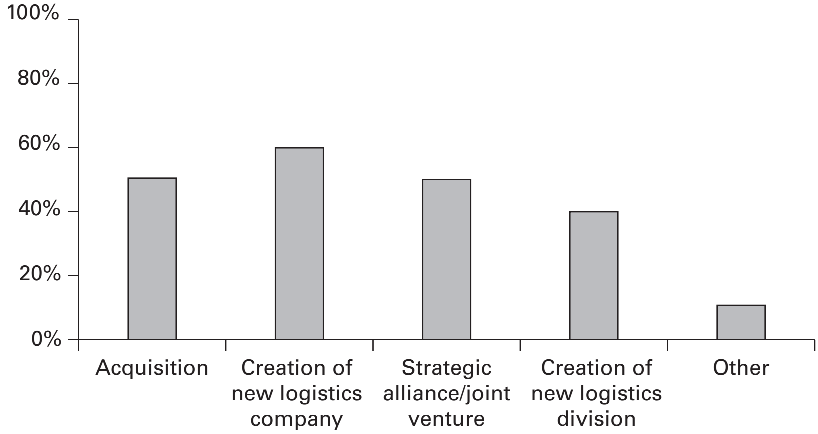


FIGURE 10.4 Organization of logistics functions by container liner operators



Development of logistics functions

Sixty per cent of lines have created a new distinct logistics company subsidiary, with 40 per cent opting (in addition to creating a subsidiary) to acquire existing logistics companies within strategic markets (Figure 10.4). Half of all respondents have entered into strategic alliances/joint ventures with established logistics providers.

Effectively a new logistics division has been created by 40 per cent of carriers. In the 'other' response category the logistics activities of one particular carrier is considered to be 'integrated into core business functions', assumed to imply liner shipping.

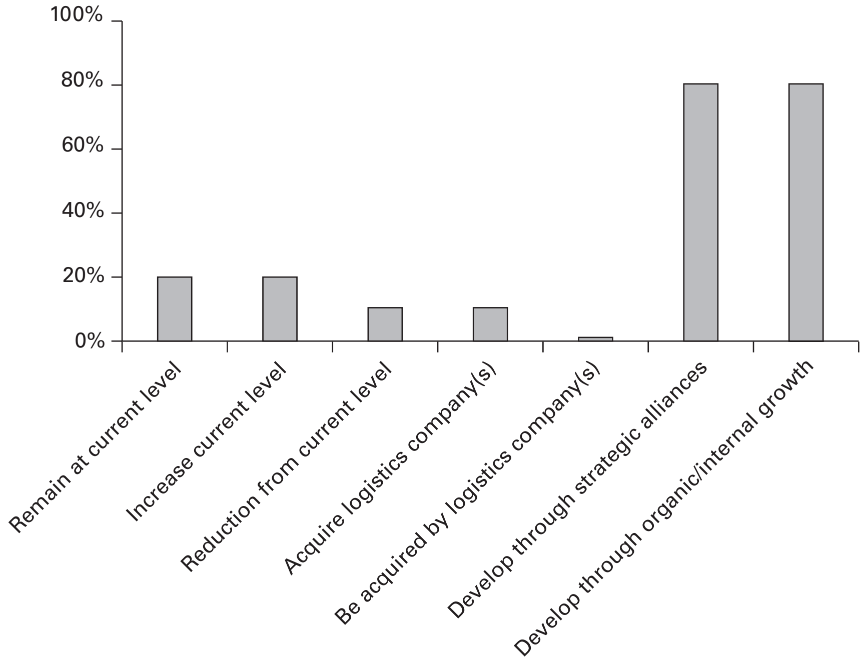
Future development of logistics activity

Some 80 per cent of lines said they intend to further develop their logistics activities through strategic alliances with specialist logistics providers, with 80 per cent saying they would also develop further through organic/internal expansion (Figure 10.5).

Half of all lines stated that they expect to increase their current level of logistics activity, with 20 per cent saying they would maintain the current level, whilst 10 per cent actually expected to reduce from the present level.

Perhaps somewhat contrary to the prevailing wisdom, it appears that some carriers do not view logistics services as critical overall relative to their core liner shipping, port and intermodal activities. Only 10 per cent stated

FIGURE 10.5 Future development of logistics by container liner operators



they would seek to acquire logistics companies; however, the analysis in the following section suggests that the actual potential for acquisitions may be rather greater than this.

Liner operator case studies

Case study approach

Additional, more detailed information has been obtained from secondary sources regarding liner operators' development of logistics services and capabilities. This information is presented in case study format below. The aim is to compare and contrast the development of liner operators' logistics services, in particular highlighting the approaches used to integrate and develop logistics services and capabilities and to ascertain motivations behind this. There are six case studies in all, most of which focus on carriers within the top 10. The aim has been to consider not only carriers which have a strong logistics focus but also to include those retaining a focus on core liner shipping activities, hence with rather less emphasis on logistics.

CASE STUDY

Mediterranean Shipping Company (MSC)

In 2004 MSC created what it called a new 'Logistics Department', based at its Geneva HQ, and which is said to 'control' over 300 inland depots worldwide. However, MSC is a carrier that is still very much focused on ocean freight services and rather less on logistics and added-value activity. Hence, these depots are mainly thought to comprise third-party facilities at which basic LCL consolidation activities are performed, rather than evidence of sophisticated supply chain activities or significant investments in this aspect of the business. 'Logistics' to MSC seems to imply not much more than inland transport, and in this regard it established (in Europe) a company called Med-Log to control inland operations (Beddow, 1999).

An extraordinary feature of MSC's meteoric growth to the number one position is that up to 1996 this was achieved entirely through purchase of second-hand or chartered ships. Now its focus has altered to include purchase of new-builds, which it volume-buys, though MSC also remains the most active line in the second-hand market.

Starting new container shipping services and bolstering existing services with larger tonnage seems to be the primary objective of MSC, with rather less interest in offering added-value and supply chain initiatives; these functions for the most part are left to independent specialist logistics service providers.

Being a private company, MSC's annual revenues from liner shipping are not known. However, given its very limited involvement in logistics and added-value services, MSC's revenues from logistics (excluding inland transport) are estimated to be under US$ 1 billion per annum, so probably below 10 per cent of its assumed total revenues from liner shipping. Thus, for the largest container operator in the world at this point in time (as of end first quarter 2011), logistics services do not seem to constitute a key part of the global corporate activity.

Maersk Line

AP Moller subsidiary Maersk Line views logistics as an increasingly important aspect of its business. Subsidiary Maersk Logistics (formerly Mercantile, and Buyers) is operated as a separate entity from the ocean carriage business. Maersk Logistics is free to offer its services to other ocean carriers, and has the freedom to book cargo with other carriers if this option is preferred.

Maersk Logistics has offices in around 100 countries, but is largely a non-asset-owning company managing its quality through careful selection of subcontractors. The company is involved in markets dominated by large freight forwarding requirements as well as those in which large clients such as major retail chains have special needs for more integrated services. In 2002, the then head of Maersk Logistics noted, perhaps somewhat optimistically that: 'the logistics activity could grow to outperform those of the liner, but it will take a while' (Le Lloyd, 2001).

Maersk Logistics has made a number of acquisitions over the years, including the purchase in 2001 of USA-based Distribution Systems Limited (DSL). DSL had offices in 60 countries plus 1,500 employees, compared with at that time Maersk Logistics total of 3,500 employees. Wal-Mart was one of DSL's major clients so the acquisition gave Maersk Line potential access to a lot of this business.

While Maersk Logistics has extensive activities in the USA, Asia and Europe, the company is increasingly active in North–South trades as well. Maersk Logistics moved into Brazil as various industrial developments expanded there, such as Ford opening a plant in Salvador (Thorby, 2003). A large number of multinational companies have assembly plants in the Manaus Free Trade Zone (eg Sony, IBM, Toshiba) at which Maersk Logistics also has a presence.

Maersk Logistics looks to establish global ocean freight contracts with clients covering a number of trade lanes. In some markets Maersk Logistics regards itself as a specialist in key sectors. For example, in South America the company specializes in the footwear and retail industries, as well as fruit and vegetable exports carried in reefers.

Maersk Logistics markets its ability to provide shippers with a single point of contact for all their transportation needs, including sea freight, airfreight, and offering a complete package of value-added land-side services. The company promotes itself as a leading provider of logistics solutions, managing and improving supply chains, from planning and procurement through to the delivery of products to their final destination. In terms of strategy, a key objective is the acquisition of logistics and distribution companies in destination countries, which can also be used to enhance secondary (ie national) distribution capabilities.

Like all major logistics companies, there is a strong emphasis on information technology. Maersk Logistics' M*Power web search facility allows users to check the status of particular consignments. The user can view full details of orders, order plans, containers, cargo receipts, B/L, as well as providing alerts of changes. Maersk's own in-house research established that customers want two main things in terms of logistics. First, customers want to extend supply chain visibility beyond the international transport move, and are looking for a single source of end-to-end supply chain visibility (Power, 2004). And second, there is considered to be a need to pull more players into the system as customers want to see manufacturers, service providers and stores all linked up. This requires an 'engine' interfacing with many different supply chain players.

The evidence suggests that Maersk, unlike MSC, is far more proactive in terms of logistics activities, initially via acquisition. However, even today its logistics activities are considered unlikely to exceed 25 per cent of its total liner revenues which means the company is still some way from making logistics equal to liner shipping revenues.

CMA-CGM

CMA-CGM established CMA-CGM Logistics in 2001, although it was originally known as Logistics-Link. CMA-CGM Logistics aims to develop customer services through what it refers to as a 'global logistics approach'. The company seeks to provide clients with a single contact to answer all their needs concerning the logistics chain.

As most of the services sold by CMA-CGM are port-to-port, there was a belief in the company that this was not enough in a changing environment. Although it was never the intention to switch all customers into its own logistics service, there is a desire to offer customers a wider range of logistics services. A key influence behind the new strategy is the fact that more and more companies have outsourced, especially in the Chinese trades. To address this challenge CMA-CGM embarked on a joint venture with a Chinese logistics partner which gave the ocean carrier access to several thousand TEU of business each year (Boyes, 2004). The entry into the logistics business therefore has as a primary aim to generate more cargo for the ocean services.

CMA-CGM Logistics intends to 'help the client elaborate and prioritize his logistics projects, as well as implement or adapt new industrial solutions', such as packaging, co-packing and co-manufacturing. CMA-CGM Logistics is established in both Europe and Asia, with increasing exposure now in other growing markets.

In June 2004, CMA-CGM Logistics acquired an 80 per cent interest in the logistics company Qualitair & Sea International, thereby further pursuing a strategy of strengthening its portfolio of integrated, global logistics services, and enhancing its ability to respond to customer needs for freight logistics, particularly in China.

At CMA-CGM, the strategy has therefore altered somewhat from a dedicated shipping business devoted to ships and sea transportation, to selective investments in logistics as well as development of more sophisticated IT systems (Dekker, 2001).

Nevertheless, as with MSC, the focus of this line is still very much on developing new shipping services and fleet expansion, and the present level of logistics activity remains limited. Hence, revenue derived specifically from logistics activity at CMA-CGM is still estimated to be below US$ 1 billion annually, which is assumed to be less than 10 per cent of total liner revenues.

APL

APL subsidiary APL Logistics (APLL) claims to have experienced double-digit revenue growth during most years since 2000. Its growth in 2001 was 72 per cent, though this reflected the acquisition that year for US$ 210 million of GATX Logistics, the second largest warehouse-based contract logistics company in the USA. The acquisition meant APLL at the time employed 5,000 people in logistics in 56 countries spread across Europe, Asia and the Americas, with 30 million square feet of warehouse space. That acquisition enabled APLL to serve customers more effectively through primary (importing) and secondary (national) distribution phases of the supply chain. A further acquisition followed in 2001 with the purchase of 51 per cent of the German freight forwarding company Mare Logistik GmbH, representing APL's first such acquisition in Europe.

In 2000, the then CEO of APL stated that he wanted: 'the logistics business to challenge the liner business as a major breadwinner of the group' (NOL, 2000). In 2001, APL's total liner revenues amounted to US$ 3.6 billion, while logistics revenues were US$ 723 million, equivalent to 20 per cent; in 2004, logistics revenues exceeded US$ 1.0 billion, equating to around 25 per cent of total revenues, with liner shipping accounting for 75 per cent; today, logistics is believed to account for around one-third of APL's revenues.

One argument put forward by APL to explain its increased investment in logistics is that shippers and carriers have historically 'been confused' by their focus on freight rate negotiations, instead of looking at opportunities to increase overall supply chain efficiencies (*American Shipper*, 2001). APLL's two key objectives are to increase revenues and to be a leading global logistics service provider.

The purchase of GATX filled a perceived gap for APL. Previously, APLL was not able to offer a fully comprehensive door-to-door logistics service to USA-based shippers. With the addition of the acquired warehouses it had more flexibility in meeting customer needs. APL also uses staff 'implants' to help customers outsource their logistics functions. Major clients include Kimberly-Clark, the world's leading paper tissue manufacturer, for whom APLL manages several logistics facilities in the USA. An EDI link is in place between APLL's IT system, Total Logistics Solution (TLS,)and the client's order processing system. A real-time order-tracking system displays the arrival, yard, build and loaded status of shipments, along with departure time. In addition, the company provides inventory staging for Kellogg Company, the world's largest cereal manufacturer. APL claims it has benefited from synergies not only through a widening customer base, but because it is now able to provide true end-to-end supply chain execution and visibility.

APLL has entered a number of emerging markets, for example the Kenya market in 2004 through a partnership agreement with Fastrak Logistics, part of the Freight Forwarders Kenya Group (*Containerisation International*, 2004). Fastrak operates logistics facilities in the Port of Mombasa and inland at Nairobi. Value-added services offered include purchase order management, export consolidation, warehousing and distribution. APL Logistics' main services include:

- supply chain management;
- consolidation and vendor services;
- warehousing and distribution;
- global freight management;
- manufacturing support;
- asset management;
- IT solutions.

APLL concentrates its activity on four business 'verticals': automotive logistics, retail, high-tech and chemicals. In this environment most of the customers are multinationals and the company's joint ventures are carefully constructed around these verticals (Dekker, 2003). For example, an association with China's Shenyang Transportation since 2002 helped to expand its business relationship with General Motors.

The key differentiators for APLL are its global presence, added to the application of sophisticated IT products 'as the backbone' of its service. This is necessary due to today's operating complexity. For example, one of APLL's customers sources from 14 different countries in Asia and it expects the right information flow at all times. APLL's suite of IT products is considered to be fundamental to its differentiation strategy. The company's IT products are 'carrier-neutral', and customers have full supply chain visibility no matter whether the carrier is APL or Maersk.

In terms of competition for logistics contracts, APLL does not come across many of the top 20 carriers apart from NYK and Maersk when tendering for business; its main rivals more often comprise the leading 3PL integrators. This tends to confirm the analysis here that most of the top 20 ocean carriers actually provide rather limited logistics services.

APLL is continuing to open more distribution centres and increasing its partnerships and services in certain areas. To some extent APLL sees itself as more of a 4PL, designing supply chains and creating simulations of, for example, distribution centre locations, routing, and inventory control, and then finding the appropriate second- or third-party logistics provider to run the client's operations.

Of all ocean carriers APL is one of the most comprehensive in terms of providing global logistics services, and this is reflected in the high share of total revenues estimated to come from logistics (ie in excess of 30 per cent).

Evergreen Line

Apart from Asia (and Taiwan in particular), Evergreen Line is not thought to have very much logistics activity outside of basic sea freight and inland transport. Evergreen has no specific logistics subsidiary or division. In 2001 the company actually stated it had no interest in logistics.

Instead, Evergreen sees its primary role as managing ships, containers and in some cases terminals and this is by far its main focus. The company considers its role is to provide excellent advanced transport systems to companies that need door-to-door service. In 2002, Evergreen did, however, announce that it would be investing in 'forwarding and logistics' in Asia and South America (Heaver, 2002), but in fact this did not mean very much more than establishing joint agencies.

At Evergreen the emphasis is very much on ships and developing new ocean transport services, rather than on logistics and added-value activities. Activities from logistics in Evergreen are estimated to be below US$ 1 billion per annum, so less than 10 per cent of total revenues from liner shipping.

NYK

NYK Logistics is part of the Tokyo-based NYK Group, which was founded in 1885. The NYK group has more than 30,000 employees around the world and offers various transportation services including container transport, RoRo, bulk and energy resource transport, terminals and cruises. When NYK started logistics solution businesses such as warehousing and distribution in the mid-1980s, revenues from this new activity were only about US$ 80 million a year. But since then revenues have steadily risen and in 2003 NYK Logistics' revenues reached US$ 2.7 billion.

NYK has invested in logistics on a large scale, and organic growth is its main emphasis rather than setting up alliances or partnerships. NYK began with warehousing and NVOCC businesses, and went on to set up subsidiary companies, country by country, all branded as NYK Logistics to give a single global identity to customers. NYK Logistics is now established in all of the main markets, including South America and Oceania.

NYK Logistics has some 11,000 employees (about one-third of the NYK Group total), and 320 warehouse and office locations. The principal sectors of its involvement in developing supply chain solutions are automotive, retail, consumer electronics, food/beverage, medical/healthcare, special cargo, chemicals, material logistics and project logistics.

NYK previously used a number of different logistics brands. In Europe the brand was New Wave Logistics, and in Asia Ocean Consolidation Service and UCI Logistics Inc, plus Yusen Air Service and Nippon Cargo Airlines. NYK now considers it is in the 'total transportation business' and this includes supply chain management. In 2001 the company was re-branded with a new title: NYK Logistics & Megacarrier. The new name was intended to symbolize the new strategic emphasis. It also showed that NYK 'catered for everything', covering all kinds of goods and supply chain requirements. Logistics within NYK has been regarded as a steadier business than shipping, although liner shipping performed particularly well over the period 2000–2007.

NYK IT initiatives include an e-commerce system called Pegasus which enables customers to monitor and interactively manage online their total supply chains – the system has a slightly different interpretation in each of NYK's four main operating regions (ie Europe, Americas, Oceania and Asia) to take account of different needs. In Europe the logistics network covers 15 countries divided into geographic areas.

NYK's logistics operations are categorized under two headings: asset-based services and supply chain management. In terms of assets, over 25 of its worldwide distribution centres are in Europe. It also has a 700+ vehicle road transport fleet in Europe. Logistics revenues have been growing at upwards of 20 per cent per annum, which is faster than liner shipping (5–10 per cent a year typically), helped by buoyant demand in key sectors such as automotive, healthcare and consumer electronics (Anon, 2003).

NYK claims to benefit from synergies between its liner logistics and car carrier divisions in the automotive sector as these have major customers in common. An operational agreement has been signed with Cosco which permits NYK to use the latter's extensive network of warehouses in China, which combined with NYK's close contact with Japanese multinationals offers a good fit.

The company is looking for logistics businesses to buy in Asia, Europe and the USA, and seeks to further develop its operations in South America. During 2001–2003, NYK bought UCI Logistics in the UK and ETA Logistics in the USA. NYK is focusing heavily on the automotive industry, with UCI acting as a main distributor for Toyota, Jaguar and Rover from its hub in Milton Keynes, UK. NYK's business plan seeks to expand logistics activity to provide a truly global network of logistics companies. All its logistics businesses are linked by IT systems via a global NYK-E Logistics software package. Reflecting the large scale of its global logistics activities, NYK spends some US$ 1 million on IT development annually.

Strategic groups

Strategic groups based on logistics service provision

Development of logistics services by container lines is not a clear cut issue. However, it is evident that relatively few shipping lines have expanded their logistics activities to become substantial LSPs in their own right, and those that have, generally tend to be operated nowadays as stand-alone business units with sophisticated IT systems. Although some of these units have in a number of cases grown faster than liner activities, overall they are still some way from matching liner operations in terms of income, or indeed profits.

Hence most of the top 20 container lines continue to adopt a strong focus (and a higher level of investment) towards ocean transport services, terminals and intermodal transport, and rather less so on logistics and added-value services. To some extent this reflects a distinct strategic orientation in terms of senior management philosophy; that is, an ocean carrier is first and foremost an ocean carrier.

On the basis of the survey plus additional analysis at the level of the firm, it has nevertheless been possible to identify and broadly define three 'strategic groups' of liner carriers with regard to the extent of their logistics service provision. This 'hierarchy' is largely determined on the basis of the following factors:

- first, the service characteristics/scope or 'extent' of logistics services provided by individual carriers, and;
- second, the estimated total share of revenues derived from logistics service activities as a proportion of overall liner service income.

These three strategic groups of carriers in terms of logistics service provision and activity are presented in Table 10.2, which describes the main service characteristics/scope of each. The groups are denoted here as Tiers 1–3, which is a hierarchical grouping corresponding with the views of leading liner operators, reflecting (their) corporate aspirations to become what in effect are considered as either 'Tier 1, Tier 2 or Tier 3 carriers', each tier representing the provision of a different level/range of logistics services and scope of activities (Baird, 2001). To some extent this hierarchy mirrors the findings of Midoro and Parola (2006), and Haralambides and Accario (2010), who also found three groups, or levels, of liner operators in terms of logistics services provision.

What are referred to here as Tier 1 carriers are those lines that provide virtually any logistics service demanded, and almost anywhere in the world thanks to their global operations. These lines also tend to generate a significant level of income from logistics activities, estimated here at above US$ 3 billion per annum. Logistics service income for these lines may account for anything between 20 and 40 per cent of overall income derived from ocean transport services. The analysis suggests that three of the top 20 lines are Tier 1 logistics providers offering comprehensive global logistics services: Maersk Line, APL, and NYK. These three carriers were also identified by Haralambides and Accario (2010) as being 'successful' examples of liner operators providing logistics services, and this also reflects the findings here.

Tier 2 carriers are those lines that can provide a reasonably comprehensive range of logistics services, but with a primary focus on the major trading regions, and particularly in the home nation/region. These lines tend to earn a more modest income from logistics activities than Tier 1 operators, and typically annual revenues of between US$ 1 and US$ 3 billion might be expected. Logistics service income for these lines may therefore account for between 10 and 20 per cent of income from ocean transport services. The analysis suggests that four of the top 20 container lines are Tier 2 carriers offering comprehensive regional logistics services: Cosco, OOCL, MOL, and K Line.

TABLE 10.2 Strategic groupings for top 20 liner shipping operators' provision of logistics services

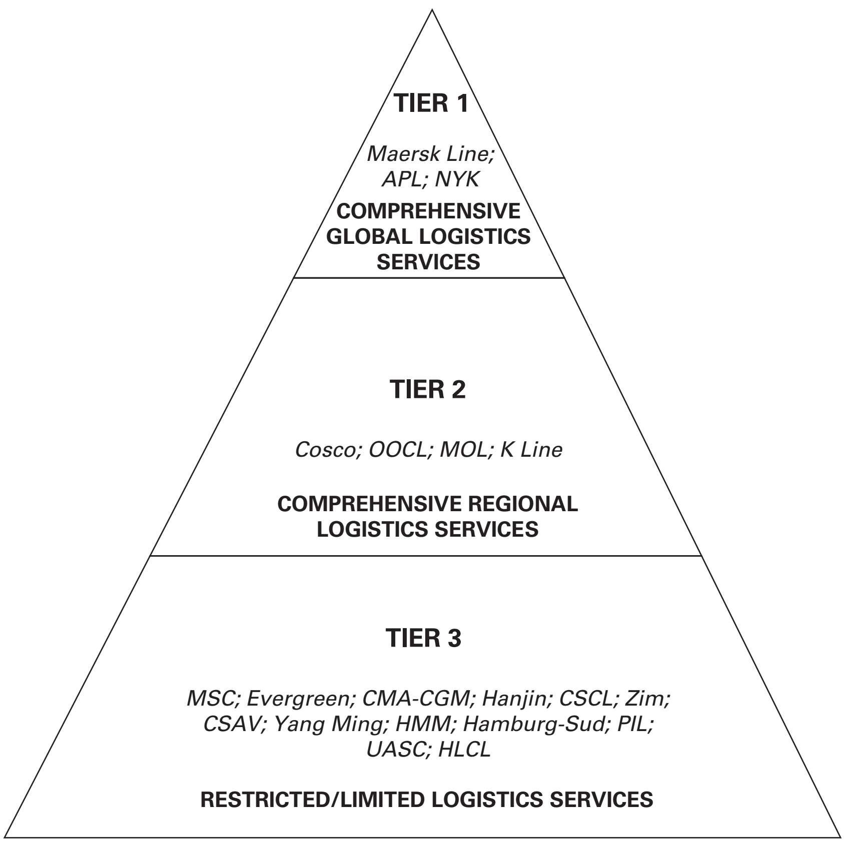
Tier 1	Comprehensive Global Logistics Services
Service Characteristics/ Scope	Carrier provides almost any logistics service demanded Logistics services provided virtually anywhere in the world Logistics service revenues exceed $3 billion per annum Logistics income amounts to 20–40 per cent of ocean transport income
TIER 1 CARRIERS:	*Maersk Line; APL; NYK*
Tier 2	**Comprehensive Regional Logistics Services**
Service Characteristics/ Scope	Carrier provides wide range of logistics services Logistics services provided mainly in major regions Logistics service revenues between $1–3 billion per annum Logistics income between 10–20 per cent of ocean transport income
TIER 2 CARRIERS:	*Cosco; OOCL; MOL; K Line*
Tier 3	**Restricted/Limited Logistics Services**
Service Characteristics/ Scope	Carrier provides restricted/basic logistics services Logistics service turnover under $1 billion per annum Logistics income below 10 per cent of ocean transport income
TIER 3 CARRIERS:	*MSC; Evergreen; CMA-CGM; Hanjin; CSCL; Zim; CSAV; Yang Ming; HMM; Hamburg-Sud; PIL; UASC; HLCL*

Tier 3 carriers are those lines that provide minimal logistics services, albeit in some cases with the possible exception of logistics activity concentrated within the home nation/market. These lines tend to have a very limited share of total income derived from logistics activities, believed to be below US$ 1 billion per annum. Logistics service income for these lines will therefore tend to amount to less than 10 per cent of income derived from ocean transport services. For Tier 3 lines ocean transport is by far the primary focus of business strategy and investment. This analysis suggests that 13 of the top 20 container lines are Tier 3 carriers offering minimal logistics services: MSC, Evergreen, CMA-CGM, Hanjin, CSCL, Zim, CSAV, Yang Ming, HMM, Hamburg-Sud, HLCL, PIL, and UASC.

Hierarchy of top 20 carriers' logistics activity

Figure 10.6 further emphasizes the results of this analysis by presenting liner operators in the appropriate respective hierarchical positions as related to their strategic approaches towards provision of logistics services.

FIGURE 10.6 Hierarchy of top 20 liner operators' logistics service provision



To a significant extent Tier 1 operators have tended to acquire logistics companies in key markets/sectors in order to more rapidly grow this part of their business, plus develop IT capabilities. Tier 2 and Tier 3 operators may have to follow a similar strategy if they wish to expand further their logistics activity; organic growth from a low base will take much longer to reach a given level, assuming the necessary supply chain management expertise exists within a line in the first place.

Several Tier 3 lines appear to be implementing to varying degrees more focused logistics service strategies, which could see them move upwards, in time, possibly to become Tier 2 operators.

There nevertheless appears to be a significant number of Tier 3 operators who seem content to remain with their strategic focus on ocean transportation. It should also be noted that some carriers have actually scaled back their logistics activity during recent years, selling off logistics assets, and reinstating their focus on what they see as their core market and core competence – ocean transportation (eg Hapag Lloyd). This development may not be entirely unrelated to the recent higher returns achieved from liner container shipping (with the exception of 2008–2009), contrasting with more modest returns from logistics activities.

Conclusions

Many of the largest container liner shipping companies operating ships, terminals, trucking, rail and inland depot operations have also developed or acquired logistics capabilities, albeit to rather varying degrees. This has been aided by the trend towards outsourcing of logistics functions by shippers to 3PLs. Thus, opportunities for carriers who are able to offer services similar to 3PLs are considered to be greater now due to outsourcing.

While some carriers have made substantial investments in logistics assets, through direct acquisition and/or organic growth, other carriers are themselves outsourcing their (and their customers') logistics needs to non-carrier LSPs. The use of strategic alliances and other forms of collaborative ventures has increased, offering ocean carriers a rapid alternative entry into a business that few seem to really fully comprehend themselves.

Analysis of the top 20 container lines' logistics strategies has revealed something of a hierarchical situation where lines are adopting rather different strategies as far as logistics and added-value services are concerned. Tier 1 carriers, or those lines offering comprehensive logistics services on a global basis, aim to grow logistics revenue up to or even beyond the level of liner shipping revenue; however, in all cases they are still far from achieving this goal, logistics accounting for an estimated 20–40 per cent of Tier 1 liner operator revenues (or in excess of US$ 3 billion per annum).

Tier 2 carriers derive rather less income from logistics than Tier 1 carriers, and tend to primarily focus what logistics capabilities they have on the major East–West trades/markets. However, Tier 2 carriers do appear to be starting to make inroads into emerging markets, so the logistics activities of these operators' should increase further over time. Tier 2 carriers are defined here as lines with income derived from logistics of between US$ 1 and US$ 3 billion per year, accounting for 10–20 per cent of total income.

Some Tier 3 carriers, that is, lines offering restricted or limited logistics services, are looking to expand further into the logistics sphere. However, on the whole, most Tier 3 carriers tend to derive limited revenue from logistics, and several lines appear uninterested in providing much in the way of logistics services, preferring to focus their attention on liner shipping, on terminals and inland transport, which is viewed as the core business activity. Tier 3 lines derive less than US$ 1 billion from logistics, which is less than 10 per cent of total income.

The reality seems to be that over half of the top 20 carriers, and not just the smaller lines, actually offer rather little in the way of logistics or added-value services. Conversely, several top 20 carriers maintain a wide portfolio of logistics investments and capabilities and hence derive considerable income from these activities. Yet it is not the case that the bigger the carrier, the more involvement it will have in logistics services. Indeed, several top 10 carriers, including some of the very biggest lines in terms of fleet size/capacity, actually offer relatively little in the way of logistics services. These results tend to reflect the findings of Haralambides and Accario (2010), the latter suggesting that there remains plenty of room for liner operators to expand their logistics services, although whether they would wish to do so remains a key question.

Moreover, there appears to be scant evidence of ocean carriers earning high profits from logistics. Indeed, higher returns received from liner shipping over recent years (especially just prior to the 2008 economic crash, and also during 2010 as traffic volumes returned) may partly explain decisions by several carriers to specify (or to re-specify) ocean transportation as the core business activity, and hence to become rather less interested in investing in logistics services. However, a return to stronger growth in the logistics sector could over time be expected to attract more lines back into that sphere of activity.

The ultimate question for the largest container lines, it seems, relates to how much additional business can be generated for the core ocean transport services through investments in logistics services. This appears to be the main objective of ocean carriers investing in logistics service capacity, to support and strengthen the core business – liner container shipping.

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Tanker shipping logistics

11

ROBERT DESROSIERS

Introduction

The bulk movement of crude oil and petroleum products made up 23.8 per cent of global maritime cargo movements in 2009, requiring 35 per cent of the world fleet (Asariotis *et al,* 2010). However, much of the literature written on cargo operations at the ship–shore interface has focused primarily on general cargo, with more recent research focused on containerization. The literature for tanker operations for the logistics practitioner has been sparse, outside of environmental concerns and technical publications for tanker and terminals operators.

This chapter focuses on the transfer of bulk petroleum at fixed terminal facilities to introduce the reader to the logistics of bulk liquid. Three major components of petroleum movement will be introduced (the petroleum itself, the cargo terminals and the ships), followed by the practice of logistics and the steps involved in transferring this increasing valuable liquid. In addition to the physical movement of petroleum, contractual aspects of petroleum movement and custody transfer will be discussed to add context to the need for careful monitoring and proactive efforts by all parties on the scene to prevent both fiscal and cargo loss.

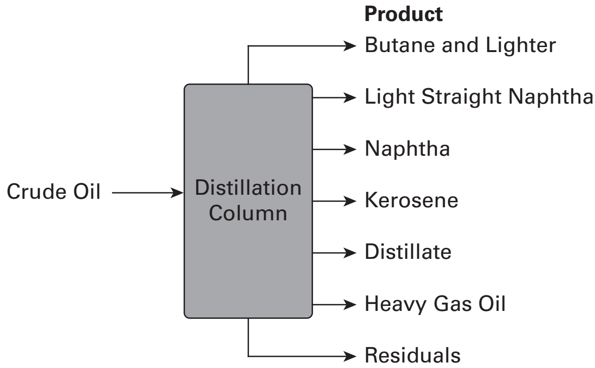
A knowledge of the legal procedures and processes involved in the transfer of bulk petroleum is important to understanding the constraints and problems that can and do arise. This knowledge will allow the practitioner to not only plan more effective operations, but enable all to take action to improve the processes and make more effective and informed decisions.

Transfer components

Petroleum

The life of the useable litre of petrol begins its voyage as crude oil extracted from beneath the earth's surface. It is often pumped via pipelines to storage tanks where some of the sediments, salts and water are allowed to settle out,

FIGURE 11.1 Crude oil fractions



after which it is either sent directly to a refinery or pumped to a crude oil tanker to be taken to a refinery.

It is important to note that the physical properties of crude oil vary with its area of geographic origin. Most crude oils are classified by their density and sulphur content. Less dense oils, or light crudes, have a larger proportion of light hydrocarbons that can be recovered by simple distillation. Denser crudes yield larger volumes of low-value product and require more complex processing to recover the more valuable petroleum product (Leffler, 2000).

With respect to sulphur contents, crude oil with high sulphur content is known as 'sour crude', as the sulphur content complicates the processing and final quality of the product. Common sour crude oils include much of the crude oil obtained from the Gulf of Mexico, Kuwait and Venezuela. Sweet crude has a low sulphur content, making the refining process easier and less expensive. Some common production areas for sweet crude are the North Sea, Libya and West Texas.

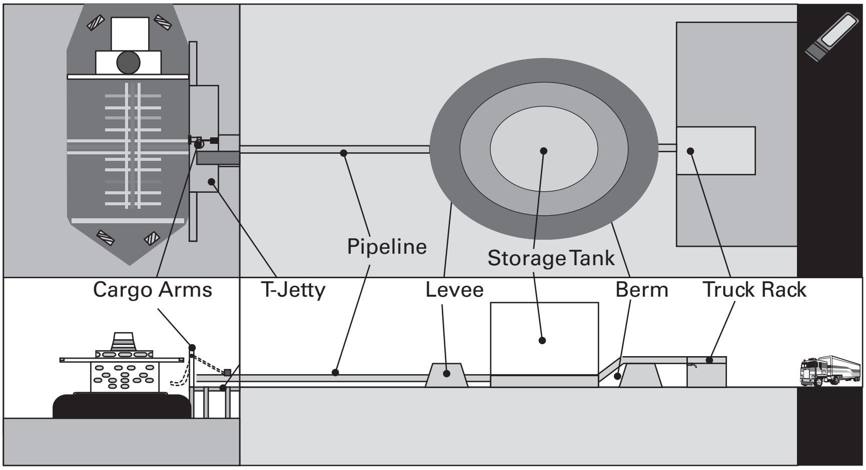
At the refinery, the crude oil is separated into its various fractions through a distillation process, similar to the distillation of alcohol, where the crude oil is heated. The various components evaporate and condense at different temperatures, allowing the crude oil to be separated out into useable fractions (Leffler, 2000). The fractions resulting from the standard distilling process are generally butanes, gasoline, naphtha, kerosene, gas oil and residue (Figure 11.1).

Once the petroleum has been separated into its refined fractions, the product is transported to a marketing terminal for further transfer, or shipped directly to its destination.

Marine terminals

Marine bulk oil transfer facilities should be designed for the safe and efficient transfer of bulk petroleum between ship and shore. Due to the nature of the materials being handled, transfer facilities should incorporate adequate fire prevention design criteria and environmental protection systems. In the

FIGURE 11.2 Simplified bulk petroleum marketing terminal



United States, the design standards are given in the National Fire Protection Association's guidelines, as well as other applicable local and national codes, and established engineering practices. The design and maintenance schedules should consider the hazards associated with marine vessels, as well as tank trucks, pipelines and rail tank cars (API, 2005).

There are two basic types of marine petroleum facilities: marketing facilities and refining facilities. Marketing terminals are generally used for receiving and storing bulk crude oil or petroleum products for further transfer. Refining facilities take crude oil delivered by tanker and refine it into various compounds, or fractions. In many cases, the refinery also serves as a marketing terminal.

Regardless of the terminal type, there are several basic elements to petroleum terminals (Figure 11.2). The main components of the terminal are: cargo transfer arms/hoses, cargo pipelines, cargo tanks, and inland transfer facilities such as truck racks. The cargo tanks are surrounded by levees, or dikes, with the area around the tank out to the levee referred to as a 'berm', a slightly different use of the term than that often seen in common usage (API, 2005). Depending on the location and size of the tanks, the transfer of petroleum into and out of the tanks may be assisted by booster pumps to overcome head pressure resulting from tanks located significantly above the transfer point.

Tank ship

Petroleum cargoes carried in bulk are most efficiently transported by tankers designed specifically for the carriage of large liquid quantities.

Oil was originally shipped in wooden barrels, resulting in a messy and risky voyage. In 1878, the *Zoroaster*, built for the brothers of Alfred Nobel, of Nobel Prize fame, was introduced as the first ship to use its hull as containment for liquid petroleum cargoes (Baptist, 2000). In 1886, the *Gluckauf*

TABLE 11.1 Oil tanker size categories

Class	Size in DWT capacity
ULCC	300,000–500,000
VLCC	150,000–299,999
Suezmax	120,000–149,999
Aframax	80,000–149,999
Panamax	50,000–80,000
Handy Product	30,000–50,000
Coastal Product	10,000–30,000

SOURCE Branch (2007)

was built and considered the prototype for the modern tanker, incorporating many of the features seen in today's tankers, such as pressure relief valves, cofferdams, cargo valves capable of being operated from the deck, aft engine room and the ability to load ballast (Tusiani, 1996).

Up until the mid-1940s, tankers remained relatively the same size where the market and trade patterns required larger tankers to meet the demands for the recovery from the ravages of the two world wars. In the 1950s, shipowners embarked on a quest to build the largest tanker. With the closure of the Suez Canal for eight years in the late 1960s, tankers were no longer limited by canal restrictions as they had to go around the Cape of Good Hope. Economies of scale dictated that larger ships could carry larger quantities at cheaper rates, culminating with the largest tanker built, the *Seawise Giant*, at over 560,000 deadweight tons (dwt).

Today, modern tankers vary in size according to their cargoes and trade routes. Table 11.1 provides an overview of the various tanker sizes used in the carriage of petroleum. While a cursory look may seem to indicate they are large floating tanks, their systems can be quite complex.

Contractual relationships

Charter parties

The legal requirements for the transfer of bulk petroleum are primarily contained in the charter parties governing the ocean carriage of petroleum and oil contracts governing the purchase and sale of petroleum.

A charter party describes the required performance of the ship in relationship to the carriage and care of the cargo, as well as performance requirements for the ship. Common performance requirements are the carriage of the cargo with less than half a per cent loss from origin to destination, ability of the ship to load or discharge the cargo within 24 hours or maintain 7.03 kg/cm^2 (100 psi) at the manifold, and the cargo to have the same characteristics upon discharge as when it was loaded (Schofield, 2000). This requirement is often referred to as the pumping clause or warranty.

The requirements of the pumping clause should not be confused with the allowed lay time as stipulated elsewhere in the charter party. While the allowed lay time is cited as a total of 72 hours, 36 hours at the load port and 36 hours at the discharge port, the lay time can be amended to cover the expected conditions and delays that may be expected at various ports (Edkins and Dunkley, 1998). However, when the time for operations exceeds the allocated lay time, a penalty or demurrage is charged against the charterer. Table 11.2 outlines some common causes of delays at a terminal in Texas City, USA.

When the 24-hour time limit is not met, as laid out in the charter party, it is commonly due to physical limitations of the equipment in use, such as only one manifold connection, small piping, equipment malfunctions, or lack of tank space. Weather and port congestion can also contribute to delays in cargo operations. Thus, problems in these areas may require significant financial investments.

The difference in lay time and pumping clause can be attributed to the activities surrounding the actual transfer of cargo. As can be seen in Figure 11.3, there are several activities that must be completed before and after the cargo transfer. Some contractual allowances are made, with two of particular note: notice of readiness and disconnection of cargo hoses/arms.

The notice of readiness (NOR) is the formal notification that the tanker has arrived at the port or berth and is ready in all respects to load or discharge cargo (Schofield, 2000). Typically, once the NOR has been tendered, the lay time commences six hours later, or upon arrival at the berth (Edkins and Dunkley, 1998) and continues until the hoses are disconnected. A common stipulation is that if the vessel is delayed in excess of three hours after disconnection of cargo hoses solely, lay time or demurrage shall be deemed to have continued without interruption from the disconnection of the cargo hoses until the termination of such delay (MSC, 2002). A common example of such a delay is the failure to deliver required documentation, such as the bill of lading (B/L), to the ship or release the ship to sail.

When a tank ship arrives in port, the ensuing cargo operations have three principal areas of concern: the performance of both the ship and terminal in accordance with the charter party, the quantity of cargo transferred, and the quality of the cargo.

At the end of the cargo operation, vessel release occurs when a person in a position of authority accepts the results of the cargo transfer. This may take the form of quantifying the cargo remaining onboard or verifying the quantity of cargo transferred, and reflects an event that is useful in determining efficiency. It should be noted that due to departing restrictions, such as channel congestion, weather delays such as restricted visibility or high

TABLE 11.2 Sources of terminal delays at Texas City, Texas USA

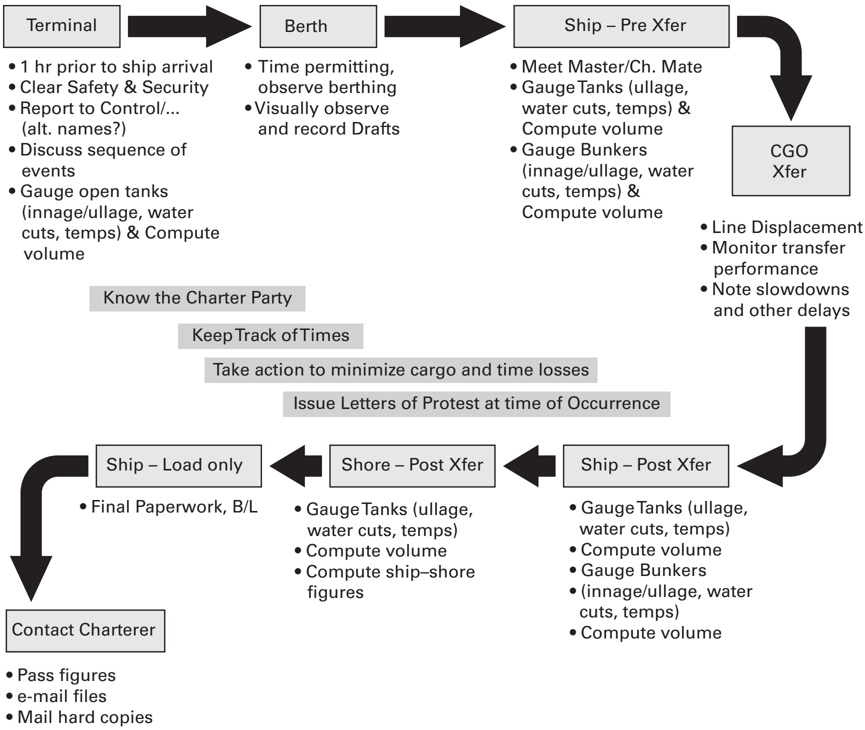
Delay category	Hours
Awaiting pilot, tugs or channel traffic	42
Awaiting daylight	125
Break down (or lack of) vessel equipment	154
Awaiting Tanker man	161
USCG delays	235
In spector Delays (sampling, gauging, arrival etc.)	243
Vessel Discharging slop/Internal stripping/Bunkering	324
Refinery Lab delays	380
Pumping limitations (Reduced Rate)	382
Awaiting pilot, tugs or channel traffic	414
Line wash delays	579
Awaiting berth (Planned outage for maintenance)	827
Breakdown of Shoreequip	962
Cargo Not Available/Not Ready	988
All Other delays (be specific)	1241
Delay at bar or fleet - no reason given	1946
Weather (fog, lightning, high seas)	2123
Scheduling (conflict or change in schedule)	2449
Unit shut down, fire, emergency etc.	2486
Lines Not Available	5694
Limited (or no) Tank Space	7081
Awaiting Berth (Dock scongestion)	7721
Grand Total	**36557**

SOURCE Fondren (2010)

winds, or night-time restrictions, using the last line event as a measure to determine process efficiency would be inaccurate.

It should be noted that at all times during ship–terminal operations, all government, local port and terminal regulations shall be complied with, as failure to do so could result in lost time, fines or vessel detention. This is particularly true in the areas of security and safety.

FIGURE 11.3 Tanker–terminal cargo transfer work flow



These requirements make for a challenging environment at terminals where loading and discharging occur, with multiple parties having a variety of responsibilities, often working towards the same end. At other times, they may be working against each other, such as working to get the last bit of cargo off the ship to maximize freight, while the terminal may want the ship off berth in order to bring another alongside.

Responsibilities

When the tanker transfers cargo at a terminal, there are generally three types of parties involved: the ship-owner, the charterer and the cargo owner. Each of these parties has distinct responsibilities.

- The *ship owner*, or ship manager, is responsible for maintaining tank calibration tables, gauging and sampling equipment and all pertinent facilities in good operating condition to enable the ship's crew to accomplish accurate cargo gauging, sampling and accounting. The ship owner instructs the master to provide cargo-gauging and sampling data, as well as reports as directed by the cargo owner and receiver. This requires that the ship's crew must be competent to undertake cargo measuring, sampling and calculations in accordance with written guides and procedures describing these operations.

- The *charterer* is responsible for providing the ship's master with written guides, procedures, instructions and orders applicable to gauging, sampling, and accounting for the cargo being carried while the vessel is under charter.
- The *cargo owner* is responsible for providing a qualified person to act as a shore representative to join with the ship's officer in the inspection of all cargo and slop tanks on board before and after the cargo transfer, and to witness all gauges, temperatures, water cuts and samples required to account for the net quantities and quality for the cargo. These measurements will also include the quantity of any oil residues or other slop material present (API, 2001b).

The cargo owner also ensures that the shore representative validates all forms used to record gauging and sampling data taken before and after loading or discharge, including tank condition, gauges, temperatures, gross and net cargo quantities and load-on-top quantities. Where the cargo owner is also the loading or receiving terminal, they make certain that safe ship-to-shore conditions exist while gauging and sampling activities are being carried out on board and whilst the vessel is moored at the terminal (IP, 1989; 2001). This is in addition to doing all necessary shore gauging and calculations and giving the results to the ship for comparison with the vessel's figures.

The cargo inspector should be regarded as a person who, by reason of his knowledge and practical experience in the field of bulk oil cargo measurement and analysis, is competent to provide impartial judgements, reports and recommendations on matters relating to the quantity and quality of these cargoes. Cargo inspectors should verify the purpose of a cargo survey, often through the use of a statement of the quantity and quality of oil loaded or discharged and to highlight matters which may be relevant to the protection of the client's interests.

Generally, the inspectors and representatives need to: understand who they represent; be knowledgeable about the terms of the charter party; understand how the terms may affect a client; understand elements of cargo quality and quantity; be conscious of international and local standards for inspection, testing and equipment; comply with safety requirements; witness the various stages of the operation; perform and observe surveys noting non-compliance with recognized standards and instructions; and keep the client informed before, during and after the survey of relevant details.

When a cargo of oil is transported by ship from one terminal to another surveys are undertaken to: establish the quantity and quality of oil loaded; establish the quantity of oil received by the receiving terminal; establish the differences in quantity of cargo discharged from a vessel as measured by a shore terminal (outturn difference); provide a time log of the events; identify other conditions at either the terminal or the vessel which may affect the above; and provide certified documents that might be used as a basis for the recovery of losses, the settlement of demurrage and despatch claims and assist in arbitration or litigation settlement (API, 1995, 2001b).

Cargo transfer procedures

Cargo inspection

Before any cargo operation commences, all the key personnel concerned with the operation should meet to discuss operational plans. Generally cargo will be delivered to a vessel from shore tanks. With tanks, it is necessary to determine the quantity and quality of material in the shore lines from the tank to the vessel, and the quantity and quality contained in the shore tank, obtaining samples of this material as appropriate. Where the line volume represents a significant proportion of the quantity to be loaded, the line contents should also be sampled for analysis (API, 2001b).

When loading quantity is determined by meters rather than measure of tank and line volumes, it is necessary to determine the type, size and maximum flow rate of the meters together with the position and accuracy of the temperature probe. The average flow rate should also be recorded for the intended cargo plus the temperature, viscosity and grade.

Shore tanks are examined for noticeable deformities that might affect the tank calibration data. Prior to quantifying the tank contents, the tanks should be isolated from other systems by closing and sealing valves on the filling, crossover and drain systems. Where tanks have floating roofs these should be free of debris, snow, water, ice and other weights, avoiding the roof being grounded or in a critical zone.

The calibration tables for the tank should be checked to record the last calibration check date together with the issuing authority. Data regarding the measurement point and referenced height should also be recorded. It is advisable to record when the tank was last cleaned and inspected, as well as the date of any repairs. If the tank has been recently inactive, a period of 30 minutes is allowed for settlement before any gauging is performed (API, 2001b; IP, 1989, 2001).

The tank reference height, which should be prominently marked at the reference point, should be compared with the calibration table, and confirmed by measurement. The tank or ullage should be measured using approved equipment and the measurement should be checked until two consecutive measurements agree within 3 millimetres.

Where tanks have sludge or debris present on the bottom, ullage measurement is preferred. This measurement should be related to the tank reference height. Where water is present in the tanks this should be gauged using water-finding paste and a steel tape or a portable sonic tape.

The tank temperature should be obtained using an electronic device or mercury-in-glass thermometer. Temperatures should be measured at a number of levels in the tank to obtain a more accurate assessment of the temperature profile and these should be averaged. Tanks should be sampled as required by the client and as specified within the industry.

Quantity

Where the parties concerned agree, automatic tank level gauging and temperature measurement systems may be used for custody transfer. Wherever possible, the surveyor should take his own measurements and compare them with those of the automatic gauge system.

Where terminals do not allow surveyors to take these, the surveyor should be satisfied from the terminal's gauge-proving records that the gauges are satisfactory, and an appropriate note made in the general comments of the survey report.

Before gauging, the surveyor must determine the nature and quality of material in the shore lines and the total capacity of the lines from manifold flange to the shore tank(s) in use. The steps taken to determine that the shore pipeline was full of liquid are recorded. Often the line check may take the form of a physical line displacement at the beginning of loading, by transferring petroleum from a single shore or ship tank to a single ship or shore tank (API, 1998). This line displacement can also be used to determine the quality of the petroleum when this may be of importance.

The terminal should arrange for lines and valves to be set so as to prevent cargo being contaminated or lost through other lines and tanks, with written confirmation. Inspectors must be satisfied as to the system's integrity, and attempt to verify previous line contents and characteristics.

When metering, the volumetric measurement of liquid flow is measured, and thus used to determine the amount of cargo transferred between the terminal and ship. Before loading, meter data should be recorded upon completion of the line-up (API, 2001b).

On board the vessel, it will be necessary to study the ship's drawings and plans to record details of the vessel. From the general arrangement plan, the position of gauging points, the length and width of the tanks, the pipeline layout and the pipeline quantities may be determined. The surveyor should also check the vessel's calibration tables to obtain the tank heights and whether the pipeline quantities are included in the tank capacities.

When possible, tanks should be visually examined from deck level to obtain an accurate picture of the interior. Where the appropriate safety precautions have been taken, tanks may be inspected by entry. A physical inspection will normally be necessary to examine the condition of the tank surfaces, heating coils, piping, submerged pumps, and to fully assess the cleanliness of the tank and the integrity of the tank coating.

Where physical inspection is not necessary or impractical, the amount and nature of any onboard quantity (OBQ) should be determined prior to loading. This should be described as either liquid, non-liquid, free water or sediment and, if possible, the temperature should be measured and a sample obtained. It is convenient at this time to check the tank reference height and this should be compared with the tabulated height in the calibration tables.

A complete inspection of a vessel should also include a check of the ballast system, the void spaces, the pump room and the bunker system. This will depend on the time available, the nature of the survey and other factors. When the surveyor is satisfied that he has obtained the necessary information to report on the vessel's condition prior to loading he should allow loading to commence. In some cases this may require his advice and supervision.

During the loading the role of the surveyor can vary. The surveyor may be required to sample the cargo during loading, the operation of meters, or the performance of the ship and shore facilities. It is upon completion of loading that the greatest involvement of the inspector will be required.

The survey of the vessel after loading is required to be rigorous and extensive. The cargo tanks on the vessel must be checked for ullage and temperature, and gauged for water. The calculation of quantities is made easier when the vessel is on an even keel. It is important that all tank valves on the vessel are closed prior to this survey and that they remain closed during the survey. It is important to check non-loaded compartments, void spaces and ballast tanks, in addition to measuring and sampling the loaded tanks. A post-loading bunker survey should be performed at this stage

Upon completion of the inspection and gauging on board, the calculation of the vessel's loaded quantity should be made using the appropriate corrections. Application of the vessel's experience factor should provide a reasonable check on the quantity stated on the shore-loading certificate. If it does not, then an investigation should be undertaken to find out the reason for the discrepancy (API, 1995).

The shore tank check after loading should be undertaken in the same manner as prior to loading. The shore tank numbers are generally the most important figures on the bill of lading. Whether the figures are acquired by tank dipping or by metering, they should be carefully checked as errors are very difficult to rectify and considerable sums of money depend on the reliability and accuracy of the B/L.

The inspection of a cargo at a discharge port essentially follows the loading survey in reverse, with the same care and attention to detail shown at the loading terminal applied to the discharge. However, there will come a time after the discharge when the quantity and quality of the cargo discharged will be compared with that at the load port. It is for this reason that the inspector's impartial report of both operations is of vital importance: the quantity loaded is rarely the same as that discharged (API, 2001b).

Traditionally, oil cargoes have been measured in barrels and long tons and corrected to a standard temperature of 60°F using the API gravity, or expressed in cubic meters and metric tons at 15°C (sometimes 20°C) using the density of the liquid. All bulk liquid cargoes are measured by volume. While the measurement of volume may be difficult to determine accurately, this task is further complicated by temperature. Due to the expansion and contraction of liquid due to temperature, making the use of a standard temperature to determine volume is critical. The difficulty lies in accurately determining the temperature of a large tank, with the cargo temperature affected by heating by the sun and heating coils and the temperature of surrounding tanks creating temperature gradient in the cargo tank (API, 2001a). It is necessary to provide correction tables showing the factor used to correct the volume to a standard temperature, as change in the volume of liquids is not linear.

While the tables have been revised over time to more accurately reflect the variety of crude oils and their characteristics, some countries will use the older set of tables, as the newer tables reduce, by a small quantity, the volume at the standard temperature. The latest tables are in fact a formula designed to be used with personal computers, now that they are considered common. The effect of the new tables compared to the old is to reduce by a small amount the volume at the standard temperature, but both methods are still considered correct.

Quality

In spite of efforts by the International Organization for Standardization (ISO) to standardize petroleum products testing, many standards are established by various national or business organizations. A single test may have a variety of different methods by which a result may be obtained. This can be compounded by two other factors: repeatability and reproducibility.

A laboratory analysis using the same method, equipment and, of course, sample of material may get two slightly different results. This is recognized as acceptable as long as the results fall within the range of repeatability. A lack of reproducibility is where the result found in one laboratory may differ from the results found in separate laboratory. The same test methods and types of equipment may have been used, but a different result is found. These results are also acceptable as long as they are within the range of reproducibility (Intertanko, 1996).

Another area where a loss may be incurred is at the point of the shore storage system. The shore tanks may have been improperly calibrated, improperly gauged, or simply the difference is between empty and full tank shell dimensions. Tanks also have bottom movement, or springing, that occurs when the weight of the liquid increases (API, 2001b). Tanks are calibrated at a fixed temperature, thus tank expansion due to heated cargoes can be significant if one is dealing with high-temperature products in large tanks.

The volume in the tank will distort the tank by the effect of pressure on the sides. The more pressure the greater the distortion. The distortion may have been allowed for in the calibration tables or it may not. In a fixed roof tank, the effect of this distortion may create a dip or upwelling that may affect the ullage and thus the volume calculation (API, 2001b). Some tanks have floating roofs that can be affected by debris, standing water, and snow and so on, affecting their weight and thus the ullage, resulting in inaccuracies.

For the purpose of custody calculations, it is often assumed that large pipelines are perfectly filled with the same grade of dry oil before and after transfer. In practice, however, there is concern about the incidence of air or void pockets and possible vapour locks in elevated sections of piping, as well as the presence of free water tending to accumulate in lower sections. With products, it is often slightly easier as line pigging (clearing the lines through mechanical means) is more common and free water is less.

Thus, there are two ways in which a loss can occur when considering pipelines. The first is simple and is easy to verify. That is that the line is not in the same condition before and after use, for example the line had air or water in it before use, but contains oil afterwards.

The way to check this is by performing a line push or displacement, or for some products a slopping' operation to a road tanker or similar. A displacement is particularly valuable with crude oil where long pipeline systems are in use, as a 30-inch pipe will contain about 45 m^3 per 100 metres (API, 1998). Thus, it does not take much of a percentage in a long pipe to lose a lot of cargo.

The second error in pipelines is that the pipeline contents are different before and after. While the pipelines may have been full of oil before, it is not known what the temperature or density of the material was. Obviously this density difference would have to be quite large to affect the volume, but the effect of only a small change in temperature is different: the effect of a 1°C change is about 0.01 per cent of the volume of the pipe.

Cargo losses

During the course of shipments of oil by tankers, it normally happens that some operational losses occur whereby the quantity delivered at the discharge port is somewhat less than the total supplied on board at the point of loading. Losses occur, to a greater or lesser extent, over each stage of the shipment, and may include evaporative losses of the most volatile fractions or 'light ends' during loading, carriage, and discharge operations; additional evaporative losses during crude oil washing operations; oil clinging to internal tank surfaces; increase in ROB (remaining onboard) in relation to the initial OBQ; unaccounted hold-up in the vessel's cargo lines and pumps; and accidental spillage and leakage or diversion to non-cargo spaces (API, 1995).

There are four distinct stages during carriage where the loss occurs: loading, voyage, vapour and washing (API, 1995). During loading, even with closed loading systems, there can be a significant loss. The cargo is entering the tanks under high pressure through a small aperture and immediately has a big empty tank to fill. Vapour generation on the surface is very rapid, particularly when the temperature of the air or inert gas in the tank is high. And all the time this vapour is being forced out of the tank as the vessel loads. It is hardly surprising that the old practice of topping off tanks with sticks through open tank ullage ports has been done away with. The losses, quite apart from the dangers, were considered too significant.

The losses occurring during the voyage depend on the weather conditions and temperatures experienced in conjunction with the duration of the voyage. As the gas and air in the ullage space heats up, there is a resultant rise in pressure that is partially contained by the pressure-vacuum (PV) valves. Eventually, this pressure will be released to the atmosphere allowing further generation of gas to occur. As the vessel moves through a seaway, this effect increases as the liquid surges in the tank, forcing the pocket of gas in the ullage space either out of the PV valve or through other points, and the tank starts to 'breathe' with the movement. Vapour is therefore continually being lost to atmosphere and continually replaced with more vapour from the liquid surface. At night the tank cools down and the tank and air space also cool. A vacuum is formed which activates the PV valve. Air then enters the tank and becomes saturated ready to be emitted the next day.

A third area of vapour loss can occur during discharge. Upon sailing after discharge, the empty tanks will be full of a mixture of oil vapour and inert gas, much of which may be lost when ROB measurement is taking place.

Finally, there is an increase in vapour losses due to crude oil washing (COW) operations. COW is used to clean the tanks by the spraying of the crude oil against the walls and floors of the tanks. This spraying of a crude oil stream inside a cargo tank generates vapours that can be vented to atmosphere due to the over-pressurizing of the tanks.

Clingage, where petroleum adheres to horizontal and vertical surfaces of cargo tanks other than the bottom surfaces, is another area of potential loss. On crude oil tankers, tanks that have been COWed are often considered to be free of sludge in the upper areas, on all verticals and most horizontals down to the bottom. Clingage can be a significant factor in oil losses when COW has not or cannot be performed.

The increase of ROB cargo after discharge against pre-loading OBQ figures can be relatively easy to quantify. However, variances in inspection procedures may result in quantity differences that can be difficult to resolve. The pipelines and pumps may also contain residual cargo oil creating further measurement errors. While preparing the vessel for loading, tanks and cargo pipelines may have been cleaned, resulting in very little cargo in the pipelines or pumps (IP, 1989). However, after discharging the cargo, the time it would take to recover the cargo from the pumps and the lines, as well as ROB, may not be economically feasible when the value of the cargo quantity is compared against the value of time of the lay time and demurrage as laid out in the charter party.

Conclusion

The logistics of transferring bulk petroleum is subject to a variety of uncertainties and potential losses that need to be monitored and mitigated in order to ensure effective and efficient operations. Losses are not limited to quantity and quality, but also encompass the dimension of time. For those engaged in the transport and transfer of petroleum cargoes, it is important to understand these issues in order to balance the priorities between these sometimes conflicting aspects of cargo transfer.

As tanker–terminal operations move into the future, additional pressure will be placed on these operations that may affect the time to complete the operations and impact the ability to effectively transfer a quality cargo in the proper quantities. These pressures may result from security, environmental and fiscal requirements and considerations. It is up to practitioners to provide the oversight and management to minimize the costs while maximizing the benefits and opportunities.

Glossary

API: American Petroleum Institute.

API gravity: An American unit used in petroleum liquids.

B/L or BoL: The bill of lading.

Calibration table: A table, often referred to as a tank table or tank capacity table, giving the volume of material held in a storage tank for various liquid levels.

Clingage: Oil residues that adhere to the surface of tank walls and structures on completion of discharge.

Cofferdam: The isolating space between two adjacent steel bulkheads or decks. This space is commonly void, but may be used as ballast in some vessels.

Critical zone: The volume close to the bottom of a floating roof tank in which there are complex interactions and buoyancy effects as the floating roof comes to rest on its legs. The zone is usually clearly marked on tank calibration tables and measurements for custody transfer should not be made within it.

Density: The ratio of the mass of a substance to its volume. Since density is dependent on temperature and pressure these should be stated.

Floating roof: A tank roof which floats freely on the surface of the liquid except at low levels when it is partially or wholly supported by 'legs'.

Innage: The depth of liquid in a storage tank measured from a reference level

Light ends: The low-density constituents which may be easily lost by evaporation.

Manifold: The final pipe of a cargo system before the shore connection. The pipe through which cargo is discharged into the loading arm ashore and from which loaded cargo is distributed to the various cargo tanks.
Onboard quantity (OBQ): All the oil, water, sludge and sediment in the cargo tanks and associated lines and pumps on a ship before loading a cargo commences.
Quantity remaining onboard (ROB): All the oil, water, sludge and sediment in the cargo tanks and associated lines and pumps on a ship after discharging a cargo has been completed, excluding vapour but including clingage.
Outturn: The quantity of cargo discharged from a vessel, measured by a shore terminal.
Slops: Material collected after such operations as stripping, tank washing or dirty ballast separation. It may include oil, water, sediment and emulsions and is usually contained in a tank or tanks permanently assigned to hold such material.
Stripping: The operation at the conclusion of a discharge whereby the final part of the bulk liquid cargo is removed from a cargo tank.
Ullage: The distance from the ullage reference level to the oil surface. The depth of free space left in a cargo tank above the liquid level. Also known as outage.
Venting: The process of releasing cargo gas or inert gas to atmosphere by way of the vessel's venting system and vent stack.

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Dry bulk shipping logistics

12

CLAUDE COMTOIS AND ROMUALD LACOSTE

Dry bulk trade

The globalization of economic activities has led to a profound mutation in the dry bulk trade. First, the world demand for bulk commodities has tripled since the 1970s to reach above 8 billion tons in 2008 with petroleum products (oil and natural gas) and the five major dry bulks (iron ore, coal, grains, bauxite/alumina and rock phosphate) accounting for 36 per cent and 25 per cent respectively of overall world seaborne trade (UNCTAD, 2010). Second, with an increasing share of East Asia's imports in dry bulk products originating in Latin America, West Africa and East Coast North America, ton-miles demand associated with this trade has expanded. Third, the long-haul trade of raw materials in support of East Asia's economic growth has created a demand for tonnage additions in the world bulk carrier fleet with new buildings entering the fleet being large units with an average size of 66,500 dwt (ISL, 2010). Fourth, the need to penetrate deep inland continents to secure provisioning or discharging of commodities combined with the importance of load factor to ensure the competitiveness of transporting bulk products gives a key role to railways and inland waterways.

More importantly, dry bulk trade underpinned by marine output is a key element in the supply chain for metallurgical producers, steel plants, aluminium industries and agro-food businesses. The participation of bulk trade within global economic processes will not diminish. The growth in the amount of dry bulk carried by sea and the mutation in the direction of flows are some of the major phenomena of world exchanges. The steady growth in the volume of dry bulk shipments has resulted in intensive demand for increasing the competitiveness of bulk logistics.

The understanding of dry bulk logistics is underpinned by key salient features. Bulk commodities have a low value/weight (or volume) ratio implying that the efficiency of land and marine transport has an impact on value added. The handling conditions of dry bulk materials are influenced by a wide range of factors (size, weight, water content, surface adhesion, ease of flow, extent of compaction). Handling equipment is often custom designed for specific dry bulk commodity. There are various types of contractual arrangement used for the shipment of dry bulk. The command centre of dry bulk trade is not always commensurate with dry bulk port location. Ships and consignment size vary enormously. These conditions raise a series of key issues. How has the dry bulk shipping fleet evolved? How is the commercial structure of dry bulk trade responding to the globalization of economic activities? Above all, how are these developments affecting dry bulk shipping logistics?

Dry bulk fleet

Diversity of the fleet

The fleet generally falls into three main categories: specialized carriers, combination carriers and all-round bulk carriers (Branch, 2007). Specialized bulk carriers consist of different types of vessels essentially built for special bulk cargo such as gypsum, bauxite/aluminium, potash, sulphur construction materials, sugar and salt. These ships are constructed with specific design and handling equipment suited for a particular niche market. Specialized bulk carriers account for 1 per cent of total bulk carrier fleet.

Ore carriers are designed for ores and heavy cargoes with a stowage factor varying between 0.35 and 0.70 m3 per tonne (Stopford, 2009). But the imbalance of traffic between imports and exports, the limited hold capacity of these ships and the increasing shipping distance has led to a decline in the original ore carrier fleet and an increasing market share of combination and all-round bulk carriers.

The combination carriers were designed with separated section holds to take advantage of two-cargo options between voyages such as ore/oil, bulk/oil, car/bulk or container/bulk. After a prolonged upward trends, the fleet of combination carriers began to decline. While these ships had a competitive advantage for being suitable for oil cargoes, they lacked flexibility of operation in the dry bulk markets. Increasing containerization brought significant demand for larger container ships. More importantly, the high capital and operating cost (regular maintenance, advanced crew training, accelerated aging) of these vessels prompted demand for all-round bulk carriers (Clarkson Research Studies, 2006; ISL, 2010).

All-round bulk carriers suitable for different bulk products vary in size and facilities. Vessels can be divided in two types: geared and non-geared. Ships with cargo gear are relatively small vessels, dedicated to minor bulk, essentially over short distances. Gearless ships are larger vessels, suited for major cargoes (iron ore and coal) with a view to covering long-distances trades.

This diversity in the dry bulk fleet aims at answering the need to adapt to the heterogeneity of bulk products, the different size of shipments, the constraints of trade routes and the geographical conditions of ports of call. Bulk carriers are thus essentially multi-purpose vessels in terms of size and equipment facilities. These vessels can carry a wide range of different cargo types and are often able to pick up backhaul cargo. They are considered as logistics tools partially in competition in an open market economy (Gardiner and Couper, 1992; Packard, 2005).

Evolution of vessel size

In 2008, the bulk carrier fleet consisted of 7,357 vessels accounting for 401,949,000 dwt (De Monie *et al*, 2010). The bulk carrier fleet comprises different classes ranging from Handysize (28,500 dwt) to Ultra-large Capesize (365,000 dwt). Any analysis of international marine bulk shipping must consider three interrelated dynamics: increasing tonnage of ships, increasing size of ships and adaptability of ships to market demand.

First, the average deadweight of dry bulk carriers is increasing. The average deadweight of Handysize has increased from 24,100 dwt in 1980 to 27,000 dwt in 2009. The average size of Panamax vessels has increased from 67,800 dwt to 71,600 dwt while average deadweight of Capesize ships has increased from 117,000 dwt to 157,000 dwt during the same period.

Second, evidence suggests a progressive shift of carrying capacity from small to larger ships. In 1980, Handysize accounted for 54.3 per cent of the world bulk fleet capacity, while 14.7 per cent was held by Capesize ships. In 2000, world deadweight tons capacity was almost at equilibrium with Handysize and Capesize accounting for 28.7 per cent and 30.8 per cent of world bulk fleet capacity respectively. The last decade has accelerated shift in carrying capacity with Handysize accounting for 16.3 per cent of world bulk fleet tonnage and Capesize 40.5 per cent in 2009 (Table 12.1).

Third, demand for dry bulk carriers is constantly being adjusted to international seaborne shipment of bulk cargoes. The market share of bulk carriers of 10–40,000 dwt is declining. In sharp contrast, the demand for Supramax bulk carriers of 40–60,000 dwt is increasing. These vessels combine the flexibility of Handymax with a higher carrying capacity without the constraints of Panamax ships in terms of length and draught. Panamax of 60–80,000 dwt are heavily used and account for approximately 25 per cent of the world bulk carrier fleet. Their niche market is increasingly being contested by the upper segment. There is a strong demand for ships above 80,000 dwt. The gradual acceleration of the growth rate for iron ore, coal and grain notably in China and India is placing increasing pressure for Capesize bulk carriers with 73 giant bulk carriers of more than 300,000 dwt on order, against only 12 in service. These changes are related to innovation in naval engineering, the search for scale economies, increasing production capacity of industrial plants, modernization of ports and terminals and changes in maritime route patterns.

TABLE 12.1 Evolution of dry bulk carrier fleet

Size (dwt)	Type	1980		1990		2000		2009	
		No	dwt (million)	No	dwt (million)	No	dwt (million)	No	dwt (million)
10–40,000	Handysize	3,156	76.2	3,131	82.0	2,887	76.6	2,502	67.6
40–50,000	Handymax	258	11.3	747	20.5	869	38.5	856	38.5
50–60,000	Supramax	233	12.6	183	9.8	124	6.6	702	37.6
60–80,000	Panamax	286	19.4	584	39.0	903	62.3	1,381	99.0
80–120,000	Babycape	102	10.6	110	11.3	57	5.5	247	22.9
120–400,000	Capesize	75	10.1	252	40.3	469	76.8	821	145.2
Total fleet		**4,110**	**140.3**	**4,734**	**203.1**	**5,309**	**266.6**	**7,481**	**414.4**

SOURCE Based on Clarkson (2006); ISL (2010)

Changes in route patterns

The high growth in international trade is a reflection of global economic processes with fewer trade restrictions. Dry bulk commodities constitute 25 per cent of the tons and 30 per cent of the ton-miles of international seaborne trade. The development of dry bulk shipping routes shows three important trends. The first trend is the growing market share of China in the international dry bulk seaborne trades related to the steel industry: iron ore, coal, steel product, bauxite and aluminium. China's economic growth rate is affecting the bulk carrier market with ship-owners ordering bigger ships contributing to increasing ton-miles for bulk carriers from 22.4 ton-miles/dwt in 1990 to 28.6 ton-miles/dwt in 2008 (UNCTAD, 2010).

The second major trend concerns the modernization of the Panama Canal. Dry bulk traffic, mainly agricultural products and fertilizers from the Gulf of Mexico and minerals from the Pacific, accounts for 25 per cent of the number of vessels in transit in the canal. The canal plays an important role in agricultural waterborne trade with 54 per cent of soya, 45 per cent of corn and 33 per cent of wheat originating from the United States and bound for Asia using the Panama Canal (USDA, 2008). By 2014, the modernization of the canal will have increased the canal lock chambers to 55 metres wide, 427 metres long and 18.3 metres deep. This should permit the transit of bulk carriers of 119,000 dwt as compared with the estimated current capacity of 52,000 dwt, thus prompting many ship-owners to acquire vessel size to the standard of the New-Panamax bulk carriers with a view to increasing their competitive position (Panama Canal Authority, 2011).

A third trend is the emergence of shipping routes in the Arctic. Bulk carriers and tankers have been using polar routes for several years albeit with limited frequencies and ports of call. But global warming and the contraction of the Arctic ice cap is lengthening the navigation season (Somanathan, Flynn and Szymanski, 2009). But currently the shortening of shipping distances allowed by the North-west and North-east passages does not compensate for the cost of operating vessels in the Arctic. The integration of polar routes in the international seaborne trade will largely depend on the price of bulk commodities.

Economies of dry bulk trade

Diversity in contractual arrangements

The commercial structure of the transport of bulk commodities is varied (Collins, 2001). Some commodities are transported in ships owned by the industrial plant, others by ships on 'time charter' to the industrial plant. In time charter the ship- owner still manages the vessel, but the charterer, often a third-party ship operator, selects the ports and the routes. A third segment

TABLE 12.2 Distribution cost of chartering a ship

Cost type	Cost items	Trip charter	Time charter	Bareboat charter
Running cost	Ports dues, canal fees, bunkers etc.	X	O	O
Operating cost	Crew, insurance, maintenance, repairs etc	X	X	O
Capital cost	Interest, dividend, debt repayment.	X	X	X

NOTE X indicates on the charge of the shipping company; O indicates on the charge of the charterer.

of commodities are moved on contract of 'affreightment' or 'trip charter'. The ship owner agrees to carry the charterer's bulk commodity in his vessel or gives to the charterer the use of the cargo-carrying capacity of the ship for the carriage of a given product on a specific voyage or a given period. A fourth group is 'bareboat charter' where shipping companies lease their vessels for long periods (several years) (see Table 12.2).

The Baltic Dry Index

Shippers have difficulties in forecasting the evolution of the dry bulk market given the number of products, the size of ships and the choice of routes. The Baltic Dry Index was created in 1986 as an indicator reflecting the price of carrying bulk commodities across the oceans. The Baltic Dry Index is based on 26 different rates linking a type of ship to a specific shipping route (ie Capesize from the Mediterranean to the Far East; Panamax in a transatlantic round voyage etc). While the index measures international shipping prices for a range of dry bulk commodities, it suffers from one important shortcoming, in that it varies according to the transport demand of a given commodity rather than the supply of ships affecting the rates of charter agreement. In 2008, the rate for time charter for Capesize ships on certain routes fell from US$ 283,000/day to US$ 5,000/day, thus affecting the financial liability of many ship owners.

Given this high-risk exposure to charter agreements, ship owners have resorted to other financial and market instruments. Freight Forward Agreement is a financial instrument for trading future freight rates for dry bulk carriers between traders, charterers and ship owners on the price of a particular freight route on a particular date. Various commodity future exchanges such as the New York Mercantile Exchange, the International

Maritime Exchange and London Clearing House contribute to the transparency and the security of the system (Alizadeh and Nomikos, 2009; Drewry Shipping Consultants, 2004).

Searching for scale economies

Scale economies are important in bulk shipping. The ratio of payload to the vessel gross weight tends to increase with increasing size. Construction costs per ton of capacity decline with increasing ship size. More importantly, the operating costs of a vessel do not increase proportionately to its size. Water resistance per ton is less with larger hulls so that horsepower and fuel consumption per ton are reduced for any given speed, while the ratio of labour cost to ton-miles performed tends to decline as vessels increase in size (Drewry Shipping Consultants, 2002). The cost of carrying a ton of freight on a 10,000-mile ocean voyage is US$ 15.49 with a Handysize, US$ 11.77 with a Handymax, US$ 9.12 with a Panamax and US$ 5.33 for a Capesize (Stopford, 2009).

But each bulk commodity is marked by constraints and opportunities affecting the search for scale economies. There is a relation between industrial market (ie production capacity, stocks etc), consignment size, vessel capacity and maritime distance. Nautical access to ports and depth of water are also factors affecting the choice of traders and ship owners.

Bauxite is a primary input for the aluminium industry and is carried in Supramax and Panamax ships as these vessels correspond to the optimal transport capacity (length of berth, depth of water, handling equipment) of the Port of Kamsa in Guinea, which accounts for 40 per cent of world bauxite export.

Coal has two main uses: steel production and power generation. Consignment sizes are varied. Coal is also characterized by multiple origins and destinations for overseas, regional and short-distance trades. Coal can be handled at specialized or multi-purpose terminals. A few terminals are located in ports with small draught. Scale economies for coal transport are thus tailored to frequency of service, ports of call and distance. Evidence suggests that 30 per cent of coal exchanges are carried in Handysize vessels, 30 per cent in Panamax and less than 40 per cent in Capesize (Fearnresearch, 2003).

Iron ore is the primary resource for steel production. The average distance in iron ore trade shows marked trends for long hauls. Steel plants require regular supplies in large consignment sizes. Vessels are thus handled in a restricted number of specialized terminals where port authorities are investing to increase the level of accessibility given the strategic importance of steel output. As a result, 75 per cent of iron ore is carried on Capesize. The search for scale economies currently translates in the commissioning of 400,000 dwt ships.

Principles of dry bulk shipping logistics

Inventory control and management

Dry bulk logistics is the control of inventory in relation to general economic activity level with a view to minimizing costs and maximizing services of dry bulk movement. The movement of dry bulk is a derived demand. The level of service to be given along the transportation chain cannot be predetermined.

Suppliers who trade dry bulk commodities must be prepared to have storage facilities where bulk commodities can be handled and shipped in consignments of the size required by the customer (Fair and Williams, 1981). Continuous availability of bulk product is a precondition to satisfy market economy production. Receivers attempt to secure reliable transport services with a view to allowing inbound transport to be directly integrated within the production process while maintaining a certain level of inventory to protect against irregularities in transport performance. The operational efficiency of dry bulk logistics is also influenced by stock in transit. Coal reserves can be built up to meet winter heating requirements. Inventories are required to meet interruption of vessel movements as a result of changes in the navigation season. The short harvesting period of agricultural products such as grain requires important storage facilities to meet yearly demand. Storage can also be employed for speculating purposes in commodity markets where price changes may be anticipated and storage costs can be offset against future price gains.

The core of dry bulk business logistics management seeks to balance production capacity of shippers and receivers against inventory. There are three principles governing bulk inventory management. First, inventory must be concentrated at strategic points minimizing stock required. Second, stock must be located to minimize small shipment transport costs. Third, the level of inventory must permit maximizing sales while minimizing storage costs.

Dry bulk supply chain

From inventory control and management, the dry bulk supply chain extends the focus of dry bulk logistics to the physical handling of dry bulk commodity flows required to optimize the transportation chain. Production and consumption rates are not constant and bulk commodities' availability is not unlimited. For this purpose storage facilities are used and secured at selected points along the transportation chain in relation to the maximum stock level capacity, the dry bulk commodity to be shipped/received and the transport mode employed. Dry bulk shipping logistics services are closely related to the transport chain that is fragmented from origin to destination into operating units composed of suppliers, land-/river-based transportation, port, ship and destination requiring intensive network control. Dry bulk supply chain management is the management of the complete process in the inventory and carriage of bulk commodities from production origin to destination locations.

Each segment performs part of the dry bulk shipping process. But transportation output cannot be stored. Therefore, each segment must have enough available capacity to meet the demand for service at the time needed. This division of function of the transportation chain and the work involved in storage, handling and transport determine the costs incurred and level of charges to be paid.

For suppliers, the dry bulk logistics system is coordinated with production scheduling. The demand for producers is generated by reduction rates in stock levels and forecasting sales. Changes in inventories or sales are translated into changes in production. Suppliers are in the first stage of the logistics system. In logistics, the issue for suppliers is the production runs of a single commodity with a view to making available the adequate volume of commodity to be delivered within allowable time limits.

In moving minerals or grain from mines or farms, the objective is to provide volume movement to the first stage of processing. Relatively small volumes of dry bulk commodities are carried by truck, barge or train. Trucks are for short-haul movement of bulk commodities. With rail and barge transport, bulk-carrying units are assembled into convoy for line-haul movement. The aggregation of these vehicles to form trains or tows accounts for the reduced cost of transportation per ton-km. The volume and speed of bulk movement on land or river transport depend on road width, railway gauge or water depth. The efficiency of dry bulk movement is strengthened with the adaptation of transport vehicles for bulk commodities in terms of size, design or technology employed. An important logistics issue is the empty backhaul of trucks, railcars or barges. Dry bulk is subject to imbalance of traffic between directions of vehicle movements. The cost may be offset by diminishing the loading/unloading cost of terminal facilities.

Suppliers who trade bulk commodities for overseas markets secure terminals where bulk products can be handled and shipped in the consignment sizes required by the customers. This process of distribution involves ports where terminal operators have made important investment in highly mechanized handling facilities. Each terminal is marked by varied loading/unloading rates and variable loading and unloading quantities. Terminal operators have invested in automated operations embracing computer-controlled conveyor systems with a view to increasing the utilization rate of facilities. The logistics service requirement at dry bulk terminals pertains to handling capacity (Talley, 2009). Capacity refers to the volume of throughput produced for a given period of time. Given the magnitude of investments in specialized equipment, the pattern of dry bulk movement reveals a concentration of both origin and destination at specialized ports. The major part of dry bulk traffic is concentrated along selected mainline ocean routes.

Bulk commodities are often located far from demand locations. The maritime transport of bulk commodities is inevitable as it offers the lowest cost per ton-mile. Consumption centres own/charter ships or outsource to 3PLs/4PLs. The work on bulk shipping logistics involving ship routing and scheduling is confronted with various conditions. First, the company assigns ships to meet customer orders, but the fleet is composed of ships varying in capacity and operating costs. Second, the nature of the dry bulk commodity affects the maximum stowage capacity. Third, bulkers do not have fixed itineraries. A ship may call at a single production port, be loaded with specific product followed by a call at specific consumption port to be unloaded. In sharp contrast, a ship may call at several production ports in succession before several consumption ports are called in sequence. Fourth, the terms and conditions of freight rates for carrying bulk cargo are negotiated between shippers and carriers in relation to demand and supply of bulk shipping services. Freight rates determine the decision of bulk carriers in adjusting fleet size. Fifth, a ship can load or discharge only one material at a time and the limited number of jetties at each port imposes ship sequences for dry bulk loading and unloading.

Those involved in the bulk supply chain aim to reduce this degree of fragmentation with a view to integrate bulk supplies and physical distribution activities. The bulk shipping industry is adopting a more integrated approach. Producers develop inland depots and port terminals to accommodate the needs of customers. Customers enter the bulk fleet shipping market. Ports undertake joint planning with maritime and inland transportation carriers. Various stakeholders synchronize and standardize their operations along the transport chain to insure the fluidity of dry bulk traffic and information flows. The development of an integrated approach among actors and components of the dry bulk supply chain creates value by increasing capacity, improving inventory management, reducing link uncertainties and achieving profitability.

The performance of the dry bulk supply chain is constrained by the chain's weakest link (Berle *et al*, 2011). Fluctuating demand in the volume and direction of international dry bulk trade affects the supply conditions in the shipping market, impacting on freight rates which in turn influence the decisions of firms in the marketplace. The volume of bulk commodity handled by a port is determined outside the domain of the terminal operators. Customers may maintain inventories against disruption of flows, preventing a single supplier from affecting market demand. Port resources may not be sufficient to prevent waterside congestion. Importers may seek alternate sources of dry bulk products through the development of new agricultural fields or the opening of new mineral deposits. Bulk supply chain stakeholders may have conflicting objectives and be reluctant to share information and technologies. These complex dynamics explain the limited number of existing models of decision support systems used in practice. The development of a systems approach for global dry bulk supply chain will always remain a key logistical challenge.

Bulk shipping vulnerability

Dry bulk supply chains are being optimized in order to reduce operational expenses. Firms are minimizing their inventory to reduce cost. This lean trend in dry bulk logistics has rendered the economy more vulnerable to disruptions in the dry bulk supply chain. Lack of capital investment is forcing the creation of buffers in the system in terms of extra inventory or excess transportation capacity with a view to mitigating potential interruptions of flows.

Vulnerability of the dry bulk supply chain refers to the capacity of the transportation system to adjust to changes, to moderate negative externalities and to realize opportunities. Failure of the transportation system can lead to loss of supply capacity necessary to source dry bulk provisions needed for elements of the supply chain to perform their function.

The transportation system relies on key elements to be able to move dry bulk products: vessel, navigable waterway, port infrastructure, trans-loading equipment, intermodal connection and storage yard. In dry bulk shipping, it is almost impossible to interchange vessels, to swap dry bulk cargo, to change vessel routing patterns or to modify customer's demand. Transportation systems are vulnerable and disruptions occur. The severity depends on flow density, elements affected and level of interdependency.

The mission of the dry bulk supply chain is to ensure the fluidity and reliability of dry bulk throughput. Risk assessment pertains to the location, frequency, concentration, duration, trends and magnitude of events that may negatively impact the capacity of the transportation system to perform its mission. Assessment of dry bulk shipping vulnerability, however, cannot be limited to physical engineering system design. Resilience analysis requires a system-wide perspective encompassing people, facilities, information and activities within and outside the system. Interviews with stakeholders in the dry bulk industry suggest seven factors are affecting the resilience of dry bulk supply chain: environment, physical geography, accessibility, security, distribution, services and governance.

The main environmental features of distance, topography, hydrology, climate change and natural hazards can complicate, postpone or prevent the activities of the dry bulk transport industry. Overcoming physical constraints in terms of land expansion and increasing depth of water is paramount to create new opportunities for bulk port and shipping operations. Accessibility pertains to network connectivity to hinterland road and rail infrastructures. Security is concerned with risk factors associated with accidents, terrorist threats and unlawful traffic that could interrupt marine shipping or port operations. Distribution capacity covers the ability to cope with shifting market conditions (ie emerging economies, China, fluctuating commodity prices). Services include enabling technologies ensuring transparency, facilitating operational improvements and enhancing competitiveness. Governance pertains to the capacity of corporate logistics in strengthening organizational structure of bulk supply chains in terms of capital investment and high-quality human resources.

The world dry bulk trade is growing faster than the world economy. The cost of disruptions in the dry bulk supply chain for society, industry and the can be particularly high for goods such as iron ore, coal and grain. The capacity of the dry bulk supply chain to adapt to changes is a key issue in sustaining its competitiveness. Assessing the vulnerability should help define metrics with a view to understanding the resilience of dry bulk supply chain and identifying adaptation strategies. Results can then be used to elaborate alternative transport policies.

Challenges in dry bulk shipping logistics

Dry bulk shipping logistics is confronted with three challenges: sustainable development, break bulk trade and containerization. The environment has become an unavoidable consideration in dry bulk shipping. While being perceived as 'green', maritime transport still has an impact on the environment (Comtois and Slack, 2005). Efforts are made by the shipping industry to comply with air and water pollution legislation through low sulphur fuel and efficient engines. The objective is to reduce the environmental footprint of vessels by restricting emissions and improving fuel consumption. Deepening channels, extending wharves and enlarging stockyards by terminal operators and port authorities require environmental impact assessment and the adoption of mitigation measures. Remediation measures are expensive even when port development is judged compatible with environmental considerations. Climate change predictions suggest significant opportunities for shipping, including longer navigation seasons, higher precipitation resulting in more run-off and deeper channels. In sharp contrast, there are potential negative externalities including greater precipitation variability, which, with higher rates of evaporation in the warmer summers, could lead to low water during certain seasons. Managing the growth of dry bulk traffic with the environmental constraints being placed on fleet and port infrastructures is likely to be one of the greatest challenges on the future expansion of dry bulk shipping logistics.

The market segment displaying the highest potential for growth in dry bulk shipping is break bulk including hazardous materials, waste management and recycling business (Comtois and Slack, 2010). One of the important activities of maritime trade concerns the movement of heavy chemical products such as sulphuric acid, petrochemical products and coal-tar products. But several industrial activities produce dry hazardous substances such as asbestos, heavy metals and hydrocarbon products. Societies are creating significant volumes of organic waste that is being considered as source of energy (ie biomass). Several countries have introduced regulations forcing businesses to consider lifecycle factors in their overall operations where returns (ie tyres, batteries, household appliances etc) are stripped, reconditioned and component parts recycled. The movement of dry hazardous products, organic waste and returns constitutes a potentially promising sector for the dry bulk shipping industry since these products can be carried as shipment of a single freight commodity, display low value added and are not subject to just-in-time production methods.

Dry bulk commodities are being containerized. Industry stakeholders increase their competitiveness through containerized bulk freight. Traders unitize dry bulk commodities with a view to reducing damage to goods movement. Shippers benefit from container liners' routing and scheduling. Carriers take advantage of the opportunities of filling empty containers with new cargo. The efficiency of dry bulk containerized freight associated with logistics considerations is based on high load factors and intermodal connections for transhipment and movement of products. The size of the local market determines the volume, frequency and regularity in goods loaded/unloaded. A fully-fledged intermodal transport network is a prerequisite to achieve high value added. The development potential of dry bulk shipping logistics in relation to containerized freight is concomitant with the creation of economies of scale at sea, on shore and in the hinterland with a view to lower costs and increased container volumes.

Conclusion

Bulk movements provide an important marker of the impacts of global economic processes. The analysis of ships' typology, vessel size and route patterns closely mirrors pronounced shifts in the world's economic geography. The emergence of a market system among industries and shippers imposes a complex interplay between the price of dry bulk commodities, the cost of vessel chartering and fleet productivity. The capacity of stakeholders to constantly adapt to changes is a key issue in sustaining their competitiveness. Dry bulk shipping must therefore be analysed in the broader context of overcoming vulnerability in the bulk supply chain to achieve traffic fluidity. The invocation of sustainable development, break bulk and containerization suggests that challenges in dry bulk shipping logistics are becoming indistinguishable from the activities of container and liquid bulk shipping logistics operations.

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PART THREE
Port logistics

Dry ports in concept and practice

13

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Introduction

Maritime transport of goods in containers has been growing at an impressive pace. The increases in volumes transported have required a matching increase in capacity on the supply side along with measures to exploit economies of scale and contain unit costs. To this end the maritime sector of intermodal transport chains has employed ever larger ships (Cullinane and Khanna, 2000); the latest vessels on order are reaching 14,000 TEU (*World Cargo News*, 2006) to fully utilize the economies of scale. The other elements in the supply chain – port operations and hinterland access – must accommodate such traffic efficiently (McCalla, 2007; Parola and Sciomachen, 2005).

As a result of growing containerized transport, the main problems facing seaports face today are lack of space at seaport terminals and growing congestion on access routes. Despite heavy investments in container terminal capacity, larger flows of containers severely strain seaport operations (Mourão *et al*, 2002; McCalla, 2007). Port capacity can be increased by physically expanding existing terminals (McCalla, 1999) at considerable cost and endeavour, by adding extra equipment or improving productivity by new forms of technology as analysed by Ballis *et al* (1997), or by work organization as suggested by Paixão and Marlow (2003).

Transport services to a port's hinterland are also strained by the increasing flows. The European Union Road Federation (2008) noted that in the period from 1996 to 2006 the European hinterland transport market share for rail decreased while that of road increased: with a 76 per cent market share, road transport dominates the inland freight transport in EEA member countries. According to Parola and Sciomachen (2005) the modal imbalance results in increased road traffic congestion, since a growth in maritime flow implies an almost proportional increase in road flow. Recent efforts of the European Parliament towards the internalization of external costs of heavy goods vehicles open up the possibility of decelerating the negative trend of the rail share (CER, 2009). The importance of aligning the capacity of seaports and of hinterland transport to the increasing demand of maritime container traffic, while containing negative environmental effects, forces seaports and other actors in the transport system and in society to look for seaport inland access by intermodal solutions. In their study on the social cost of intermodal freight transport, Ricci and Black (2005) suggest that intermodal transport is a major potential contributor to solving environmental problems and that full internalization of external costs would greatly benefit intermodal transport.

Dry ports are a means to increase port throughput, hinterland reach, and transfer parts of port operations to inland terminals by relying on intermodal transport. In fact, according to Roso *et al* (2009) a dry port is 'an inland intermodal terminal directly connected by rail to seaport(s) where customers can leave/pick up their units as if directly to a seaport'. Following this definition, dry ports are also a means to rationalize transport in and out of a port by bundling the flows and transferring container transport from road to rail, thus reducing congestion in the proximity of the port – typically relevant for port cities – and bringing about other environmental benefits.

The dry port idea has been discussed in scientific journals as far back as 1986 (Hanappe, 1986) and in trade journals since 1980 (Munford, 1980). After several years the concept is now enjoying renewed interest among researchers (Leveque and Roso, 2002; Tsilingris and Laguardia, 2007; Roso, 2007; Roso *et al*, 2009; UNESCAP, 2009), as well as among policy-makers eager to find sustainable solutions to issues due to growing containerized transport (European Commission 2000, 2001).

To discuss the dry port concept it is useful to mention some points about intermodal services and review some of the different forms that an inland freight terminal may take.

Intermodality and seaport inland access

Reduced energy consumption, optimization of the usage of the main strength of different modes (European Commission, 2000; Rutten, 1998), a reduction of congestion on road networks, and low environmental impacts (Woxenius, 1998; Kreutzerberger *et al*, 2003) are considered the advantages of intermodal (road–rail) transport. Furthermore, there are economies of scale resulting in lower costs per unit with the use of appropriate intermodal transport solutions. The viability of intermodal transport on long distances is argued by many academics; for example, by van Klink and van den Berg (1998) and McCalla (1999). Those authors elaborate that seaports can generate scale economies to operate cost-effective intermodal transport with high frequency to different destinations beyond their traditional hinterland, ie to use rail to enlarge their hinterland and at the same time to stimulate intermodal transport. Distance is not the only prerequisite for the success of intermodal transport; the volume of goods and the frequency of the service provided are also central (Woxenius, 1998).

Despite the advantages stated above there is a relatively low share of rail in the transport of containers from seaports to the hinterland (European Union Road Federation, 2008). Apart from lack of sufficient rail infrastructure or free slots, there are many obstacles that prevent transport buyers from using the railway as a major means of transport, lack of flexibility (in time and space) and damaged goods being the most significant.

Notteboom (2006) and van Klink and van den Berg (1998) note that many seaports, as well as shipping lines, integrate vertically to control hinterland transport. An example of such a trend is the participation of the Port of Hamburg – more precisely HHLA Intermodal – into companies providing intermodal port-to-door transport and running terminals (Jürgens, 2010).

Indeed, hinterland access is a critical factor for the seaports' competitive advantage since they are not competing only with seaports in their local area but also with distant seaports attempting to serve the same hinterland (Notteboom, 2001). Progress only in the maritime part of the transport chain and in seaport terminals, without improvements in seaport inland access, is not sufficient for successful market expansion. However, the quality of inland access depends on the behaviour of a large variety of actors, such as terminal operators, freight forwarders, transport operators and port authorities (de Langen and Chouly, 2004). Hence the tendency to control hinterland transport by port actors.

It is generally accepted today that serving seaport hinterlands is more competitive than before intermodality (McCalla, 1999). However, a key element for intermodal connections between seaports and their hinterland is the provision of terminals with suitable facilities and services.

Intermodal terminal facilities

An intermodal road–rail terminal can simply be described as a place equipped for the transhipment and storage of intermodal loading units (ILUs) between road and rail. Intermodal terminals come in a great variety of shapes and sizes (eg Woxenius, 1998) and a number of value-added services such as stuffing and stripping, storing and repair of ILUs might be offered.

As suggested by Höltgen (1995), intermodal terminals can be classified according to some basic functional criteria like traffic modes, transhipment techniques, network position or geographical location. Nevertheless, the transhipment between traffic modes is the characterizing activity.

TABLE 13.1 Terms used in relation to inland terminal facilities

Source	Term	Definition
UN ECE (1998)	Inland Clearance Depot	A common-user inland facility, with public authority status, equipped with fixed installation, and offering services for handling and temporary storage of any kind of goods (including container) carried under customs transit by any applicable mode of inland surface transport, placed under customs control to clear goods for home use, warehousing, temporary admission, re-export, temporary storage for onward transit, and outright export.
Indian Customs (2004)	Inland Container Depot	A common-user facility with public authority status equipped with fixed installations and offering services for handling and temporary storage of import/export laden and empty containers carried under customs transit by any applicable mode of transport placed under customs control. All the activities related to clearance of goods for home use, warehousing, temporary admissions, re-export, temporary storage for onward transit and outright export, and transhipment take place from such stations.
Cardebring & Warnecke (1995)	Intermodal Freight Centre	A concentration of economically independent companies working in freight transport and supplementing services on a designated area where a change of transport units between traffic modes can take place.
UN ECE (2001)	Logistic Centre, Freight Village	Geographical grouping of independent companies and bodies that are dealing with freight transport (for example, freight forwarders, shippers, transport operators, customs) and with accompanying services (for example, storage, maintenance and repair), including at least a terminal.
UN ECE (1998)	Inland Freight Terminal	Any facility, other than a port or an airport, operated on a common-user basis, at which cargo in international trade is received or dispatched.
Harrison *et al* (2002)	Inland Port	Located inland, generally far from seaport terminals; they supply regions with an intermodal terminal offering value added services or a merging point for different traffic modes involved in distributing merchandise that comes from ports.
UN ECE (2001)	Dry Port	An inland terminal which is directly linked to a maritime port.

Depending on the role and the services offered, the transport industry operates different kinds of terminals under different names. Table 13.1 reports a series of terms and definitions related to intermodal terminal facilities, some of which have been used to characterize a dry port.

India introduced 'inland container depots' (ICDs) in 1983 and Indian Customs (2007) bases its definition of an ICD on the UN ECE definition of inland container depots, but restricts it to containers. India also uses the term 'container freight station' (CFS), which differs from an ICD since containers are stuffed and stripped there. Hence, an ICD is a consolidation node for containers whereas a CFS aggregates individual consignments into containers. A CFS function might be added to an ICD. ICDs are normally located outside the port towns but there are no site restrictions regarding CFSs.

The term 'freight village', given in Table 13.1 with the definition of UN ECE, although similar in concept, varies in definitions among countries: *Güterverkehrszentren* in Germany, *plateformes multimodales logistiques* in France, freight villages in the UK or *interporti* in Italy. They all provide transhipment from one mode to another as well as auxiliary services such as warehouses, customs, maintenance workshops, insurance offices etc.

Several possible definitions of dry port are actually included in the list on Table 13.1. The 'inland port' as characterized by Harrison *et al* (2002) is sometimes also termed a 'dry port'. Moreover, Beresford and Dubey (1990) use a dry port definition that corresponds to the definition of inland clearance depot. This definition is very specific regarding ownership and services, and in particular customs clearance, although with no mention of a particular type of connection to a seaport. Beresford and Dubey (1990) emphasize the importance of a dry port as a common-user facility that would promote the transfer of goods from origin to destination without an intermediate customs examination, the so-called through-transport concept.

Hanappe (1986) refers to dry ports as 'multifunctional logistics centres' with a variety of firms operating at the same site. This description corresponds to the concept of freight villages, according to UN ECE, since it does not emphasize a connection to seaports nor does it specify the range of services offered at the terminals.

The dry port UN ECE definition ('an inland terminal which is directly linked to a maritime port') is rather broad in its meaning, therefore it may apply to all the terminal facilities mentioned in Table 13.1 when linked to seaports.

The dry port concept

We use the definition of dry port formed by Roso *et al* (2009): 'a dry port is an inland intermodal terminal directly connected to seaport(s) by rail where customers can leave/pick up their units as if directly to a seaport'. This definition takes the UN ECE one stage further by implying the conscious and strategic development of intermodal terminals in the seaport's hinterland and in relation to the seaport. It also adds to the previous definition by underlining the operational side of the connection to the seaport that makes the dry port the actual interface for shippers to the seaport and the shipping lines thus extending the gates of the seaport inland. This, in turn, implies a focus on security and control by the use of information and communication systems, not just for customs needs. Moreover, this definition highlights the intermodal character of the terminal and the rail connection to the seaport.

A previous version of this definition emphasized the use of high-capacity transport means between port and dry port, including rail and barge, since some existing dry ports or advanced intermodal terminals use both means of transport. However, the word 'dry' may seem contradictory when barges are used. On the other hand there is a concept of inland port which is defined by the use of barges. Therefore the definition referring to the use of rail is deemed more suitable.

The functions taking place at a dry port include those of a freight terminal which, as recalled by Slack (1999) are: transfer of cargo, mostly unitized, between two modes; the assembly of freight in preparation for its transfer; the storage of freight awaiting pick-up; and delivery and the logistical control of flows. In addition to all functions mentioned above, services such as maintenance of containers, customs clearance, and other value-added services should take place at a dry port terminal in accordance with customers' needs.

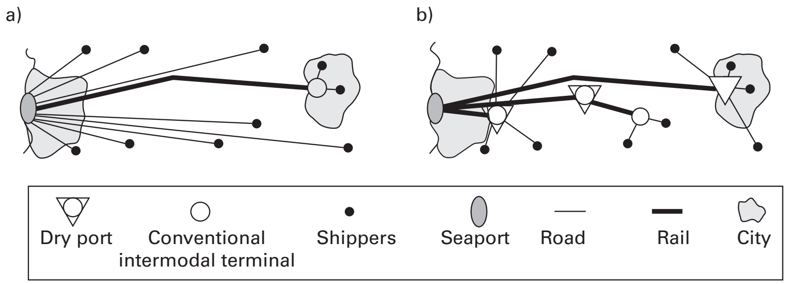
The quality of the access to a dry port and the quality of the road–rail interface determines the dry port's performance. Scheduled and reliable high-capacity rail transport to and from the seaport is therefore necessary.

To summarize, the main features of a dry port are:

- intermodal terminal;
- situated inland;
- rail connection to a seaport with scheduled and reliable services;
- offers services that are available at freight terminals and at seaports, such as container maintenance, storage of containers, forwarding, road haulage; and
- customs clearance.

Conventional hinterland transport is based on numerous links by road and only a few by rail, which is generally limited to serving major conurbations at relatively large distances from the seaport, as shown on the left of Figure 13.1. When dry ports are implemented the transport network is rationalized as on the right of Figure 13.1, with road transport limited to collection and distribution of intermodal units in the market areas of each dry port. The figure also shows a seaport and the three types of dry ports – close, midrange, and distant dry ports – that may be characterized based on their function and location (Roso *et al*, 2009).

FIGURE 13.1 Comparison of conventional hinterland transport and an implemented dry port concept



SOURCE Roso *et al* (2009)

Benefits of dry ports

Distant dry ports bring about benefits deriving from the modal shift from road to rail, resulting in reduced congestion at the seaport gates and its surroundings. Since one train can substitute for about 35 trucks in Europe, the external environmental effects along the route are reduced. Nowadays, seaports compete not only on tariffs and transhipment capability, but also on the reach and quality of inland access. A distant dry port also brings a competitive advantage to a seaport since it expands the seaport's hinterland, ie it improves the seaport's access to areas outside its traditional hinterland by offering shippers low-cost and high-quality services. Rail operators benefit from distant dry ports simply by the movement of containers from road to rail, which increases their business. From the shippers' perspective, a well-implemented distant dry port offers a greater range of logistics services in the dry port area. For environmentally conscious shippers it gives the option of using rail rather than road, thus reducing the environmental impact of their products.

The benefits of a *midrange dry port* are comparable to those of a distant dry port since the same serves as a consolidation point for different rail services, implying that administration and equipment specific to sea transport are needed at only one terminal away from the seaport. The high frequency achieved by consolidating flows, together with the relatively short distance, facilitates the loading of containers for one container vessel in dedicated trains. Hence, the dry port can serve as a buffer, relieving the seaport's stacking areas.

Implementation of a *close dry port* in the seaport's immediate hinterland enables the seaport to increase its terminal capacity and hence manage the problem of lack of space or inappropriate inland access. The dry port may be used for storage of containers in the vicinity of the port. With increased terminal capacity comes the potential for increased productivity, since bigger container ships may call at the seaport. Road hauliers lose a marginal market share in terms of road-kilometres, but would still benefit from shorter waiting times at dry port terminals. In cities not allowing long or polluting road vehicles, calling at a close dry port is an alternative to splitting up road vehicles or replacing them with less polluting vehicles.

Positive effects on regional development and job opportunities due to the implementation of dry ports are exemplified by the cases illustrated

TABLE 13.2 Impacts generated by dry ports for the actors of the transport system

	Distant	Midrange	Close
Seaports	Less congestion Expanded hinterland Interface with hinterland	Less congestion Dedicated trains Depot Interface with hinterland	Less congestion Increased capacity Depot Direct loading ship–train
Seaport cities	Less road congestion Land use opportunities	Less road congestion Land use opportunities	Less road congestion Land use opportunities
Rail operators	Economies of scale Gain market share	Day trains Gain market share	Day trains Gain market share
Road operators	Less time in congested roads and terminals	Less time in congested roads and terminals	Less time in congested roads and terminals Avoiding environmental zones
Shippers	Improved seaport access 'Environment marketing'	Improved seaport access 'Environment marketing'	Improved seaport access
Society	Lower environmental impact Job opportunities Regional development	Lower environmental impact Job opportunities Regional development	Lower environmental impact Job opportunities

SOURCE Roso (2009b)

later in this chapter. This is consistent with the findings of Bergqvist and Pruth (2006) who discuss regional attractiveness in terms of environmental sustainability, cost-efficiency and transport quality through the establishment of intermodal road–rail terminals, with the focus on regional logistics collaboration.

Dry port implementation thus generates advantages for the actors of a transport system, as summarized in Table 13.2. This illustrates how dry ports have the potential to generate environmental benefits which can be translated into cost reductions, as, for example, less congestion on the road generates time and consequently cost savings for road carriers. This is discussed in Roso (2007), one of the few studies about environmental effects of freight terminals. Roso (2007) shows that with a dry port in the system CO_2 emissions should decrease, queues and long waiting times at seaport terminals should be avoided, and the risk of road accidents reduced.

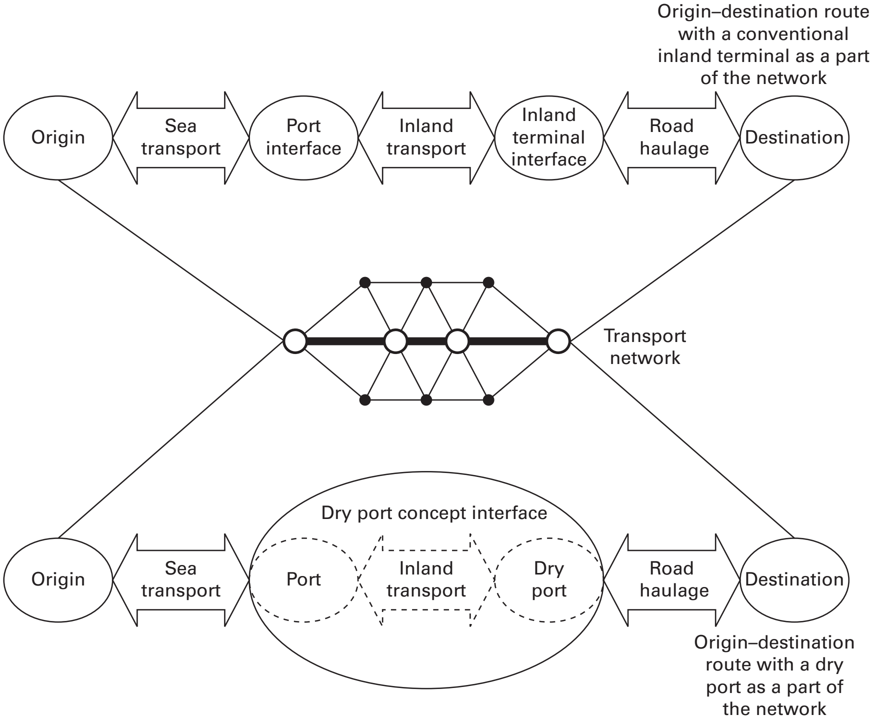
Although a dry port implementation, as a sustainable logistics solution, involves significant investments for the owners, the same has the potential to gradually generate much higher total revenue for all actors of the system, not just for direct investors. The dry port concept should be arranged as a joint venture of all beneficiary stakeholders, of which the biggest one eventually is society.

Dry ports are useful facilities to accommodate some seaport activities such as storage of containers to gain valuable space in ports where space is an actual issue, typically large ports; however, seaports that do not face a lack of space at their terminals will not gain by moving their storage area to an inland terminal. On the contrary, they might lose a significant portion of the profit (Roso, 2009b). When it comes to time savings that result from implementation of a dry port into a seaport transport system, the same can be obtained by eliminating queues at the seaport's gates or by eliminating storage at the seaport. The former gives significant gains, not only for the seaport that performs better without congestion at the terminals, but for the carriers who suffer from financial losses due to delays caused by the congestion. Furthermore, there is a whole range of administrative activities that could be moved inland with implementation of a dry port, generating further time and cost savings, specifically those related to customs and truck transport paperwork. In an ideal situation direct loading/unloading of a ship to/from a train would result in a significant reduction of internal vehicle transport.

Ultimately, full implementation of a dry port could create seamless seaport inland intermodal access, ie smooth transport flow with one interface in the form of a dry port concept instead of two, one at the seaport and the other one at the inland destination (Figure 13.2).

The concept can be compared to the case of an increased level of functional integration of supply chains (Notteboom, 2006), where many intermediate steps in the transport chain have been removed and therefore enabled a so-called one-stop-shop, creating a single contact point on a regional or even global level.

FIGURE 13.2 Transport network with and without a dry port



SOURCE Roso (2009b)

In transport systems a node is often equivalent to a stop in the flow, and there are often needless long stops in nodes as discussed by Woxenius (1997) who questions the functionality of intermodal terminals and even sees them as possible barriers to intermodality. The functional connection between dry port and seaport, instead, aims at creating a seamless series of physical and procedural links so as to provide a smooth flow of goods in containers Figure 13.2).

Although a concept of a dry port should bring numerous benefits to the actors of the transport system there are still many hindrances to the implementation of the same. Roso (2008) identified four impediments to the implementation of dry ports: regulations, environment, land use and infrastructure. It is not just about general awareness of the benefits from rail freight transport or the environmental issues arising from it; it is about regulations and policies. The question of environmental impact is closely related to the issue of land use; the closer the potential site for an intermodal terminal is to a metropolitan area, the higher the price as well as the greater the demands regarding environmental impacts.

Dry port examples in Europe

There are a number of dry ports already in operation in several parts of the world (eg Roso and Lumsden, 2010). The following are three examples of dry ports in Europe.

Dry Port Hallsberg in Sweden is jointly owned by the municipality and rail operators, who also initiated the development of the combi-terminal at the end of the 1990s. It is a well-established dry port today, handling 65,000 TEU per year. It started as a conventional intermodal terminal with basic terminal services and gradually, by introducing new value-added services, it developed into a dry port with no particular obstacles during the implementation process. Hallsbergkombiterminallen AB (owned by the dry port owners) has been running the dry port since 2003. There are daily rail connections to the ports of Göteborg, 260 km; Trelleborg, 500 km and Malmö, 470 km away. On its 6.2 ha site, the dry port offers the following services: transhipment with two reach stackers, storage and depot of 0.4 ha, customs clearance, maintenance of containers, cross-docking, sequencing, kitting, forwarding and road haulage. The dry port has 27 employees who are trained to do all services that the terminal offers. At peak times there is a need for all personnel to be involved in transhipment but in the meantime they can perform other value-added activities such as sequencing; consequently, the cost for sequencing can be low. Diversity of value-added services is recognized as a very important factor for the attractiveness of the dry port. However, functioning rail connections to the seaport and road haulage are essential. The biggest advantage, apart from improved customer service, is the attractiveness of the region for the establishment of new businesses, which has resulted in new jobs in the region. Furthermore, with the dry port, rail transport increased and generated increased capacity and volumes at the seaports, as well as improved inland access to them. Consequently, congestion at seaport terminals as well as environmental impacts decreased.

Dry Port Madrid in Coslada, Spain, is a result of joint efforts and interest of the Spanish Ministry of Development, the municipalities of Madrid and Coslada, the Spanish Port Authority and the Spanish national rail operator, RENFE. Today the dry port's major owners are four Spanish ports with the following distances from the dry port: Barcelona at 600 km, Bilbao at 400 km, Algeciras at 660 km and Valencia at 360 km. Its uniqueness is in the fact that it is promoted not by a single port but by four competing ports. The idea for its implementation came in 1995 and the terminal was operational in 2000; however, its dry port status was gained only in 2003. The main goal of the facility was to facilitate transport organization, customs and administrative procedures to achieve a competitive position for the ports in the region in which the dry port is located. The Coslada location was chosen due to its proximity to Madrid as well as its good national and international intermodal connections. The biggest impediments to its success were the condition of the existing rail infrastructure, as well as regulations (monopoly of the rail), which were eventually overcome. The dry port generates advantages such as increased use of rail, which resulted in increased volume and consequently lower transport costs, as well as lower environmental impact and lower congestion at the seaports. Furthermore, the use of the dry port brings competitive advantages to the seaports as well as attracting new business to the area, resulting in the creation of new jobs. The dry port is equipped with one rail-mounted gantry crane, three reach stackers and three forklifts, for the handling of 60,000 TEU a year, on an area of 14 ha. Full customs clearances as well as forwarding are available on the site. There is a storage area for 2,500 TEU of loaded container as well as a container depot for 1,700 TEU of empties.

Dry Port Rivalta Scrivia in Italy is 67 km away from the Port of Genoa and is a spin-off of the adjacent freight village set up in the 1960s intended as a dry port for Genoa. The dry port company Rivalta Terminal Europa (RTE), set up in 2006, is mainly private but counts on shares by regional public authorities. The RTE facility extends for 90 ha, part of which is still being equipped. The rail terminal is connected by intermodal rail services with several locations, but the most interesting service for this paper is a rail shuttle connecting it with the Voltri container terminal in Genoa, with no intermediate stop. Thanks to a change in customs procedures, the containers carried on those shuttles undergo inspections and clear customs in the dry port, where a branch of the Genoa Customs has been set up. This was the first application of such procedures in Italy. The dry port management expects to extend it to connections with other terminals in Genoa. The special rail shuttle started in 2009 with one service per day in each direction, soon increased to two services per day, five days a week. As of 2014, the shuttle runs twice daily in each direction, six days a week, with the possibility to add a third return service on any day. Each shuttle has a capacity of 57 TEU, and allows for high cube containers. Shunting within the dry port and to the adjacent rail station is performed on own account and RTE owns shares in the company providing the traction between the seaport and the dry port as well as in the company providing shunting in the seaport. The RTE railyard consists of five tracks with a length of 750 m over which operates a rail-mounted gantry crane, with a second one expected soon. Operations are also performed with four reach stackers and four front loaders but it should be recalled that the facility deals with a total traffic of 51,000 containers/year including other rail connections. Services in the dry port include container storage, repair and cleaning, forwarding and road haulage, and warehouses are being built. All containers carried by the bonded shuttle between Rivalta and Genoa Voltri arrive or leave the dry port by truck, and are mostly picked up or distributed within a range of 70–100 km. The rail shuttle service avoids the need to use trucks on the congested road system of the city of Genoa and crossing the mountains that line the coast while the transit procedure reduces container delivery time.

Conclusions

A dry port is an inland intermodal terminal directly connected to seaport(s) by rail where customers can leave/pick up their units as if directly to a seaport. The physical connection – the rail link used by intermodal services – is one aspect which is made fully operational by the procedural set-up, allowing shippers to refer to the gates of the dry port as if they were at the seaport. Dry ports are thus inland extensions of the seaports, are consciously set up as such, and are not limited to the provision of mode transfer but include coordinated and efficient services such as storage, maintenance of containers, customs clearance, and tracing and tracking.

Dry ports may bring advantages for all operators involved as well as for the environment thus making green logistics interesting rather than something perceived as an added cost. Operators' advantages include cost and time savings (due to reduced road congestion but also to the inland interface of the port and the efficient document handling), bundling of containers flows and economies of scale, space added to those in space-constrained seaports, and regional development. Environmental advantages are fostered by rationalization of flows and by the use of intermodal transport and may include reduced congestion, less pollutant emissions, lowered accident risks, avoidance of the need to use port cities' roads and cross environmental zones with trucks. Regional development and job opportunities are further advantages for society as a whole.

Dry ports are to some extent extensions of seaports inland and as such are part of the process of regionalization of seaports characterized by Notteboom and Rodrigue (2005). In that process, and due to the importance of inland distribution, seaports expand their hinterland reach through a number of strategies including close links with inland freight centres based on higher functional integration.

This chapter has discussed three examples of dry ports in Europe (Hallesberg in Sweden, Coslada in Spain, Rivalta in Italy) and more have been developed elsewhere in the world.

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Port-centric logistics in concept and practice

14

NIKOLAOS VALANTASIS-KANELLOS AND DONG-WOOK SONG

Introduction

The word port can refer to either *water-related* or *non-water-related ports* (Bichou and Gray, 2005). Ports located by lakes, rivers, inland waterways and canals are other potential meanings of water-related ports, while non-water-related ports are dry or inland ports (Wood *et al*, 2002; Bichou and Gray, 2005). However, for the purpose of this chapter the word 'port' refers to seaports.

Ports are defined as 'a geographical area where ships are brought alongside land to load and discharge cargo – usually a sheltered deep-water area such as a bay or river mouth' (Stopford 2009, p 81). Additionally, ports are characterized as four-modal nodes where waterborne and land transport can converge (Charler and Ridolfi, 1994; Paixão and Marlow, 2003).

Moreover, ports are referred to as 'economic catalysts' for the regions that they serve. This characterization is grounded on the fact that ports trigger the creation of many work positions both internally and externally (Wood *et al*, 2002). In alignment with this view ports can be perceived as 'clusters of economic activity'. According to de Langen (2004) the main function of ships and cargo accommodation that takes place at a port is responsible for the attraction of various economic activities to the proximity of the ports. Carbone and Martino (2003) consider ports as organizational clusters in which various logistics and transport-related firms collaborate and provide value for the final customer. In this view, the multifaceted combination of products and services provided by the port cluster create the diversified port offering (de Langen and Sharypova, 2013).

The notion that ports are generators of trade and commerce can be traced back to the era of the Phoenicians. At that time ports constituted the market of the city as the main trade of products was undertaken around them (Sletmo, 1999).

Additionally, van der Lugt *et al* (2013) characterize ports as business networks. Within these networks companies are interdependent for the holistic development of the system. Thus, inter-firm relationships are of high importance. Additionally, according to van der Horst and de Langen (2008) and Notteboom and Rodrigue (2012), effective network integration of port terminal operators with transport or third-party logistics providers (3PLs) is in many cases the strategy enabling the offering of door-to-door services by ports.

However, as this chapter focuses on ports in the logistics environment, a relevant definition must be employed. Bichou (2009, p 2) defines ports as 'the interface between land and a sea or a waterway connection providing facilities and services to commercial ships and their cargo, as well as the associated multimodal distribution and logistics activities'. This definition matches the scope of ports in a maritime logistics environment as it combines the main function of the port, which is the reception of vessels, with the additional logistics services that ports are called on to offer as part of a system.

The remainder of this chapter is divided as follows. Initially, the contemporary business environment of ports and its effects on ports are outlined. The evolutionary development of ports on a global scale is then discussed from three different perspectives. The first perspective is involved with the port generations model, the second is involved with the privatization of ports, while the third with the emergence and expansion of global port operators (GPOs). Finally, before the main theme of this chapter, which is the development of port-centric logistics (PCL) in the UK over the last decade, the unique paradigm of the ownership and management mandates of UK ports is outlined.

Contemporary business environment of ports

The discussion in the introduction of this chapter reflects one of the many academic conceptions of ports' evolution. This development of port definition is in line with changes in ports' operating environment. According to Notteboom (2007) ports have operated in an environment driven by changing economic and logistics systems, which increased the level of uncertainty and forced port managers to identify strategies that would enable them to respond effectively to the dynamics of their market. Thus, the role and governance of port authorities and port management teams, with particular economic objectives, has been reassessed.

Pallis *et al* (2011) also argue that the rapidly changing environment in which ports operate is driven by developments in logistics. Particularly, they support the view that increased vessel sizes, horizontal and vertical integration of shipping lines, developments of land-side logistics services and increased attention to the rationalization of the hub-and-spoke system, were some of the actions of shipping lines and terminal operating companies in their attempt to increase profit margins and customer satisfaction.

The need of ports to respond to these changes created the notion that ports should be considered as 'elements in value-driven chain systems' instead of simply being perceived as highly complex places (Robinson, 2002, p 252). According to this view, ports need to deliver value to their customers but also need to capture value for themselves. The paper by Robinson was one of the most influential papers that triggered academic interest in the need for port transformation. Until that point ports were perceived as 'pawns in the game' (Slack, 1993). In particular, even though ports were required to invest heavily in order to accommodate customers' needs, they did not have control over global commerce. Privately-owned companies have taken control and exploited ports' resources. This notion was also supported by Sletmo (1999) who argues that the emergence of containerization and supply chain restructuring practices were the reasons that ports competitive role in multimodal systems was undermined (Pallis *et al*, 2011).

According to Juhel (2001) there were two reasons for the need to reformulate national port systems development strategies. The first is related to the changing nature of the cargo generating hinterlands, while the second is related to the fact that shipping lines have reconstructed their ocean transport network. According to the same author, port strategies need to include reforms in the *legislative, institutional* and *procedural provisions* of ports.

Furthermore, according to Pettit and Beresford (2009), ports are also perceived as important contributors of supply chain integration as a result of their actions to include logistics activities in their operations spectrum, which can be offered as value-added services (VAS) (Paixão and Marlow, 2003). It should be mentioned here that the factors that influence the evolution of a port system are not totally understood (Ducruet *et al*, 2009). In particular, port development can be characterized as path dependent because past decisions, structures and processes influence future actions, but port system evolution 'is also contingent and open ended as decisions may deviate from an existing development path' (Wilmsmeier and Monios, 2013, p 118).

Port generations model

According to Paixão and Marlow (2003) the development of ports after World War II has been categorized by UNCTAD (1992) who in an attempt to describe the development of ports during the second half of the 20th century, developed the 'three generations port model' (Verhoeven, 2010). This model aims to describe ports' development from a functional and institutional perspective (Bichou, 2009).

However, it should be mentioned that UNCTAD's 1992 model has been criticized as unrealistic and inaccurate due to the fact that ports have been observed to present a continuous development instead of evolving in discrete steps (Beresford *et al*, 2004; Bichou and Gray, 2005; Pettit and Beresford, 2009; Verhoeven, 2010). The same commentators on the port generations model argue that within the same port, elements of different evolution streams might be identified due the composite nature of ports. Additionally, elements of previous generations can still be observed within later generations. Nevertheless, the port generations model does provide a useful conceptualization of how large multi-purpose gateway ports have evolved (Verhoeven, 2010) and for this reason will be discussed here.

First-generation ports (pre-1960s)

Before the 1960s ports were considered as the changing points between transportation modes, where only cargo loading/unloading and storing activities would take place (UNCTAD, 1992). Additionally, Beresford *et al* (2004) argue that ports operated in isolation from transport trade activities and did not attempt to meet their users' requirement. Monopolistic behaviour (UNCTAD, 1992) and isolation from the surrounding municipalities would also be observed in ports before the 1960s with the exception of some separate development plans (Beresford *et al*, 2004). Furthermore, first-generation ports lacked promotion at commercial level due to the isolated behaviour of the companies operating within the port. Distinct characteristics were also low productivity and consequent slow cargo movements and unfamiliarity of port users with the entire entity of the port (UNCTAD, 1992).

Second-generation ports (1960s–1980s)

In contrast with first-generation ports, the range of activities of a second-generation port was broadened and the notion that ports operate as 'transport, industrial and commercial service centres' became prevalent (UNCTAD, 1992, p 13). Consequently ports were allowed to offer various industrial or commercial services to their users (UNCTAD, 1992). Particularly, commercial services were considered as services that add value to cargo, while industrial services resulted in the build-up of industrial facilities which were observed to extend further into the hinterland of the port (Beresford *et al*, 2004). The industrial facilities developed around the port and its hinterland were involved with 'iron and steel, heavy metallurgy, refineries and basic petrochemicals, aluminium, paper pulp making, fertilizers, sugar and starch, flour milling and various agro-food activities' (UNCTAD, 1992, p 14). Additionally ports developed closer relationships with transport and trade partners as well as with surrounding municipalities (Beresford *et al*, 2004).

Moreover, second-generation ports were characterized by increased cargo throughput speed as a result of integrated port activities. However, this integration was not organized but spontaneous (UNCTAD, 1992). Another basic distinction between first and second generation ports was the fact that second-generation ports were characterized as capital-intensive in contrast with the labour-intensive first generation ports (Bichou, 2009).

Third-generation ports (1990s–2000)

Global containerization and intermodalism are the two factors that triggered the development of the third-generation ports after the 1980s (Beresford *et al*, 2004). During the early 1980s the competition among North American ports was heavily influenced by the emergence of intermodal transportation (Hayuth, 1987; van Klink and van den Berg, 1998). Europe lagged behind in the implementation of intermodal transportation until the 1990s when various deregulations associated with the emergence of the European Union (EU) were introduced (Slack, 1993).

During this time period the requirements imposed by the expansion of containerization needed to be taken into consideration by ports in order to accommodate the demand at national and international levels. Additionally, ports were forced to incorporate intermodal transportation systems in order to accommodate the seamless transfer of containers among land and sea transportation modes (Parola and Sciomachen, 2005). This development acted as a significant enabling factor of increased throughput but also increased congestion around ports (Parola and Sciomachen, 2005).

Furthermore, during the 1980s ports were considered dynamic nodes within global trade networks, an opinion based on their proactive management which envisioned the development of ports in transport centres and logistics platforms integrated within the global trade networks (Beresford *et al,* 2004). Additionally, port services were more specialized, variable and integrated with the traditional services provided during the previous generations. In particular, the provision of VAS in addition to cargo-handling services is a key characteristic of third generation ports (Bichou and Gray, 2004). However, the usage of modern equipment and information technology was perceived as standard for the provision of conventional services by ports (Beresford *et al*, 2004). Furthermore, ports' offerings were enhanced by two kinds of industrial services (UNCTAD, 1992). The first was involved with ship/vehicle industrial/technical-related services (eg ship repairing, engineering services). On the other hand, the second kind involved cargo-related industrial services, where the port either provided industrial services or allowed third parties to establish operations in its proximity in order to generate cargo throughput and value-added for the port (UNCTAD, 1992).

Moreover, the reduction of the environmental impact of ports was addressed by the implementation of environment protection measures (Beresford *et al*, 2004). Additionally, the introduction of advanced information and communication technologies in port operations increased the administrative efficiency of ports and in terms of infra- and superstructure utilization, ports moved towards seven days per week operation. Consequently, the spectrum of third-generation ports' capabilities was enriched by improved administration and extended commercial services.

These ports were also characterized by the provision of logistics and distribution services. A result of this change was the fact that the medium- to long-term warehousing functions were no longer needed, as ports were perceived as passing corridors after the emergence of containerization. However, according to Beresford *et al* (2004) warehousing services were still needed by ports but in the form of high storage quality.

Additionally, various IT developments were adopted by ports (eg electronic data interchange systems). Other key characteristics of third-generation ports were increased profitability triggered by the provision of VAS, reduced custom regulation and various internal and external organizational changes (UNCTAD, 1992; Beresford *et al*, 2004).

Bichou (2009, p 44) summarized the development of third-generation ports 'as the product of the unitization of sea trade and multimodal cargo packaging which has led to the development of ports as logistics and intermodal centres offering valued added services, with technology and know-how being the major determining factors'.

Relevant to the third-generation port model is the conceptualization of ports as logistics systems offered by Paixão and Marlow (2003). They argue that in contrast to manufacturing units, ports are bi-directional logistics systems due to the fact that they accommodate product flows from sea to land and vice versa.

The conceptualization of ports as logistics systems by Paixão and Marlow (2003) implies that ports are engaged with the receipt and dispatch of goods and information both inbound and outbound as well as with all the internal associated processes (Panayides and Song, 2008). Furthermore, port logistics systems can be broken into three further subsystems. According to Paixão and Marlow (2003) these subsystems are related to goods and information transfer from sea to land and vice versa (1st and 2nd subsystems) and to the ship-to-ship transfer (transhipment), which includes the feeder shipping and inland waterways transport trades.

Fourth-generation ports (post-2000)

According to Pettit and Beresford (2009) since the three-generation port model of UNCTAD, technological changes and developments in working practices and the commercial environment have taken place. Consequently, the relationships and linkages between service providers, facilitators, and end consumers became tighter. In 1999, UNCTAD introduced the concept of fourth-generation ports, 'which are physically linked through common operators or through common administration' (UNCTAD, 1999, p 9). They provide the example of the ports of Copenhagen and Malmö which formed a joint venture in order to promote the competitiveness of the ports under a single administrative unit. However, they argue that far more frequently terminals in various places around the world are linked under the common management of a single global port/terminal operator or a shipping line.

UNCTAD's definition of fourth-generation ports is constrained to the spatial evolution of port and takes no account of other operational and societal changes that occurred in port development during the 21st century. Additionally, academics interpreted fourth-generation ports in a different to that intended by UNCTAD (Verhoeven, 2010). In particular, Perez-Labajos and Blanco (2004) argue that fourth-generation ports should focus on attracting big logistics operators. Furthermore, Paixão and Marlow (2003) argue that a fourth-generation port should become proactive rather than reactive to the changes in their environment. Thus, they support the view that port managers should adopt new strategies which encompass the concept of agility.

Global port operators

As global port operators (GPOs) are defined, those companies that expand their activities in order to include international port operations with the intension to establish worldwide network services can be deemed to be global port operators (Bichou and Bell, 2007). Three reasons can justify the emergence of GPOs. The first two relate to the port evolution and development stages while the third relates to the vertical integration activities of shipping lines (Slack and Frémont, 2005). In particular, the limitations of their original scope of operations, and the limited opportunities for internal growth and profitability enhancement, triggered many port/terminal operating companies to seek to expand the scale and scope of their operations through horizontal integration (Notteboom and Winkelmans, 2001). Thus, by means of refining and applying already successful management practices in different countries, these companies have successfully managed to increase their profits (Slack and Frémont, 2005).

The second reason that justifies the emergence of GPOs relates to port privatization and liberalization schemes implemented in various countries. Thus, many port/terminal operators, driven by the incentive of expanding their operational and managerial expertise in new markets, acquired terminals or entire ports and created joint ventures with other port/terminal operators (Slack and Frémont, 2005). The international expansion through horizontal integration practices such as M&A or new terminal constructions represent the first wave of GPO development. The success experienced by the international expansion strategies of the pioneers described above triggered the emergence of the second wave of GPO development (Notteboom and Rodrigue, 2012).

Vertical integration activities of shipping lines are considered as the third reason for the emergence of GPOs (Slack and Frémont, 2005). Through the implementation of such activities shipping lines achieved economies of scale and scope, internalized terminal handling costs, and increased their level of control by extending operations further down the supply chain. The vertical integration activities of container shipping lines shape the third wave of GPOs development (Notteboom and Rodrigue, 2012). In particular, according to Slack and Frémont (2005), Midoro *et al* (2005), Parola and Musso (2007), and Notteboom and Rodrigue (2012) the vertical integration activities of shipping lines can be summarized in the following four forms:

- a unique contractual agreement between a third-party stevedore company and the ocean carrier;
- acquirement of a minor shareholding of the terminal by the shipping line;
- joint venture between the shipping line and a third-party stevedore company that will be associated with dedicated terminal use;
- a dedicated terminal in which the shipping line or a terminal-operating sister company will possess at least 51 per cent of its shares.

Based on various GPO classifications Notteboom and Rodrigue (2012) have proposed the following three group categories: stevedores, maritime shipping companies, and financial holdings. The first category, stevedores, refers to terminal operators that have expanded globally. The second category, maritime shipping companies, refers to the vertical integration activities of container shipping lines. The third category, financial holdings, refers to firms from various backgrounds that have adopted an interest in port/terminal operations due to the revenue generation potential of the sector. Pawlik *et al* (2011) identified a category of investors in port terminal operations which resemble the financial holdings category. They call them private equity funds (PEFs) and argue that the expansion of PEFs in the port industry represent a fourth wave of GPOs' expansion. Table 14.1 shows the top 10 GPOs according to the Global Container Terminal Operators Annual Review and Forecast of the shipping consultants firm Drewry (2013).

Port privatization

Ports are managed by port authorities (PAs), which are responsible for the provision of the services needed to accommodate ships (Mangan *et al*, 2008). Thus, they plan, authorize, coordinate and control and in some cases also provide port services (OECD, 2011). PAs construct and maintain port infrastructure which is then provided to other private entities under the form of leases or concessions (Dooms *et al*, 2013). Additionally, PAs aim to enhance the competitiveness of the port cluster (Dooms *et al*, 2013) and to secure cargo by the promotion of an efficient intermodal system (Woo *et al*, 2011).

For the majority of the world PAs are public or semi-public organizations (Baird, 2002). The public involvement in the management of ports, in the form of nationally or locally administered PAs, has been prevalent since the early modern European era (Verhoeven, 2010). Public PAs exist

TABLE 14.1 Top 10 global/international terminal operators' equity-based throughput (2012)

Ranking	Operator	Million TEU	% share of world throughput	Characterization according to Notteboom and Rodrigue (2012)
1	PSA International	50.9	8.2%	stevedores
2	Hutchison Port Holdings	44.8	7.2%	stevedores
3	APM Terminals	33.7	5.4%	maritime shipping company
4	DP World	33.4	5.4%	financial holding
5	COSCO Group	17.0	2.7%	maritime shipping company
6	Terminal Investment Limited (TIL)	13.5	2.2%	maritime shipping company
7	China Shipping Terminal Development	8.6	1.4%	maritime shipping company
8	Hanjin	7.8	1.3%	maritime shipping company
9	Evergreen	7.5	1.2%	maritime shipping company
10	Eurogate	6.5	1.0%	stevedores

SOURCE Drewry (2013)

in two forms or schemes. The first scheme is centralized port governance, where the government of the country is responsible for the management and operations of the ports. The second is decentralized port governance where the management and operation of ports is the responsibility of regional or municipal public authorities (Goss, 1986; Cullinane and Song, 2002).

Currently PAs are recognized as hybrid organizations in the sense that they are ruled by both public and private law (Verhoeven, 2010; van der Lugt *et al*, 2013). Additionally, a PA, in the form of a GPO, may manage more than a single port in different countries (Mangan *et al*, 2008).

Ownership, structure and mandate are the determinant factors that shape the objectives guiding the actions of the PA (Heaver *et al*, 2001). Ports may have various forms of ownership. The entity that owns the port is referred to as the port landlord, who owns the land and in many cases owns the port infrastructure as well. It is possible that the PA may also be the port's landlord but examples where PAs and landlords are different organizations exist (OECD, 2011).

Some ports are managed by the government of the country they are located in, while others are managed by private companies (Stopford, 2009). However, few examples of ports exist which are entirely public or private (Cullinane *et al*, 2002). The dissimilarity of port ownership models obstructs the development of a common approach to ports, a problem that also arises amongst ports with similar functions and roles (Bichou and Gray, 2005). According to Thomas (1994) diversity of ownership and organizational structure in ports exists because port development is influenced by various social, political, cultural, commercial and military circumstances.

Interest in the effects of private sector involvement in PAs' strategy formation was initiated by Goss (1990) who challenged the need for public sector PAs (Verhoeven, 2010). It is a common understanding nowadays that the operational efficiency of PAs is linked to the increased involvement of the private sector in the ownership and operation of ports (Tongzon and Heng, 2005). Additionally, the efficiency of a port can create the basis for a nation's competitive advantage in international commerce, because ports are perceived as vital links in global trade. Pallis and Syriopoulos (2007) argue that port governance is a crucial determinant of port performance. The development of port trajectories and their divergent governance structures are related to the concepts of path dependency and lock-in, concepts which originated in the fields of institutional economics and evolutionary economics respectively (Notteboom *et al*, 2013). Regardless of their ownership structure, ports should provide a certain set of facilities and services (see Table 14.2).

TABLE 14.2 Facilities and services offered by ports

Infrastructure	Approach channel, breakwater, locks, berths
Superstructure	Surfacing, sotrage (transit sheds, silos, warehouses), workshops, offices
Equipment	Fixed: ship-to-shore crane, conveyor belts etc Mobile: straddle carriers, forklifts, tractors etc
Services to ships	Harbour master's office (radio, vessel traffic system etc), navigational aids, pilotage, towage, berthing/unberthing, supplies, waste reception and disposal, security
Services to cargo	Handling, storage, delivery/reception, cargo processing, security

SOURCE UNCTAD (1995, p 27)

However, the contemporary understanding about services and facilities offered by ports is that they should reflect the developments of the supply chains that pass through them. Thus, many ports have altered their offerings towards the provision of more than the traditional port services (Bichou and Gray, 2005; Brooks and Cullinane, 2007).

With regard to offering the facilities and services presented in Table 14.2, a distinction between two types of ports can be made, the comprehensive port and the landlord port:

- To the *comprehensive* port type belong those ports where the provision, management and operation of facilities and services is the complete responsibility of the public PA. These ports are also characterized as totally integrated ports (Cullinane *et al*, 2002).
- Ports belong to the *landlord* port type if the PA's role is limited to the provision and maintenance of basic infrastructue and crucial services (eg fire services, security etc), while independent third parties are responsible for the provision of all other facilities and services (Cullinane *et al*, 2002). These ports can be also referred to as purely regulatory ports.

According to Baird (1995), Brooks and Cullinane (2007), World Bank (2007), Debrie *et al* (2013) and Dooms *et al* (2013), the vast majority of PAs around the world operate under the landlord port model (eg the ports of Rotterdam, Antwerp, New York and Singapore).

A modification of the two port types model exists, which divides ports into three categories: service, tool and landlord ports (Cullinane and Song, 2002). The classification of ports into three models is referred to as the 'traditional port organization model' (Baird, 2000; Chen, 2009):

- The *service port model* refers to those ports where the public PA is the owner of the port's land and assets and is responsible for the management and operations of the port. Additionally, some of the cargo-handling services can be conducted by an independend public entity (Brooks and Cullinane, 2007). However, Cullinane and Song (2002) argue that the service port model is by definition identical to the comprehensive port model.
- The *tool port model* refers to those ports where the PA is public and is responsible for the development and maintenance of port infrastructure and superstructure (Brooks and Cullinane, 2007). However, some onboard, quay and apron operations are performed by private organizations.
- The role of the PA and its functions in the *landlord model* are the same in each of the two or three models of port classification.The tool port model can be considered as a modification of the landord model (Cullinane and Song, 2002).

Port function privatization matrix

Baird (1995) developed the port function privatization matrix (Table 14.3) which summarizes the various types of port administration in four models: pure public sector, public–private, private–public and pure private sector. According to the port function privatization matrix, the functions of a port can be divided into three categories: the port landowner function, the port utility function and the port regulatory function.

The majority of container ports fall into the second model where the *public sector* is the landlord of the port and is also responsible for the functions and regulations of the port, while the handling of the cargo is the responsibility of the private sector (Baird, 1995). Ports that are owned and managed by the public sector which is also responsible for the handling of the cargo are assigned to the first model, the *pure public sector* (Baird, 2005; Mangan *et al*, 2008). The third model, *private–public*, describes the case of ports that have a private landlord and cargo-handling organization but the functions of the port follow the regulations set by the public sector (Baird, 1995). The fourth model is the *pure private sector* model. Ports that have employed this model are owned and managed by a private company which is responsible also for cargo handling. This model is applicable to UK ports (Baird, 2005) and a few examples in the rest of the world such as Australia and New Zealand (Dooms *et al*, 2013). Baltazar and Brooks (2001), based on the matrix of Baird (1995), developed the Port Devolution Matrix. However, as this has not been validated (Brooks and Cullinane, 2007) it will not be further discussed.

World Bank Port Reform Toolkit (WBPRTK)

The World Bank (2007) extended the traditional port organizational model with the addition of a fourth port type, the private service port or *private port*. According to Chen (2009) the private port was generated by the splitting of the service port into a public service and a private service port.

TABLE 14.3 Four models of port administration

	Port functions		
Models	**Landowner**	**Regulator**	**Utility**
Pure public sector	Public	Public	Public
Public–private	Public	Public	Private
Private–public	Private	Public	Private
Pure private sector	Private	Private	Private

SOURCE Baird (1995, p 136)

Table 14.4 presents the allocation of responsibilities among the four port models as suggested by the WBPRTK. Furthermore, according to the WBPRTK the private port type refers to ports where the government has no interest in any of the port activities (Brooks and Cullinane, 2007). The private sector is responsible for the regulatory, capital-related and operational activities of the port and is the owner of the port land.

However, it should be mentioned that although the models proposed by the WBPRTK are widely used in the relevant literature they are general in their construction and consequently decontextualized (Debrie *et al*, 2013). On the same lines, Brooks and Cullinane (2007) argue that WBPRTK classifications can be treated as the starting point towards an understanding of the allocation of infrastructure and superstructure investment responsibilities and the allocation of the managerial and operational functions of the port. However, these models 'fail to fully provide an understanding of the strategic intent of a port, its role in the economy as seen by government and the allocation of responsibility for regulatory monitoring (such as environmental and safety monitoring)' (Brooks and Cullinane, 2007, p 410).

The discussion so far has conceptualized the universal development of ports. However, one exception is the UK ports paradigm which is discussed in the following section.

Port privatization in the UK

Although ports around the world operate according to the landlord model, in the UK the majority of ports are completely privatized. This section briefly addresses the reasons that led to the current situation and the challenges that UK ports face with the implementation of a complete privatization scheme. However, first a short description of the UK port sector situation after World War II is provided.

During the 1970s, UK had more than 250 PAs or public operators and approximately 1,400 companies involved in stevedoring, towage and

TABLE 14.4 Allocation of responsibilities based on the World Bank Port Reform Toolkit

Responsibilities	Service	Tool	Landlord	Private
Infrastructure	Public	Public	Public	Private
Superstructure	Public	Public	Private	Private
Port labour	Public	Private	Private	Private
Other functions	Majority public	Mixed	Mixed	Majority private

SOURCE Brooks and Cullinane (2007, p 410) warehousing activities (Cullinane and Song, 2002). Four different port types existed in the UKL public or nationalized ports, trust ports, municipal ports and company ports (Thomas, 1994). Liu (1995) highlights that in the UK even public ports were not financially supported by the government. Instead they were required to create revenue that would cover their operational costs and finance any investment without subsidies or any other form of financial support from the government. Additionally, UK public ports were also free from any government interference in their management. To that extent UK public ports were perceived as being similar to private ports with the exception that UK ports were non-profit organizations and customers had the right to appeal if they thought that port prices were unfair.

The British port industry was nationalized after World War II (Suykens and van de Voorde, 1998). The British Transport Docks Board was created which covered all the ports of the country, and in 1947 the National Dock Labour Scheme was created. The aim of the labour scheme was to provide balance between the bargaining power of employers and employees in the most important UK ports. Additionally, the scheme aimed to preserve the so-called dock work activities of registered dockers. These arrangements granted privileges such as standardized payment even in periods of no work availability (Asteris and Collins, 2009).

The scheme adversely affected the reliability and efficiency and increased the cost of UK ports, which, in combination with the developments of containerization, resulted in the loss of UK ports' competitiveness against leading ports in mainland Europe. A threefold strategy was adopted by shipping lines in order to overcome the barriers set by the scheme. Initially, the shipping lines preferred to call at ports that were not included in the labour scheme, explaining the rapid development of the so far insignificant Port of Felixstowe. Second, shipping lines preferred to tranship products through continental ports which were not protected by similar labour schemes. Third, they initiated a campaign focused on the removal of the constraints of the scheme, which proved effective towards the end of the 1980s. This deregulation resulted in increased efficiency of UK ports before the millennium (Asteris and Collins, 2009).

The full privitization scheme of the UK has been implemented for three reasons (World Bank, 2007). The first was the need to modernize the outdated institutions and installations in order to meet demand needs. The second was the aim to achieve financial stability and targets with the increasing flow of private funds. The third reason mentioned in the World Bank report was involved with the establishment of labour stability and rationalization which would be followed by a higher degree of labour participation in the new organizations. Cullinane and Song (2002) maintain that the main reason for the implementation of a full privitization scheme in the UK was the poor financial performance of the ports.

The first UK port privatization scheme was implemented through the Transport Act 1981 (Suykens and van de Voorde, 1998). The Act included the managerial takeover of 19 ports, managed by the British Transport

Dock Board, by the newly formed Associated British Ports (ABP) (Cullinane and Song, 2002). ABP was controlled by Associated British Port Holdings, a government formed organization. However, in 1983 49 per cent of the company's shares were offered to private investors. Thus, Associated British Ports PLC was formed, which had no 'authority over the directors of ABP with respect to the exercising of their statutory powers and duties as a port authority' (p 70). Goss (1998) argues that the abolishment of the labour scheme which was discussed earlier was perceived as a prerequisite for the implementation of privatization in UK ports. He further argues that no distinction between PAs' statutory duties and economic functions, and the port activities has been made by the government's policy regarding the extent of privatization level of ports at that time.

Further privatization of the remaining public ports was made in 1991 by the UK government (Suykens and van de Voorde, 1998). In particular, according to Goss (1998, p 67) the Port Act 1991 enabled the government 'to compel the remaining trust port to transfer their rights, duties, assets, and liabilities to companies formed under the Companies Act, which would then be sold to some other company'. The preferred scheme supported by the government was the management–employee buy-out (MEBOs) (Farrell, 2013). Furthermore, in 1992 five trust ports were voluntarily sold: Tees and Hartlepool, Clyde, Forth, Medway and the Port of London (Tilbury) (Baird, 1995).

In addition, in 1993 the Secretary of State for Transport, using the powers under the Ports Act, was able to force the remaining trust ports, with annual turnovers above £5 million, to pursue privatization (Baird, 1995). In particular, the Port Act 1991 was focused on the privatization of trust ports and was applied to the majority of PAs. The Department of Transport intended to sell those ports by competitive tender in order to achieve the highest possible price. Furthermore, PAs had the right to proceed with the formation of a limited company that could take over the property, rights, liabilities and operations owned by the PA (Baird, 1995).

According to Farrell (2013), the acquisition prices of those trust ports were low, a fact responsible for the enduring 'get rich quick' image of the port sector. Baird (2013) argues that the increased profits of UK ports, ever since the various deregulations and privatization schemes, attracted the interest of the banking community in UK ports. In particular, UK ports were re-sold to private equities[1] under highly leveraged transactions. One result of this is that the profits made by ports are used to pay off those transactions. This situation prevents the development of new advanced port infrastructure, a fact that can endanger the future international competitiveness of UK ports. Additionally, the UK Department for Transport does not encourage port investment, as this requires ports to contribute to enhanced road and rail infrastructure and results in lengthy and expensive public enquiries (Baird, 2013).

From the discussion above it is clear that UK ports belong to a specialized category of private ports that is not encountered in the rest of the world. Furthermore, several disadvantages have been identified regarding the UK port governance model which can be related to the lagged development of UK ports. Regardless of these concerns, UK container ports appear to have adopted a new strategy which is proving to be very popular and yields many benefits for the ports and their users. This strategy is the so-called concept of port-centric logistics, which is discussed in the next section of this chapter.

Port-centric logistics in concept

Port-centric logistics (PCL) is a concept that has attracted increasing attention from the maritime, logistics and supply chain management scholars over recent years. PCL is defined by Mangan *et al* (2008, p 36) as 'the provision of distribution and other value-adding logistics services at ports'. It should be mentioned here that the revived interest in PCL concerns containerized cargo, as port-centric activities for bulk cargo have been in existence for several years, and evidence of PCL activities on non-containerized cargo is available for a number of years (Falkner, 2006).

As currently conceived, 'port-centric operations' refers to the practice of destuffing imported containers on the port's premises, where the cargo will be held in warehouses until the final destination is known and the products transported there directly without being stocked at other points in the supply chain. This practice is in contrast to the UK model in which containers are transported inland to be destuffed at the centrally located DCs (distribution centres) and then transferred empty back to the port in order to be loaded onto vessels (Wall, 2007).

Falkner (2006) argues that PCL represents a step back from the current port development model, as it is based on the notion that the port acts as the sole point at which goods are imported, stored and distributed inland. Consequently, PCL challenges traditional supply chain models, as it enables entire segments of the supply chain to be removed, a fact that will result in increased efficiency and visibility, reduced demurrage and inventory levels. Additionally, the relocation of companies' warehousing operations to the proximity of a port can offer increased flexibility to those firms in terms of response time to delays in vessel arrivals.

An example of early PCL operations in the UK is the Port of Tyne which was focused on the accommodation of bulk cargo, mainly coal. However, in the early 2000s considerable investment in the expansion of the port's super- and infrastructure was made in order for the port's capabilities to be enhanced with the accommodation of containerized cargo and the offering of various PCL services (Falkner, 2006).

Another port that has been extensively promoting its port-centric strategy is the north- east-based medium-sized Teesport, operated by PD Ports. The project to establish port-centric operations was considered as successful when leading supermarket chains Asda, with a 30-year contract lease and Tesco moved part of their warehousing operations to the proximity of the port (Falkner, 2006). Wall (2007) argues that a focus on the development of Teesport as a northern gateway is the result of the need to decongest the UK's southern ports which face strong pressures and have no plans to develop their infrastructure further. Particularly, Asteris and Collins (2009) argue that the development of PD Ports at Teesport is one of the two port projects, the deep-water port development of Peel ports at Liverpool being the second one, that have been approved outside the south-east of the UK. The managers of Teesport exploited the fact that 'big' retailers have moved their warehousing operations near to the ports in order to attract more shipping lines to call there (Falkner, 2006).

The implementation of PCL implies various benefits for ports and their users. Four distinct categories of benefits can be identified: environmental, operational, cost savings, and increased competitive advantage related benefits. The following sections provide an overview of those benefits.

Environmental benefits

Piecyk and McKinnon (2010, p 31) evaluate the forecasts for 'CO_2 emissions of road freight transport in 2020'. They argue that the extensive use of the hub-and-spoke system increases road-kms, thus an increase of tonne-kms is expected. However, the expected development of PCL can balance out the increase of road-kms, as some parts of the supply chain can be eliminated. Furthermore, Monios and Wilmsmeier (2012b) argue that the expected environmental benefits of PCL can help ports to seek government support for the development of their infrastructures to accommodate PCL activities.

The advantage of using rail or canals for inland transportation and thus reducing road-kms and the associated CO_2 emissions is highlighted by many practitioners. In particular Analytiqa (2007) provides the example of Eddie Stobart. The company claims to eliminate 13,000 annual truck journeys by using rail services instead. Additionally, Wall (2007) argues that reduced emissions will occur from the use of red diesel within the bonded areas of ports that implement PCL. Moreover, removing unnecessary road movements by delivering to the retailers' DCs directly, instead of moving cargo to the DCs in the Midlands and then redistributing them according to demand will aid green initiatives and reduce carbon emissions (Allen, 2008a; Anon, 2011a; Hearn, 2012; Mannix, 2012). Dossetter (2010) and Anon (2011b) support this argument by describing the reduction in carbon emissions as a result of the PCL and airport-centric approach of Samsung and their inland distribution partner Yusen (previously known as NYK-logistics) who claimed to have saved 869,880 road-kms. Anon (2010a) and Jack (2010) argue that fewer road-kms equals lower CO_2 emissions. Anon (2010a) justifies this speculation with the example of Taylors of Harrogate, a tea company that signed a contract with Teesport to handle all their imports. This new contract is expected to result in 100,000 road-miles reduction per annum, as Teesport is conveniently located closer to their DC compared with the two ports that were previously used as import points. However, in this case the reduction of road-miles is caused by the difference in distance between the DC and the port used and not because of any PCL activities.

Operational benefits

Mangan *et al* (2008) mention faster repositioning of containers as one of the main operational benefits of PCL. According to the definition of PCL, containers will not travel to inland DCs, thus they can be available for shipping lines faster as they can be unloaded within the port's premises. Additionally, the full weight capacity of containers can be utilized. Weight restrictions for road transportation prohibit the full capacity utilization of imported containers. However, as the containers can remain within the port's premises, in the case of PCL, such restrictions will not apply. McKinnon (2014) argues that shippers have verified increased container loads of imported containers and in addition he identifies opportunities for the full weight utilization of containers if a PCL model is adopted for the outbound movement of containers as well. By this practice exporters could also be benefitted by PCL. He particularly argues that 1.5 tonnes extra load per container would result in a 6 per cent reduction in vehicle-kms and assorted CO_2 emissions. Moreover, Pettit and Beresford (2009) suggest that road congestion between the port and logistics centre can be reduced as a result of fewer empty runs.

Furthermore, Neale (2006), Analytiqa (2007), Allen (2008a), Falkner (2009), Tindall (2009), Jack (2010), Anon (2011b), Mannix (2012), Landon (2013) and Clark (2013) argue that the implementation of PCL can lead to faster distribution as a result of the reduced number of transportation legs in the supply chain and the elimination of empty runs, which are also linked with easing of road congestion and the removal of expensive and wasteful practices from the supply chain. Analytiqa (2007) and Falkner (2009) also suggest that increased visibility can be introduced into the importer's inventory levels the inventory can be managed at a single point prior to further inland distribution. Wall (2007) argues that operational benefits can be realized because the implementation of PCL can allow the owner of the cargo to use a single point for import, customs clearance and storage of the goods. Allen (2008a, 2008b) mentions that PCL can reduce the double handling of containers and imported goods, a fact that directly influences the containers' turnaround time. Moreover, the reduction of double handling reduces the risk of cargo damage (Jack, 2010). Tindall (2009) and Anon (2010b) comment that increased operational efficiencies can be achieved by the use of rail services or canals for inland distribution, a fact that can reduce the number of trucks approaching the port to load and unload cargo. Anon (2012) mentions that improved operational efficiencies are expected to benefit the retailers who use the shared storage facilities such as the Wynyard logistics park at Teesport.

Cost savings benefits

Savings in transportation costs can be derived from the dramatic reduction of empty runs associated with the implementation of PCL strategy, as containers will never leave the port. Moreover, PCL can benefit supply chains that adopt lean strategies and are in need of continuous stock replenishment of products with predictable demand and short or long lead-time. As the cargo will be stored in a single warehouse located in the proximity of the port of import, direct replenishment to customers can occur. Thus, inventory will not have to be held in multiple locations and savings in warehousing costs will occur (Mangan *et al*, 2008; van Asperen and Dekker, 2013).

From another point of view Neale (2006), Analytiqa (2007), Allen (2008b), Anon (2011a) and Clark (2013) mention lower operational costs in terms of reduced transportation costs, arising from the elimination of transportation legs from the supply chains. This will be achieved as PCL enables faster and more efficient deliveries to the stores through bypass of regional distribution centres (RDCs). Transportation costs can also be reduced by taking advantage of multimodal operations, which are crucial for PCL activities. According to Hearn (2012), 30 per cent of the outbound inland transportation of London Gateway will be moved with the more cost-effective rail transport. Furthermore, reduction in transportation costs can also be caused by reduced fuel consumption. The 86,988 gallons reduction in fuel consumption after the adoption of port- and airport-centric models by Samsung and Yusen support this argument (Jack, 2010).

Based on the Samsung/Yusen case study, several authors support the arguments that PCL implementation can help in the reduction of storage costs (Dossetter, 2010) and enable costs to be taken out of the supply chain (Tindall, 2009; Anon, 2011b). Additionally, Allen (2008a), using statements by the group development director of PD Ports, argues that the adoption of PCL can lead to reduced labour and land costs, as these costs are lower near the port when compared with the Midlands, where the majority of the DCs are currently located. Savings related to reduced inventory levels are mentioned by Allen (2008b) and Falkner (2009), who both also argue that cost savings can arise from the elimination of demurrage fees, which retailers used to pay to the port for the time the containers remained fully loaded in the port yard when the inland DCs had no storage space available. Shared warehousing facilities used by 3PLs to accommodate the imported cargo of their customers will reduce the capital cost of these customers as they will no longer need to maintain their own inland storage facilities (Mannix, 2012; Joyce *et al*, 2013). However, this cost saving is applicable only to the users of shared facilities.

Increased competitive advantages

Increased competitive advantages can be gained for the port and other users of the PCL activities. In particular, Mangan *et al* (2008) highlight that by the implementation of PCL, ports can change their role in the supply chain from passive to active. Moreover, the authors argue that additional VAS provided within the port's premises as a result of PCL implementation will increase port revenue.

Monios and Wilmsmeier (2012b) build on the same argument and suggest that the increased revenue for the ports will be secured by the increased cargo throughput derived from the presence of the retailers' establishment close to the port. The new role of ports after the implementation of PCL and the fact that VAS can help ports to support this new role, is also mentioned by Pallis *et al* (2011). Pettit and Beresford (2009) argue that the thrust for supply chain integration in the case of PCL is promoted by the provision of VAS. Additionally, Monios and Wilmsmeier (2012a) suggest that ports can become more integrated in supply chains because of the influences of inland transportation after the implementation of PCL. From another point of view Feng *et al* (2012) argue that if the Humber port invested in PCL, retailers could be attracted to set up warehouses in the proximity of the port and the need for inland transportation and logistics services within the direct hinterland of the port will be created. According to the authors this practice can bring competitive advantage to the port and increase the port's competitiveness. Additionally, PCL together with the port regionalization and the development of hub-and-spoke networks can provide productivity gains for the terminal operators (van Asperen and Dekker, 2013).

Dossetter (2010) and Smith (2010) use the Samsung–Yusen example and argue that Samsung was able to enter new market segments and increase service levels because of the enhanced logistics performance and market capability provided by the application of PCL. Anon (2011a) argues that PCL can help a port to gain hub status and achieve competitive advantage over ports that are considered only as feeder ports. Moreover, the same author argues that PCL increases the VAS and the service level provided by the port which will be to the direct benefit of the port users. One example is the advanced inventory systems adopted by the Port of Tilbury which can increase the visibility of inventory for cargo owners.

Furthermore, PCL can optimize the inbound supply chain, and can increase supply chain efficiency (Anon, 2008; Mannix, 2012). Finally, Song (2013) argues that the competitive advantage of a single-point-control solution can be provided by the implementation of PCL. This practice increases the control of the supply chain and the provision of VAS.

Disadvantages of port-centric logistics

Several disadvantages associated with the implementation of PCL are also anticipated. In particular, Holter *et al* (2010) suggest that PCL might increase the transit time of international freight transport by up to one week. This can negatively affect the cash-to-cash cycle of the shippers. However, the main focus of their paper is the development a new model that takes into consideration various trade-offs associated with long-range freight transport and can provide considerable saving to shippers. The testing of the model showed that transport costs, transit times and payment terms can affect routing decisions. However, conclusions regarding the effects on routing decisions and the implementation of PCL have not been provided. Such a relationship must be evaluated by further research.

More recently, Monios and Wilmsmeier (2012b) expressed concerns that the application of PCL will undermine the advantage of intermodal transport, as the container will break into smaller loads at the port. Moreover, the authors also mention that PCL can influence exporters, as containers will remain at the port and will not be available inland. Similarly, storage facilities at ports can interrupt the seamless flow of cargo between ports and dry ports (Ng *et al*, 2013).

Additionally, Monios and Wilmsmeier (2013) argue that companies located at regional UK ports which have implemented an PCL strategy might encounter the risk of raised prices of shipping lines and no alternative choice.

Demirbas *et al* (2014) identified, by case study research, certain disadvantages and constraints of PCL. They particularly argue that one of the prerequisites for the adoption of PCL strategy is land availability. However, PCL can be implemented outside the perimeter of the port. The risk in this situation is that the port needs to ensure high-quality service provision even in those premises. Failure to do so can lead to customer and reputational loss. Additionally, their findings lead them to conclude that PCL can increase both the complexity of operations at the port and the responsibilities of the port operating company which will need to sort imported goods against orders and notify the responsible bodies for their collection. Another factor that increases the complexity of PCL operations is the fact that the port is required to work with different ICT systems of the various entities involved in the PCL operations (Demirbas *et al*, 2014). Coronado Mondragon *et al* (2012) anticipated this implication in the implementation of PCL and suggest the use of dedicated short range communication (DSRC), which is a form of intelligent transport system (IST), in order to overcome these issues.

Further disadvantages can be identified from the practitioner's point of view. Particularly, concerns are expressed regarding the risks involved with the multi-user warehousing functions proposed by some PCL operators. These risks need to be evaluated and included in the new contracts between warehouse operators and cargo owners (Joyce *et al*, 2013). Moreover, Joyce *et al* (2013) express concerns about potential negative effects on the performance of the supply chain, caused by loss of control over its legs. This is due to the fact that the owner of the cargo will not be in control of a particular segment as it used to be prior to the implementation of PCL.

Tindall (2009) also expresses concerns about negative effects of PCL. The first concern is related to PCL at Teesport. As the geographical location of this port is in the north of England shipping lines might not be willing to call there because of the increased travel time. The second concern regards the port land cost and particularly the fact that it might not be possible to balance out the high land costs with the cost savings the cost savings derived from the elimination of inland journeys. Hearn (2012) is concerned with the road congestion risk involved in case of inadequate rail connections to the port and the risk and cost associated with relocating warehouses. However, none of the concerns have been supported by empirical research.

From the discussion above, the various advantages and disadvantages of PCL appear to be concentrated only in the UK. The following section aims to justify this phenomenon, and also aims to support the view that PCL is not a new strategy for container ports on a global scale, as similar activities have been identified since the 1980s, but it is a new strategy for container ports within the UK.

Criticism of PCL and its importance for the UK ports and distribution system

According to Monios and Wilmsmeier (2012b) the definition of PCL provided by Mangan *et al* (2008) does not describe anything different from the common practice of warehousing services at ports. Pettit and Beresford (2009) also argue that value-added logistics services provided by a port is not a new concept. The so-called 'distriparks' in Rotterdam and the 'districentres' in Singapore have applied these practices for many years now. This view is also supported by port managers, who associated PCL with the concepts of distriparks and free trade zones (Demirbas *et al*, 2014).

Allen (2008a) agrees that the 'new' term is not considered so 'new' in mainland Europe, but it is perceived as the continuation of a practice that has been implemented for many years. Rodrigue and Notteboom (2012) link the PCL's suggested practices with the gateway distribution system (GDS) which in practice replaces RDCs and DCs with a DC at the point of import. They provide examples of European GDSs, which are called EDCs, and mention that in North America the GDCs are divided by coast. Their paper is another one that suggests that PCL is a term only used within the UK, as similar practices have been in existence for several years in mainland Europe and North America.

However, according to Demirbas *et al* (2014) PCL is a relatively new concept for UK ports. They argue that the practices of relocating DCs inland, experienced during the 1960s and 1970s, resulted in the transformation of ports as simple transit points. On this notion, Pettit and Beresford (2009) argue that UK ports and port operating companies focused solely on the provision of cargo and ship handling services, while neglecting entirely the provision of warehousing and VAS. Such practices have been implemented by major mainland European ports since the 1980s, a fact that enabled them to be advertised as logistics platforms. Rodrigue and Notteboom (2010) argue that UK ports fall behind the mainland European ports, which experienced high container throughput volumes, even in the new millennium. Indicative of this situation is the fact that the ports in the Hamburg–Le Havre range handle more than 48 per cent of European container throughput.

The importance of PCL in the UK is highlighted also by Monios and Wilmsmeier (2012b).They argue that the current distribution network of the UK was developed when the majority of products were sourced locally, a fact that led to the development of the golden triangle of logistics. However, the shift of manufacturing towards the developing countries of East Asia changed UK sourcing patterns (Mangan *et al*, 2008; McKinnon, 2009). Imports through ports have increased, thus the centralized distribution model developed in the 1980s is no longer efficient. Additionally, Monios and Wilmsmeier (2012b) believe that PCL can enable retailers and 3PLs to optimize their distribution network by balancing cost and time between primary and secondary distribution. In this sense, the same authors argue that heavy containers can be kept off the road network as they will be emptied at the port site and direct distribution to the stores could be made by trailers instead of containers.

In particular, de Langen *et al* (2012) argue that the majority of distribution centres are located centrally in the UK while the deep-water ports are in the south. The authors suggest that PCL developments in the Humber port area are a response to the need for a change in this pattern. Additionally, Pettit and Beresford (2009) argue that a new model needs to be developed in accordance with the notion that maritime freight is passing through ports. PCL is a vital aspect of this new design, as it is involved with the moving of DCs from inland locations towards the ports. This shift is caused by the influences of inland transportation which can help ports become more integrated with the supply chain (Monios and Wilmsmeier, 2012a). Additionally, Coronado Mondragon *et al* (2012) also support the argument that PCL acts as a new strategy for UK ports which aims to attract companies to establish their logistics-related operations on ports' premises, in order to take advantage of the fact that products are imported in the UK by ports.

Moreover, Wilmsmeier and Monios (2013) argue that PCL is relevant to the UK as it can support the changing logistics paradigm and facilitate the partial transposition of the UK's gateway role to location in mainland Europe. Furthermore, the same authors argue that PCL can enable the shift of UK ports from their gateway role to become transhipment hubs, a fact that will initiate a deconcentration in the existing port system.

PCL has also been academically investigated as a way to overcome Scotland's problem of double (geographical and institutional) peripherality (Monios and Wilmsmeier, 2012b). Two solutions related to PCL are suggested as solutions to this problem. The first solution is involved with PCL development in Scotland in order to attract feeder services, while the second is the use of offshore PCL activities. The offshore logistics activities would involve the use of warehouses located at ports in mainland Europe and the utilization of the existing RoRo connectivity of Scotland with the Port of Zeebrugge in Belgium (Monios and Wilmsmeier 2012b).

Large-scale port-related investments occurring in the UK and the response of retailers to this trend are also evidence to support the emerging importance of PCL as a contemporary strategy for UK ports. New ports were constructed based on the PCL concept (eg Teesport, London Gateway, Liverpool 2), while other existing major ports altered their strategies in order to implement PCL (eg Felixstowe, Humber, Grangemouth, Tilbury and others). Examples such as Tesco, Asda and Sainsburys, the UK's top three retailers, which set up warehouses at Teesport and Felixstowe, confirm the fact that retailers have shown a great interest in this concept (Wall 2007; Analytiqa 2007; Mangan *et al*, 2008; Clark, 2013).

Before any conclusion it must be made clear that PCL was initially adopted as a strategy by medium-sized container ports in the UK as a way to compete with the greater container ports in the south.

Port-centric logistics in practice

During the last decade many UK ports have altered their strategies towards the provision of PCL services. Based on the offerings of each port the following list of PCL services has been created:

- custom clearance and inspection facilities;
- freight forwarding services;
- state-of-the-art warehousing and warehousing managing systems;
- multi-user warehouses with leasing opportunities;
- packing, relabelling and light manufacturing services;
- cross docking – transhipment;
- inland distribution and cargo tracking;
- multimodal connections (rail, barge, short sea shipping, road);
- hazardous goods specialized services;
- supply chain management;
- ancillary services and container repair and maintenance.

It should be mentioned that the spectrum of services offered by each port varies and is dependent upon each port's capabilities and resources.

In the majority of PCL operations across the UK, as shown in Table 14.5, the PA of the port itself is also the provider of the value-added PCL services. However, it is apparent that in some ports the PCL services are either provided by a third-party logistics provider (3PL) or by another PA. For example, the port authority of the Port of Southampton, the second largest UK container port, does not offer PCL services. These services are offered by a 3PL that stores the imported products, free of duty and taxes, in warehouses adjacent to the port until their final shipment to the retailers. The same applies currently also for the Port of Bristol. The cases described above can be characterized as PCL offering by a single entity.

On the other hand a port's PCL offering can be provided by multiple entities. For example, a common practice is the provision of PCL services

TABLE 14.5 PCL at UK container ports

	Port authority and PCL provider	PCL services by another port authority	PCL services by a third party
Port of Felixstowe	•	•	•
Port of Southampton			•
Port of Tilbury	•		•
Port of Liverpool	•		
Thamesport	•		
Port of Grangemouth	•		
Belfast Harbour	•		•
Port of Hull		•	
Tees and Hartlepool	•		
Port of Immingham		•	
Bristol			•
Clyde	•		
Tyne	•	•	
Gateway	•		•

by various 3PLs in addition to the PA of the port. In these cases the PA might have offered port land to 3PLs to establish operations in the port's premises or the 3PL might have built the distribution centre in the proximity of the port. The anticipated development of the biggest logistics park in the proximity of the London Gateway is an example of the former case. Similar developments are the London Container Terminal and the London Distribution Park at the Port of Tilbury. Property management companies are responsible for the marketing and utilization of the land.

Another form of PCL is the provision of PCL services at a port by another PA in addition to the PA of the port. An example of such practice is the Port of Tyne, which operates its own PCL facilities, but PCL services are also provided by another PA. A similar case of PCL services offered by multiple entities is the Port of Felixstowe. In Felixstowe PCL services are offered by the PA of the port and by the logistics department of another port authority as well as by many other 3PLs that have established operations near the port.

Conclusion

Ports around the world have developed in various ways in order to cope with the ever changing business environment in which they operate. Although there is considerable diversification among types of port, the UK example stands unique amongst developments in other parts of the world. As discussed, UK ports have been entirely privatized, a fact that resulted in the loss of their competitive position and a need to change their strategies. Over the last decade many container ports in the UK have adopted the so-called PCL strategy as a way to enhance competitiveness and experience many other benefits. These benefits have been identified in the extant literature and have been presented in four categories environmental, operational, cost saving and increased competitive advantage. However, the implementation of PCL is associated with several disadvantages which were also extensively discussed. Finally, the chapter supported the view that PCL is not a new universal strategy for container ports, but a new strategy for container ports in the UK. Before this chapter ends it must be mentioned that the current practices of PCL are focused at a single port. The ambitious developments in the west of the country where a 'network of PCL operations' is created will expand the 'narrow focus' of PCL beyond the limits of the port per se. The centre of those developments is the Port of Liverpool, where a major new container terminal is being built. This new terminal will be connected with distribution centres along inland waterways and with other ports, thus offering an extended network of PCL.

Note

1 Private equity is an asset class consisting of equity securities in operating companies that are not publically traded on a stock exchange (Baird, 2013, p 159).

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Container hub ports in concept and practice

15

HYUNG-SIK NAM AND DONG-WOOK SONG

Introduction

Since the hub-and-spoke concept was introduced to the aviation market after the US airline deregulation in the late 1970s, it has become a primary distribution model employed by leading international logistics companies. This pattern drives companies to consolidate large-scale shipments at major terminals (ie hub) and to redistribute smaller-scale shipments to their respective destinations via radial links (ie spoke). In the field of logistics and supply chains, however, the hub concept has been often introduced under various terms based on functionality, such as logistics centre, logistics zone, freight terminal, distribution centre, and warehouse. Such a heterogeneous terminology for the concept of 'logistics hub' seems still to be in usage by practitioners and academics alike. Having recognized this rather ambiguous concept and its definition in the literature, this chapter attempts to define the logistics hub concept as it applies to the maritime industry by synthesizing existing studies/perspectives and examining its possible implications.

Logistics hub in perspective

The development of international trade and industrial distribution patterns have had impacts on the development of logistics facilities as they have been recognized as main strategic contributors to achieving competitiveness and attractiveness (Cullinane and Song, 1998). However, there has been no clear-cut definition of what a logistics hub is. The *Concise Oxford Dictionary* (2005) defines the term 'hub' as a central part of vehicle's wheel and exchangeable with 'centre'. The hub is commonly used in the aviation (especially the passenger sector) industry after the US Airline Deregulation Act in

1978; since then the route structure has been adopted by a large number of airlines that operate in the deregulated market. A hub is strategically located at an airport utilized as a collection–distribution centre for passengers and serviced generally by a single carrier (Cavinato, 1989). Since the Deregulation Act eliminated routing restrictions, networks based on a hub-and-spoke architecture have proliferated in the US freight transportation industry as well. In the 1990s, the hub concept became the primary distribution model employed by logistics integrators such as DHL, TNT, UPS, and FedEx, and leading international carriers. Shipments coming from several origins are consolidated at major terminals (ie hub) and redirected to their respective destinations through radial links (ie spoke) (Cavinato, 1989).

The hub concept has been often introduced under various terms mainly in accordance with its storage and transportation functionality: eg logistics centre, logistics zone, freight terminal, distribution centre, warehouse, intermodal terminal, international transport terminal, intermodal terminal and so on.

According to Rimiene and Grundey (2007), the ‘logistics facilities’ (or ‘logistics centre’) concept appeared around 30 years ago and can be classified into three different generations over the course of its evolution. Europlatform (2004) provides a precise definition of logistics centre: the hub for a specific area where all the activities relating to transport, logistics and goods distribution, both for national and international transit, are carried out on a commercial basis by various operators. Johnson and Wood (1996) view a logistics centre as a cost reduction centre which is defined as a facility where commodities move constantly to the end of circulation and warehousing and other relevant costs are reduced as much as possible. UNESCAP (2002) states that a logistics centre should be equipped with all the public facilities necessary to carry out all logistics-related activities. Logistics centres serve a variety of purposes including cargo transhipment, production synchronization, facilitating business and trade, whereas others aim to strengthen the logistics capability for transforming a region into a more attractive or competitive market. However, the fundamental requirements for a logistics centre are being on a nodal point of transport network, common infrastructures, intermodality, and logistics and transport services (Bhutta *et al*, 2003).

Over time there have been changes to how things are produced stored and moved, which have been significant for the development of logistics centres. The logistics facilities concept could, however, be derived from three different perspectives: a ‘traditional logistics and supply chain management’ perspective (ie distribution centre or warehousing); a ‘freight transport’ perspective (ie load centre, freight village and transport node point); and a ‘foreign direct investment’ perspective (ie international logistics zone and international free trade zone). Rimiene *et al* (2007) provide three stages of development of logistics facilities: 1960s to 1970s, 1980s to early 1990s, and mid-1990s to the present. In the first stage, logistics facilities are viewed as mere warehousing and as a physical location for inventory, with no direct linkage with production. Relevant references, terms and highlights are summarized in Table 15.1.

TABLE 15.1 Perspectives on logistics centre/hub

Perspectives	Types of hub	Key points	References
Traditional Logistics and Supply Chain Perspective	Distribution Centre / Warehouse	• Place for a physical facility used to complete the procedure for the product line adjustment in the exchange channel. • Warehouse for storing finished goods. • Facility from which wholesale and retail orders can be filled. • Place where consignments from different origins are grouped and/or split. • Control the product flow in contrast to storage. • Place for creating value-added services. • Connecting link between producer and customer	Rushton *et al* (2006); Cavinato (1989); Europlatform (2004); Johnson and Wood (1996)
Freight Transport Perspective	Freight village / Logistics node	• Place for transport, logistics and goods distribution functionality. • Provide geographic coverage. • Facilities which include warehouse and storage area. • Provide for public service and full territory access.	Europlatform, (2004); Bhutta *et al* (2003)
	Freight Terminal	• A terminal for freight transport modes change • Provide a service for handling operation • Place for value-added services	Bhutta *et al* (2003); Roso (2005)
	Dry Port	• Inland location for consolidation and distribution of goods • An integrated and intermodal extension of ports.	Ng and Gujar (2009); Roso (2005)
Foreign Direct Investment / International Facility Location Perspectives	International Logistics Zone (or International Free Trade Zone)	• Parts of the territory of a state where any goods introduced are generally regarded, in so far as import duties and taxed are exempted. • Space for an arrangement where different trading entities, usually member countries, agree to cut or scrap taxed in order to lower business costs and remove bureaucracy	Reynaud and Gouvernal (1987); Min and Guo (2004)

Bowersox (1968) defines 'distribution centre' as a physical facility used to complete the process of product line adjustment in the exchange channel, and its primary function concerns product flow in contrast to storage. However, Reynaud *et al* (1987) expand its simple warehousing function into transportation, and define it as a place where consignments from different origins are grouped or split; it is above all a transportation organizational centre, located at a nodal point in the logistics system. In the second stage of development, these centres are engaged with additional outbound transportation functions (Mangan *et al*, 2008) and are often called a 'transport terminal' and a 'freight village'. Freight village is 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 (Rimiene *et al*, 2007). It is claimed that there are four requirements for being a freight village: it must allow access to all companies involved in the logistics activities in order to comply with free competition rules; it must be equipped with all the public facilities including staff and equipment; it should preferably be served by a multiplicity of transport modes (ie intermodal transportation); and it must be run by a single body, either public or private (Europlatform, 2004). In the final stage, logistics facilities become a market-oriented logistics node, offering value-added services and a point where diverse routes converge (Min and Guo, 2004). UNESCAP (2002) identifies determinant factors that make up successful logistics centre as follows:

- a community desire to have a comprehensive hub development strategy;
- existence of comparative cost advantages;
- a favourable fiscal environment;
- existing high-tech manufacturing industry base;
- one-stop-shop local marketing organization that proactively promotes the location;
- supporting infrastructure at all transport terminal facilities and human resources;
- appropriate incentive packages for foreign investors.

Application of logistics hubs to container ports

The development of container ports

Maritime logistics is often referred to as a process of planning, implementing and managing the movement of goods and information with ocean carriage being involved. It has, in particular, highlighted the role of maritime transportation in global logistics and supply chains (Panayides and Song, 2008), and its strategically significant role within the logistics integration system (Agapio *et al*, 1998). However, as Notteboom (2002) indicates, maritime logistics is concerned with individual functions relating to sea transportation as well as an effective logistics flow as a systematic entity of the logistics integration system.

Maritime logistics consists of three key players of maritime transportation: shipping companies, port operators and freight forwarders. Although shipping is mainly concerned with moving goods from one port to another, it also provides related logistics services in order to support an overall logistics flow, including pick-up services, inbound/outbound bills of lading, intermodal services and container tracking. Ports in modern logistics systems involve not only loading/off-loading cargoes to/from a vessel, but also various value-adding services including warehousing, storage and packing and arranging inland transportation modes. Freight forwarding, as the third component of the whole maritime logistics systems, encapsulates the process of sea transportation in order to arrange the complex process of international trade such as booking vessels on behalf of shippers, preparing documents for ocean carriage and arranging logistics services for the shippers.

Although the concept of hub was traditionally developed by the passenger airline industry (Martin and Roman, 2004), which identifies hub-and-spoke airports in the international aviation market, there have been a number of studies concerned with building seaport-based logistics hubs and their integration into the global supply chain network (Mangan *et al*, 2008; Min and Guo, 2004; Lee *et al*, 2008). Botha and Ittmann (2008) describe the role of seaports as main components in determining the competitiveness of a nation's economies, and there is a close relationship between development and expansion of seaport and economic growth. Therefore, in this chapter, the main context of maritime logistics hub is defined as *seaport and hinterland* in terms of spatial boundary where logistics activities are conducted.

Traditionally, ports have been defined as areas made up of infra- and superstructures capable of receiving ships and other modes of transport, handling their cargo from ship to shore and vice versa (Paixão and Marlow, 2003). However, the definition has been expanded to encompass the provision of logistics services which create value-added (Paixão and Marlow, 2003), with ports constituting a critical link in the supply chain, and their level of efficiency and performance influencing to a large extent, a country's competitiveness (Cullinane and Song, 2002). Tongzon (2007) provides nine key determinants for a successful port (and a logistics hub): port operation efficiency level, cargo handling charges, reliability, port selection preferences of carriers and shippers, the depth of the navigation channel, adaptability to the changing market environment, land-side accessibility, product differentiation, and government role (including government support, and law/regulation).

Notteboom and Rodrigue (2005) and Lee *et al* (2008) have shown the importance of a port's hinterland as a new phase of development. Hinterlands are categorized into two types: main and competition margin (UNESCAP, 2005). The fundamental (main) hinterland is the space over which a port has near exclusivity for providing services. The competition margins are the areas where other ports are in competition. The fundamental hinterland is being challenged by intense port competition with a port regionalization mainly composed of competition margins and few fundamental hinterlands. Notteboom and Rodrigue (2005) explain four phases of port development (called Bird's model) in terms of level of functional integration: setting, expansion, specialization and regionalization. The important role of the hinterland can be found in the last phase: the hinterland reach of the port through a number of market strategies and policies linking it more closely to inland freight distribution centre. Lee *et al* (2008) provide three regional patterns of hinterland concentrations in three geographical areas: North America, Western Europe and South and East Asia. According to their research, current Asian ports are characterized by ports concentrated in coastal region with relatively low hinterland coverage.

UNESCAP's report (2005) provided three evolutional patterns of port development. Until the 1960, ports played a simple role as the junction between sea and inland transportation systems. At that time, the main activities in the port region were cargo handling and cargo storage, leaving other activities extremely unrepresented. Such a way of thinking greatly influenced relevant people in government and local administration. It also influenced people related to the port industry, who considered it sufficient to develop and invest only in port facilities, as the main functions of the port were cargo handling, storage and navigation assistance. It was for these reasons that important changes in transportation technology were neglected.

Moving to the next pattern of development (ports built between 1960 and 1980), ports had been run either by central/local government or by port authority, so the port service providers could understand each other and cooperate for mutual interests. Activities were expanded ranging from packaging, labelling to physical distribution. A variety of enterprises were also founded in ports and hinterlands. Compared to first-generation ports, these second-generation ports were characterized by a tighter relationship between freight forwarders and cargo owners. It could be said that the second-generation ports had begun to notice the needs of customers, but when it came to keeping long-term relationships with customers, they took a passive attitude.

From 1980, container transportation developed quickly, and the new intermodal transport system emerged. Production and transportation activities were linked to form an international network. The former services function was expanded to include logistics and distribution services. Environment protection is becoming more important, so the ports are developing closer relationships with those in their surrounding neighbourhoods. Compared to the past, today's port authorities are focusing on efficiency rather than effectiveness. In the third-generation ports, the needs of customers are analysed in detail and port marketing has been actively engaged. The late 1980s saw the emergence of major changes (Notteboom and Rodrigue, 2005). Customers began to ask ports to provide a greater variety of services. Providing value-added services is a powerful way for ports to build a sustainable competitive advantage. Shippers and port customers are becoming increasingly demanding. Customers now tend to look at value-added logistics services as an integral part of their supply chain. As a result, ports must attempt to satisfy these needs by offering differentiated services.

Among a number of logistics value-added service (such as consolidation, packaging, labelling, assembly, economic processing, contingency protection, and operation efficiency), the importance of a port's value-added service is varied by different authors. Carbone and De Martino (2003) indicate that procurement and pre-assembly service are of greater significance, but Panayides and Song (2008) conclude that the provision of port facilities for adding value to cargoes is an important criterion for ports integrated in the supply chain. In order to develop maritime transport as an integrated logistics and supply chain management system, ports have to simultaneously work in several directions, by taking into account the requirements of the senders and receivers of goods (such as physical accessibility from land and systematic organization of the information flow, which affect the choice of seaport) as they become their business partners in addition to the traditional ones (such as shipping companies, terminal operators, and forwarding companies). Chen (2001) also points out that the main contribution of modern ports depend upon: the availability of efficient infrastructure and inland connections, as part of a global transport system; and the ability of logistics and transport operators to contribute to value creation and to meet qualitative customer demands (such as reliability, frequency, availability of information, security etc).

TABLE 15.2 The transhipment volume of main ports in Asia-Pacific region in 2005

Port	Region	Total throughput (Million TEU)	Transhipment estimates (Million TEU)	Estimate transhipment incidence
Singapore	Southeast Asia	23.19	18.79	81.0%
Hong Kong	Southeast Asia	22.60	10.15	44.9%
Busan (South Korea)	Northeast Asia	11.84	5.18	43.7%
Kaohsiung (Taiwan)	Northeast Asia	9.47	4.82	50.9%
Tanjung Pelepas (Malaysia)	Southeast Asia	4.17	4.00	96.0%

SOURCE Huang, Chang and Wu (2008)

According to hub-and-network development, the container port can be divided into three categories: hub port, trunk port, and feeder port. Huang *et al* (2008) pointed out that the main criterion for being a hub port is not throughput cargo rate but *transhipment cargo rate*. They conclude that there are five hub ports in Asia Pacific region: two in South East Asia (Tanjung Pelepas, Hong Kong and Singapore) and three in North East Asia (ie Kaohsiung and Busan) in terms of total throughput and transhipment (see Table 15.2). In 2005, the ratio of transhipment container and container throughput for these five ports was over 40 per cent. Singapore port handles the highest transhipment volume, 18.79 million TEU, equivalent to 81 per cent of throughput volume. The second highest is Hong Kong, which handles 10.15 million TEU of transhipment container equivalent to 44.9 per cent of container throughput. The third is Busan port, with a transhipment volume of 5.18 million TEU (43.7 per cent). The fourth is Kaohsiung port (4.82 million TEU/50.9 per cent) and the fifth is Tanjung Pelepas port (4 million TEU/96 per cent). Although the container throughputs for Shanghai port and Shenzhen port are already over 10 million TEU, their transhipment volumes are only 0.40 million TEU and 1.30 million TEU, lower than 10 per cent of container throughput. As Huang *et al* (2008) conclude, this is why Shanghai and Shenzhen ports cannot be called hub ports.

Having the aforementioned discussions in mind, we would propose an operational definition of maritime logistics hub as follows:

> A maritime logistics hub is i) *a nodal point* of cargo transit or transhipment assuring flawless door-to-door cargo movements, ii) a *principal distribution centre* functioning as a temporary storage and sorting, and iii) *a place* creating and facilitating value-added services on the regional and/or international scale.

The above definition could be easily applicable to the regional or international container ports, competing to have more shipping lines calling at a particular port that wants to be a maritime logistics hub in the region or on the global stage by establishing, extending and sustaining networks for the shipping lines.

Economics and social network theories for container hub port evolution

Economic and social network theories could be conceptual frameworks within which to examine the evolutionary development of container hub ports.

Economic theories

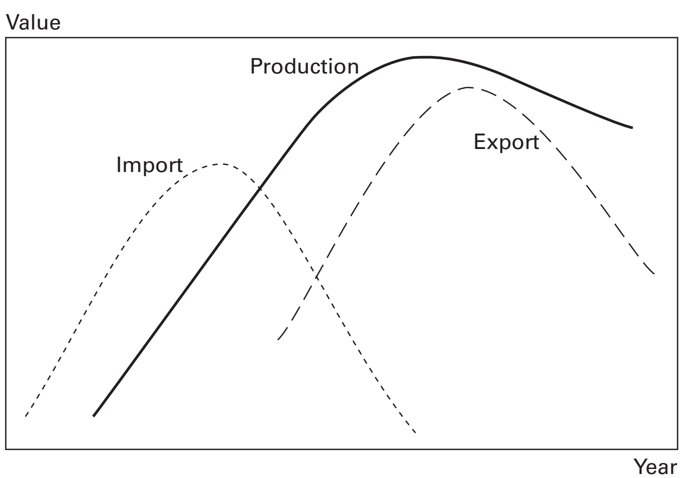
As Wooldridge (2008) noted, economic theories and econometric models are useful tools, which are based on the development of statistical methods for estimating economic relationships, and evaluating and implementing government and business policy. These methods are commonly used when forecasting future trends which are based on past historical data. Econometric models are often used in the field of transportation logistics particularly airport networks for passenger aviation, seaport competition, and consideration of multinational companies' (MNCs) facility location. Three notable econometric models are summarized as:

- *Traditional hub-and-spoke model*: Marianov *et al* (1999) use the hub-and-spoke model to find the best location for a hub airport in a competitive aviation environment, and to show the relationship between cost of fare, captured traffic flow and airport location. Their research addresses customer capture from competitor hubs, which happens whenever the location of a new hub results in a reduction of the time or distance needed by the traveller to go from origin to destination. Their model is useful when an airline wishes to relocate hubs when there are also several competitor hubs. The model used by Martin and Roman (2004) could apply to maritime transport when liner shipping chooses ports in the neighbouring countries.
- *Foreign direct investment (FDI) model*: Bhutta *et al* (2003) provide an FDI investment model for distribution centres and production facilities using a number of variables such as capacity requirement, capacity changing costs, inventory holding costs, shipping costs, exchange rate factor in the marketplace, and government policy (in terms of tariffs and custom duties). The model provides a cost-effective way to study the impact of global factors on the operations of firms and provides help with facilities configuration decisions.
- *Time series data analysis method:* This method is useful for making forecasts based on past historical data. Different stationary and trend stationary models of economic and financial time series often imply different predictions, therefore deciding which model to use is of vital important for applied forecasters. Diebold and Kilian (2000) suggest three important choices for forecasters: always difference the data, never difference, or use a unit root pre-test. The time series data analysis model consists of three stages of data analysis: Stationarity Test (or Unit Root Test), Cointegration Test, and the Granger Causality Test (or Error Correction Model). Yap and Lam (2006) provide a theoretical framework for competition dynamics between 10 major container ports (five in China, one in Korea, and three in Japan) in East Asia. Using time series data of container throughput in terms of TEUs, the study adopts two models: Cointegration Test (to determine the existence of long-run relationships between various port pairs) and Error Correction models (to determine short-run inter-port dynamics). Although the

study has been limited to a single variable, the authors conclude that the study could be complemented with other information sources and perspectives which include information on container throughput handled by trade route, financial data, operational data and general economic impact.

Apart from above three econometric models, the Japanese economic development theory called the 'Flying Geese Paradigm' could also be identified as vital in this respect, as this theory explains economic and industrial development in East Asia, and the maritime transport sector that are mainly influenced by a nation's economic growth and industrial development. The term 'flying geese pattern of development' was originally coined by Kaname Akamatsu (1961) The flying geese model explains the 'catching-up process' of industrialization of late-coming economies. Japan was flying at the head of the Asian economies, leading the formation of the other flying geese. Korea and Taiwan were flying closely behind Japan, followed by the member countries of the Association of South East Asian Nations (ASEAN), then by China at some distance. Akamatsu's original model has been developed by Kojima and Ozawa, students of Akamatsu, and the flying geese model is well established to explain economic and industrial development, and trade patterns in East Asia. There is a close relationship between economic and industrial development and the maritime industry, as the latter (mainly the development of shipping, seaports and containerization) plays a key role during a nation's growth. Therefore, the model can be adapted to prove how and why North East Asia's maritime container ports have been developed.

FIGURE 15.1 Flying Geese pattern of economic development



SOURCE Kwan (2002)

Akamatsu's original model (called the 'fundamental wild-geese-flying pattern') is illustrated in Figure 15.1. Akamatsu (1962) explained the 'fundamental pattern' of the flying geese model in the following four stages:

1. Import of manufactured consumer goods begins.
2. Domestic industry begins production of previously imported manufactured consumer goods while importing capital goods to manufacture those consumer goods.
3. Domestic industry begins exporting manufactured consumer goods.
4. The consumer goods industry catches up with similar industries in developed countries. Export of the consumer goods begins to decline, and capital goods used in production of the consumer goods are exported.

Akamatsu's 'fundamental' model is based on the case of Japan's industrial development, specifically industries involving cotton yarn and wool. He provides statistical evidence to support the flying geese pattern and completes a picture of import, production, and export in Japan's cotton yarn and wool industries from the 1860s to the 1930s (Dowling and Cheang, 2000).

Social network analysis

Analysing container hub ports used to involve evaluating their throughput, largely in terms of TEUs. There is, however, a question whether greater volume of container throughput should be regarded as the main or sole condition to become a regional hub port. As defined in the previous section, a greater level of connectivity with neighbouring ports via shipping lines could be another signal that indicates whether a port is a regional hub or not.

A promising alternative for such an examination is a network theory, which is part of graph theory in social network analysis (Wasserman and Faust, 1994) and is an area of computer and network science useful for mapping and measuring relationships and flows between objects (ie people, groups, organizations, and other connected information/knowledge entities). It can be presented in a form of visual and mathematical relationships. Network theory is concerned with the study of graphs as a representation of either symmetric relations or, more generally, of asymmetric relations between discrete objects. Each graph represents a set of objects called 'vertices' (or nodes) connected by links called 'edges' (or arcs). Scott (2000) explains that a graph structure can be extended by assigning a weight to each edge or by making the edges to the graph directional (eg X links to Y, but Y does not necessarily link to X, as is in web pages), which is technically called a 'digraph'. In graph theory, a digraph with weighted edges is called a 'network'. A primary aim/usage of graph theory is to identify an 'important' objective (called 'actor'). On the other hand, the centrality and prestige concepts of graph theory seek to quantify graph theoretic ideas about an individual actor's prominence within a network by summarizing structural relations among the nodes (Freeman, 1979). The centrality concept shows how many inter-relationships an actor is involved in with other actors in the network, regardless of sending and receiving directionality (ie volume of activity), whilst the prestige concept indicates how many directed ties an actor receives from other actors, but the actor does not initiate such relations (ie the actor's popularity is greater than extensivity) (Wasserman *et al*, 1994; Freeman, 1979).

These two concepts (centrality and prestige) are potentially highly applicable to the maritime transport and logistics sector, which is in essence a network-based industry. Measuring the centrality is a widely used methodology in the field of transportation: for example, Ducruet *et al* (2009), Blonigen and Wilson (2006), and Ducruet *et al* (2010). Ducruet *et al* (2010; 2009) examine North East Asia's hub port status according to centrality measurement with 'degree centrality' and 'betweenness centrality'). The degree centrality can be simply measured by the sum of direct networks between nodes: a sum of direct network connection by shipping lines between two ports. The betweenness centrality is a measure of a node within a graph, and nodes that occur on a number of shortest paths between other nodes have higher betweenness than those that do not: the sum of proportions, for all pairs of ports, in which a main port is involved in a pair's geodesics.

These centrality measurements would be a useful tool to diagnose the regional hub port competition in North East Asia or even other parts of the world where a number of adjacent ports make significant efforts to be key ports in that region. Currently both Japanese and South Korean container ports have lost their competitive position to Chinese ports in terms of container throughput. However, it does not necessarily indicate that they have also lost their relative hub port status; it might have been maintained or even have been strengthened, based on network analysis. An analysis of regional hub port competition based on network theory would deliver a useful insight into how regional ports build an advantage against competitors and cooperate each other within the region.

Concluding remarks

This chapter has attempted to make a meaningful concept and definition of maritime logistics hubs in the spirit of an effective literature review enhancing academic knowledge. There have been a number of empirical studies on the topic but these have been conducted under vague assumptions or definitions of maritime logistics hubs, generally proxied in a form of container hub ports. While those empirical analyses have their own merits by offering a fact-based picture of industry trends over the past years, they are unfortunately unable to clarify issues of what a maritime logistics hub or container hub port is, what factors make a hub, how to predict the next steps, and what measures, in terms of policy and strategy making, are required to make a hub. It is hoped that this chapter initiates further discussion and scientifically rigorous examination into the topic from a variety of qualitative and quantitative perspectives. This line of study will surely be beneficial to those engaged in port development and policy-making, in daily port operations and management, and other strategically related industry sectors.

Nevertheless, the existing literature is not rich enough to be directly applicable to the topic concerned, and the boundary of disciplines associated with the issue is still high, which makes it difficult to reach a consensus on the concept, definition and scope of the matter. It is sincerely hoped that we in the maritime academic community can deal with these issues in an objective and scientific manner so that our understanding and knowledge are elevated and embellished.

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Multinationalizing container ports: Business models and strategies

16

FRANCESCO PAROLA

Introduction

In recent decades, the container port sector experienced unprecedented transformations, which profoundly re-designed industry structure and its competitive boundaries (Song, 2003; Bichou and Bell, 2007). The explosion of globalization made world economies increasingly interrelated as a result of focused manufacturing and growing international trade. In this context, the World Bank favoured the process of integration and trade development, also stimulating port reform in developing countries and financing numerous terminal projects (Peters, 2001). This new economic and institutional environment, which also heavily impacted on advanced economies, offered many investment opportunities in port facilities worldwide and progressively opened the stevedoring market to global competition (Olivier *et al*, 2007).

Some terminal operators, previously bounded within national borders, paved the way to industry internationalization and started to outgrow their respective home ports. Hereinafter, numerous container port multinational enterprises (MNEs) expanded operations overseas, looking for portfolio diversification, network and scale effects in their cost base and additional financial margins (Olivier, 2005; Peters, 2001). The port industry is now witnessing an increasing number of terminal projects fuelled by the massive diffusion of containerization in global commodity chains (Parola *et al*, 2013). These overseas initiatives entail a high degree of complexity in terms of amount and variety of allocated resources, eg financial investment, managerial and organizational skills, staff, ICT etc (Fung *et al*, 2011). Besides, they expose the parties involved to a range of commercial, technical, regulatory, political and financial risks (Estache and Pinglo, 2004). The magnitude of such worldwide investments is considerable. In the 1986–2013 period, the World Bank recorded approximately 200 container port projects involving private participations referring to developing countries alone, for a total investment amount of roughly US$ 40 billion.

The nature and ultimate strategic objectives of container port MNEs are not univocal. Some heterogeneous business models, in fact, establish themselves in the market and mutually influence each other (Drewry, 2005). Notably, there have been increased levels of investment on behalf of shipping lines in container facilities, looking for cost control and port operations efficiency (Haralambides *et al*, 2002; Cariou, 2003). At the same time, pure stevedoring companies have emerged and are now the dominant force in the industry. These players understood that the fierce competition driven by port privatization could not allow them to survive only by managing their domestic operations, and decided to expand their focus internationally (Olivier, 2005). In recent years, however, there has been a blurring of the distinction between shipping lines and pure stevedores, as they began to adopt rather converging strategic and organizational behaviours (Parola *et al*, 2013). Finally, the industry was also penetrated by an array of large equity firms and financial corporations, whose prime objective is to generate a return on investment (Notteboom and Rodrigue, 2012).

Unlike many other industries that now enjoy advanced stages of internationalization, worldwide deregulation of the port sector is still a relatively recent phenomenon. Container port MNEs present, in some cases, unique spatial and temporal dynamics of internationalization, which require a new and different conceptual toolbox to those offered by traditional international business (IB) theories.

In particular, container port MNEs from emerging economies performed as a powerful force spearheading the internationalization drive, and quickly 'leapfrogged' traditional temporal phases of internationalization, sketching patterns of spatial outreach different from those of traditional MNEs (Olivier *et al*, 2007). These emerging MNEs, due to their latecomer status, have been somehow forced to undertake more risky and accelerated overseas paths, exploiting the benefits accumulated during inward operations (Satta *et al*, 2014b). In addition, the recent surge of born-global financial operators demonstrated that equity firms have an unsurpassed capacity to allocate large amounts of resources and set up new subsidiaries by acquiring shares in multiple locations (Notteboom and Rodrigue, 2012).

Rapidly expanding container port MNEs are experiencing fundamental shifts in entry pattern dynamics. Basically firms can adopt internal or external growth strategies, which means that they can enjoy concession contracts under privatization or greenfield schemes (internal option), or resort to financial transactions (external option) to acquire existing terminal entities (Parola *et al*, 2013). In equity terms, in addition, firms need to decide their degree of commitment in the new venture, ranging from a minority shareholding to a fully controlled subsidiary (Olivier, 2005). Notably, entry strategies and organizational forms adopted by container port MNEs are strongly affected by ongoing competitive shifts as well as changes in local institutional settings (de Souza *et al*, 2003). The growing market and financial pressure triggered numerous players to massively resort to large networks of equity joint venture (EJV) arrangements for supporting overseas ambitions (Parola *et al*, 2014).

Empirical context and aim of the chapter

This chapter is based on empirical data regarding container port MNEs collected from Drewry Shipping Consultants (Drewry, 2002–2012), and integrated with additional information sourced from consolidated firms' annual reports and financial statements, corporate websites, specialized press and port authorities' web portals. This approach achieves a high degree of completeness and consistency for all the observations. Group structure is also taken into account in data elaboration. Overall, approximately 60 MNEs have been monitored over the 1962–2011 period. An in-depth investigation has been carried out on the 2002–2011 timeframe, which appears particularly dynamic and insightful for achieving an overarching interpretation of main industry trends.

We define container port MNEs as firms operating/holding at least one terminal/subsidiary overseas. The dataset includes approximately 1,000 MNEs entries in port facilities worldwide (since the early 1960s) and a systematic record of container port MNEs terminal portfolios in the 2002–2011 period. Overall, more than 550 facilities located in 84 countries have been scrutinized, including information about (over 300) local shareholders. The main data collected regarding each facility are: geographic location (port, country and region), annual throughput, shareholders, equity participation, operational capacity and utilization ratio.

This chapter aims to provide an exhaustive overview of the container port business state of the art and evolution, depicting mainstream trends and common managerial practices. For this purpose, extant academic literature has been scrutinized in-depth and critically discussed. The second section of the chapter conceptualizes the nature and typology of the stevedoring services, enlightening the differences between dedicated and multi-user facilities. This section also introduces business models of leading market players, exploring the main drivers of growth. The chapter then goes on to analyse spatio-temporal dimensions of container port MNEs' internationalization, illustrating the timing and the geographic scope of overseas expansion. This is followed by a section depicting the most common firm entry patterns and expands understanding of inter-firm partnerships, which originate 'hidden families' of cooperation across multiple locations. The final section outlines some concluding remarks.

The supply of stevedoring services: Leading players and business models

Stevedoring service and customers: Dedicated vs common-user facilities

Ports are strategic nodes inside maritime logistics chains. Container terminals have to ensure a smooth synchronization between transport modes, such as maritime, rail, and road transport, which are characterized by diverse economies of scale and frequency of arrivals (Notteboom and Rodrigue, 2005). In this perspective, transloading operations from ship to shore (and vice versa) assume a vital importance as they affect overall logistics efficiency. The terminal customer, ie the shipping line, looks for high-level and reliable operational performance at reasonable (and stable) handling charges. The provision of stevedoring services, as typically happens in service industries, is not only the result of the organizational and operational capabilities of the supplier itself, but to a great degree also of the input of the customers as well (Stenvert and Penfold, 2004; Midoro *et al*, 2005).

Where vessels arrive ahead of schedule, containers may not yet be stacked all in the yard. Also, the container-related information provided by the shipping agency and/or stowage coordinator might be inaccurate. Where ships arrive considerably later than planned, the equipment and labour may be allocated for handling other vessels. In these circumstances it might take a lot more to perform the same service as (contractually) agreed upon. Therefore, the best service is delivered where the terminal operator and customers work together to produce a joint optimal output. Optimization is definitely a keyword in this context (Lun and Cariou, 2009). Schedule integrity and window reliability, optimal cargo distribution over the ships, predictable container arrivals at the land-side (road, rail and barge), minimized late arrivals, timely, accurate and complete (pre-) information on incoming cargo, all improve the joint performance (Stenvert and Penfold, 2004). Various forms of cooperation between stevedores, ocean carriers and intermodal operators can be stipulated to enhance the service levels, ranging from joint performance improvement teams to dedicated (equity) ventures between major clients and terminal operators. Such arguments provide further evidence that the terminal operator has to co-produce handling services acquiring the active contribution of other supply chain actors and, primarily, of the shipping lines (Drewry, 2002).

Given the multifaceted nature of stevedoring services and the close interaction between provider and customer, these services can be produced and delivered under a range of organizational solutions, in relation to the clients served and their bargaining power (ie customer portfolio), the characteristics of demand (eg size, seasonality, type of vessels, transhipment share), the degree of service customization and the awarding of ad-hoc resources (eg equipment, quay line, yard space, staff etc) to special ship owners. Then we can identify two diametrically opposite ways of conceiving terminal operations and service provision, ie the 'dedicated' and the 'common-user' formulas (Notteboom and Rodrigue, 2012). These models are ideally located at the two ends of a service continuum, which contemplates a large spectrum of organizational and marketing solutions as well as different shareholder structures (Olivier, 2005).

The fully dedicated terminal is a facility which is devoted to one customer only. Whole infrastructural resources, staff and managerial capabilities are dedicated to provide handling services to such clients (Heaver *et al*, 2001; Cariou, 2003; Drewry, 2008). Suppliers and customers can profit from mutual benefits in terms of operational efficiency and productivity but, at the same time, both might lose organizational flexibility and control (Haralambides *et al*, 2002). Stevedores use this option for 'locking in' the customer, although the return is lower than running multi-user terminals. On the customer side, this option allows for better integration of maritime and port operations and the attainment of high-quality handling services. Basically, ocean carriers can obtain dedicated terminal services in different ways (Parola and Musso, 2007). First, shipping lines can stipulate a special contractual arrangement with a stevedoring company for being the unique customer of the facility (without any equity commitment). Alternatively, ocean carriers might decide to be more directly involved in terminal management and service provision, becoming shareholders of the facility. Such equity commitment might lead either to the holding of minority or even majority stakes. In some cases, the carrier decides to take full managerial control of the facility (100 per cent share), and to self-produce handling services for its own vessels (cost-centre approach) (Frémont, 2007; Olivier *et al*, 2007).

A common-user (or multi-user) terminal, by contrast, is a facility where the stevedoring company has to seek cargo in a competitive market and manage a customer portfolio for making money (profit-centre approach). Each client presents diverse needs in terms of number, type and size of vessels to be served, generates different cargo volumes and, as a consequence, holds a specific bargaining power with regards to the supplier (Cariou, 2003; Slack and Frémont, 2005). Notwithstanding, the terminal operator should be able to ensure good service levels to all customers, preventing in principle any discrimination in favour of any one of them. This solution is more flexible for the carrier, which could easily decide to move to other facilities, even in the short term, avoiding sunk costs. However, service quality might be lower than in dedicated terminals, especially in case of traffic peaks and deployment of mega-vessels, which notoriously need a higher amount of (ad-hoc) resources (Midoro *et al*, 2005). The stevedore, contrary to what happens in fully dedicated facilities, should be equipped with a smart commercial department able to secure significant traffic volumes as no customer can be taken for granted.

In business practice, however, a wide array of intermediate solutions exists between the above two (extreme) options, offering diverse compromises in terms of customer base balance and shareholding structure (Parola and

Musso, 2007). Until the late 1990s, fully dedicated terminals (or berths) were relatively common, especially in some geographic areas (eg USA, Japan, Taiwan). Afterwards, carriers and stevedores tried to find hybrid and more flexible solutions. For instance, the stevedore may contractually provide berthing and crane priority for some special customers, allocate a reserved productive capacity (eg the 'virtual terminal agreements' stipulated between PSA and some clients in Singapore) or even dedicate specific terminal resources, as well as allow a cargo-volume-based discount on handling charges (Notteboom and Rodrigue, 2012). In other cases, the carrier might get semi-dedicated services as a minority (usually less than 20 per cent) shareholder of the terminal. A 50/50 joint venture between the carrier and the terminal operator is also common for dedicating even more resources to the (only/main) customer–shareholder. Finally, in the case of a partially- (POS) or wholly-owned subsidiary (WOS), the shipping line has the managerial and strategic control of the facility and autonomously decides handling charges (or simply reporting costs, in case of internalized transactions) and resource allocation. Usually, the spare capacity of the facility is used for serving third-party customers (eg members of the same consortium or strategic alliance and, residually, other carriers), in order to exploit available resources more extensively and increase turnover.

Main business models

Given the large spectrum of solutions available in terms of organizational settings and service provision, container port MNEs operate according to heterogeneous business models, which might partially overlap each other. A strict categorization of terminal operating companies is indeed difficult to establish (Notteboom and Rodrigue, 2012). Various authors attempted to propose a classification of container port MNEs but there is no clear consensus on that (Olivier, 2005; Slack and Frémont, 2005; Bichou and Bell, 2007; Parola and Musso, 2007; Notteboom and Rodrigue, 2012; Drewry, 2013). In this chapter we present a taxonomy derived from extant literature, which tries to capture the ontological essence of business models going beyond the different terms used to date. The main analytical dimensions we applied for identifying a firm's business models are: 1) the core business of origin; 2) the nature of core competences and resources; 3) the approach to the stevedoring business and the ultimate strategic objective; 4) the drivers of firm's internationalization; 5) the entry patterns adopted in pursuing growth strategies.

As a result, four categories of container port MNEs are identified: pure stevedores, ocean carriers, hybrid operators and financial operators.

Pure stevedores: Looking for risk diversification and global profits

Stevedores are companies whose primary business is port operations and who run facilities as profit centres (Peters, 2001; Notteboom and

Rodrigue, 2012). Preferably, stevedores tend to provide multi-user services, and to have the managerial and strategic control of the facility (majority stake). Entry is typically in the form of concession (privatization and greenfield) and through competitive bidding.

These actors decided to outgrow their home port/country by penetrating attractive foreign locations where investments became possible or lucrative, thanks to port reform opportunities (Olivier *et al*, 2007). Their objective is to achieve greater efficiency by implementing common organizational routines and technological systems across a terminal network, plus the spreading of commercial risk in various geographic markets (Bichou and Bell, 2007). Stevedores commonly exploit a competitive advantage with respect to local operators of host countries, as they can easily replicate in the new ventures the core competences and technical/ICT resources developed in the 'home fortress'. These actors accumulate a vast international experience in interacting and bargaining with the most relevant suppliers, such as port authorities (concession awarding), equipment manufacturers, ICT companies and labour pools/unions (dockworker hiring). In addition, the leading 'pure stevedores' hold superior financial capabilities deriving from the monopolistic rentals enjoyed at home and the large cash-flows often available at the parent-company level. In pursuing overseas ambitions, pure stevedores aim to follow their customers into the most attractive geographic markets, ensuring high-quality services and homogeneous operational standards worldwide. By expanding in a horizontal fashion and gaining market strength, these players want to improve shipping lines' loyalty and mitigate the bargaining power of their global counterparts (Parola and Musso, 2007).

The major stevedoring groups are Hutchison Port Holdings (Hong-Kong, China SAR), PSA International (Singapore), Dubai Ports World (United Arab Emirates), Eurogate (Germany), SSA Marine (USA), Group TCB (Spain), International Container Terminal Services Inc (Philippines), and HHLA (Germany).

Ocean carriers: Supporting the shipping service network

Shipping lines are firms for which container shipping is the prime focus of their business. Terminals are often managed as cost centres, as stevedoring operations need to support the wider parent shipping line network by acquiring some forms of dedicated handling services (Drewry, 2002; Cariou, 2003). Carriers enter new facilities commonly in the form of concession (privatization and greenfield); meanwhile they might prefer to limit their financial exposure by holding a minority stake. In the event that the shipping line takes the full equity and managerial control of the terminal, handling charges are often transformed (in-house deal) into internalized costs (Parola and Musso, 2007).

The internationalization process of these firms is triggered by the integration of the terminals with the wider parent shipping line service network

(Panayides and Song, 2008). With regard to stevedores, however, shipping lines invest only in facilities, which are vital for their major trade lanes (eg trans-Pacific), neglecting other (even relevant) geographic markets. As mentioned earlier, carriers have an active role as customers in co-producing stevedoring services. For this reason, shipping lines that undertake a process of vertical integration in ports can exploit the expertise and technical capabilities developed over time as clients of many terminals worldwide. First, their integration in port operations ensures shipping lines make more efficient use of vessels which need to find suitable port facilities and minimize turnaround times (Midoro *et al*, 2005). In this regard, the notorious rush to economies of scale and mega-vessels (Cullinane and Khanna, 1999; Parola and Musso, 2007) impose even greater financial pressures on these maritime assets which are required to generate enormous cash-flows for rewarding initial investments (ie purchase price) and capital costs. Through vertical integration in ports, ship-owners try to safeguard their maritime investments by reducing physical bottlenecks (eg nautical accessibility, undersized infra- and superstructures etc) and boosting operational performance.

Second, carriers should have a more accurate control of stevedoring costs (stabilization), which represent a relevant portion of whole running costs. In some ports and regions the available handling capacity is scarce and stevedores might claim much higher handling charges and/or provide low quality services because of facility congestion. Third, shipping lines can potentially generate economies of scope, by investing in a business which is highly correlated and synergic with the primary industry. Ocean carriers, by controlling a longer segment of the logistics chain, might improve the quality of door-to-door services and match shippers' expectations more appropriately (Haralambides *et al*, 2002). The investments of carriers in some mega-terminals (eg Los Angeles, Laem Chabang, Maasvlakte II in Rotterdam etc) go exactly in this direction (Parola and Musso, 2007).

The leading ocean carriers investing in container terminal operations under a cost-centre approach are: Evergreen (Taiwan), Hanjin (South Korea), K Line (Japan), OOCL (Hong-Kong, China SAR), MOL (Japan), Yang Ming (Taiwan), Hyundai (South Korea) and APL/NOL (Singapore).

Hybrid operators: A mixed approach

Hybrids are firms where the main business, or that of the parent company, is container shipping, but where a separate terminal operating (internal) division or company has been established. These units support shipping activities but also provide an additional business stream by handling a significant amount of third-party traffic (Notteboom and Rodrigue, 2012). Hybrids are the result of a progressive transformation undertaken inside some shipping groups which detected the opportunities of making profits in this industry and decided to modify the approach to terminal operations (Stenvert and Penfold, 2004). The facilities representing pivot points in the shipping network remained cost centres whereas other terminals, with a high market potential, were turned into profit centres. Undoubtedly, such migration towards a hybrid business model sounds attractive and risky at the same time. Critical concerns are not mainly related to the organizational and operational transformations needed to provide appealing services for potential third-party clients, but to the marketing and strategic implications of the whole challenge. Hybrids in fact must demonstrate to rival shipping lines that they are able to provide reliable services at a good price (like a pure stevedore), adopting a fair, transparent and non-discriminatory behaviour in service delivery and customer care (Frémont, 2007).

The demonstration of the complexity of such a process is provided by the case of APM Terminals, the major hybrid operator. This firm, belonging to the AP Moller-Maersk Group, set up a separate port division in 1999 and only after a long multi-step process was able to become a trusted stevedoring provider, with a separate brand name and logo as well as an autonomous position and strategy inside the group. Contrary to most hybrids, indeed, liner business is a sister company for APM Terminals, not a parent company (Drewry, 2013). Other successful hybrid operators are: NYK Line (internal division of the carrier), MSC (Terminal Investment Limited), Cosco Group (via Cosco Pacific) and Cosco Container Line, CMA-CGM (Terminal Link), and China Shipping (China Shipping Terminal Development).

Financial operators: Speculators or long-lasting investors?

The relentless growth of international trade made maritime shipping and port activities an increasingly profitable industry, not fundamentally in terms of rates of return but mostly in return volumes (Rodrigue *et al*, 2011). This trend drew the attention of a fourth category of container terminal MNEs, ie financial operators. These suitors include a rather vast range of firms, such as investment-holding companies, pension funds, merchant banks, insurance companies, private equity funds and hedge funds, seeing transportation assets, such as port facilities, as an investment class, and part of a diversified global portfolio across various industries (Baird, 2013).

Basically, financial operators undertake an indirect management approach as they buy an asset stake and leave the incumbent (commonly a stevedore) to take care of day-to-day operations. Thus, acquisition is the preferred entry mode because these players do not have the managerial expertise and market experience to deal with tendering procedures and facility planning/building (Farrell, 2012).

Pension funds became interested in terminal assets because of the time horizon of port investments (concession agreement), which matches well with their long-term time horizon. Besides, the scale of required investments also played a positive effect in their drive to penetrate the industry. Financial operators generally look at opportunities large enough to accommodate the vast quantities of capital at their disposal and terminals represented an asset typology that well suited the scale of this allocation (Notteboom and Rodrigue, 2012).

In addition, large equity firms, such as mutual and retirement funds, started to acquire shares in port terminal assets due to some interesting value propositions. First, physical terminal assets hold an intrinsic value mostly related to real estate, infrastructure and equipment (Haralambides, 2002). These assets can increase their value over time because they are 'scarce' and not easily substitutable. The intrinsic value of terminals is also directly related to the handled traffic and, in such a context, it was expected that terminal assets would steadily increase in value. Second, port facilities provide a source of income directly proportional to traffic volumes, insuring a constant revenue stream to the financial operator (Baird, 2013). Finally, the investment in transport infrastructures located in a variety of markets enables private equity firms to diversify their portfolio in different business segments (ie ports, airports and railways) while undertaking a geographic diversification. In this perspective, terminal assets located in various regional contexts help mitigate a number of risks, eg demand fluctuations, pricing and capacity strategies of competitors, trade lanes, financial and political risks etc (Notteboom and Rodrigue, 2012).

Among financial operators, hedge funds notoriously adopt a higher speculative behaviour. These firms are investment vehicles that pool capital from a number of investors and, generally avoiding direct regulatory oversight, operate with greater flexibility than other investment funds. In the container port business, hedge funds mostly invested in the pursuit of 'hit and run' behaviours, attracted by demand growth rates and financial margins. Their speculative approach somehow underestimated the intrinsic risks of the industry and was not supported by any market-related or technical knowledge. This background was even exacerbated by the explosion of the global financial crisis, which drove some of these suitors to encounter heavy losses and exit the market (Pallis and de Langen, 2010).

Some highly reputed financial operators which have invested in the container port business are: China Merchant Holdings International (CMHI), NWS Holdings and Wharf Holdings Ltd, AIG Highstar Capital (which owns Ports America assets), Deutsche Bank (RREEF), Goldman Sachs, Macquarie, OTTP Fund, Global Infrastructure Partners, Morgan Stanley, Brookfield, JP Morgan and Citi Infrastructure Investors.

Container port MNEs: Timeframe and geographic scope of internationalization

Timing and waves of internationalization

The dramatic surge of container port MNEs worldwide has driven a fast expansion of private commitment in terminal management (Peters, 2001; de Souza *et al*, 2003). As a result of this process the share of state-owned port facilities has decreased over the last few decades. In the early 1990s the public sector still controlled almost 45 per cent of container port throughput, while in 2012 its share dropped to about 23 per cent (Drewry, 2013). This trend is expected to continue as in many locations there is a larger number of private port expansion programmes in comparison to those promoted by the state.

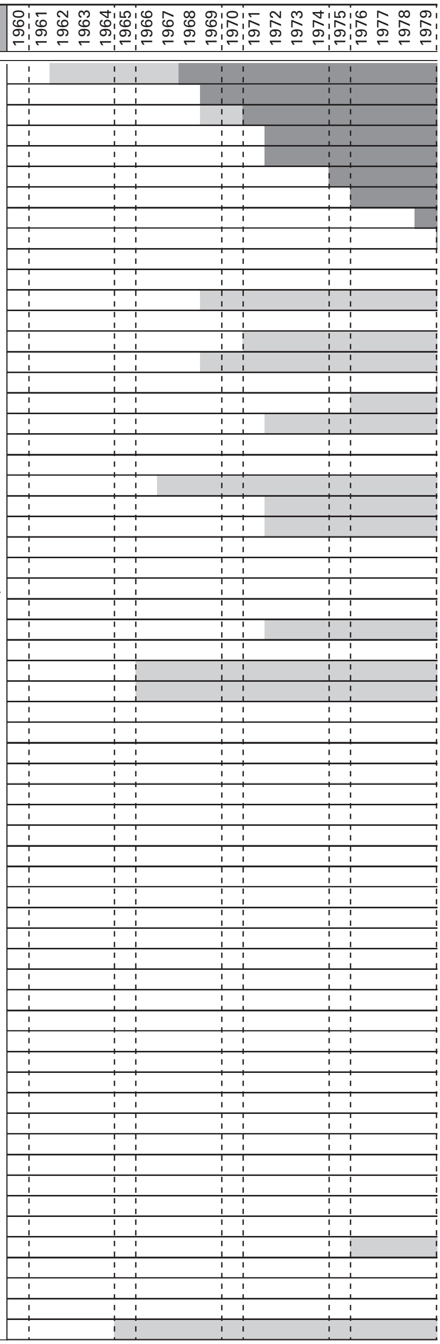
Against a world throughput of 622 million TEU (2012), a large group of about 50 container port MNEs handles approximately 385 million TEU, which represents over 60 per cent of overall volumes. The industry is rather concentrated as the top five players hold roughly a 30 per cent share. Pure stevedores are the most active terminal operators, accounting for more than 30 per cent of the world throughput. In this category, PSA International (50.9 million TEU in 2012), Hutchison Port Holdings (44.8) and Dubai Ports World (33.4) are the market leaders. Global hybrids are the second force as they control over 10 per cent of the whole port volumes. Among them, APM Terminals (33.7), Cosco (17.0), MSC (14.2) and China Shipping Terminal Development (8.6) are the dominant ones. Finally, both ocean carriers and financial operators attract around 9 per cent of the world throughput each. Hanjin (7.8) and Evergreen (7.3) are the most aggressive carriers whereas Merchant Holdings (20.8) and AIG Highstar Capital (9.1) lead the financial operators' category.

The internationalization of this business has been triggered by many factors, which stimulated terminal operators to invest abroad (Bichou and Bell, 2007; Midoro *et al*, 2007). Basically two drivers are common to all players undertaking overseas ventures, regardless of the business model adopted. The first force generating momentum for MNEs' expansion was the port reform and liberalization process taking place in many countries. This opened up a lot of investment opportunities over the last 20 to 30 years (Cullinane and Song, 2002). A second powerful factor was the massive rise of container port volumes, which have been experiencing two-digit growth rates for many years. It is hard to find an industry like the port business which has achieved a relentlessly fast growth (except for 2009) for such a long period of time. The increase in demand characterized numerous countries progressively joining container trade and this stimulated firms to start their internationalization drive (Peters, 2001).

Besides these two drivers, which have continued to affect all container port MNEs for many years, numerous other drivers impacted firms in a more peculiar manner. These drivers, in fact, appear to be more time- and firm-specific. The materialization of such drivers in the industry followed specific temporal patterns and stimulated breakthrough changes (eg growing economies of scale, diffusion of transhipment etc). Also, these drivers affected the business models/types of operators in different ways, thus making the internationalization process an uneven game. Therefore, we can argue that the timing of internationalization of container port MNEs is inextricably linked to the emergence of specific circumstances and events boosting foreign expansion (Olivier and Slack, 2006).

FIGURE 16.1 Time scale of internationalization of container port MNEs

Shareholders	Business model	Home
Sea-Land	carrier	US
P&O Ports	stevedore	UK
K Line	carrier	JP
OOCL	carrier	HK
APL (pre-NOL)	carrier	US
APM Terminals	hybrid	DK
Mitsui & Co.	stevedore	JP
Hyundai	carrier	KR
Evergreen	carrier	TW
Cosco Container Lines	hybrid	CN
China MerchantHoldings Internat.	finan op	HK
Eurokai	stevedore	DE
Hanjin	carrier	KR
NYK	hybrid	JP
MOL	carrier	JP
Yang Ming Line (YML)	carrier	TW
Hutchison Port Holdings	stevedore	HK
Wharf Holdings (MTL)	finan op	HK
Cosco Group (Cosco Pacific)	hybrid	HK
ICTSI	stevedore	PH
SSA Marine	stevedore	US
PSA International	stevedore	SG
Group TCB	stevedore	ES
APL Terminals (NOL)	carrier	SG
NWS Holdings	finan op	HK
P&O Nedlloyd	carrier	UK/NL
CSX World Terminals	stevedore	US
Dubai Ports World	stevedore	AE
Eurogate	stevedore	DE
HHLA	stevedore	DE
BLG	stevedore	DE
MSC (TerminalInvest.Ltd.)	hybrid	CH
Dragados	stevedore	ES
Grimaldi Group	carrier	IT
Portek	stevedore	SG
Wan Hai	carrier	TW
Bolloré Group	carrier	FR
CMA-CGM (Terminal Link)	hybrid	FR
Global Ports Investments	stevedore	RU
Peel Ports Group	stevedore	UK
Hapag-Lloyd	carrier	DE
National Container Company	stevedore	RU
CSAV (SAAM Ports)	carrier	CL
Zim Ports	carrier	IL
Babcock & Brown	finan op	AU
Deutsche Bank	finan op	DE
Macquarie	finan op	AU
Goldman Sachs	finan op	US
OTTP fund	finan op	CA
Global Infrastructure Partners	finan op	US
Ultramar	stevedore	CL
Morgan Stanley	finan op	US
Euroports	stevedore	LU
China Shipping Term. Develop.	hybrid	CN
Brookfield	finan op	CA
JP Morgan (Noatum)	finan op	US
Shanghai International Port Group	stevedore	CN
Gulftainer	stevedore	AE
Yildirim Group	stevedore	TR
Citi Infrastructure Investors	finan op	US
AIG Highstar Cap. (Ports America)	finan op	US
Jurong Port	stevedore	SG

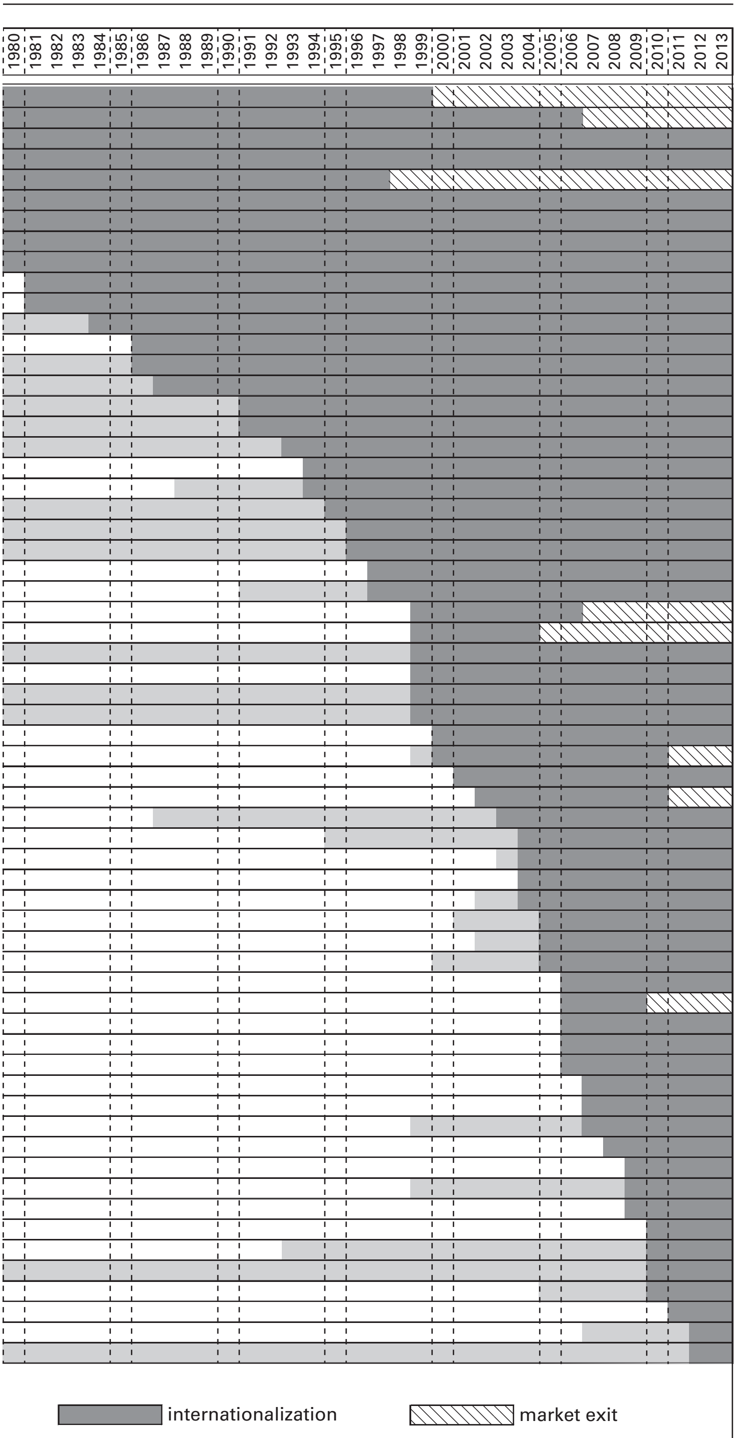


Legend

delay in market entry

domestic phase

SOURCE Author's elaboration from Drewry annual reports (various years), corporate websites and specialized press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Given such premises, it becomes easy to understand that the time scale of internationalization is a rather complex issue in this industry, as many waves of entry overlap each other. The first investments abroad started in the early 1960s but only in the 1990s did the process begin to show its real momentum. Players exhibit rather heterogeneous entry timings and a diverse length of the pre-internationalization phase (Figure 16.1). This means that some operators decided to accumulate a large stock of domestic experience before internationalizing while others undertook apparently more risky strategies, penetrating foreign markets right from their inception. For clarity, we first outline the different waves of internationalization for each type of operator (business model) separately.

The internationalization of pure stevedores can be split into three waves. In the late 1980s some firms decided to expand overseas to look for new opportunities and to diversify their risk. Their home ports/countries became more competitive settings and incumbents needed to find additional revenue streams in other locations. P&O Ports (later taken over by Dubai Ports World), Hutchison Port Holdings (HPH), SSA Marine, International Container Terminal Services Inc (ICTSI) and Eurokai were the major firms who paved the way in this industry (Midoro *et al*, 2005). Later on, the financial success enjoyed by these actors stimulated a second wave of operators to emulate the same overseas ambitions. PSA International, Dubai Ports World (DPW), CSX Corporation (later taken over by Dubai Ports World), BLG, HHLA, Dragados and Group TCB are the brand names of the key followers. More recently, even after the financial crisis, a latest group of stevedores entered the market (Rodrigue *et al*, 2011). Some of them belong to countries that experienced the benefits of liberalization at a later stage such as Russia (Global Ports Investments and National Container Company), Turkey (Yildirim Group) and Chile (Ultramar).

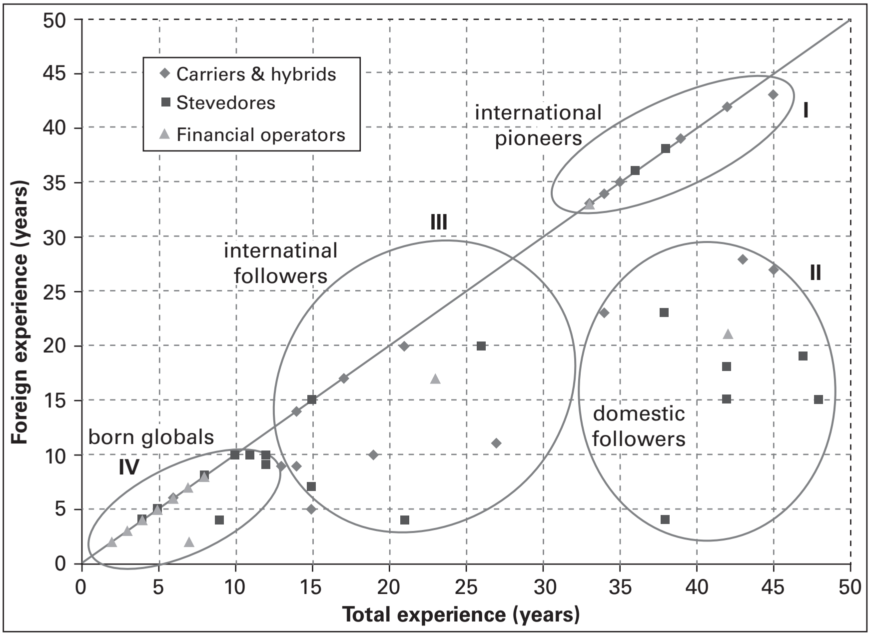
The internationalization drive of carriers can be divided into three waves as well (Midoro *et al*, 2005). Basically, shipping lines have been asked to satisfy the evolving needs of their core business. The origins of carriers' investment in port facilities date back to the very beginning of the container revolution (first wave). The lack of standardized terminals represented the main driver of these ventures. Sealand (later acquired by Maersk), Matson and K Line were the protagonists of trans-Pacific trade and established dedicated terminals in key ports. Afterwards, the massive spread of intermodal transport in North America forced carriers to better integrate sea–land operations for gaining efficiency and preserving financial margins. A second wave of vertically integrated carriers materialized: APL, Maersk, Evergreen, Hanjin, MOL and NYK Line.

Despite such interests in overseas facilities, a substantial breakthrough in the internationalization trend only happened in the late 1990s. The acceleration in vessel size growth required enormous investments and the availability of highly efficient terminal hubs (Cullinane and Khanna, 1999). Thus, other carriers started to run facilities for safeguarding service standards and the financial resources invested in maritime assets. MSC, CMA-CGM, Wan Hai, ZIM, CSAV and China Shipping comprised this latter wave of shipping lines, among others. Finally, this category of actors gave rise to some hybrid operators, as explained earlier in this chapter. Since the early 2000s a handful of carriers (eg Maersk, CMA-CGM, Cosco, MSC, China Shipping etc) transformed their organization and strategic orientation towards the port business and focused on third-party traffic (Drewry, 2013).

The internationalization of financial operators unveils different patterns with respect to traditional players. Already in the 1990s, early entrants with a financial background expanded overseas from the Hong-Kong setting: China Merchant Holdings International (CMHI), NWS Holdings and Wharf Holdings Ltd (Olivier, 2005). These ethnic Chinese conglomerates are investment-holding companies with interests in infrastructure sectors and who diversify risk by managing large portfolios of assets. Their geographic focus is, however, quite narrow as they basically invested abroad in China mainland and in the Far East. The financial industry has taken a more active role in global port affairs only in recent years, understanding that container ports are an attractive domain for asset allocation with a high potential for cash-flow generation. A second wave of financial players, in fact, materialized in the second half of the 2000s from the United States, Germany, Australia and Canada (Rodrigue *et al*, 2011; Baird, 2013). These firms aggressively entered the port business and undertook financial transactions to acquire stakes in single or multiple facilities. AIG Highstar Capital (Ports America), Deutsche Bank, Babcock & Brown (liquidated), Macquarie, Goldman Sachs, JP Morgan, Morgan Stanley, Brookfield and Citi Infrastructure Investors are the main equity firms of this wave.

The combination of the above waves under one unique analytical framework now provides considerable insight into the in-depth meaning of the whole process. Figure 16.2 sheds light on the temporal overlaps in market entry, which affected the industry's internationalization, by illustrating the internationalization patterns which characterize each container port MNE's business model. Foreign experience is compared with total experience, in order to appreciate the length of the domestic incubation period before undertaking overseas ventures. The diagonal line pinpoints firms which internationalized since their establishment. In total, four groups of players have been identified. First, 'international pioneers' (I) are MNEs which quickly became international since their inception in the 1970s or early 1980s. This group basically includes ocean carriers, such as K Line, OOCL, Hyundai, Evergreen and Cosco Container Line. The stevedore P&O Ports constitutes a notorious exception belonging to this cluster of firms, which paved the internationalization drive of the whole business. 'Domestic followers' (II) are firms which entered the port sector some decades ago but needed a rather long domestic period before internationalizing. These container port MNEs have been preceded by carriers in overseas expansion but have been able to catch up to the early movers by undertaking aggressive expansion strategies later on. This group mainly consists of stevedores such as HHLA, Group TCB and SSA Marine as well as the current leaders HPH, PSA and DPW.

FIGURE 16.2 The waves of internationalization in the container port industry



NOTE Foreign and total experience has been calculated at 2014 or at the last available year (in case of market exit or acquisition by another player).

SOURCE Author's own elaboration from Drewry annual reports (various years), corporate websites, and specialized press

'International followers' (III) are other container port MNEs that basically act as imitators. This group has a rather heterogeneous composition, including stevedores, eg ICTSI, Eurogate and SIPG, as well as carriers, eg Wan Hai, APL Terminals and Bolloré Group. Finally, the industry experienced the rise of some 'born-global' firms (IV), characterized by a latecomer status coupled with a rapid internationalization drive. These container port MNEs are business organizations that aim to derive significant competitive advantage from the use of resources and the provision of services in multiple countries from the earliest days of their establishment. This group is populated by the financial operators recently approaching the port business and by latecomer stevedores (mainly) from emerging economies, eg National Container Company, Global Ports Investments and Yildirim Group.

Pace of growth and geographic scope of internationalization

In a globalizing industry like the port sector, leading players are forced to undertake horizontal growth strategies to keep the pace of demand expansion and diversify risk across various regions (Notteboom and Rodrigue, 2012). Some distinctions, however, must be taken into account given the diverse business models adopted by container port MNEs and the specific drivers affecting them. For instance, integrated carriers which dedicate their stevedoring efforts to defending the core business do not necessarily need to grow fast if their shipping network is already well supported. Pure stevedores, instead, might be tempted to undertake new ventures in search of additional revenues if opportunities pop up (Drewry, 2013).

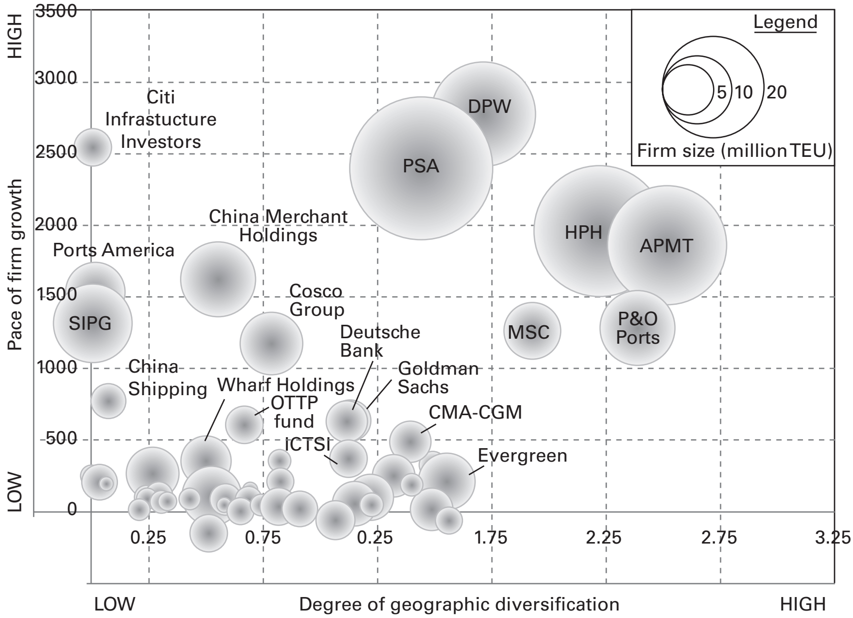
In this section we briefly explore temporal and spatial dimensions of (foreign) growth and show the unique internationalization pathway of some MNEs. Addressing the recent rise of MNEs from emerging economies, IB literature provides empirical evidence that their internationalization process is at odds with mainstream assumptions. Yeung (1999) states that Asian MNEs undertake overseas paths of expansion following a logic of their own. Li (2003) and Warner *et al* (2004) argue that these MNEs have to 'leapfrog' conventional temporal phases of internationalization and perform diverse patterns of a wider geographic scope. Other emerging streams of literature focus on the rise of born-global MNEs (Bell *et al*, 2001), arguing that extant management theories are not able to explain the non-incremental dynamics of internationalization of these firms, characterized by a very limited domestic phase of incubation.

In this regard, the container port industry constitutes an ideal site for debating about spatio-temporal dimensions of internationalization in service industries, given the fast international opening of local markets and the unconventional overseas expansion of some private firms. As argued by some scholars (Olivier *et al*, 2007; Notteboom and Rodrigue, 2012; Parola *et al*, 2014; Satta *et al*, 2014b) evidence from this sector questions the applicability of mainstream internationalization theories (Johanson and Vahlne, 1990) to container port MNEs from emerging economies and to born-global equity firms. Some container port MNEs from emerging countries, often as latecomers, undertake accelerated non-sequential patterns of internationalization in an attempt to catch up with the early entrants. Besides, the recent rise of born-global equity firms demonstrates that these financial operators have an unsurpassed capacity to commit large amounts of resources and establish new subsidiaries by taking over stakes in multiple locations (Notteboom and Rodrigue, 2012).

Figure 16.3 corroborates such arguments by unveiling the speed at which container port MNEs grow over time and the geographical spread of a firm's operations.

Two groups of firms demonstrate superior growth rates. First, some leading stevedores coming from emerging economies (ie PSA, DPW, HPH and SIPG) show a high speed of expansion, confirming themselves as a powerful force spearheading the internationalization drive. Second, we find a handful of financial operators, which recently penetrated the industry as born-global firms, following irregular pathways: Citi Infrastructure Investors, AIG Highstar Capital, Goldman Sachs, Deutsche Bank (RREEF) and OTTP Fund. Nonetheless, the geographic scope of these fast-expanding container port MNEs appears rather

FIGURE 16.3 Pace of growth and geographic diversification of container port MNEs (2002–2011)



NOTE Pace has been calculated as the average throughput growth (000 TEU) in the 2002–2011 period; the degree of geographic diversification has been calculated using an entropy measure conceived by Jacquemin and Berry (1979) and further developed by Vachani (1991). For details regarding the construction of the index see Satta *et al* (2014). Data refer to 2011 or to the last available year (in case of market exit or take-over by another player); bubble size indicates average firm size (throughput) during the monitored period.

SOURCE Author's elaboration from Drewry annual reports (various years), corporate websites, and specialized press

differentiated. Top stevedores from Asia (except SIPG) have to date managed broad and diversified portfolios of assets, the result of a fast expansion process regardless of geographic distance concerns. Equity firms, by contrast, despite the fast growth, seem to be quite selective in their market entry (Anglo-Saxon areas) and do not have a geographically spread focus yet. Even though adopting a different business model, APM Terminals and MSC also belong to this cluster of firms characterized by an accelerated expansion.

The majority of container port MNEs undertake regular expansion drives at a slower pace and achieve a narrower geographic scope. Some of them are promising born-global stevedores (eg Yildirim Group, Global Ports Investments, National Container Company and Ultramar) which still have to demonstrate their full potential, while others are in a rather inactive position or are even dismantling non-core stakes/facilities.

Strategies for growth

Entry patterns in expansion strategies

The pursuit of sound growth strategies heavily affects the scope, speed and success of the whole internationalization process. In particular, two dimensions are relevant in implementing expansion strategy: the entry mode, and the degree of commitment to new ventures.

Basically, entry mode solutions contemplate internal and external growth options. Both types of growth strategies are often used simultaneously, and show advantages and drawbacks. Internal growth implies increasing firm assets, output or turnover through the reinvestment of cash-flows in existing/new businesses. Organic growth offers more corporate control, encourages internal entrepreneurship, and protects organizational culture, but typically generates a slower growth pace compared to M&A since it requires the internal development of new resources. External growth is undertaken via M&A and is capable of yielding synergies and market power, against the risk of destroying value in case of resources or free cash-flow misallocation in unproductive ventures.

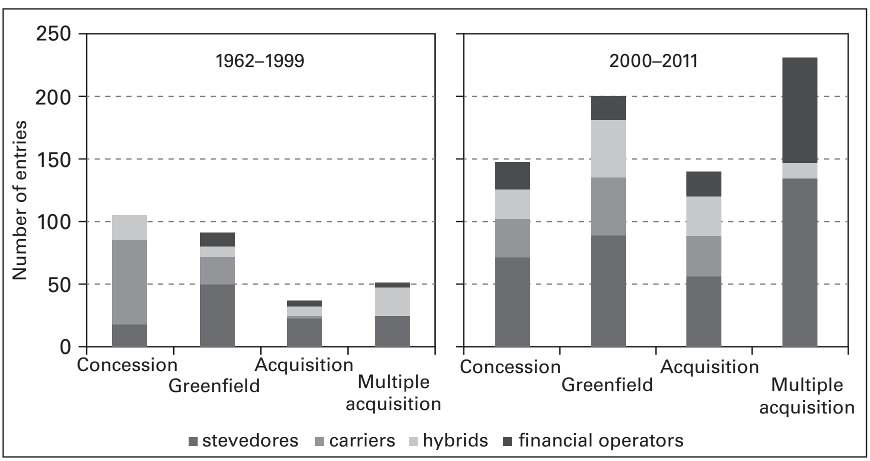
In the container port business, internal growth means being granted a concession to operate the port facility, either under a privatization process or a build–own–operate/BOT (greenfield) scheme (Farrell, 2012). Stepping into a new public–private partnership requires the active participation in the different phases of the awarding procedure, including negotiations with public parties and other private (joint) bidders if a consortium is involved (Pallis *et al*, 2008). This type of entry demands a strong commitment in terms of financial and managerial resources, and involves the firm in a complex and potentially long awarding procedure, during which candidates have to deal with multiple public and private stakeholders (Parola *et al*, 2013).

External growth translates into the acquisition of stakes or terminal operating companies through financial transactions, thus stepping into existing public–private arrangements (concession agreements). This aggressive solution allows the capture of market opportunities (de Langen and Pallis, 2007; Olivier *et al*, 2007), avoiding a 'direct' negotiation with local public institutions. External entry strategy enables MNEs to compress the time between the decision to enter and the actual beginning of operations, to avoid some of the economic, institutional or normative barriers to market entry and to moderate the transaction risk (Notteboom and Rodrigue, 2012). Nevertheless, acquisition also presents disadvantages. Firms might encounter strong competition from a number of other interested bidders in taking over stakes, and the valuations of terminal companies or assets (ie selling price) could be higher than real market values. Acquisitions may be also restricted by institutional factors, particularly the policies of national and supranational competition authorities who closely monitor the risks of having dominant actors in regional container markets (de Langen and Pallis, 2007). Finally, large acquisitions could impose on the firm rather accelerated growth paths, producing 'time-compression diseconomies' and negative effects on performance because of organizational concerns as well as environmental misadaptation in the (new) host countries.

Figure 16.4 depicts the evolution of entry mode options over the last decades. Empirical evidence shows that internal solutions were dominant prior to 2000, with a slight preference for regular concession (under the privatization umbrella). Ocean carriers opted for regular concessions while pure stevedores favoured greenfield projects. The latter exploited their large amount of financial resources committed to the (core) business, as well as their know-how in terminal design. After 2000 BOT schemes became a widespread entry mode, given the need to expand port physical boundaries and find offshore/deep-sea terminal solutions. In addition, financial transactions turned into the most preferable choice not only for private equity firms but also for pure stevedores. Recent literature (Notteboom and Rodrigue, 2012; Parola *et al*, 2013) demonstrated that external entry strategies increasingly assumed a 'multiple acquisition' dimension (eg DP World on CSX and P&O Ports, PSA on HPH, Goldman Sachs on SSA Marine etc), as company take-overs often involve two or more terminals in multiple locations. In the 1997–2013 period approximately 40 multiple financial transactions took place, for an overall amount of resources committed equal to US$ 40 billion.

Another essential dimension in growth strategy implementation is the degree of commitment in new ventures. Firms have a variety of options along a continuum, which is typified by diverse degrees of equity engagement,

FIGURE 16.4 Entry mode per container port MNE typology



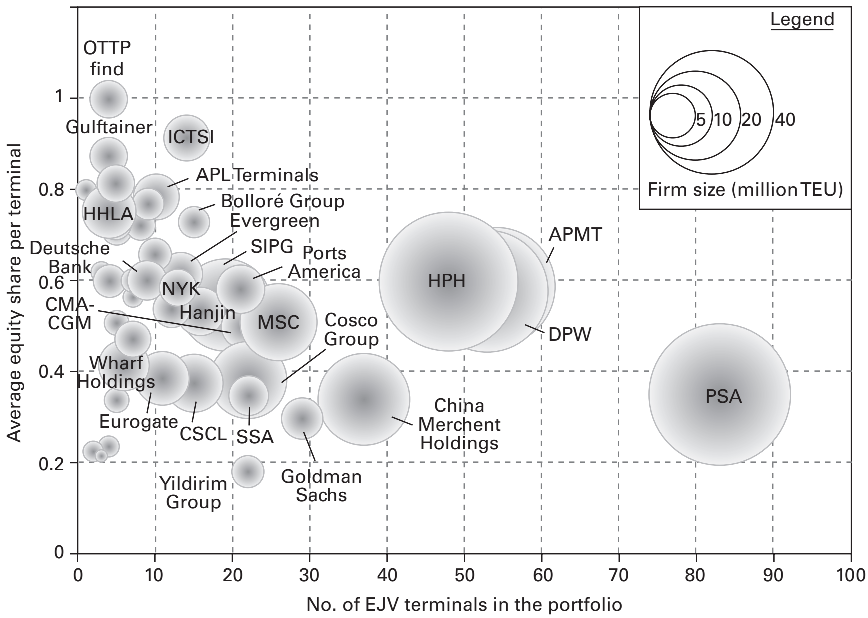
SOURCE Author's elaboration from Drewry annual reports (various years), corporate websites, and specialized press exposure to market risk, as well as managerial and strategic control (Olivier, 2005; Slack and Frémont, 2005). The spectrum of strategic options includes:

- wholly-owned subsidiary (WOS), which allows container port MNEs full control of the terminal;
- partially-owned subsidiary (POS), where the firm holds a majority stake;
- a 50/50 joint venture in which the two partners share the financial risk whereas operational responsibilities might even be entrusted to only one of them (or to a third party);
- minority share, where the firm holds a minority equity interest but has a strong influence on strategic decisions;
- shadow entry, which contemplates the holding of a very low share (5 per cent or below), just translating into a financial presence in a specific market context.

As a contrast, it seems to be appropriate to discriminate between WOS and EJV solutions, as suggested by mainstream scholars (Brouthers *et al*, 2008). In the specific case of the container port industry, this classification allows the central role of collaborative forms of entry and the diverse attitude of each business model towards EJV solutions to be appreciated (Vanelslander, 2008). Focusing on EJV advantages, we first have to recognize that equity joint ventures constitute real options for firms willing to develop new projects. This strategic solution allows firms to limit investments and retain the right to increase commitment in the venture at a later stage. EJVs are mainly utilized to accelerate overseas investments, reduce risk and overtake political and regulatory barriers (de Langen and Pallis 2007; Rodrigue *et al*, 2011). By cooperating, container port MNEs gather additional financial resources, complementary assets and technical capabilities for developing terminals (Olivier, 2005). In addition, EJVs moderate project uncertainty in concession awarding and infrastructural realization (Parola, *et al*, 2013). EJVs shelter container port MNEs from market volatility, by pooling partners' cargo base and encouraging overseas expansion and geographic diversification (Heaver *et al*, 2001). With regard to the WOS option, however, EJVs entail a lower managerial and strategic control on the facility. Opportunistic and obstructionist behaviours could materialize and harm the interests of some partners, typically in the case of minority shareholding. Furthermore, alliance implementation is a delicate phase within the overall process. A diverse cultural background or business model (eg carrier vs stevedore) might generate communication problems, ideological divergence, managerial contrasts and mismatch on firm objectives.

Figure 16.5 presents the diverse attitude of container port MNEs towards being engaged in EJVs and the average degree of equity commitment, which characterizes each player. Stevedores and hybrids have a similar average firm size (10–11 million TEU throughput), which is more than twice bigger than carriers and financial operators (around 4 million TEU). At its most

FIGURE 16.5 The resort to EJV terminals by container port MNEs (2011)



NOTE Bubble size indicates firm size, ie the annual throughput of the overall terminal portfolio.
SOURCE Author's elaboration from Drewry annual reports (various years), corporate websites, and specialized press

basic, stevedores are more involved in EJV terminals than competitors. PSA, HPH, DPW are indeed the three players that most resort to the collaborative option. In terms of average equity participation, stevedores and financial groups unveil a higher commitment (around 60 per cent share) than carriers (54 per cent) and hybrids (52 per cent). In greater detail, substantial disparities come out among port MNEs, although many are concentrated in the 40–60 per cent range. Market leaders adopt similar strategies, with the exception of PSA, which demonstrates a lower commitment (below 40 per cent). Some stevedores show a high equity engagement (ICTSI, Gultainer, HHLA etc) in contrast to others (SSA Marine, Yildirim Group, Eurogate). Among hybrids, MSC, CMA-CGM, Cosco and China Shipping are clustered in a similar position, whereas APM Terminals is close to the top pure stevedores.

From stand-alone equity joint ventures to 'cliques'

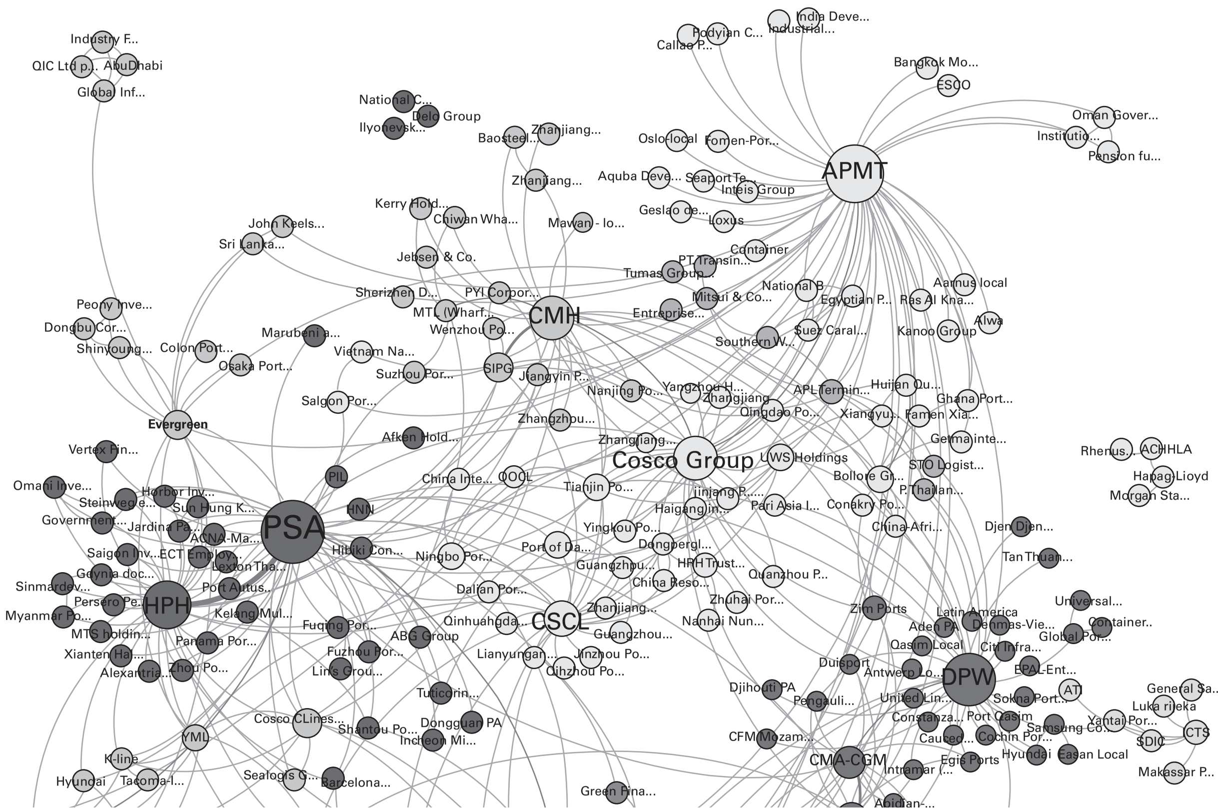
In recent years, container port MNEs increasingly resorted to EJVs for undertaking growth strategies abroad. The closure of the 'privatization window' and the progressive scarcity of available port space for greenfield projects somehow forced international terminal operators to abandon stand-alone paradigms (Heaver *et al*, 2001). The need for a large amount of financial resources for financing mega-terminal projects also played a decisive role in feeding this trend. In the 2002–2011 period the number of EJV terminals strongly increased, climbing from 136 to 336 facilities at approximately a 10 per cent growth rate per annum. To date, over 70 per cent of port terminals, where at least one container port MNE is involved, are run under an EJV scheme, demonstrating the massive trend towards cooperation.

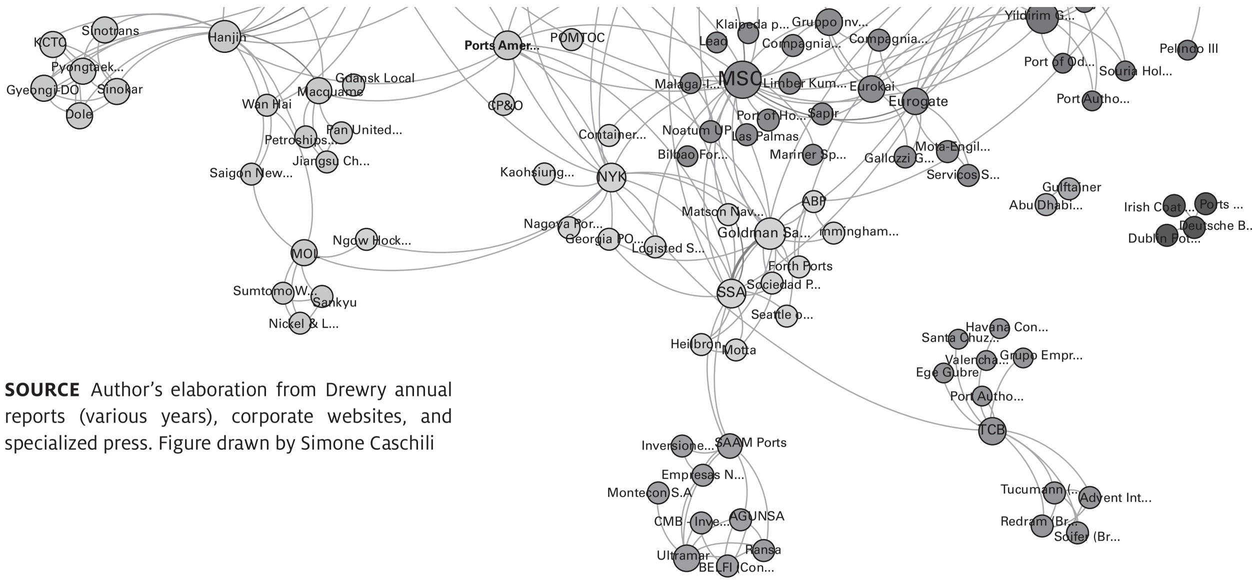
The stevedore–carrier dyad is the most common combination in EJV solutions (Parola and Musso, 2007). Despite the bargaining fight at transactional level, these players also have complementary objectives and can share financial and operational risks (Olivier, 2005). EJV terminals jointly owned by carriers and/or hybrids are increasingly widespread. Conversely, the cooperative relations among international stevedores are extremely rare, as they are reluctant to share resources, know-how, confidential information and respective customer bases. Domestic stevedores may actively take a part in building up EJV schemes and often assume a mediating role with local institutions and business background. In turn, national players can utilize the EJV ('foreign') experience accumulated in the domestic market (ie inward internationalization) to become international and invest abroad (outward).

The acceleration in EJV development worldwide provoked a breakthrough in mainstream cooperative paradigms, which are no longer anchored to single ventures but relate to multiple facilities across the globe. Greater awareness of the regional and multi-regional nature of inter-firm agreements arose from the emergence of a complex architecture of voluntary dyadic ties within the container port industry (Vanelslander 2008; Soppé *et al*, 2009). Some scholars (Lam and Yap, 2011) started to address this phenomenon, using as a basis the assumptions of inter-organizational network theory. Parola *et al* (2014), adopting community detection analysis techniques, demonstrated that inter-firm (equity) networks are not random, as container port MNEs tend to cooperate in a selective way, building up 'cliques' (hidden families) of affiliated members. Such hierarchical network structure arises from the sum of direct and indirect dyadic relationships, which, instead, might appear mimetic if taken individually. The notion of cliques derives from network theory and concerns stable groups of firms more densely interconnected with each other than with other firms. Notably, cliques stimulate the birth of new business ties as partners of partners tend to frequently become partners as well (Watts, 1999).

In line with recent studies (Parola *et al*, 2014; Satta *et al*, 2014a), Figure 16.6 shows the network architecture of collaborative ties in the container port industry. Many port MNEs establish dense (equity) relations with other MNEs as well as domestic firms, resulting in clique formation.

FIGURE 16.6 Cooperative EJV networks and cliques in the container port industry (2011)





SOURCE Author's elaboration from Drewry annual reports (various years), corporate websites, and specialized press. Figure drawn by Simone Caschili

The monitored industry network comprises 48 international players and 232 local terminal operators. A few container port MNEs are not in this collaborative network because they are just involved in wholly-owned ventures. Figure 16.6 discloses the main structural features of the 16 cliques identified through the community network analysis. On average, each cluster consists of over 17 terminal operators, of which 3 are MNEs and 14.5 are local firms. Clique size appears rather heterogeneous in the network. Evidence shows the existence of 4 large cliques (above 20 members), 4 medium-size cliques, which are made up of 10 to 20 affiliates, and 8 small families, comprising fewer than 10 terminal operators.

The analysis of clique composition provides interesting outcomes. All clusters include international players, confirming their active leadership in shaping the overall network. In most cases (9), the family is constructed around very few MNEs (1–3), which hold the highest number of relations and act as charismatic force(s) in the clique. This typically happens in the presence of small and medium-size families. Except in one case, large cliques consist of quite a number of international operators, demonstrating that a certain critical mass can be achieved only through the joint contribution of some MNEs bundling all members together. Network analysis reveals that pure stevedores are present in 14 out of 16 cliques. Moreover, these stevedores tend to equally distribute themselves across different cliques (one each), in order to reduce intra-clique competition. Only in a couple of cases, two or more stevedores cooperate together in the same (large) cluster. The other types of operators, instead, tend to concentrate their presence in some selected cliques.

The governance structure and the distribution of leadership power inside the clique are key issues affecting management ties and clique survival. Despite the large presence of pure stevedores in most cliques, in just six cases they unveil the highest number of relations inside their collaborative family. In the other 10 clusters, financial operators (4), carriers (3) and hybrids (3) occupy a more barycentric position in the relational network. In this regard, one delicate matter concerns the type of leadership hold by the most connected player within the clique. Is it a hegemonic or a democratic leadership? Evidence from the field is inconclusive and varied, especially for large cliques, which demonstrate a more complex architecture.

The large cluster of HPH and PSA does not include any other MNEs. This means that they rule their community of local operators as a hegemonic duopoly. The other big cliques differ profoundly in the distribution of leadership power. In one case the stevedore DPW dominates the scene and coordinates a number of partnering MNEs, such as Yildirim Group, CMA-CGM, Global Ports Investments, and ZIM. In the biggest clique (64 members), on the other hand, the exercise of power seems to be more equally balanced. Despite the APM Terminal leadership, we also find other members with an influential market power and a substantial number of relational ties inside the clique, ie Cosco Group, China Shipping Terminal Development, NWS Holdings and Bolloré Group. Finally, there is a clique where the power and the relational ties are shared fairly and no clear leadership emerges. It is an example of democratic organization, where Hanjin, Evergreen, and Ports America (AIG Highstar Capital) constitute the backbone of the cluster, which is also supported by Macquarie and other carriers. In this clique no stevedore is involved.

Concluding remarks

The new economic and institutional environment in which ports operate triggered a number of container port MNEs to outgrow their home country, paving the way to industry internationalization. The nature and ultimate strategic objectives of container port MNEs are not univocal. Some heterogeneous business models established themselves in the market and mutually affect each other.

Pure stevedores from emerging economies and equity firms from Anglo-Saxon countries presented unique spatial and temporal dynamics of internationalization, which impose a new analytical lens with regard to those offered by traditional IB theories.

This chapter provided an extensive overview of the container port business state of the art and evolution, analysing cutting-edge trends and managerial practices. In particular, the main business models have been introduced, emphasizing the strategic implications of firm growth. This study explored the drivers of internationalization, characterizing different business models and shed light on spatio-temporal dimensions of overseas expansion. Finally, the chapter expanded knowledge of inter-firm partnerships in the industry, revealing that container port MNEs are organized in cliques in order to share risk across multiple locations.

Despite the fruitful academic debate on this topic, many promising streams of research are still under-explored and deserve more attention by scholars. First, future studies have to achieve a more sophisticated understanding of the objectives and strategic attitudes of financial operators, being aware of the profound differences among equity firms. Second, the unique internationalization drive of some container port MNEs makes this industry a meaningful empirical context for expanding traditional internationalization theories and adopting innovative perspectives. Third, the accelerated resort to EJVs and the formation of cliques still require a massive analytical effort in a number of directions. Clique leadership and governance, intra-clique management ties, geographic scope of cliques, role and functions of domestic members in clique organizational structure, and clique evolution and survival are just a few of the cutting-edge themes to address. Finally, to date academic literature has neglected to include economic and financial performance into the mainstream analytical frameworks of container port MNEs. This is a major gap, which must to be bridged despite the lack of easily accessible data.

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Public–private partnerships and port logistics performance

17

JASMINE SIU LEE LAM, FRANCESCO PAROLA AND PHOTIS M PANAYIDES

Introduction

Developing and operating ports is a highly capital-intensive business. The rapid pace of technology advancement has seen tremendous growth in vessel sizes in various shipping sectors including container ships, dry bulk carriers, and tankers. For example, nowadays ultra large crude oil carriers are greater than 320,000 dwt. A mainline vessel operating on the Asia–Europe trade route would range above 9,000 TEU in size. In fact, the largest container ship that operates on this trade holds the record at 18,000 TEU in size. In order to handle these vessels, ports have to expand their capacity as well as equip these facilities with a new generation of cargo-handling system designed to achieve greater productivity and efficiency from the logistical perspective. Today, ports are seen as important nodes where efficiency in logistics has become a critical source for competitive advantage and holds the key for anchoring supply chains and their corresponding cargo traffic (Zhang *et al*, 2014). Failure to do so could lead to the inevitable loss of connectivity and hub status and eventual relegation to spoke port status. Conversely, success in this could result in significant economic gains in the form of revenue growth, value-added gains, more taxation and employment opportunities for the local city as well as the hinterland which the port serves.

The pursuit of greater handling capacity requires enormous financial resources and professional expertise that many ports around the world do not possess. As such, ports have been seeking private-sector participation through various forms of public–private partnership (PPP) schemes. PPPs are not narrowly defined to mean the full privatization of public services. Rather, they include collaboration to pursue common goals, while leveraging joint resources and capitalizing on the respective competences and strengths of the public and private partners (Nijkamp *et al*, 2002; Pongsiri, 2002). The benefits of PPPs are potentially numerous and include efficiency improvements, reduction of public expenditure in financing infrastructure investments, access to private finance as well as clearer objectives, new ideas, flexibility, better planning, improved incentives for competitive tendering, and greater value for money for public projects (Nijkamp *et al*, 2002; Spackman, 2002).

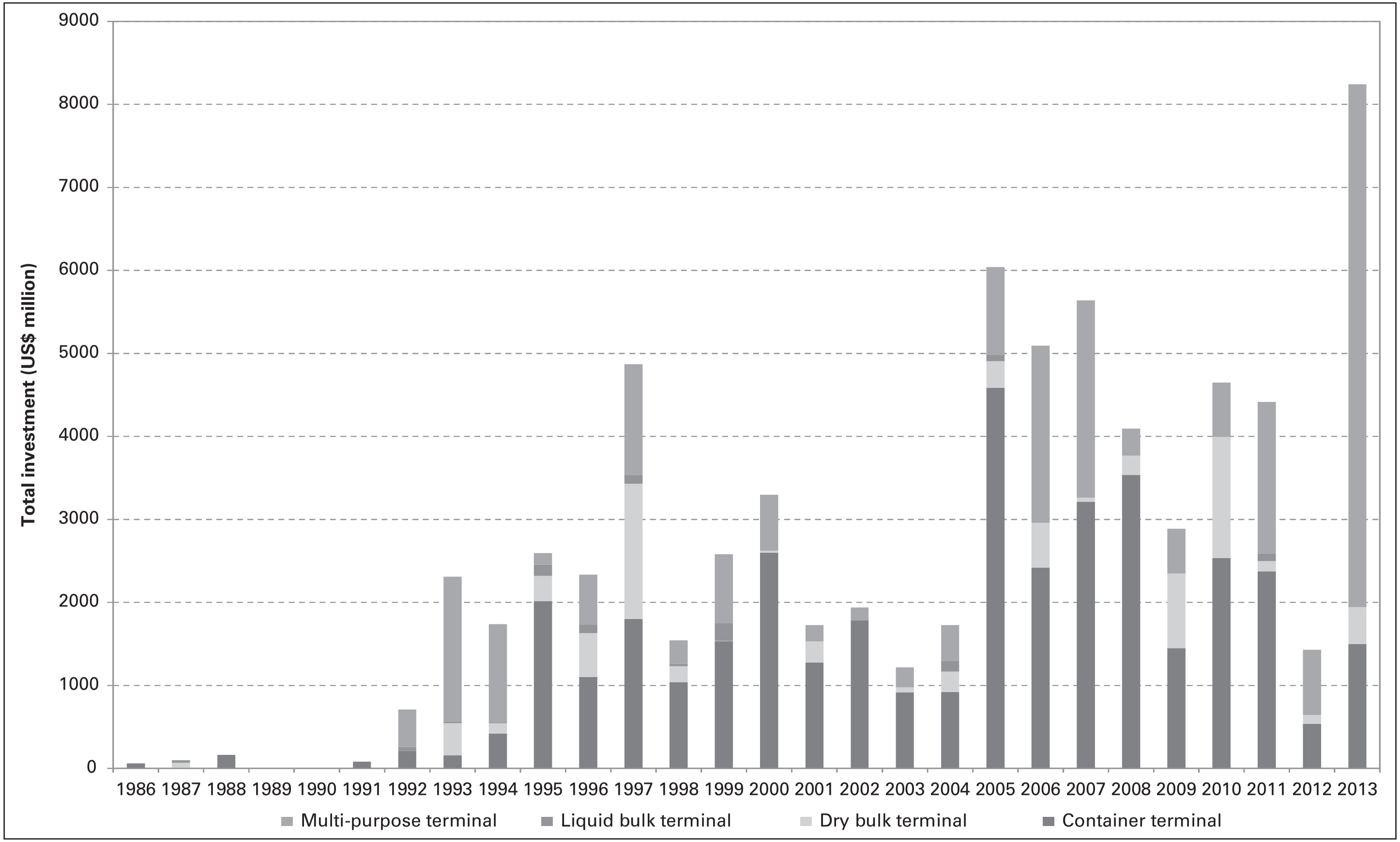
This chapter adds value to the body of port literature in view of the growing trend in port PPPs. The aim of this study is to perform an exploratory investigation into the impact of PPP on port logistics performance through a discussion of examples from the port industry and the respective countries' situations. In particular, we identify relevant institutional factors to frame the discussion and draw inferences.

The overall development in port PPP

Port PPP in various regions

The quest for better port management and performance has led to increasing involvement from the private sector in port operations. Port liberalization and privatization started in the late 1970s and since the late 1990s–early 2000s has become prevalent in both advanced and developing economies. The progressive opening up of the port sectors worldwide presented opportunities for pure stevedoring companies and shipping lines to expand their market arena in various organizational forms (Parola and Musso, 2007). Despite the variations in private-sector participation, the majority of institutional frameworks are founded on cooperation between a public port authority and a private terminal operator. Thus, such frameworks are commonly known as port PPPs (Siemonsma *et al*, 2012). PPPs are attractive since they provide new opportunities to both parties. But whether the opportunities offered by PPPs will be fully exploited in practice is indeed an important question. Van Ham and Koppenjan (2001) asserted that public authorities should not unilaterally define port projects, since this limits the scope for the creation of genuine partnerships. This deters utilization of market experience and the creativity of the private parties. Port PPPs should be cooperations between public and private actors in which they jointly develop port services and share risks, costs and resources connected with these services (van Ham and Koppenjan, 2001). The public and private parties should maintain a mutually supporting relationship in which the parties can realize a stake in the success of each other (Bagchi and Paik, 2001).

FIGURE 17.1 Port PPPs in developing countries 1986–2013: Investment breakdown per project typology



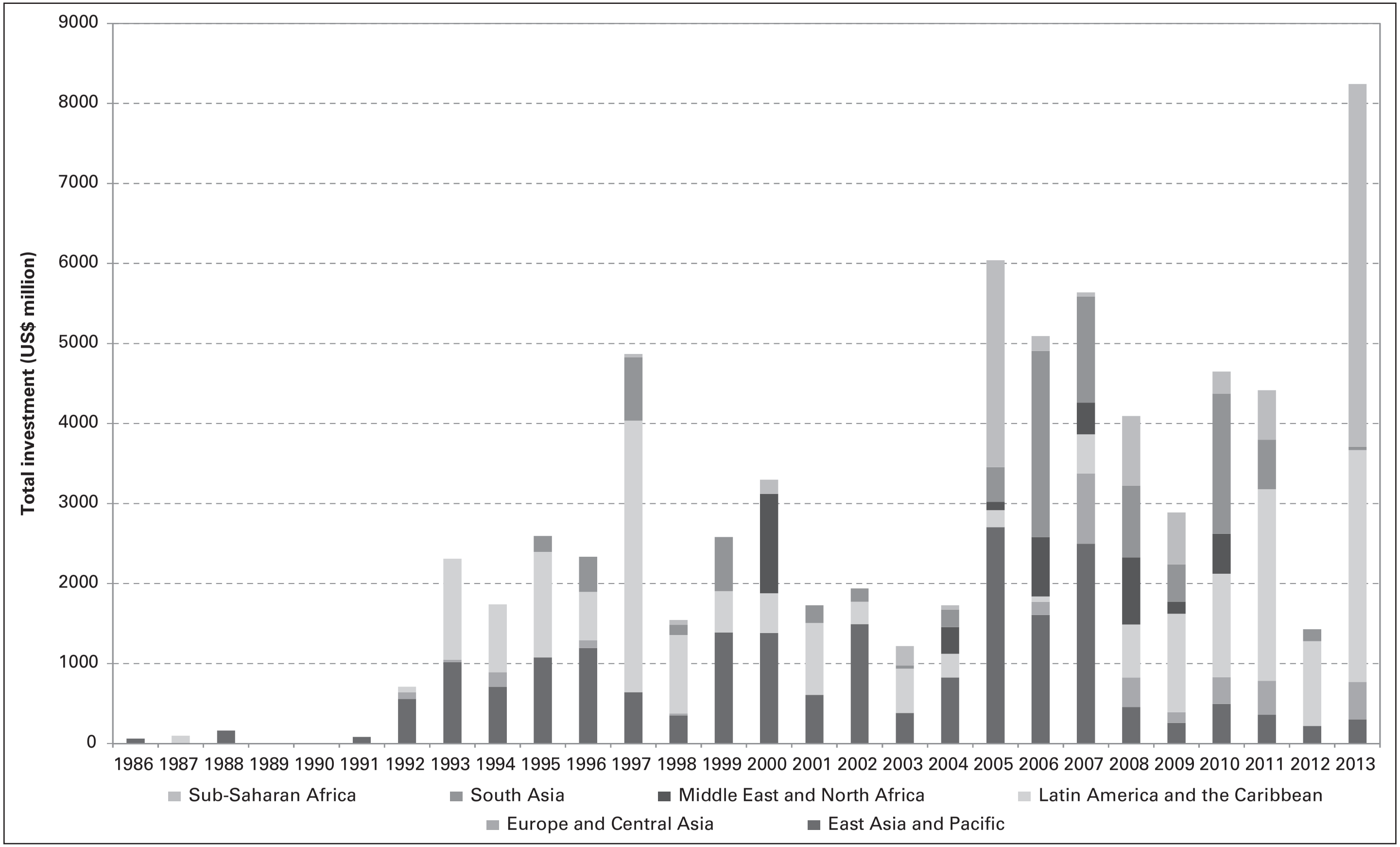
SOURCE Authors' elaboration from the World Bank's Private Participation in Infrastructure (PPI) project database

Over the last 30 years, PPP schemes have been increasingly adopted in ports, especially in those countries which needed to reform their port operations for attracting private funding, managerial expertise and innovative capabilities. In particular, developing countries were protagonists for a spectacular surge in port infrastructure PPP activities as reported by the Private Participation in Infrastructure (PPI) project database of the World Bank. Within the 1986–2013 timeframe, over 400 projects have been recorded in low- and middle-income countries (Figure 17.1), taking into account the port facilities in which private parties assumed operating risks (and often also equity shares). Overall, the accumulated amount of investment in the period was over US$ 70 billion. Container (US$ 38.2 billion, 184 projects) and multi-purpose (US$ 24.3 billion, 131 projects) facilities attracted the majority of investments, followed by dry and liquid bulk terminals (US$ 9 billion in total, 94 projects).

The magnitude of the investment bears witness to the significance of the overall trend over time. After the acceleration that took place in the late 1980s, however, the investment materializing in the following years reveal rather dissimilar figures which derive from the fast-changing environmental conditions and the volatility of time–window opportunities. This heterogeneity becomes even more noteworthy when analysing cross-regional (Figure 17.2) and cross-country differences. The timing of the port reform process, the positive (or negative) attitude of governments towards liberalizing port activities, the presence (or absence) of entry barriers for overseas investors and the evolution of the institutional conditions in each host country are just some of the factors which profoundly influence the development of PPP schemes over time. Figure 17.2 shows the long-term dramatic rise of investment in the East Asia and Pacific region which, however, witnessed a remarkable decline in recent years.

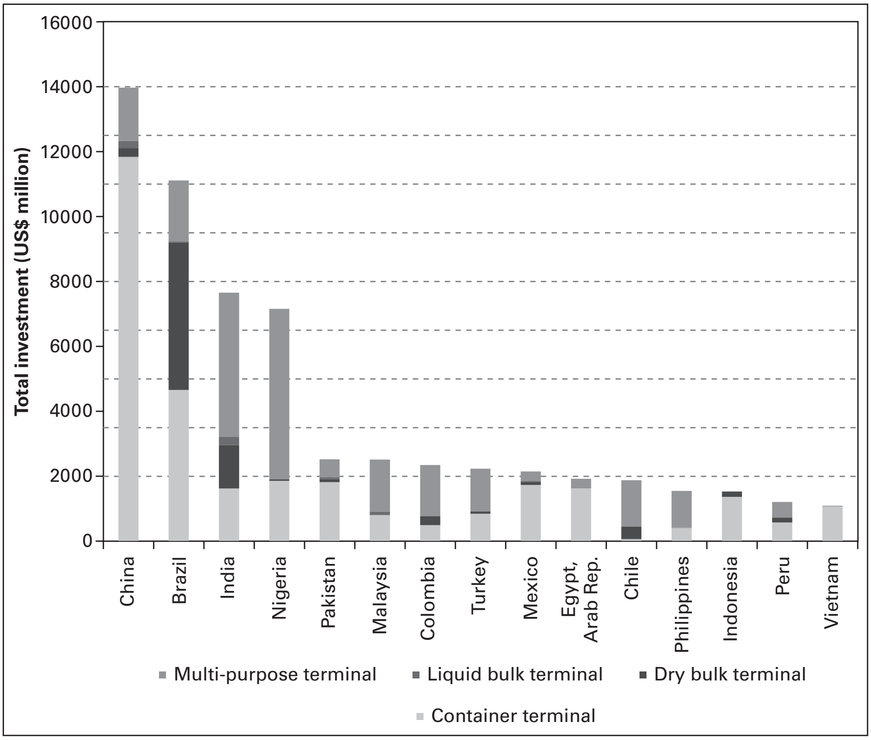
The Middle East and North Africa entered the port PPP game at a later stage (2000s) and showed a quite irregular trend. South Asia had already initiated PPP activities in the mid-1990s but investment volumes remained quite modest and irregular until the recent growth. Sub-Saharan Africa was a region marginalized from containerization and main trade lanes until a few years ago, whereas it now enjoys remarkable levels of investment in port infrastructures. Finally, Latin America and the Caribbean region demonstrated high levels of activity, providing numerous PPP opportunities in ports, and even gaining momentum in the post-crisis period. Notably, leading countries in port PPPs in terms of the total amount of generated investment are the People's Republic of China (almost US$ 14 billion), Brazil (US$ 11.1 billion), India (US$ 7.6 billion), and Nigeria (US$ 7.1 billion). Amongst the top 15 countries some latecomers also appear in the ranks such as Turkey, Chile, and Peru (Figure 17.3). Again, remarkable differences can be seen with regard to the type of facilities involved in PPP schemes. Beside those countries which appear mostly 'specialized' in container terminals (eg China, Mexico, Egypt), others demonstrate a more diversified portfolio of interests (eg Brazil, India, Nigeria, Colombia).

FIGURE 17.2 Port PPPs in developing countries 1986–2013: Investment breakdown per geographic region



SOURCE Authors' elaboration from the World Bank's Private Participation in Infrastructure (PPI) project database

FIGURE 17.3 Leading developing countries in port PPPs: Investments per project typology



SOURCE Authors' elaboration from the World Bank's Private Participation in Infrastructure (PPI) project database

Advantages and disadvantages of port PPP

When countries enter into port PPPs, the overall expectation from such a move is the enhancement of port performance as compared to a public port. Specifically, the supposed benefits of port PPPs include: higher levels of operational efficiency, enhancement of trade facilitation, generation of revenue for the government, greater access to capital markets, the removal of restrictions on investment, new industrial relations practices, a more commercial approach to management, and promotion of greater competition between ports, all of which should in turn enhance financial and economic performance (Saundry and Turnbull, 1997; Baird, 2000; van Niekerk, 2005; Vining and Boardman, 2008). Using a stochastic frontier analysis Tongzon and Heng (2005) demonstrated that private-sector participation to some extent can improve port operation efficiency, which will in turn increase port competitiveness. However, the outcome of port privatization may not always be positive or up to expectations. For example, Saundry and Turnbull (1997) commented that the sale of public ports in the UK represented a significant loss to the taxpayer and other stakeholders due to inferior financial performance of the private ports. Also, involving private firms in port operations is not a uniform solution which equally suits all ports. Through the use of case studies on Colombia, Costa Rica and Nicaragua, Kent and Hochstein (1998) showed that ports have to monitor and react to the extent of cargo activity and volume handled. In countries with a limited number of ports having relatively small cargo volumes, commercialization of public port services, instead of privatization, would still be useful in pursuing marketing strategies and induce inter-port or inter-terminal competition. The cases reveal the complexity of port reform and privatization issues.

Some ports also expressed concerns about private-sector investment. In a survey conducted on the world's top 100 container ports (Baird, 2002), 31 per cent of them stated that the loss of control was a main issue. Political and commercial ambiguity, difficulties in service operator selection, and the lengthy process for securing concessions were also found to be disadvantages of port privatization. Possible risks should be completely understood and controlled in order to avoid an unnecessary waste of economic resources (Cullinane and Song, 2002). Furthermore, weak institutional or regulatory frameworks, long-term sovereign risk management, assets' economic depreciation and weak domestic financial markets will result in higher-risk perceptions which are negative for port PPPs (Juhel, 2001). Seen from the private investors' perspective, Wiegmans *et al* (2002) commented that the risks involved in port projects would be a deterrent. Their article analysed the characteristics of investments in container terminals. Risks borne by private investors in European port projects would be lower than for other infrastructure projects since substantial public resources have contributed to port infrastructure development, thus allowing investors to earn healthy profits by charging reasonable terminal handling charges.

Coordination in public- and private-sector participation

The nature and division of public- and private-sector participation is also central to the discussion on port PPPs. The increasingly prevalent port ownership structure is the landlord model, in which a port authority is the landlord for various private terminal operators providing cargo-handling and storage services to port users (Baird, 1995). Everett and Robinson (1998) asserted that the regulatory regime is a key to port reform. They commented that the public sector can refrain from day-to-day port operations but legislation is required to ensure the effectiveness of such strategy. Trujillo and Nombela (1999) analysed port reform in the process of getting private investment in developing countries. They suggested that the government authority reduce its role so that a favourable legal environment for port reform would be created. In Trujillo and Nombela's (1999) opinion, the primary tasks of the public port authority should be to manage the public infrastructure, safety and environmental conditions. From pricing's perspective, Meersman *et al* (2010) investigated whether short-run marginal cost (SMC) pricing is feasible to implement in seaports. SMC would not be helpful for stimulating private involvement in the port sector because only a very minor part of the investment would be paid for by port users. More lucrative pricing mechanisms are needed to attract private investors.

We should also take note of a country's economic and market conditions, as well as institutional issues which would further complicate the formulation of port PPP. The degree of openness of foreign markets largely dictates both opportunities and modalities of private entry in the port sectors worldwide (Olivier *et al*, 2007). The history of a country, its geography and the attitudes of its people affect port governance decisions in general (Fawcett, 2007). For instance, the United States has to trade with overseas countries rather than just with Canada and Mexico due to great economic demand and dissimilar political institutions. Thus the federal government has a long-standing interest in maintaining seaport infrastructure and navigable waterways. This is the background reason why public agencies seek to retain control over major infrastructure and essentially own all the nation's major general cargo seaports, while the private sector participates in terminal operations (Fawcett, 2007).

Taking another example, Singapore's government holds a majority stake in its seaport mainly because it favours a common user system, rather than dedicated terminals, which would be more suitable for maintaining its transhipment hub status (Lam *et al*, 2011). The port went through corporatization, not privatization, since the two terminal operators PSA and Jurong Port ultimately remain under government-owned entities. The private sector's involvement accounts for a small portion in terms of joint ventures with three shipping lines in container berths (Cullinane *et al*, 2007). As for Singapore's neighbouring country Malaysia, Leeds (1989) analysed the privatization of the Port Klang Container Terminal. Due to Malaysia's unique ethnic composition, the government has to protect the Bumiputra community's interest. Hence, having both government-owned corporations serving as the surrogate investor for Bumiputra and private firms at the same time in operating the terminal is the appropriate approach. Shashikumar (1998) provided another example from a developing country – India. In his critique on the Indian port privatization model, he stated that using market forces to achieve port privatization would be more effective than having a tariff regulatory body, based on the fact that India is one of the fastest growing economies in the world.

Frameworks for developing port PPP in specific country settings

The above examples show that decisions on port PPPs should be aligned with the country's circumstances. Scholars have derived various frameworks to assist practitioners in developing port PPPs. Due to the uncertainty and dynamism of a country's market and institutional environment, Baltazar and

Brooks (2007) suggested applying contingency theory to the management and governance of ports. There exists no 'best way' to partially or fully privatize a port, but for any given situation a suitable model can be found. They noted that not all ports have profit-motivated objectives so going for a high level of privatization with the aim to maximize profit would not always be the most suitable approach. Bagchi and Paik (2001) proposed a three-phrase process model which consists of setting pre-conditions, PPP development and implementation, and performance assessment. The key point is to have strategic vision and proactive commitment within government departments in the process. In another study focusing on the awardof port PPP contracts, Siemonsma *et al* (2012) illustrated that, particularly for complex port projects, early dialogue with candidates in the private sector would lead to enhanced project value by reducing expected transaction costs and increasing expected contract value. They suggested a competitive dialogue procedure to allow early private-sector involvement in the design and awarding of the port PPPs. In addition, given the growing technological complexity and financial burden currently imposed by greenfield projects, bidders are often used to build up large consortia for sharing resources and capabilities among members.

Based on the above literature review, we observe that port PPP has generated a lot of interest from researchers. Prior studies focus on the intrinsic characteristics and institutional aspects of port PPPs. Most of these studies are qualitative or descriptive in nature. Basically, the most common research approach adopted is (port) single or multiple case study. More rigorous empirical analysis would deepen our understanding on the topic. In addition, in both port research and industry practice, ports are increasingly seen as logistics platforms integrated in globally outstretched supply chains (Panayides, 2006). Nonetheless, the literature has only barely touched on port PPP in connection with a wider logistics perspective. Juhel (2001) recognized that private-sector involvement is conducive for commercial operations of logistics facilities since ports are vital nodes inserted in market-driven supply chains. Furthermore, mainstream contributions also neglected to investigate to what extent the institutional background of a country is capable of (positively or negatively) affecting port PPP development. The literature has yet to provide any systematic investigation in this direction. This chapter attempts to narrow this literature gap, identifying some relevant institutional factors and debating their influential role in shaping port PPPs.

Institutional factors and PPPs: Which impact on port logistics performance?

World Governance and Doing Business Indicators

Based on the institutional framework established by Daude and Stein (2007) and focused on the World Governance (Kaufmann *et al*, 2009) and Doing

Business Indicators[1] (World Bank, 2012b), we conceptualize some major institutional factors that would have an impact on port logistics performance in the context of PPPs which are:

- voice and accountability;
- government effectiveness;
- regulatory quality;
- market openness;
- ease to start a business;
- contract enforcement;
- protecting investors.

The ability of a country's citizens to participate in selecting their government, together with their freedom of expression, freedom of association and a free media, constitutes a country's 'voice and accountability' (Kaufmann *et al*, 2009). It also indicates if the government can be answerable to its citizens. Countries with high voice and accountability ratings are usually able to provide investors with more freedom while giving them confidence in the countries' accountability. It is therefore an important factor in determining the willingness of the private sector to participate in PPP projects.

For port PPP, its success can be affected by the extent of freedom afforded to its investors as well as the presence of a reliable government. Private investors (such as private terminal operators) value liberty in making decisions such as the employment of their workforce; having the freedom to employ their own workforce allows them to be more efficient as workers are hired to their specific requirements. Workers' performance can be traced and training can be streamlined if terminal operators can hire their own employees. They will in turn benefit from cost savings and be more efficient. With increased involvement of the private sector in the port's privatization, it would improve the port logistics performance as a whole. This can be credited to having a more efficient and well-trained workforce.

This can be substantiated using the example of the Port of Rotterdam, which was corporatized in 2004. Its efforts to involve the private sector are evident from the number of private terminal operators in the port. Some notable examples are APM and Euromax terminals. Netherlands boasts a high percentile of 98 in the World Governance Indicators (WGI) for voice and accountability. It constantly adjusts its labour system for ports to ensure that investors have autonomy in employing their workforce. For example, the Port of Rotterdam used to have a labour pool system through which operators had to employ dock workers. In view of its failure to match up with uncertainty in demand, the government privatized the labour pool system in 1995 to make it more efficient. To date, the Port of Rotterdam's labour pool systems are characterized by a collective agreement system where terminal operators can have their own permanent workers and employ extra from the labour pools when needed (Notteboom, 2012). With a high level of voice and accountability, Netherlands is successful in implementing port PPP which further improves its port logistics performance. This can be seen from the World Bank's Logistics Performance Index, in which Netherlands is ranked 4th overall for logistics performance.

'Government effectiveness' refers to a measure for the quality of public services, policy formulation and implementation (Thomas, 2009). It reflects the competence of the civil service and the degree of its independence from political pressures, and the credibility of the government's commitment to its policies. These qualities reflect the ability of a government to formulate and implement good policies over the long term. As such, government effectiveness would be fundamental to port development in general as a country's overall well-being is influenced by government effectiveness.

In the context of port PPP, we recognize that one of the major drivers of port privatization and reform is represented by the scarce capacity of public bodies (governments, local public bodies, and port authorities) to efficiently handle port operations and management. For example, public bodies may be less responsive to market changes than private entities. Hence, port authorities located in countries where the effectiveness of government bodies is low are more inclined to seek private investors and operators in order to enhance port logistics performance. On the other hand, if a government is very effective in developing and implementing policies with respect to port operations and management, it would not be highly necessary to involve private investors.

The Port of Singapore can be taken as an example. There are two terminal operators in Singapore, namely PSA Corporation and Jurong Port. In 1997, the PSA Corporation was formed by the corporatization of the former Port of Singapore Authority. While PSA operates on a commercial basis, it is a government-owned entity (Cullinane *et al*, 2007). There is rather limited involvement of the private sector with PSA, and that is restricted to joint ventures with shipping lines Cosco, Mediterranean Shipping Company (MSC), and Pacific International Lines (PIL) in several container berths, and with NYK and K Line in a dedicated car terminal. Similarly, another terminal operator, Jurong Port, is also a government-owned entity. It is a multipurpose port and was corporatized in 2001.

The two terminal operators do not have to rely on private investors in port operations partly due to the high government effectiveness of Singapore. Referring to World Bank's WGI (2013), Singapore's government effectiveness is ranked in the 100th percentile (ie the highest) from 2006 to 2012. In the World Bank's Logistics Performance Index (World Bank, 2012c) which reveals port logistics performance, Singapore is also ranked first for efficiency in terms of customs clearance and timeliness of shipments delivered. The government of Singapore is proactive in taking actions to enhance port logistics performance. For instance, the government's Workforce Development Agency (WDA) worked closely with the port industry by conducting competency-based training for port employees and professionals. The Port Services Workforce Skills Qualifications competency framework has been developed for enhancing labour skills and efficiency (WDA, 2012).

A government's ability to devise and carry out sound policies and regulations that encourage and make room for private-sector development is measured by its 'regulatory quality' (Kaufmann *et al*, 2010). To be successful in promoting the private sector and attaining economic growth, having an effective legal and regulatory framework is vital (Hafeez, 2003). A weak institutional structure, on the other hand, decreases the potential of growth due to poor design and implementation of policies (Jalilian *et al*, 2007). For private investors to participate in PPP initiatives, they will be seeking growth in their business as well as the country's economy. Hence, this implies that PPP initiatives are affected by regulatory quality.

The United Kingdom attained 95 per cent for Regulatory Quality in 2012's World Governance Indicator. Its efforts in port PPP include having a National Policy Statement under the Planning Act 2008. Under the National Policy Statement, frameworks are developed to select suitable proposals for port developments. This allows investors' proposals to be regulated and simplifies the process for selection. It is also more cost-effective for investors to work towards a standard requirement. Having such regulations can therefore attract more private investors to take part in port PPP and contribute to its success. This in turn enhances port logistics performance. The UK is ranked 10th overall for its logistics performance. For example, the 3.5 million-TEU London Gateway, as the newest port investment from private terminal operator DP World, will be the UK's largest and deepest container facility (*IHS Fairplay*, 2011). London Gateway aims to substantially enhance the port's logistics performance by reducing delivery times and investing in distribution centres.

The 'market openness' of a country is also considered a vital institutional factor in affecting port PPP. It can be characterized by the amount of government intervention which is not limited to just tariffs and subsidies (Stensnes, 2006). An open market can thus allow economic actors to trade without any external constraints. Such a market encourages the entry of investors into the market as barriers to entry are reduced. As such, this can greatly influence port PPP since the private sector's participation is crucial.

There are many cases of opening the market to increased competition so as to improve performance. In the context of ports, besides opening the market for private terminal operators, many port services are also liberalized to increase access to the market. This is justified by the EU's constant attempt to liberalize port services to make them more efficient, providing more opportunities for the private sector's involvement, thereby contributing to the enhancement of a port's logistics performance.

One example is pilotage services in Denmark. Denmark, ranked first in the ICC's Open Market Index, adopted a Pilotage Act in 2006 to introduce competition to its state-owned pilotage service in an attempt to enhance the efficiency of pilotage services. Danish Pilotage Service, the first private pilotage company in Denmark, competed with the state-owned DanPilot. However, based on the experience of some countries, giving market access for pilotage services may be detrimental to safety as well as efficiency since it compromises professional standards (Danish Maritime Pilots Association, 2013). In addition, after introducing more competition, the dues for pilotage services by the state-owned DanPilot in fact increased by 20 per cent as indicated by Loodswezen (2013).

Comparing the Danish and German ports enables an evaluation of both. Denmark, with a higher open market index than Germany, has a mixture of public and private pilotage service providers. On the other hand, Germany's pilotage services are handled by the public sector through local pilotage organizations (PwC, 2012). Yet, pilotage services in Germany are efficient and highly regarded in the port industry. Though having an open market contributes to port PPP initiatives, it does not necessarily increase port logistics performance.

'Ease to start a business' is another institutional indicator which measures the number of procedures to start and operate a company, taking into account the cost and time needed to complete them. It also constitutes the paid-in minimum capital that companies have to deposit (World Bank, 2013a). Hence, fewer procedures, shorter time, lower cost and lower paid-in minimum capital allow greater ease of starting businesses and open up foreign markets, thus attracting the participation of private investors in the port sector (Olivier *et al*, 2007).

Hong Kong, having a free enterprise policy system and a free port status, is ranked 5th out of the 189 economies for the ease to start a business – a testament to the Hong Kong government's consistent efforts. In 2010, the government eased registration formalities and reduced the number of procedures by merging them together. Online electronic services to register businesses and companies were also introduced in 2012.

The ease of starting a business in Hong Kong is one of the reasons for active port PPPs and this is evident with the port having a number of private terminal operators such as Modern Terminals Ltd, Hong Kong International Terminals Ltd, Dubai Port International Terminals Ltd and Asia Container Terminals Ltd. The Port of Hong Kong is ranked 4th in the world for the cargo volume handled in 2013. Despite being a busy port, Hong Kong is ranked 2nd overall for its logistics performance in 2012 while also being 4th for the timeliness of shipments in reaching their destination. This can be credited to the success of port PPP in Hong Kong as the increased involvement of the private sector enables the port to be more efficient (Pagano *et al*, 2013; Baird, 2012). As such, it can be deduced that since the success of port PPP can be attained by having an easy environment for business start-up, port logistics performance will therefore be improved.

Turning to another aspect, the measure of 'contract enforcement' includes the number of procedures required to enforce a contract through the courts, and the time as well as the cost required to complete the procedures. These indicators ultimately illustrate the efficiency of the judicial system on resolving a commercial dispute (World Bank, 2013b). The importance of contract enforcement is highlighted by a survey conducted by Stone *et al* (1992) in Brazil. The results showed that ineffective contract enforcement obstructs the growth of businesses. Thus, we can infer that the effectiveness of a country in enforcing contracts can affect the willingness of private investors to participate in PPP initiatives.

Port PPP normally involves huge amounts of capital and thus it is crucial to have an effective contract enforcement environment to bolster confidence in private investors. While it is also a common venue for commercial disputes to occur, contract enforcement in port PPP cannot be ignored. Ports that participate in PPP often have a good reputation for its contract enforcement. The Port of Busan in Korea can be used to illustrate this point.

Ranked 2nd in the World Bank's Enforcing Contracts indicator, Korea boasts an effective environment for contract enforcement. In 2012, Korea introduced an electronic case-filing system, which allows cases to be registered electronically and subsequently assigned to a judge to review. Together with the e-court system, private investors benefit from the transparency of judicial decisions as well as fighting corruption. Such benefits ultimately foster better growth (World Bank, 2013c). The Port of Busan was ranked 5th for container throughput volume. With Korea's effectiveness in contract enforcement, there are numerous PPPs in the Port of Busan. Some examples include private operators such as Hanjin Logistics and Hutchinson Korea Terminals. With the success of port PPP enhanced by having effective enforcement of contract, there are increasing port PPP initiatives with the construction of Busan new port. A total of 16 berths are allocated to private terminal operators and the increase in PPP may increase the port's efficiency (Pagano *et al*, 2013).

'Protecting investors' reflects the protection of minority shareholders against directors' misuse of corporate assets. This is also an important institutional factor as it gives confidence and assurance for investors to invest in companies as minority shareholders. Companies can therefore benefit through the funding attained from such investments. According to the World Bank (2013d), the measure of protecting investors consists of the following dimensions: transparency of related-party transactions, liability for self-dealing and minority shareholders' access to evidence before and during trial. The stronger the protection of investors, the greater the willingness for investors to participate. Translating it in the context of PPP, having more protection for private investors can positively influence PPP initiatives. This is ascertained by Love *et al* 's (2002) point that weaker investor protection leads to higher internal ownership.

The United States is ranked 6th for its ability to protect investors based on the data from the World Bank. Its high ranking is justified through the US Securities and Exchange Commission (SEC), which was formed to protect investors, ensure the efficiency of market and assist in capital formation. To give private investors access to basic information about an investment, SEC mandates public companies to provide such information to the public. As such, sound decisions can then be made. The SEC is also in charge of the legal enforcement for violation of securities law which includes fraud and providing false information.

As mentioned earlier, having strong protection for investors can encourage the uptake of port PPPs. The United States has a total of 34 landlord ports with notable ports such as those of Los Angeles and Long Beach (Fawcett, 2006). They are the two busiest and among the most efficient ports in the United States with various terminals operated by private operators.

Some evidence from leading port PPP countries

After discussing the institutional factors with illustrations from real-world examples, Table 17.1 reports some World Governance and Doing Business indicators in regard to the leading developing countries in port PPPs. Before analysing the data a cautionary note is necessary. All the disclosed figures relate to developing countries only whereas the source database (except for market openness) also includes advanced economies. Therefore, the selected countries might appear to occupy a low or mid-position in the range (in absolute terms) simply because they are developing economies and basically rank lower vis a vis many advanced nations.

First, the variable voice and accountability reports that half of the leading countries ranked above the 50th percentile, an outcome rather in line with main theoretical arguments. Nevertheless, some countries which indeed are quite successful in attracting port PPPs do not appear to rank highly. China has a very low value, which derives from the minimal opportunities its country's citizens have to participate in selecting their government, as well as to express their opinions through the media. Contrary to expectations, most countries show rather high values for the variable government effectiveness, except for Nigeria, Pakistan and Egypt. This means that the effectiveness of governmental institutions at the national level should act as a positive stimulus for developing port PPPs. Further investigation is therefore required due to the specific nature of this business which, indeed, takes place within port boundaries and is often subject to ad hoc legislation. Future studies should also concentrate on the relations among diverse governmental tiers (from central to local ones) and how institutions are able or unable to coordinate their efforts for growing port PPP schemes.

Regarding the variable regulatory quality, most countries disclose rather high values, confirming the main theoretical assumptions. This means that, also for location-bounded businesses like ports, the quality of the regulatory environment at the national level is an important factor for ensuring private long-term commitment and promoting port PPPs. Moving to Doing Business indicators, the variable market openness brings evidence which corroborates arguments from literature. Except for Colombia and Peru, all the leading countries have a relatively long-standing experience in port privatization schemes and this factor seems to have a positive effect on PPP development. The variable ease to start a business exhibits mixed outcomes. The top five countries are low ranked, partially contradicting the theory. Conversely, many other nations, such as Malaysia, Colombia, Turkey, Chile

TABLE 17.1 World Governance and Doing Business indicators in the leading developing countries in port PPPs

			World governance indicators[1]			Doing business indicators[2]			
Rank	Country	Total investments (US$ million)	Voice and accountability	Government effectiveness	Regulatory quality	Market openness	Ease to start a business	Contract enforcement	Protecting investors
1	China	13,956.7	4.7	56.0	43.5	22	153	19	95
2	Brazil	11,098.7	60.7	50.2	54.5	20	121	121	80
3	India	7,641.8	58.3	47.4	34.0	16	177	186	32
4	Nigeria	7,146.1	27.5	15.8	25.4	11	114	138	67
5	Pakistan	2,514.8	23.7	23.4	24.9	20	99	159	32
6	Malaysia	2,506.6	37.9	80.4	69.9	27	19	29	4
7	Colombia	2,337.0	45.5	56.9	63.6	4	74	157	6
8	Turkey	2,224.7	40.8	65.1	65.6	12	73	38	67
9	Mexico	2,138.9	55.0	63.2	67.0	20	41	73	67
10	Egypt, Arab Rep.	1,917.1	26.5	25.4	33.0	15	44	155	147
11	Chile	1,869.2	80.1	86.6	93.3	14	30	32	64
12	Philippines	1,541.7	47.9	57.9	51.7	31	166	112	127

13	Indonesia	1,519.1	51.2	44.0	43.1	19	171	146	51
14	Peru	1,201.3	53.6	48.8	67.9	8	60	108	16
15	Vietnam	1,087.0	9.5	44.5	27.3	16	107	46	169

NOTES

1. World Governance Indicators: percentile rank among all countries (2012), ranging from 0 (lowest) to 100 (highest) rank (derived from World Bank).
2. Doing Business Indicators: 'market openness' reflects the numbers of years (at 2014) from the start of the port privatization process in each country (authors' own elaboration from Drewry Shipping Consultants, corporate websites, Port Authorities annual reports, and specialized press); 'ease to start a business', 'contract enforcement', and 'protecting investors' reflect the country rank (where 1 is the highest position and 189 the lowest), as defined by World Bank (2013).

etc, have a high standing and thus seem to demonstrate that the existence of a limited number of effective procedures for setting new business stimulates PPPs in ports. Similar evidence emerges for the variable contract enforcement. Except for China, which ensures short timing and low costs in resolving commercial lawsuits, other leading PPP nations are ranked low. Finally, the variable protecting investors provides evidence which is rather consistent with theory. The protection of minority shareholders against directors' misuse of corporate assets appears to be a relevant institutional dimension capable of affecting port PPP development.

Conclusion

Public–private partnerships (PPPs) have increasingly became a common tool in the development, modernization and privatization of port operations worldwide. In particular, since the late 1990s port PPP schemes have been largely adopted both in many advanced and developing countries, characterized by a spectacular surge of private investments (World Bank, 2012b).

This chapter conducted an exploratory investigation into the impact of PPP frameworks on port logistics performance, also raising the importance of environmental country-related factors in conditioning the development of public–private cooperative arrangements. In this perspective, the study feeds the academic debate on the advantages and disadvantages of PPPs and questions the need to include some institutional dimensions for a more complete understanding of port PPP trends.

In this regard, this chapter has provided an extensive analysis of major institutional factors that would affect the impact of PPPs on port logistics performance, based on the institutional framework of Daude and Stein (2007) and the empirical data provided by the World Bank (2012b). Overall, three World Governance indicators and four Doing Business indicators have been identified and discussed bringing some anecdotal evidence for corroborating theoretical arguments. Based on the examples from various ports, PPPs could improve port logistics performance primarily attributed to the private sector's operational and managerial expertise. However, there are also examples showing the capability of the public sector in achieving a high level of port logistics performance. Hence, having PPPs would not be the only or major way to advance port logistics performance. Further, an in-depth investigation into the top 15 developing countries pioneering port PPPs disclosed some mixed results in relation to the explanatory power of institutional factors in affecting PPP's growth. Some institutional factors, indeed, seem to be influential only in specific countries, and thus generate apparent contradictions in the understanding of the overall picture. Actually, such outcomes might be biased by the unique legislative environment in which ports operate: governments often establish ad hoc territorial legislative regimes in ports, provoking institutional asymmetries with respect to the investments carried out in the rest of the country, for instance in other types of infrastructures. In other words, ports could represent a unique setting where the assumptions of previous scholars (Daude and Stein, 2007; Kaufmann *et al*, 2009) trying to capture the influence of institutional factors in business practice need to be contextualized and partially rethought.

This chapter has contributed to increasing awareness of the complexity of this theme, and has raised the urgency of performing extensive empirical research for a clearer understanding of these arguments. In particular, it could be valuable to investigate other analytical dimensions besides those approached in this study, and to carry out cross-industry comparisons among various types of PPP transport infrastructures (eg airports, railroads, motorways, pipelines) which might be affected in different ways by institutional factors.

Note

1 In this chapter we utilize some Doing Business indicators provided by the World Bank. In addition we also elaborated the variable *market openness*, defined as the numbers of years (at 2014) from the start of the port privatization process in each country (authors' own elaboration from Drewry Shipping Consultants, corporate websites, port authorities' annual reports, and specialized press).

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Port and logistics chains: Changes in organizational effectiveness

18

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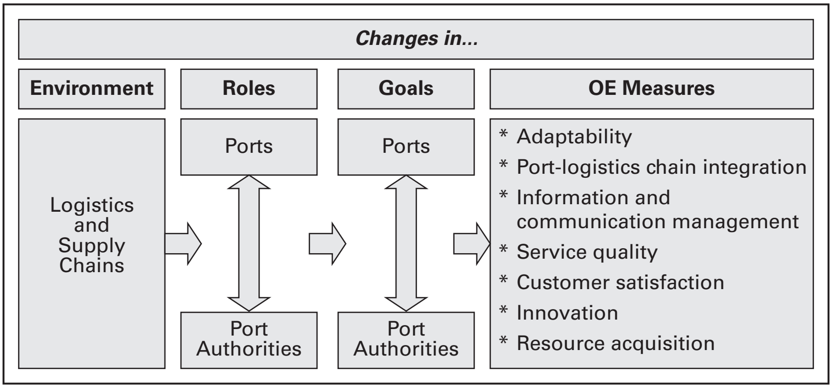
Introduction

Seaports are uniquely structured social and technical organizations (or systems) and the most vulnerable nodes in logistics chains directly affected by the oscillations in the logistics and transport markets. The developments in the supply chain, logistics and transport industry such as the horizontal and vertical integration between actors, product and process innovations, shortening product life cycles, minimization of time to markets, advances in information and communication technologies, new practices in manufacturing and logistics, restructuring of logistics networks and repositioning of regional and local distribution centres, developments in intermodal transport and, as a result of these, changes in the expectations of the players in the supply chains, have all changed the roles of ports from being places providing loading and discharging operations to intermodal terminals in the supply chain system that add value to port users and final customers. Ports have become the most important logistic link in the production, distribution and consumption chains of economies worldwide (Sanchez, 2006) and parts of intermodal networks, with competition increasingly taking place between complete logistics chains instead of between ports (de Langen and Chouly, 2004). The competitiveness of ports within logistics chains is thus a much higher priority than it was before. Due to restructuring in the markets surrounding ports and accelerating competition in the logistics, transport and port industry, organizational effectiveness (OE), which is a rather new concept for port studies aiming to assess the success of seaports, is becoming more

FIGURE 18.1 Conceptual framework



important in today's port business. OE has both an internal and external focus, which means it provides an overall evaluation of the port organization and does not solely focus on the operational measures such as efficiency and productivity.

This study is organized in accordance with the conceptual framework illustrated in Figure 18.1. The aforementioned changes in the logistics and supply chains and especially the severe competition among the actors in these chains, impel ports to provide more specialized, integrated, value-added logistics services, to integrate themselves within logistics chains by cooperating with supply chain actors, utilizing information and communication systems and knowledge sharing, increasing accessibility to the hinterland and developing intermodal transport opportunities. The changes in the traditional roles of ports put responsibility on port authorities as the administrative bodies of port organizations. Their landlord, regulator and operator roles are shifted towards a coordinator, facilitator and integrator role in port clusters, international transport, logistics and supply chains. As the roles and functions change, so too the goals. The scope of port authority goals extends towards the hinterland and logistics chains. Where the effective organization is both efficient and able to modify its goals as circumstances change (Carnall, 2003), as a member of restructuring supply and logistics chains, port authorities re-define their goals and priorities in accordance with the needs of the changing market. The changing goals also change the OE criteria. It appears that in today's port business, commonly used port performance measures such as efficiency, profitability and growth are not enough to assess a port organization's success at all points. With respect to the developments in logistics chains, in this study it is proposed that port logistics chain integration, adaptability to the changes in the environment, customer orientation and satisfaction, information and communication management, service quality and provision of value-added and intermodal services, innovation and resource acquisition gain more importance than before.

Ports and logistics chains

Developments in logistics chains and their effects on ports

Port organizations accommodate the dynamism and turbulence in their environments that are brought about by driving forces like globalization, technological advances and the changes in the expectations of the players in the supply chains. The liner shipping industry is now more concerned with being a key provider in the market for door-to-door and value-added logistics; this is an aspect that has largely been made possible by the vertical integration of traditional liner shipping companies, ports and logistics companies (Cullinane, 2005). The structural changes in the shipping companies, as the main customer of ports, force ports to adapt to their needs and expectations. Furthermore, the developments in supply chains and the logistics industry have put pressure on ports to position themselves in re-organizing supply and logistics chains and to re-define their strategies and goals to maintain their competitive positions in the market. These developments are listed below (UNESCAP and KMI, 2005; Johnson and Kaplan, 1987; Neely, 1999; Henri, 2004; Storey *et al*, 2006; Haugstetter and Cahoon, 2010):

- the globalization of manufacturing and outsourcing;
- global trends of logistics network restructuring and repositioning of regional and local distribution centres;
- one-stop-shopping concept and intermodal transport linking strategically between ocean, railway, road and inland waterway;
- rapid progress in product and process technology;
- the power of information technology;
- shortening product life cycles;
- the changing nature of work and organizational roles;
- changing external demands;
- new manufacturing practices such as total quality management, just-in-time, computer-integrated manufacturing systems and customization;
- more responsiveness to customer demand with shorter lead times;
- better dispersion of information and knowledge among stakeholders and customers.

Where ports are the most vulnerable area in the logistics and transport chains, exposed to the coming and going of the demanding parties in a highly-movable, changing, dynamic and closely inter-related port environment (Sanchez, 2006), these developments had more serious effects on ports than on the other actors in logistics chains. The developments in the logistics and port environment have created the need for ports to be part of wider logistics networks and to provide value-added services (Verhoeven, 2010). In an era of economic globalization ports are evolving rapidly from being traditional land – sea interfaces to being providers of complete logistics networks (UNESCAP and KMI, 2005) and value-added logistics services (Bichou and Gray, 2004) and their pre-eminent role in international distribution is unlikely to be challenged in the foreseeable future (Notteboom and Winkelmans, 2001a).

Changing roles of ports in logistics chains

There are various definitions of seaports in terms of their changing roles within global logistics and supply chains. Seaports can evolve from a pure import/export and transhipment centre to a complex of trade and industrial functions within a logistics system (UNESCAP and KMI, 2005; IAPH, 1996). They are the value-adding transfer points (Notteboom, 1998) and central links in complex supply and logistics (Banister *et al*, 1995) and transportation chains, providing seamless transport facilities (Branch, 1986) with a strong interface with other modes of transport services (Branch, 2007). According to Paixão and Marlow (2003, p 358) seaports function as 'bi-directional logistics systems' and this logistics system requires a high level of coordination and inter-connectivity capabilities within the port system (Panayides and Song, 2006). A more comprehensive definition of a seaport highlighting its role in logistics chains is as follows (Notteboom, 1998, p 9):

> A sea port is a logistic and industrial node in the global transport system with a strong maritime character and in which a functional and spatial clustering of activities takes place, activities that are directly or indirectly linked to seamless transportation and transformation processes within logistic chains.

According to de Langen's (2004) port cluster perspective, apart from their traditional roles, seaports should be regarded as logistics centres, industrial zones and centres of trade. Branch (2007) and Notteboom and Rodrigue (2005) state that the free trade zone, the inland clearance depot, the freight village, container freight stations, distriparks are the components of the ports as trading and industrial centres with an increasing role in global supply chain management and logistics network structures (UNESCAP and KMI, 2005).

Table 18.1 lists the changing roles of ports in terms of the developments in the external environment, functional and spatial organization, and port organization and strategy. In light of UNCTAD's (1992) port generation concept and the WORKPORT model (Beresford *et al*, 2004), Pettit and Beresford (2009) demonstrate the role of ports in supply chains and how this has changed during the last four decades, with the increasing emphasis on value-added activities, lean and agile logistics concepts categorized as port production characteristics (in Table 18.1) and the vertical integration of ports into supply chains. Notteboom (1998) illustrates the functional and spatial development of seaports and describes ports as integrated transport, logistics and information complex and networks.

TABLE 18.1 Characteristics of logistics-oriented (fourth-generation) ports

External environment	
Period of development	After 2000s
Decisive factors	Global information technology/know-how and port networks
Exogenous developments	Global economy Information systems Environment Informatization
Functional organization	
Type of cargo	Specialisation in cargo types: Bulk cargo, containerised cargo, special cargo
Port functions	Cargo loading, discharging, storage and navigational services Cargo transformation; ship-related industrial and commercial services Cargo and information distribution, total logistical activities Logistics and distribution centre services Logistic control
Production characteristics	Cargo/information flow Cargo/information distribution High value logistic facilities (network oriented) Integrated logistics services Dedicated terminals Agility and leanness Chain management Emphasis on quality of service and trained work force
Spatial organization	
Spatial expansion of port	Port–city separation (loosening relations) Regionalization (cooperation with inland, dry ports and seaports in proximity) Terminalization (global port network: networks of terminals under corporate logic) Network-related functional expansion
Locational factors	Availability of transhipment facilities Access to sales market Space Flexibility and costs of labour Available know-how Quality of life

(*Continued*)

TABLE 18.1 Characteristics of logistics-oriented (fourth-generation) ports (*Continued*)

Societal organization	
Ecosystems	Environmental interactions with the outside Greater environmental control Green port (sustainability)
Human factor	Sustainable co-habitation with local communities
Port organization and strategy	
Organization characteristics	Port network community Close relation between port network and public authorities Close relations between shipping lines, shippers and ports Enlarged port organization (joint ventures between port authorities) Physically separated ports linked through common operators/administration
Port authority's task	Nautical services Development of port area and infrastructure Port marketing Network management
Attitude and strategy	Global commercial oriented Logistics and distribution platform for global trade Integrated transport, logistic and information complex and network

SOURCE UNCTAD (1992); World Bank (1992); van Klink and van den Berg (1994); van Klink (1995); Notteboom (1998); UNCTAD (1999); UNESCAP (2002); Beresford *et al* (2004); Alderton (2008); Paixão and Marlow (2003); Yan (2009); European Parliament (2009); Verhoeven (2010); Teurelincx (2011)

The changing roles of ports in logistics chains are commonly studied from the perspectives of port logistic chain integration, port – hinterland relations and value added in logistics chains. There have been a number of papers on the orientation and integration of ports and terminals into the supply and logistics chains (Carbone and De Martino, 2003; Song and Panayides, 2008; Notteboom, 2009; Pettit and Beresford, 2009; De Martino and Morvillo, 2008; Panayides and Song, 2008, 2009; Woo and Pettit, 2009). The Council of Supply Chain Management Professionals (CSCMP) declares that supply and logistics chain 'includes coordination and collaboration with channel partners, which can be suppliers, intermediaries, third-party service providers, customers' and as the key constituents of many supply and logistics chains 'seaports' (Notteboom and Winkelmans, 2001a; Sanchez, 2006, Pettit and Beresford, 2009).

Panayides and Song (2009) indicate that ports and terminals should strategically position themselves to facilitate the provision of high-quality services for their users through integration with their supply chain. Woo and Pettit (2009, p 3) define port supply chain integration as 'a strategy undertaken by a seaport terminal to integrate various functions and organizations in a supply chain to become an integral part of the supply chain' and they determine its components as: information sharing, information and communication systems, long-term relationships, value-added and intermodal services, and supply chain integration practices. Bichou and Gray (2004, 2005) propose a channel approach and conceptualize the role of ports from three perspectives: 'logistics channel' perspective, where the port serves as an intermodal transport intersection and operates as a logistics centre; 'trade channel' perspective, where the port acts as a key location where channel control and ownership can be identified and trading takes place; 'supply channel' perspective, where the port not only links outside flows and processes but also creates patterns and processes of its own.

Logistics drives port development primarily involving intermodal transport services (Branch, 2007) and allows seaports to connect to the inland and dry ports. The European Parliament (2009) explains the evolving role of seaports in the fast-changing logistics environment in terms of three spatial development phases: 'port community', 'port regionalization' and 'port terminalization'. At present, a terminalization phase – characterized by increased connectivity of the port with its hinterland through intermodal networks and inland terminals – is going on. Verhoeven (2010) analyses characteristics of multi-purpose gateway ports in terms of operational, spatial and societal dimensions. He highlights the developments in port terminalization and regionalization, and indicates that logistics-oriented ports of today form networks beyond the port area by cooperating with inland ports, dry ports and with other seaports in proximity (port regionalization or port networking) (Notteboom and Winkelmans, 2001a); and albeit they are physically separated, they are linked through common multinational operators (port terminalization) (UNCTAD, 1999). Notteboom and Rodrigue (2005) stress the importance of inland terminals, corridors and freight distribution centres in port regionalization and indicate that inland accessibility should be regarded as a cornerstone in port competitiveness.

Ports' ability to integrate their operations vertically both upstream and downstream in the logistics chain gives them the ability to control the movement of cargo and create value within logistics chains (Paixão and Marlow, 2003). Robinson (2002) introduces the concept of value chains in the port environment and discusses that competition takes place along value (viz logistics) chains not between individual ports. The author advocates that ports contribute to the supply chains through the creation of competitive advantage and value-added delivery. Achievement of the highest possible value added, together with minimization of the cargo transport service, is currently the most important criterion of the economic activity of every seaport (Mistzal, 2007). The gateway position of major seaports offers opportunities for the development of value-added logistics services. Mangan *et al* (2008, p 36) define port-centric logistics as 'the provision of distribution and other value-adding logistics services at a port' and advocate that higher profit margins can be made by the provision of non-core port activities. Carbone and De Martino (2003, p.306) define a value-added service as 'an activity along the chain that adds value to the product or service and for which the final customer is willing to pay' and these services vary from simple processes such as packaging, labelling and bar-coding to more complicated processes such as inventory management and quality control (UNESCAP, 2002). Ports are becoming part of complex logistics and value chains (Haugstetter and Cahoon, 2010), and the value is 'created as much outside a company as within' (Gratton, 2006, p 2). By offering value-added logistics services, ports aim to attract a large portion of the value-added creation within product and logistics chains (Notteboom and Winkelmans, 2001a, Paixão and Marlow, 2003).

Port authorities in logistics chains

The developments in logistics chains did not only change the role of ports and terminals, but also changed the roles, strategies and functions of port authorities as the administrative body of the port organization. It is important to look at the changes in their traditional roles, as they are the strategic decision-makers and goal-setters in a port organization and responsible for the overall effectiveness of the port.

Traditional roles of port authorities

A 'port authority (PA)', which is defined by Commission of the European Communities (2001, p 28) as 'a body which, has as its objective under national law or regulation the administration and management of the port infrastructures, and the coordination and control of the activities of the different operators present in the port or port system concerned' is gaining new roles together with the changing functions of ports within the supply and logistics chains.

There have been a number of studies on the traditional roles of port authorities (UNCTAD, 1985; Baird, 1995, 2000; Haralambides *et al*, 1997; Baltazar and Brooks, 2001; Brooks and Cullinane, 2007; World Bank, 2007). Principally, port authorities are the major owners of the port land (Bichou and Gray, 2004) and thus the primary asset of a port authority is the land inside the borders of the port area (van der Lugt and de Langen, 2007). In this respect, the major two revenue drivers of port authorities are

TABLE 18.2 Traditional roles of port authorities

Regulator	Landlord	Operator
- licensing port works - port policy - VTS services - laws and regulations - port labour regulations - environmental policy - customs - protection of public interest for port community	- management, maintenance and development of port estate - civil engineering works - provision of infrastructure and facilities - implementation of policies and development strategies - protection and maintenance of port infrastructure - marketing of port location - port safety	- physical transfer of goods and passengers between sea and land - provision of technical – nautical services - waste disposal - equipment maintenance

SOURCE UNCTAD (1998); Baird (2000); World Bank (2007); Verhoeven (2010)

land value and port throughput (de Langen, 2009; Estache and Trujillo, 2009). By stressing the efficient management and development of the port estate as an entrepreneur, and also when seen from the value chain perspective, Verhoeven (2010) states that the principal function of contemporary port authorities is the landlord function.

Baird (1995, 2000), Baltazar and Brooks (2001), Brooks and Cullinane (2007) and Verhoeven (2010) categorize the traditional roles of port authorities into three headings: 'regulator', 'landlord' and 'operator' (see Table 18.2). Estache and Trujillo (2009) use the term 'strategic' instead of landlord function and state that strategic activities of a port authority include port planning and development, preparation of the business plan and management of the economic interactions regarding port infra- and superstructure. UNCTAD (1998) advocate that beside the landlord and regulator functions, a modern port authority has to concentrate its efforts on the provision of policy-making, port planning, promotion and training. De Langen (2009) classifies the traditional landlord roles of port authorities into four categories as traffic, area, customer and stakeholder management. Stakeholder management issues are of great importance considering the need for the involvement of port authorities into the hinterland chains.

Changing roles of port authorities in logistics chains

The ever-changing port environment has had serious effects on the traditional roles of port authorities. After the 1970s, running alongside the impact of containerization, the globalization and liberalization processes increased the power of private players and reduced the role of the port authority (Verhoeven, 2010). In particular, after the 1990s, the power of port authorities with regards to port administration were gradually decreased (Meersman and van de Voorde, 2002).

Estache and Trujillo (2009) organize the need for changes in port authorities around two themes: 'operational' and 'strategic'. Operational includes the poor monitoring of economic and financial performance and the effects of bureaucratic environment; at the strategic level, political interference is the main reason for change in port authorities' roles. Van der Lugt and de Langen (2007) summarize the reasons for these changes in the roles of port authorities as follows:

- restructuring of division of responsibilities and changes in institutional position of port authorities as a result of the ongoing port reforms;
- the need to prove the value of port's contribution to society in social and economic terms;
- because of the extension of port competition towards the hinterland, allocation of port resources to the improvement of the inland chains.

The division of roles and responsibilities of port authorities is a controversial issue. There are different and sometimes opposite views on whether the duties of a port authority should be solely covered by port administration and regulation-related issues or whether, as a market player, a port authority should get involved in operational and commercial issues (Delwaide, 2007 vs De Monie, 2004). Estache and Trujillo (2009) and the European Parliament (2009) claim that port authorities' 'regulatory' functions are becoming less important. Coltof (2000) advocates that in the port environment there is a trend to turn port authorities into more autonomous organizational units as a 'coordinating body' between the central government, the local/regional authorities and the private sector. While Delwaide (2007) claims that as an entrepreneur, port authorities should be involved in port operations by taking strategic shareholder positions in global terminal operators, De Monie (2004) indicates that this approach can jeopardize the impartiality of port authorities. Considering the 'landlord' port authorities, their 'operator' role has declined with the effects of the accelerating trend on port privatization and the shift of port operations to the private sector. The operator role now consists of the 'granting and surveillance of concessions' (Verhoeven, 2010).

The traditional roles of port authorities have been shifted towards a 'coordinator, facilitator and integrator role in port clusters, international transport, logistics and supply chains' (see Table 18.3). There have been many studies supporting the view that 'beyond their traditional landlord functions, port authorities should acquire a facilitator role in logistics chains for the development of efficient and effective port – hinterland relations by acting as a mediator and coordinator of port stakeholders' (Notteboom and

TABLE 18.3 Port authorities' changing roles in logistics chains

Study	Port authorities' roles	Port authorities' functions
Notteboom and Winkelmans (2001a)	'Facilitator in Transport Chains–Coordinator in Port Networks'	*provision of value-added logistics services *development of information systems *planning and implementation of intermodal services *port networking
Chlomoudis, *et al* (2003)	'Smart Port Authority' – 'Brain of the Port Society'	*following the market developments *advancing the networking of market players *setting the targets in co-operation with several partners (public authorities, municipal authorities, scientific societies etc) *developing a port 'culture of trust'
De Langen (2004)	'Port Cluster Manager'	*together with private port operators and other stakeholders, co-investing in hinterland nodes
De Langen and Chouly (2004)	'Collaborator in Port Hinterland Access Regime'	*having a clear hinterland strategy *creating a network of inland representatives *developing market intelligence to identify opportunities
Notteboom and Rodrigue (2005)	'Facilitator in Transport Chains'	*working together with various stakeholders to identify issues affecting logistics performance *promoting an efficient intermodal system *development of strategic relationships with other transport nodes *active engagement in the development of inland freight distribution, information systems and intermodality
Panayides (2006)	'Planner of the Transportation Networks beyond Port Boundaries'	*planning for the smooth/cost-effective flow of cargoes by considering the transportation flow beyond the port's boundaries.
Sanchez (2006)	'Catalyst of Logistic Integration and Networking' 'Transport and Logistics Facilitator'	*reaching the fine equilibrium between the public policies and the political power, with the private sector and the social players *promoting the competition *cooperating with the hinterland and other regional and non- regional ports/port authorities *imposing measures for environmental protection *information sharing and coordination in port community *developing efficient communication between port and city

(*Continued*)

TABLE 18.3 Port authorities' changing roles in logistics chains (*Continued*)

Study	Port authorities' roles	Port authorities' functions
van der Lugt and de Langen (2007)	'Port Authority beyond Landlord Function' 'Coordinator in Port Clusters'	*activities beyond the landlord function (port hinterland activities) -own/non-own port-related activities -operational and supporting activities -activities within port boundaries and extending hinterland *creating platforms that facilitate collective action in port clusters *training, consulting, innovation, ICT services, port promotion, investing in hinterland facilities
Cahoon and Notteboom (2008)	'Integrator in Supply Chains'	*integrating the port into the business relations network shaping supply chains
De Martino and Morvillo (2008)	'Identifier of the Critical Assets'	*improving port infrastructures and their connections within existing transport systems *keeping in mind the criteria of environmental, social and economic sustainability *allowing free competition between port operators through concessions of terminals and spaces for the supply of value added services *enhancing the collaboration and co-ordination of port activities through IT systems *promoting the development of its own hinterland by creating economical, relational and social connections between the port and the market place
de Langen (2009)	'Coordinator in Port Clusters and International Transport Chains'	*investing in rail and barge terminals in port and hinterland *setting infrastructure access rules for rail and road *investing in port community system *setting the conditions in concession contracts *enabling competition and reducing entry barriers
Estache and Trujillo (2009)	'Facilitator of Intermodal Coordination and of Logistics Integration'	*having focused policy and strategic responsibilities *integrating into regional, national or supranational ports *having a mandate to support multiple ports within a region or across a port range

European Parliament (2009)	'Facilitator in Logistics Chains'	*optimizing port processes and infrastructure *playing a central role in developing platforms in conjunction with all stakeholders in order to address issues affecting logistics performance *promoting and sustaining an efficient intermodal transport system *developing strategic relations with the hinterland
Notteboom (2009)	'Facilitator in Port Hinterland Networks'	*setting up task forces together with various stakeholders to address issues affecting logistics performance *establishing links with inland and dry ports *improving the port–hinterland interface *structuring hinterland networks *promoting an efficient intermodal system in order to secure cargo under conditions of high competition
Woo and Pettit (2009)	'Port Supply Chain Integrator'	*providing facilities for value-added logistics and intermodal transport
Haugstetter and Cahoon (2010)	'Collaborator in Supply Chains and Logistics Networks'–'Port Cluster Manager'	*networking and cooperating beyond port boundaries *gaining knowledge and integrating information by the use of strategic collaborations in supply chain networks
Verhoeven (2010)	'Port Community/Port Cluster Manager' 'Entrepreneur': Investing in the port hinterland 'Facilitator': Strategic partnerships with inland and dry ports–cooperation with neighbouring ports	*Landlord and regulator functions. *Operator functions: dynamic use of concession policy in combination with real estate development role. *Economic functions: – solve hinterland bottlenecks and facilitate the coordination between port stakeholders – provide training and education – provide ICT services – promotion – lobbying *Societal functions: – accommodate conflicting interests – lobbying – promote positive externalities

Winkelmans, 2001a; Chlomoudis *et al*, 2003; de Langen and Chouly, 2004; Notteboom and Rodrigue, 2005; Sanchez, 2006; van der Lugt and de Langen, 2007; Cahoon and Notteboom, 2008; de Langen, 2009; Estache and Trujillo, 2009; Haugstetter and Cahoon, 2010 and Verhoeven, 2010).

'The greater integration of international logistics and the increased pressure on the port/inland interface is resulting in more attention to relationships in port communities' (Heaver, 2006, p 29) and force port authorities to take new roles to manage and control the whole port community and port clusters. In this respect, Verhoeven (2010) defines port authorities as 'port community and cluster managers' and approaches their changing roles from social and economic dimensions. Concurring with the author, de Langen (2009) stresses the importance of the new role of a port authority, which is 'coordinator in port clusters and international transport chains'. Together with Verhoeven (2010), according to a number of scholars (de Langen and Chouly, 2004; van der Horst and de Langen, 2007; van der Lugt and de Langen, 2007; de Langen, 2009), the changing roles of port authorities can be grouped as follows:

- Economic dimension:
  - solving hinterland bottlenecks;
  - coordinating port stakeholders;
  - providing training and education;
  - providing information and communication technology (ICT) services;
  - port promotion;
  - lobbying.
- Social dimension:
  - promoting positive externalities;
  - accommodating conflicting interest;
  - lobbying.

In this context, it can be deduced that involvement within the hinterland and logistics chains, cooperating with the stakeholders both inside and outside the port by solving conflicting interests and using the latest ICT for coordination in port community are the main concerns of today's port authorities.

According to some other studies (European Parliament, 2009; Notteboom and Winkelmans, 2001a; Notteboom and Rodrigue, 2005), the main role of port authorities is to act as 'facilitators within logistics chains' and their changing functions are as follows:

- optimizing port and logistics processes and infrastructure;
- focusing on value-added logistics;
- playing a central role in developing platforms in order to address issues affecting logistics performance;

- developing the information and port community systems;
- promoting and sustaining an efficient intermodal transport system and participating in the planning and/or implementation of new (intermodal) transport services;
- developing strategic relations with the hinterland and inland connectivity;
- port networking with overseas ports, neighbouring ports, and/or inland ports.

Notteboom and Winkelmans (2001a) stress the importance of 'port networking' with overseas ports for knowledge and idea sharing, among neighbouring ports for preventing port authorities from wasting scarce resources on inter-port competition and finally with inland ports for decreasing port congestion. Van der Lugt and de Langen (2007) note that port authorities develop their activities beyond the landlord functions, towards the port hinterland. The authors develop a framework based on Porter's (1985) 'value chain approach' regarding the port authorities' activities beyond the landlord. In their approach, they structure port activities along three dimensions: home-port related vs non-home-port related; primary vs secondary activities; within port boundaries vs extending to the port's hinterland. The examples of the operational activities of port authorities extending to the hinterland are mainly investing in the inland distribution network, inland terminals and logistical sites.

UNESCAP (2002, p 23) accentuates the role of port authorities in logistics chains by indicating that 'the logistics chain consists of activities that facilitate the movement of goods from supply to demand. As many such activities require the use of ports, port authorities have taken a particular interest in the various port activities involved in logistics'. Notteboom and Rodrigue (2005) and Notteboom and Winkelmans (2001a) state that major European port authorities are involved in hinterland operations by introducing shuttle train services to the hinterland together with the rail operators, national railway companies, terminal operators, shipping companies and large shippers. For instance, by acting as an intermediary between the various port actors and an initiator of hinterland transport projects, Rotterdam Port Authority is actively involved in improving the hinterland access (de Langen and Chouly, 2004), invests in inland terminals, and cooperates with rail transport companies for the hinterland accessibility of the port.

Port authorities located in intermodal hubs have many opportunities for collaborating and linking strategically across boundaries (Haugstetter and Cahoon, 2010). The European Parliament (2009, p 74) indicates that 'port authorities' future role can be described as developing good interconnections between the port area and the hinterland through various intermodal transport systems'. De Langen (2009) advocates that port authorities should contribute actively to better hinterland access by improving coordination in port clusters and supply chains. By sharing the same point of view, Verhoeven (2010) states that port authorities develop an 'entrepreneurial' role by investing in the port hinterland and should be 'facilitators in logistics chains' through ensuring strategic partnerships with inland and dry ports and by cooperating with neighbouring ports.

Port authorities' focus will be on embedding the port in strong networks with other ports and inland terminals (European Parliament, 2009; Notteboom, 2009) and developing strategic relationships with other transport centres within the same logistics chain. Traffic management, hinterland connections and services, environmental protection, marketing, and research and development are the main fields of cooperation between ports (Notteboom and Winkelmans, 2001a). Estache and Trujillo (2009) advocate that as 'facilitators of intermodal coordination and of logistics integration', port authorities will have a mandate to support multiple ports within a region or across a port range and thus they ensure financial autonomy and control over a larger market.

Port authorities could stimulate the logistics activities in and near the port area by providing flexible labour conditions, smooth customs formalities and powerful information systems (Notteboom and Winkelmans, 2001a) and improve hinterland access by setting infrastructure access rules, investing in a port community system, setting conditions in terminal concessions and assuring sufficient competition between firms in the supply chain (de Langen, 2009).

Port authorities invest and get involved in hinterland activities because they have an interest in the ports' hinterland. Since port competition is much more related to the performance of the whole network than to the ports' internal performance, the smooth functioning of the logistics chains and efficient flow of inland transport system contribute to the performance of the port. Inadequate connections may provide port management with an incentive to reduce port dues or offer financial compensations in an effort to maintain or increase its market share (Suykens and van de Voorde, 1998). The coordination and cooperation among ports in logistics chains provides more traffic and more port activity, as this will increase total revenue of port authorities (Notteboom and Winkelmans, 2001a) and the involvement of port authorities in the activities outside the port area contributes significantly to the utilization of the infrastructure inside the port area (de Langen, 2009).

Changes in effectiveness of port organizations

Because of the ongoing developments in logistics chains and the accelerating competition between ports, in today's port business circumstances, commonly used port performance measures such as efficiency, profitability and growth are not enough to assess a port organization's success at all points.

Multivariate approaches are needed. Organizational effectiveness, which is not a widely studied concept in port literature, allows the assessment of overall success of ports by the use of many different variables that could be determined in accordance with the stated goals.

Organizational effectiveness and ports

From the earlier stages of organizational theory on effectiveness to the present, there is still an ambiguity about the definition and measurement criteria of effectiveness. In order to examine the effectiveness of the modern port environment, the wide research area of OE has to be analysed and some basic definitions regarding this notion should be given. There are many approaches to organizational effectiveness supported by pioneer theorists in management, and the main OE theories/approaches and their proponents are listed below:

- the goal attainment approach (Etzioni, 1960);
- the systems approach (Yuchtman and Seashore, 1967);
- the internal process approach (Bennis, 1966; Steers, 1977; Pfeffer, 1977; Nadler and Tushman, 1980);
- the human relations approach (Argyris, 1964; Ahmed, 1999);
- the strategic constituencies approach (Pfeffer and Salancik, 1978; Connolly *et al*, 1980; Jobson and Schneck, 1982, Keeley, 1984; Tsui, 1987; Zammuto, 1984; Ehreth, 1988);
- the competing values approach (Quinn and Rohrbaugh, 1983; Shilbury and Moore, 2006);
- the ineffectiveness approach (Henri, 2004).

Assuming that seaports are open systems (Berrien, 1976) with permeable boundaries between itself and broader supra-systems which are transport, logistics and supply chain systems, it has been decided that 'systems approach to organizational effectiveness' best fits with the nature of ports. A more comprehensive and detailed explanation on the 'ports-as-open-systems' approach was given in Karatas Cetin and Cerit (2010a, b, c). Systems approach takes into consideration the environment and the whole system that an organization works within, not just the organization itself. Therefore, in this study, the systems concept associates the port organization's effectiveness with the supply and logistics chains. From the systems' point of view, organizational effectiveness is defined as) 'the extent to which an organization as a social system, given certain resources and means, fulfils its objectives without incapacitating its resources' (Georgopoulos and Tannenbaum, 1957, p 535). In line with this definition, Argyris (1964) advocates that three core activities of an effective organization are: achieving objectives, maintaining the internal system and adapting to the external environment. A useful framework for assessing OE suggests four main categories: achieving goals, increasing resourcefulness, satisfying clients, and improving internal processes (Cameron, 1980; Bramley, 1986; Redshaw, 2000). It can be inferred that, along with the goal attainment as the primary concern of effectiveness, the other important measures are continuous 'acquisition of port resources' such as land, infrastructure, superstructure, labour, etc, 'adaptability' to the changing environmental conditions and 'customer satisfaction' while improving 'efficiency'.

According to Kast and Rosenzweig (1972), the questions of OE must be concerned with at least three levels of analysis: the level of the environment, the level of the social organization as a system, and the level of the subsystems within the organization. In this study, effectiveness of port organizations is assessed considering the changes and developments in the port environment, mainly within logistics chains as well as the changing role of ports at the organization level. In accordance with Katz and Kahn's (1966) view that effectiveness is linked explicitly to an external referent, and efficiency to internal activities especially economic and technical aspects more easily controlled by the organization, it is believed that evaluating internal systems or processes of ports is the concern of 'efficiency' rather than 'effectiveness'. Here, it will be useful to specify that in the management discipline many researchers (Mahoney, 1967; Gibson *et al*, 1973; Webb, 1974; Sayareh and Lewarn, 2006) used efficiency as a criterion for the assessment of organizational effectiveness. However, Baltazar and Brooks (2007) claim that some minimum level of both efficiency and effectiveness is critical to organizational survival.

Organizations are constructed to be the most effective and efficient social units. The actual effectiveness of a specific organization is determined by the degree to which it realizes its goals. It is evident that although many ports are in possession of the right infrastructure and necessary equipment, what they lack is effective management or modern management know-how. In many instances, basic management principles including the clear description of objectives appear to be amiss (Haralambides *et al*, 1997). Notteboom and Winkelmans (2001b) state that a successful (viz effective) port organization requires the adoption of a market-oriented management system based on clear goals. Therefore, for a port organization to achieve effectiveness, before all else, the goals of the port should be clearly defined. Since effectiveness associates with the whole port organization, goal setting is the responsibility of the port authorities. Based on analysis of about 60 annual reports of port authorities, van der Lugt and de Langen (2007) derive two main goals that are common to most port authorities and distinguish these goals as one port level and one port authority level. They define (p 5) the port level goal as 'to facilitate a sustainable economic development of the port as a whole' and the port authority (firm) level goal as 'to become an efficient and effective organization that generates income to cover costs, to make investments and in some cases to return to shareholders' investment'. However, Brooks and Cullinane (2007) found that not all ports focus on achieving similar strategic goals: it depends on the governance structure of ports.

They classified the strategic goals of ports as economically oriented, mainly concerned with the maximization of throughput, and those where the wider macroeconomic benefits are the main concern.

Meersman and van de Voorde (2002) believe that the goals of a port authority are closely connected with what is considered to be the 'economic function' and 'the product' of a seaport. They state that, in the past the goals of a port authority were restricted mainly to increase throughput, maximize profits, generate value-added and create employment. Suykens and van de Voorde (1998) state that the goals of a port authority are often extremely diverse and they may change considerably over a longer period of time. As the relative strength of the various players in the logistics chains changed (due to the vertical and horizontal integrations in shipping, transport and logistics industries), so too did the port's products and functions. Since the roles of ports has changed within logistics chains, port economic functions are not restricted to the transhipment of goods but also cover value-added logistics and intermodal transport services and in some cases industrial activities. Thence, the scope of port authority goals has extended to the hinterland and through logistics chains. Where the effective organization is both efficient and able to modify its goals as circumstances change (Carnall, 2003), as a member of restructuring supply and logistics chains, port authorities should re-define their goals and priorities in accordance with the needs of the changing market and its members.

Brooks and Pallis (2008) propose that effectiveness relates to how well the firm uses its strategies, structures, and task environment to meet its stated goals. When the degree of uncertainty and complexity of the port environment is high, the strategies focus on the delivery of highly differentiated and specialized services and the organizational structures and decision-making are becoming more decentralized, effectiveness-oriented performance measurements rather than efficiency-oriented measurements are needed to achieve the port's goals (Baltazar and Brooks, 2007). This perspective ties in neatly with our claim that 'ports-as-open-systems' function in a frequently changing environment with a high degree of complexity, where global production and trade chains, supply and logistics chains and transport chains force ports to restructure their organizational setting. Furthermore, the rapid increase in port competition within the logistics chains has put pressure on ports to improve the quality of their traditional port services, implementing differentiation strategies by providing more specialized, value-added services and delivering door-to-door transport solutions.

Changes in port effectiveness measures

Whether efficiency and performance are widely studied concepts in port business and economics literature, there are a limited number of papers attempting to explain the effectiveness of port organizations (Sayareh and Lewarn, 2006; Baltazar and Brooks, 2007; Sayareh, 2007; Brooks and

Pallis, 2008, Karatas Cetin and Cerit, 2010a, b, c). As Brooks (2007) states, it is not enough to use only broad organizational performance measures such as volume throughput, sales volume and profitability, especially at the time of change in port environment. Since the goals of the ports and port authorities change over time, so should the effectiveness measures needed to achieve them. Table 18.4 lists 13 port effectiveness measures which can explain the effectiveness of port organizations at all points in this new competitive landscape. It is necessary to clarify that this study does not deal with all of the 13 measures determined. It would be unreasonable to deny the importance of commonly used port performance measures such as productivity, efficiency, profitability and growth. However, this study aims to expound new criteria which are becoming crucial for ports to achieve effectiveness and sustain competitiveness within the logistics chains. The measures are derived from the results of the Delphi study applied in Karatas Cetin and Cerit (2010a) and a comprehensive review of 38 theoretical and empirical publication on organizational effectiveness (Karatas Cetin and Cerit, 2010b), which resulted in 108 different effectiveness measures. The result of the review shows that the most frequently used effectiveness measure is 'adaptability/flexibility' (appeared in 17 of 38 studies). Other main effectiveness criteria include the tangible measures (Sahni, 2000) such as productivity, profitability, growth and efficiency, which are more conveniently measured than eg adaptability, integration, and information and communication management.

In accordance with the conceptual framework, due to the developments in logistics chains and their impacts on ports' roles, goals and functions, it is proposed that some other criteria including integration, adaptability, customer satisfaction, information and communication management, service quality, innovation and resource acquisition are gaining importance over the others. The review of port studies concerning the effectiveness, success and competitiveness of ports (see Table 18.5) indicates that ports and port authorities should focus on the following factors to sustain their competitive positions in view of the developments in supply and logistics chains:

- supply chain integration practices: organizing activities beyond port area in its hinterland;
- facilitation of inter-connectivity with other modes of transport;
- agility/adaptability: adapting to the new logistics trends;
- the development of information and communication technologies, and availability of powerful information channels;
- provision of high-quality value-added and intermodal services;
- customer orientation and satisfaction, familiarity with customer needs;
- innovation and knowledge sharing.

TABLE 18.4 Port effectiveness measures and their definitions

Effectiveness measures	Definition
Productivity.	Achieving maximum level of outputs by using minimum level of inputs in port services.
Efficiency.	The production of the desired results with minimum waste of time, effort and skill.
Service Quality.	The reliability and competence of the traditional and value-added port services.
Profitability.	Ability of the port to generate earnings as compared to its expenses and other relevant costs incurred.
Growth.	Increase in port's business volume, incomes, manpower, assets, capacity and market share.
Adaptability.	Successful adjustment of the port's internal system to internal organizational changes and successful adaptation of the port to externally induced change.
Information and Communication Management.	Completeness in the collection and analysis of information and successful functioning of all the channels of communication within and between ports and other related parties.
Innovation.	The level of usage of science and technology in port and successful implementation of creative ideas to generate value added services.
Organization's Worth. . .	The extent to which port organization is of value to its employees, and the extent to which the port and its employees are of value to society.
Employee Satisfaction. . .	The degree to which a port satisfies its employees' needs and expectations.
Customer Satisfaction. . .	The degree to which a port satisfies its customers' needs and expectations.
Resource Acquisition.	Ability of the port to acquire all the required resources (eg financial, technological and infrastructural).
Integration.	Integration of the port to the supply chain and logistics networks, by the use of utilizing its multimodal transport connections.

NOTE The measures listed are extracted through a survey study conducted by the author in August 2010.

TABLE 18.5 Port success/effectiveness measures

Haralambides, *et al* (1997)	Effective Management Factors: clear description of objectives and area of authority and responsibility, accountability and control, adequate rules and regulations, good statistical and information systems, analytical accounting and cost control, quality control, human resource development.
Suykens and van de Voorde (1998)	Port hinterland transport connections.
Coltof (2000)	Market share, geographical location, availability of port facilities, hinterland, frequency of lines, port service quality, reliability, financial position.
Notteboom and Winkelmans (2001a)	Adoption of a market-oriented management system based on clear goals, managerial skills and accountability, commercial attitude, mentality, entrepreneurial culture, providing value-added logistics services, investing in information systems, providing intermodal connections and port networking.
Notteboom and Winkelmans (2001b)	Flexibility to adapt quickly to changing opportunities, integral approach to logistics issues in transport chains.
UNESCAP (2002)	Providing a diverse range of highly integrated port services.
Chlomoudis, *et al* (2003)	Increased quality of services, high levels of flexibility/adaptability, closer integration with other transport modes, higher levels of product and process innovation, better management and marketing strategies, more efficient labour mobilization and participation.
Marlow and Paixao (2003)	Agility, leanness.
Paixao and Marlow (2003)	Adapting to 21st century logistics trends, delivering higher value and intermodal services, internal and external integration within logistics chains.
Bichou and Gray (2004)	Ability of ports to interact with channel members, integrate into logistics, trade and supply channels.

De Langen (2004)	Value generated by the port cluster.
De Langen and Chouly (2004)	Ability of a port to serve markets in the hinterland efficiently by improving the quality of hinterland transport services.
Park and De (2004)	Productivity, profitability, marketability, overall efficiency.
Song and Yeo (2004)	Customer orientation
Notteboom and Rodrigue (2005)	Inland accessibility, capability to fit into the networks that shape supply chains, the availability of powerful information channels and the capability of having knowledge transfer among the parties.
Panayides (2006)	Provision of value-added services, facilitation of inter-connectivity/inter-operability with other modes of transport, hinterland accessibility, leanness, agility, time compression, the performance of other parties in the supply chain.
Sayareh and Lewarn (2006)	Adaptability, productivity, profitability, efficiency, growth, planning, communication/information management, stability, output quality, customer satisfaction, leadership, human resource management, professionalism.
Baltazar and Brooks (2007)	Fit between strategy, structure and environment.
De Langen and Van der Lugt (2007)	Fit between local environment, port governance model, strategy and port resource/capabilities.
Notteboom (2007)	Reliability and flexibility in services, transparency in port governance, external coordination and control, planning and concession policy approach, customer orientation, information management and communication, logistics orientation, community support and strong environmental record.
Brooks and Pallis (2008)	Effective use of strategies, structures, and task environment to meet the mission and stated goals.

(*Continued*)

TABLE 18.5 Port success/effectiveness measures (*Continued*)

Cahoon and Notteboom (2008)	Ability to integrate the port effectively into the networks of business relationships that shape supply chains, familiarity with customer needs, being solution based in encouraging trade facilitation throughout the logistics chains and networks, developing pricing and communications strategies that clearly articulate the port service offering and value proposition for customers.
Song and Panayides (2008)	Price, quality, reliability, customisation, responsiveness.
Notteboom (2009)	Ability to fit into the networks that shape supply chains, close coordination with logistics actors outside the port perimeter, integrated approach to port infrastructure planning, ability of port community to exploit synergies with other transport nodes and players in logistics network.
Panayides and Song (2009)	Establishing information and communication systems that facilitate the integration of supply chain partners, providing value-added services, efficient operation of multimodal systems, engaging in supply chain integration practices.
Pettit and Beresford (2009)	Ability to provide tailor-made services.
Haugstetter and Cahoon (2010)	Innovation, growth, sustainability, knowledge sharing and management, information systems, collaboration in logistics networks, open communication, learning and strategic thinking.

Adaptability to the changes in logistics chains

The integration of the supply chain actors and the introduction of seamless transport systems using state-of-the-art technology force ports to be more flexible to respond the parties in the supply chain and adapt to the changing conditions in the uncertain port business environment. Wang and Cullinane (2006) state that in order to survive and prosper in a competitive and challenging environment, the port industry needs to look both externally and internally. According to Carbone and De Martino (2003), port competitiveness is becoming increasingly dependent on external coordination and control of the whole supply chain, rather than on its internal strengths (efficient cargo handling and hinterland connections). From an external perspective, the port industry needs flexibility to adapt quickly to changing opportunities and should have an integral approach to logistics issues in transport chains (Notteboom and Winkelmans, 2001a).

In their study analysing fourth generation ports, Paixão and Marlow (2003) indicate that the port environment is surrounded by a high degree of complexity and uncertainty and therefore ports need to adapt to 21st-century logistics trends. Again, Marlow and Paixão (2003) and Paixão and Marlow (2003) indicate that the two main success measures of logistics-oriented ports are leanness and agility, which means optimizing operations and streamlining processes in order to reduce waste and increase flexibility to respond to the changes in the port environment. Concurring with the authors, Panayides (2006) notes that leanness, agility, time compression as well as the performance of other parties could be regarded as the most important success measures of ports functioning in the supply chain era.

Port logistics chain integration

Barnard (1938) reasons that organizations are ‘cooperative systems’. His definition of OE is the accomplishment of the recognized objectives of the cooperative action. Managers in logistics networks tend to focus on integration and analysis for decision-making, with collaboration a key element in effectiveness and efficiency gains (Haugstetter and Cahoon, 2010; Barratt, 2004). Notteboom (2009) indicate that a port’s success is directly related to the close coordination with logistics actors outside the port perimeter and an integrated approach to port infrastructure planning. De Langen and Chouly (2004, p 361) claim that ‘effective hinterland access is at least partially an inter-organizational challenge’ and depends on the behaviour of actors in the logistics chain. Therefore, the coordination and integration of the port community with the other supply chain actors (which is a primary role of port authorities) is a critical point in ensuring effectiveness throughout logistics chains. Notteboom and Winkelmans (2001a) believe in the importance of coordination between different port authorities for solving some specific problems in supply chain. The authors claim that initiative, cooperation and consultation constitute the key components of an effective port management and this can be achieved by creating a platform in which port authorities are working together with various stakeholders to identify and address issues affecting logistics performance.

The higher the level of integration among the actors of a supply and logistics chain, the higher the effectiveness for the entire chain (Bowersox *et al*, 2000; Carbone and De Martino, 2003) and for the port. Many authors (Notteboom and Rodrigue, 2005; Cahoon and Notteboom, 2008; Notteboom, 2009) agree on the fact that the success of a port depends on the ability to integrate the port effectively into the networks of business relationships that shape supply chains. There have been a number of studies (Carbone and De Martino, 2003; Bichou and Gray, 2004; Marlow and Paixão, 2003; Wang and Cullinane, 2006; Song and Panayides, 2008; Panayides and Song, 2009; Woo and Pettit, 2009) investigating the performance of ports within the context of global supply and logistics chains.

Wang and Cullinane (2006) analyse the efficiency of European container terminals by linking supply chain management to port and terminal objectives and outputs. In their study, the main objective of a port is assumed to be the minimization of the use of port resources such as infrastructure, equipment and labour. Carbone and De Martino (2003) investigate the port operator's involvement in a specific (automative) supply chain in a case analysis of the Port of Le Havre. They apply the Lambert tri-dimensional model based on supply chain structure, business processes, and management components. The most suitable variables chosen were: relationships between the port operator and the focal firm, supplied services, information and communication technologies used and performance indicators that are shared by supply chain actors. Bichou and Gray (2005, p 89) state that port performance should be analysed, valued and assessed in terms of a port's contribution to the overall combined channel added value; and thus port competition will shift from the institutional, functional or spatial levels to the channel management level.

Woo and Pettit (2009) develop a conceptual model assuming that port supply chain orientation has a positive impact on port supply chain integration, and port supply chain integration has a positive impact on port performance. The authors believe that integration strategy is primarily concerned with both improving port effectiveness and operational efficiency which are the two main port performance indicators determined in their study. Panayides and Song (2009) stress the importance of port/terminal supply chain integration (TESCI) and indicate that port performance is directly related to the effectiveness of the whole supply chain. Their empirical study reveals that port supply chain integration could be achieved by four measures: the development of information and communication technologies, providing value-added services, offering multimodal infrastructure and systems to facilitate intermodality, and organizing activities beyond the port area in its hinterland (supply chain integration practices). The authors indicate that 'there are implications with respect to the relationship between port/terminal integration and port/terminal effectiveness' (p 142). In this respect, it can be inferred that TESCI measures can also be regarded as the measures of port/terminal effectiveness.

Regarding the increasing importance of logistics chains, Suykens and van de Voorde (1998) state that the success of a port is not exclusively dependent upon its own performance, but also upon other factors such as its connections with the hinterland. The strategy of developing port networks with hinterland nodes and dry ports in the hinterland has become widely accepted as a viable strategic option (de Langen and Chouly, 2004). Panayides (2006) indicates that port authorities can contribute to port effectiveness in logistics chains by proper planning for the smooth and cost-effective flow of cargoes by considering the transportation flow beyond the port's boundaries.

Information and communication management

Notteboom and Rodrigue (2005, p 306) stress the importance of information and communication management and state that 'the success of a port depends on its capability to fit into the networks shaping supply chains and indicate that the availability of powerful information channels and the capability of having knowledge transfer among the parties are the main determinants of success of port networks'. According to Bichou and Gray's (2004) channel perspective, ports act as key nodes in integrating trade, logistics and supply channels and the ability of ports to interact and collaborate with the channel members and adequate information access and sharing improve the level of integration and thus performance of ports. Panayides and Song (2009) advocate that efficient use of information and communications systems is one of the main determinants of port supply chain integration. In logistics-oriented ports, advances in communications and information technology (UNCTAD, 1999) and the more sophisticated use of automation and the standardization of information and procedures (Alderton, 2008) allow terminal operators to increase their productivity through better planning and reducing the time in the port.

Service quality and value-added intermodal services

UNESCAP (2002) claim that an ideal port should provide a diverse range of services that are highly integrated. As such, there is a need to seriously consider the increasing importance of ports in logistics management. The rapid increase in port competition, mainly because of the developments in logistics, has put pressure on ports to improve the quality of traditional port services, implementing differentiation strategies by providing more specialized, value-added services and delivering door-to-door transport solutions. The ability of port companies to provide tailor-made, specialized services has become fundamental to the overall effectiveness of the port within the supply chain (Beresford *et al*, 2004; Pettit and Beresford, 2009). The performance of a port depends on its ability to serve markets in the hinterland efficiently by improving the quality of hinterland transport services (de Langen and Chouly, 2004). According to the research results of Song and Panayides (2008), value-added services are positively related to port service price and customization, and there is a strong positive association between technology adoption and service quality. Paixão and Marlow (2003) claim that ports should deliver additional value-added and intermodal services and internally and externally integrate to become the key logistics elements of the transport chain by proper design, planning, organization and management.

Customer satisfaction

Both the horizontal and vertical integration in the transport industry result in a concentration of power amongst port customers and an increase in the bargaining power of customers over port management. This emphasizes the importance of 'customer satisfaction' in the port industry. As real competition is not 'port against port' but rather supply chain against supply chain' (De Martino and Morvillo, 2008), the ports need to respond rapidly to markets that are driven by sudden changes in customer demand to sustain their competitive positions in the market (Yusuf, *et al*, 1999). The changing role of ports is heavily dependent upon the supply chain strategies of those who use these ports (Mangan *et al*, 2008). Therefore, ports need to re-think the measurement of their performance and systematically monitor whether they serve their users effectively and with a full understanding of users' needs (Vitsounis and Pallis, 2010). To be effective, 'ports must become more familiar with the needs of port customers and in encouraging trade facilitation be solution-focused, not only within the port but throughout the logistics chains and networks' (Cahoon and Notteboom, 2008, p 2). Song and Panayides (2008) found that the relationship between ports and shipping lines has beneficial effects on reliability and responsiveness of ports.

Effectiveness-oriented port authorities recognize that they must first meet the needs of customers whose product and service expectations are more sophisticated and varied than before (Baltazar and Brooks, 2007; Brooks and Pallis, 2008). Woo *et al* (2008) also emphasize the importance of effectiveness, by stating that in the global supply chain era, port performance should reflect effectiveness aspects of ports from customers' perspectives.

Innovation

Prastacos *et al* (2002) argue that to successfully manage change, organizations need to be innovative and flexible. Chlomoudis *et al* (2003) state that in a changing and restructuring port environment, the main issues that a modern port must address are: increased quality of services, high levels of flexibility and adaptability, closer integration with other transport modes, higher levels of product and process innovation. Ports should create and promote innovation to integrate themselves within supply and logistics networks. De Martino and Morvillo (2008) indicate that port activities in relation to its hinterland are fundamental factors of development and innovation. Concurring with the author, Vanelslander (2011) argues that innovation in port – hinterland activities enables sustainability in transport. As Awad and Ghaziri (2004, p 17) state, 'beyond efficiency and productivity, the real benefit of collaboration is innovation'. By collaborating with supply chain members for innovation, the possibility of a supply chain retaining competitive advantage in the long term can be realized (Kim, 2005; Miles *et al*, 2005; Sahay, 2003 cited in Haugstetter and Cahoon, 2010, p 31). 'Innovation provides the potential for a new competitive advantage to develop' (Haugstetter and Cahoon, 2010, p 31).

Resource acquisition

As ports are open systems, having inputs, processes and outputs and interacting with their internal resources to the changing environment (Karatas Cetin and Cerit, 2010b), continuous acquisition and efficient use of port resources are critical for the survival of port organizations. As a proponent of the systems approach to OE, Yuchtman and Seashore (1967) indicate that universally required resources are: personnel, physical facility, technology, and money as a liquid resource. The main resources of ports are: port infra- and superstructure, equipment and information and communication technology, financial resources and human capital (Karatas Cetin and Cerit, 2010b, c). 'Within ports, resources are those necessary to perform both port and value-added logistics activities' (De Martino and Morvillo, 2008, p 584). These key resources, defined in literature as 'critical assets' (Cox *et al*, 2002), have a central position for the acquisition of value in the supply and logistics chains.

Conclusion

The developments, restructurings and shifts in the power of the actors in logistics and supply chains combined with accelerating competition lead port organizations to extend their activities towards hinterland and logistics chains, and thence re-assess their goals and means of performance measurement. Within a framework, the interrelations between the changes in the supply and logistics chains, the roles and goals of ports and port authorities, and, where effectiveness is directly related with the goals, the changes in the measures of port effectiveness, have been explained in this study.

Principally, this study deals with the changes in ports' and port authorities' roles as a result of the new trends in logistics chains and the importance of port authority strategies and activities for repositioning the ports in these chains. In their study, van der Lugt and de Langen, (2007, p10) ask the rhetorical question, 'Why should port authorities get involved in the hinterland?' The answer is 'to ensure port competitiveness'. Answers can be extended by stating that ports are central nodes in supply and logistics chains (Bichou and Gray, 2004; Notteboom, 2007, 2009); port, foreland and hinterland are closely bound together in a symbiotic relationship (Notteboom, 1998); ports are not competing as sole entities but as parts of complete transport and supply chains (Suykens and van de Voorde, 1998; Verhoeven, 2010; Notteboom and Winkelmans, 2001a); and coordination and control of the whole supply chain by the port is a more important factor than its internal strength in port competition (Carbone and Martino, 2003).

However, another question is, 'What should port authorities do to achieve port effectiveness within logistics chains, what are the factors (measures) that should be considered?' In order to develop effective ports within logistics chains, port authorities should function as a coordinator, integrator and facilitator in logistics chains, follow the market developments, promote and sustain efficient intermodal transport systems, develop strategic relations with the hinterland and supply chain partners, invest in the port community system and cooperate closely with inland terminals and neighbouring ports. In accordance with the new roles of port authorities, this study attempts to identify the effectiveness criteria of port organizations that are gaining importance through developments in logistics chains, which are port logistics chain integration, adaptability to the changes in the environment, customer orientation and satisfaction, information and communication management, service quality and provision of value-added and intermodal services, innovation and resource acquisition.

It is believed that, although commonly used performance measures are still viable, they are not sufficient for the overall performance evaluation of port organizations functioning in an environment with a high degree of complexity and uncertainty. However, as a suggestion for further studies, it should be admitted that one limitation of the effectiveness measures is that they are mostly intangible and their assessment would depend on perceptive judgements rather than concrete facts: thus they cannot be measured as conveniently as tangible measures like growth, profitability or efficiency. In consequence, in order to maintain their competitiveness in logistics chains, ports should focus on the factors identified in the study and seek ways to improve their performance in each factor. Being efficient is no longer enough for success in the new competitive landscape.

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Logistics performance of supply chain-oriented ports

19

SU HAN WOO, STEPHEN PETTIT AND ANTHONY BERESFORD

Introduction

This chapter primarily aims to investigate the effect of supply chain integration of seaports on port performance by examining the causal relationships among the integration strategies of seaport terminals along the supply chain, and the antecedents and consequences of the integration strategies. The integration strategy is termed 'port supply chain integration' (PSCI) and the antecedents of PSCI are identified as 'port supply chain orientation' (PSCO). Logistics performance of ports (LPP) is considered as consequences of PSCI because it is suggested that traditional performance measures such as cargo throughput is not sufficient for a proxy of port performance in the global supply chain era (Panayides and Song 2008; Bichou and Gray, 2004). Structural equation modelling (SEM) is used to validate the constructs and rigorously test the relationships among the constructs.

This chapter is organized as follows. Prior to the examination of the causal relationships, an extensive literature review is carried out to identify the literature pertaining to the logistics performance of supply chain-oriented ports and to figure out how ports have been researched in relation to supply chain management and integration. Subsequently, we examine how seaports should be understood and considered in a supply chain by clarifying terminology relevant to supply chain management and port operation. The following sections develop a research model consisting of constructs and measures through a literature review and interview programme, and examine the hypothesized relationships using SEM analysis.

Review of relevant port literature

The overall port literature published in academic journal for three decades from 1981 to 2009 was categorized through a review process using eight categories as detailed in Table 19.1. Of these, the key categories relevant to this chapter are 'competition and performance'; 'ports in supply chains' and 'terminal operations'. Woo (2010) categorized journal papers according to research themes over three decades in five-year periods and the result of this categorization is provided in Table 19.1. Over three decades, the themes researched the most extensively are 'management and strategy (19.6 per cent)', 'competition and performance (19.3 per cent)' and 'planning and development (14.9 per cent)'. The category with the fewest publications is 'ports in supply chains' (5.2 per cent).

Port competition and performance

This category accounted for almost as large a proportion of studies as the 'port management and strategies' category (20 per cent). Port competition studies begin with conceptualizing and characterizing seaport competition (Verhoeff, 1981) and can be advanced with new concepts of seaport competition such as co-opetition and intra-port competition (Song, 2003; de Langen and Pallis, 2006). However the number of these studies is limited (see Table 19.2). A substantial number of papers are devoted to analysing the current situation and development of port competition of a region or country in the 2000s (Comtois and Dong, 2007; Yap and Lam 2006). Advanced methods, analytical tools and new measures helped researchers analyse and assess the complex nature of competition dynamics and relationships among competing ports (Lam and Yap, 2008; Notteboom, 2009; Woo and Pettit, 2010).

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

Ports in supply chains

The papers in this category were separately classified even though the proportion in all the papers was the lowest (=5.2 per cent) among the eight categories. The reason for this is that they take a different view on seaports from

TABLE 19.1. The number of papers in research theme categories

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

TABLE 19.2 Research topics in 'port competition and performance' studies

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

TABLE 19.3 Research topics in 'ports in supply chains' studies

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

those of traditional studies which see seaports as a node between sea and land transport. They argue that seaports should be viewed as parts of supply chains (Robinson, 2002; Bichou and Gray, 2005) and as an extended system which can interact with other members in the supply chain. In this context, a number of papers investigate the integration strategies and practices of seaports along supply chains (Carbone and De Martino, 2003; Tongzon *et al*, 2009) and their impact on performance (Song and Panayides, 2008) (see Table 19.3).

Terminal operations

This approach seeks optimal solutions in terminal operations and appears to be a separate field from port management and policy studies. It is indispensable in coping with increasing container transportation and achieving higher efficiency in seaports. Its importance is also shown by the 11 per cent

TABLE 19.4 Research topics in 'terminal operation' studies

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

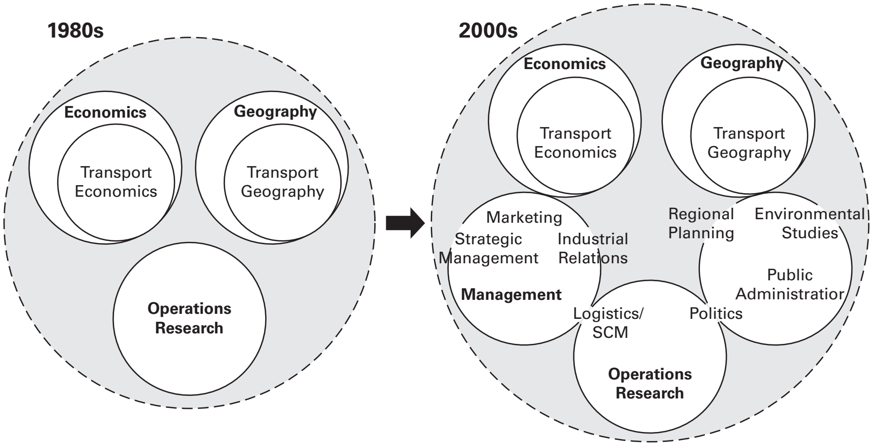
proportion of total papers for this category, even though a number of optimization studies were classified in other categories such as demand and supply analysis and port selection. With the increasing interest in optimized terminal operations, a variety of review studies and methodological discussions have been provided in recent times (Monaco *et al,* 2009; Stahlbock and Vos, 2008; Steenken *et al*, 2004). Research topics were identified according to the processes of terminal operation, thus they are not as detailed as the review studies are (see Table 19.4). The sea-side operation subset is concerned with ship planning processes and loading/unloading processes such as berth allocation, stowage planning, quay crane scheduling and queueing problems.

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

Evolution of port research

It is clear from the literature review that port research has multidisciplinary characteristics and the intensity has become stronger over time, as shown in Figure 19.1. In the 1980s, three primary disciplines (economics, geography and operations research) were involved. In that decade, seaports were studied as a part of transport economics and transport geography, and this recognition

FIGURE 19.1 Disciplinary evolution of port research

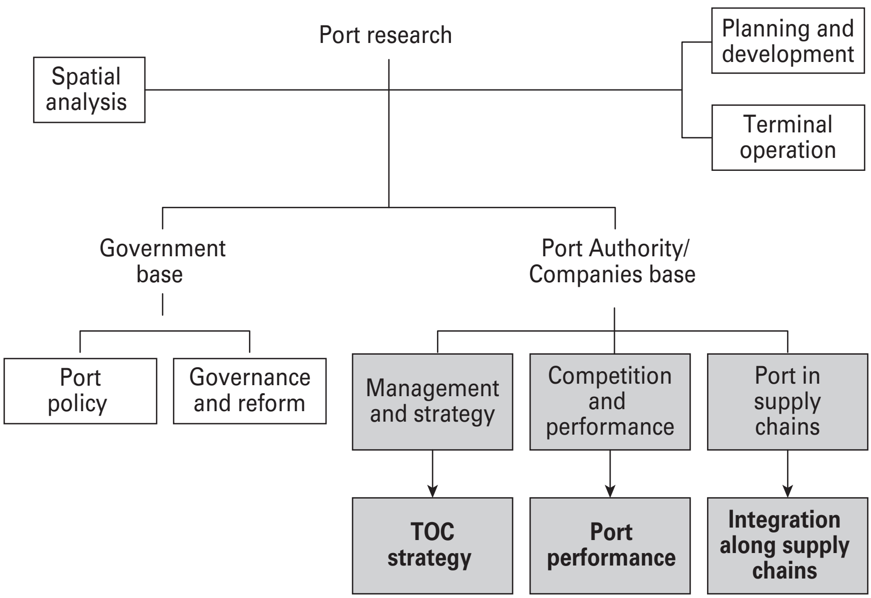


is still generally accepted. Therefore, theories and analytical tools used in transport economics and transport geography were applied to seaports by transport economists and transport geographers. This implies that economic and geographical theories were applied to seaports through sub-disciplines such as transport economics and transport geography rather than directly.

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

Figure 19.2 shows how this chapter fits into port research in terms of research themes and topics. This chapter is basically concerned with terminal operating companies' (TOCs) strategies to achieve performance improvement and competitive advantage through integration along supply chains. Therefore, three areas of port authority/companies-based research are important: TOC strategy, integration along supply chains, and port performance. Strategies of TOCs are pursued, in a broad sense, in two directions: expansion of global coverage through horizontal integration, and integration along logistics and supply chains through vertical integration (de Langen and Chouly, 2009). The latter strategy is a main focus of

FIGURE 19.2 Research themes and topics relevant to this chapter



this chapter. In addition, port performance is relevant because this chapter assesses the impact of this strategy on performance of TOCs. For performance measurement, an index approach is used rather than the frontier approach which is generally used in the studies categorized under 'port efficiency'.

Although there are three topics at the heart of logistics performance in ports, the 'ports in supply chains' category is central. While the previous section briefly discussed how the studies in this category have been conducted, the discussion was not exhaustive and was limited to research topics. This section, therefore, discusses in more detail the involvement of supply chain management (SCM) concepts in port research and the varying approaches of port research to SCM practices.

In port research, the term 'supply chain' or 'SCM' did not often appear until the early 2000s. Although the evolving role of seaport terminals from a gateway into a logistics hub has been recently discussed relatively well, it is not easy to associate SCM issues with port operation and management. However, Kuipers (2005) also highlights the possibilities for maritime transport to be flexible in terms of sea operation, transhipment operations and inland transport operations to deal with the requirements of SCM. In addition, researchers indicate that the increasing demand for integrated logistics and transport services makes maritime transport and port operation inseparable from logistics and supply chain management (Panayides, 2006; Robinson, 2002). Thus, maritime researchers increasingly have addressed port-related issues from the SCM context or associated SCM issues with port studies in several ways. Three approaches to address the SCM philosophy and practices could be identified from these studies on: the influences of SCM on shipping and port industries; the applications of SCM concepts and models to port research; the integrating activities along supply chains.

Influences of SCM on the port industry

The first approach investigates the influence of SCM strategies adopted by manufacturing companies on the port industry. This approach tends to regard SCM as a phenomenon which takes place outside of port operation, and analyses the dynamics among market players when the impact is made from outside. Table 19.5 shows the influences of new logistics strategies on shipping and port industries and the response adopted in the literature. Such new strategies require transportation companies both to cover a wider geographical area and to provide a wider range of services to meet increasingly

TABLE 19.5 Studies on the influences of SCM on port industry

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

diversified demand patterns with lower price and higher quality than before (Heaver, 2001; Slack *et al,* 1996). To deal with these requirements, shipping companies have integrated horizontally through mergers, acquisitions and strategic alliances, and vertically through operating dedicated terminals and by providing integrated logistics and intermodal services (Notteboom, 2004). Additionally, shipping companies have rearranged service networks with the dual aim of global coverage and diversification. The reactions of shipping companies ultimately affect every facet of the maritime industry, especially port operations (Slack *et al*, 2001).

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

Applications of SCM concepts to port research

The second approach regards SCM concepts and models as analytical tools to address and expand the issues of port operation and management as shown in Table 19.6. This approach is also based on the standpoint that the port industry has been substantially affected by SCM practices and accepts the SCM approach as the dominant logistics perspective. The basic reason that the researchers adopt an SCM approach is that they view the port system as the extended system which connects and actively interacts with other actors in supply chains beyond the traditional system which simply services ships and cargoes, and stays in a passive position in the supply chain.

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

Bichou and Gray (2004) also apply the SCM approach to port performance. The SCM approach, in their study, extends a traditional ports system to an integrated channel management system where the port stands as a key location linking the trade, supply and logistics channels. Under their integrated port system, 'the actors and operators within the port community such as stevedores, multimodal transport operators and logistics providers are sub-members of the port management system, not part of the external

TABLE 19.6 Studies on the applications of SCM concepts to port research

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

world'. In addition, their port management system encompasses internal and external integration of the port, and the port performance management system considers both values for customer and operational productivity.

Integrating activities along supply chains

This approach also views ports as an extended system which interacts with other members in supply chains. Furthermore, this approach recognizes SCM and supply chain integration as phenomena which can take place throughout ports along supply chains, and regards ports as an integral party which proactively participates in the phenomena. Initially, researchers attempted to explore how ports become integrated in supply chains, and conceptualized integration in the port context as shown in Table 19.7. Carbone and De Martino (2003) identified four SCM components – mutual relationships, supplied services, information and communication technologies and performance measurement – and investigated how port operators in the Port of Le Havre became involved with Renault's components supply chain.

Rodrigue and Notteboom (2009) show that ports become increasingly embedded by supply chain practices because logistics service providers actively use ports as 'extended distribution centres'. Pettit and Beresford (2009) demonstrate that, depending on the strategies of supply chains ports belong to, the distribution facilities of the ports can be variably developed and different types of logistics activities can take place. Panayides and Song (2008) conceptualize the integration of seaport terminals along supply chains, and develop instruments to measure the degree of the integration. They derive four variables from relevant literature – information and communication systems, value-added service, multimodal system and operation, supply chain integration practices – and empirically validate them using confirmatory factor analysis. De Martino and Morvillo (2008) presented a new framework of port competitiveness relating to supply chain integration. They suggest that inter-organizational relationships are another crucial source of port competitiveness, which the integration of activities and resources along the supply chain has developed into a source of competitive advantage.

Supply chains and seaports

This section clarifies terminology in relation to supply chains and ports. Although the term 'supply chain' is frequently used in the port literature, it is rarely defined or specified. In addition, several similar terms, such as logistics supply chain, service supply chain and port supply chain, appear in literature without clarification. Stevens (1989) defines supply chain as 'a connected series of activities which are concerned with planning, coordinating and controlling materials, parts, and finished goods from supplier to customer'. A more common definition of a supply chain is a system of

TABLE 19.7 Studies on the integrating activities of ports along supply chains

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

NOTE ICS: information and communication systems; VAS: value-added service; MSO: multimodal system and operation; SCIP: supply chain integration practices; DC: distribution centres.

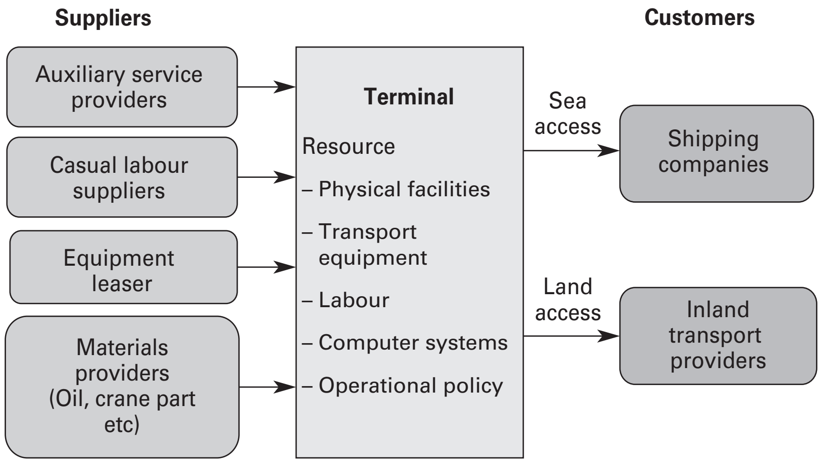
suppliers, manufacturers, distributors, retailers and customers where materials flow downstream from suppliers to customers and information flows in both directions (eg Jones and Riley, 1985; Lamming, 1996).

These definitions do not explicitly show whether transportation or transport companies such as port operators are included. Mentzer *et al* (2001) define supply chains as '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'. They also identified three degrees of supply chain complexity: a 'direct supply chain' which consists of a company, an immediate supplier, and an immediate customer; an 'extended supply chain' which includes suppliers of the immediate supplier and customers of the immediate customer; and an 'ultimate supply chain' which includes all the organizations involved in all the upstream and downstream flows from the ultimate supplier to the ultimate customer. Only the third, an ultimate supply chain, includes third-party logistics (3PL) providers with whom transport companies can get involved.

Some definitions explicitly include carriers and logistics service providers as members of supply chains (eg Gentry, 1996; Lalonde and Masters, 1994). From the holistic view, all functions and organizations involved in the flow of materials and information are included as members of a supply chain. It follows that ports also play certain roles somewhere between companies or organizations if the supply chains involve maritime transport. However, the term, 'supply chain' is defined variably according to the scope and interests of studies, as done by Mentzer *et al* (2001). They used the 'ultimate supply chain' concept to consider the final customer and supplier in their study. If a study does not consider ports much in defining or specifying a supply chain, this may mean issues related to port operation and management are not addressed in the study. More specific terms have been proposed concerning supply chains in which seaports or shipping companies are involved. Van Niekerk and Fourie (2002) define a 'maritime supply chain' as management by shipping companies of the supply-side of supply chains to exercise control over the entire chain in pursuance of the lowest cost and efficiency gains. Lee *et al* (2003) decompose supply chains with the concept of 'port supply chains' which focus on port operations of the supply chain of products, materials and services. Lopez and Poole (1998) used the term 'maritime port logistics chain' which describes integrated and sequential physical and other transport activities confined to ports and the maritime–land transport interface. Robinson (2006) specifies 'port-oriented land-side supply chain' to investigate integration of functions and activities of land-side logistics.

All the above are cases where a whole supply chain of materials or products passing through ports is decomposed, focusing on, or confined to, maritime transportation and port operation. Then, in contrast, it is also possible to think about the supply chain of services ports provide. In this case, TOCs are the focal companies, and suppliers and customers for the services can be identified according to the service range ports provide. Figure 19.3 shows a simple case where a terminal provides a stevedoring service combining

FIGURE 19.3 Supply chain of port services

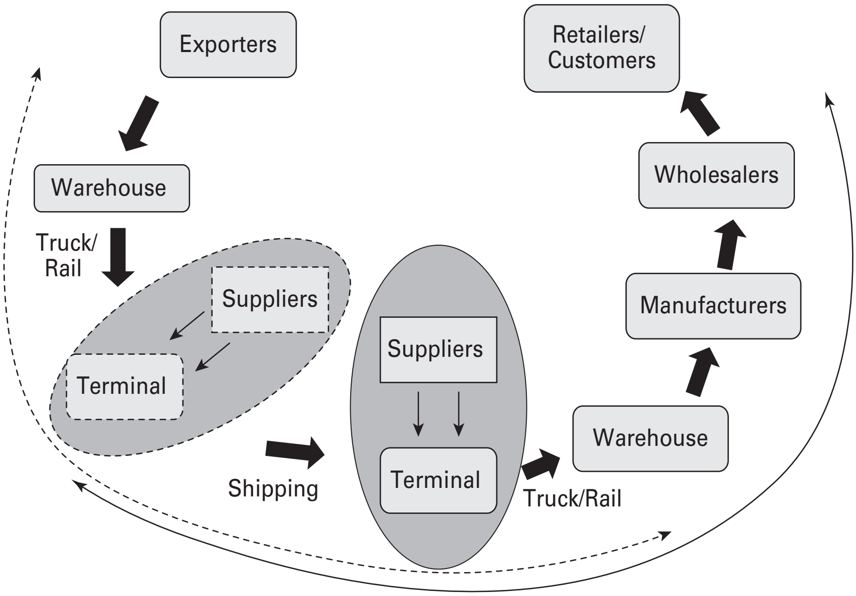


auxiliary services such as lashing and inspection. In this case, customers and suppliers would be relatively limited. Shipping companies for sea access and inland transport providers for land access would be considered as 'customers'. If the terminal provides additional services, for example, services combining stevedoring (with auxiliary services), inland trucking and warehousing, then forwarders, third-party logistics service providers and shippers would be considered as customers of the port services, and more suppliers would be involved in this supply chain.

A distinction, in this case, can be made in that here the opinions of the suppliers are being taken into account. In research elsewhere the opinions of port customers are generally sought as the primary focus of research in the field of port-related supply chains. Example cases are found in Lai *et al* (2008) and Lai (2009). These studied channel relationships and buyer–supplier relationships in the context of a supply chain where a TOC is the focal company, and data were collected from the TOC's suppliers. However, in this chapter, 'supply chain' means 'supply chain of goods and materials' passing through ports rather than 'supply chain of services ports provide', and 'port' is considered as one of the members of the wider (ultimate) supply chains. Figure 19.4 illustrates the supply chain of goods where maritime transport is involved.

Between the end-supplier who exports and the end-customer, there may exist a number of members and functions. Seaport terminals play a traditional role in linking sea shipping and land transport. In Figure 19.4, suppliers of port services are encircled because they are not considered separately from seaport terminals. The arrows stand for the possible extension of the role and function of ports in the supply chain. In conclusion, this chapter uses the term 'supply chain' as supply chain of goods; and considers ports as a member of the supply chain and as an actor who is able to proactively integrate functions along the supply chain.

FIGURE 19.4 Ports in a supply chain



Integration of ports in supply chains

This section explores how supply chain integration of ports has been researched and attempts to conceptulize this phenomenon through a literature review and interview study. This leads to a scientific examination of the extent of integration of seaports and its impact on the logistics performance of ports. This literature review includes SCM and logistics literature since supply chain integration is rather a new concept which was borrowed from such disciplines. In an interview study in December 2008 and January 2009, components and measurement scales used to operationalize the concept in existing literature were screened with 21 practitioners and academics.

Supply chain management, supply chain integration and performance

The reason that SCM has become popular and is recognized as a crucial firm strategy is that companies have become more dependent on supply chains and find it necessary to manage supply chains more effectively in order to meet complicated customer requirements in a global economy. Lai *et al* (2002) state that the emergence of the global economy and intensified competition have led firms to recognize the importance of managing their supply chain for fast introduction of product and service innovations into the markets. Thus, firms have embraced SCM to increase organizational effectiveness and to achieve organizational goals such as improved customer value, better utilization of resources, and increased profitability. Mentzer *et al* (2001) also state that specific drivers to supply chain management may be traced to the trends in global sourcing, an emphasis on time and quality-based competition and their respective contributions to greater environmental uncertainty. Cooper and Ellram (1993) define SCM as 'an integrative philosophy to manage the total flow of a distribution channel from the supplier to their ultimate user'. SCM is also defined as the integration of key business processes to end-users through original suppliers that provide products, services and information that add value for customers and other stakeholders (Lambert *et al*, 1998).

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

The relationship between supply chain management (SCM) and firm performance have been examined by a number of researchers (eg Li *et al,* 2006; Shin *et al*, 2000) as shown in Table 19.8. Mentzer *et al* (2001) demonstrate that the improvement of competitive advantage within the supply chain is the motive for, and the consequence of, SCM. They propose that competitive advantage can be achieved through enhancing customer value and satisfaction by implementing SCM. Li *et al* (2006) present empirical evidence that SCM practices have a direct impact on the financial and marketing performance of an organization. Researchers also identified the relationship between supply chain integration and firm performance, as integration is the main concept underpinning SCM, and strategic integration is expected to impact firm performance. The results of most research indicate that the higher the level at which integration occurs, the better firm performance is (Johnson, 1999; Lin *et al,* 2005).

Johnson (1999) identified five antecedents of strategic integration (dependence, age, continuity expectation, flexibility and relationship quality) and showed that dependence, continuity expectation and flexibility positively affect strategic integration, and, in turn, strategic integration enhances performance. Mentzer *et al* (2001) differentiate supply chain orientation (SCO) from SCM, defining SCO as 'the recognition by an organization of the systemic, strategic implications of the tactical activities involved in managing the various flows in a supply chain' and calling 'the actual implementation of SCO across various

TABLE 19.8 Causal relationships in SCM literature

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

NOTE SMO: supply management orientation, SCM: supply chain management, SCO: supply chain orientation, MO: market orientation, IT: information technology.

companies in the supply chain' SCM. Their conceptual model, accordingly, identifies SCO as an antecedent of SCM, and SCM as an enhancer of firm performance. Min *et al* (2007) associated their SCM concepts with market orientation (MO). In their model, SCO and SCM act as mediators of the relationship between market orientation and performance, in other words, MO and SCO were the antecedents of SCM.

Port supply chain integration (PSCI)

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

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

Components of PSCI

Considering the intensive efforts to conceptualize SCM and supply chain integration concepts, it is fair to say the components of PSCI have rarely been identified. Fortunately, a few recent works (Carbone and De Martino, 2003; Panayides and Song, 2008; Song and Panayides, 2008; Tongzon *et al,* 2009) have presented the components or validated the constructs which can be used to conceptualize PSCI (see Table 19.9). Carbone and De Martino (2003) identified four SCM components by interviews with French terminal-operating companies (TOCs): mutual relationships, supplied services, information and

TABLE 19.9 Components and constructs of PSCI

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

communication technologies and performance measurement. Based on their discussions, Panayides and Song (2008) conceptualized TESCI with four components: information and communication systems; value-added service; multimodal systems and operations; supply chain integration practices. They validated the measurement scales for the components using confirmatory factor analysis (CFA), and showed they were the constructs representing TESCI with a second-order measurement model. Song and Panayides (2008) use seven constructs to examine the relationships between PSCI and port performance with multiple regression analysis, but the seven constructs have not been tested with the second-order model. In addition, Tongzon *et al* (2009) validated the components and measurement items which were adopted from Carbone and De Martino (2003) and Panayides and Song (2008): relationship with users, value-added service, intermodal infrastructure and channel integration practices. They subsequently evaluated the degree of supply chain integration of terminals of Inchoen port in Korea using the measurement instruments. Based on the discussion above in this chapter, five constructs are used to constitute PSCI: information and communication system (ICS), value-added logistics (VAL) services, intermodal transport (IMT) services, long-term relationships (LTR), and supply chain integration practices (SCIP).

Pananyides and Song (2008) defined ICS as 'the establishment and use of seamless communication systems that facilitate efficient servicing of supply chain operations and achievement of supply chain goals'. The role of the establishment of ICS has been emphasized in facilitating integration among supply chain members by most SCM researchers, and has been undoubtedly considered as core components for SCM and supply chain integration (Mentzer *et al*, 2001; Tyndall *et al*, 1998; Ellram and Cooper, 1990). In addition, the port literature highlights the importance of ICS for higher degrees of PSCI (Bichou and Gray, 2004; Kia *et al*, 2000; Paixão and Marlow, 2003; Panayides and Song, 2008). Heaver (2001) also suggests that the quality of an IT system to a supply chain is critical to its performance since IT enables supply chains to reduce order cycle times, cut inventories and make the systems more flexible. An effective ICS uses EDI (electronic data interchange) and establishes integrated information systems in order to communicate with supply chain members and this can be measured with such items (Vickery *et al*, 2003; Marlow and Paixão-Casaca, 2003). Interviewees suggested the inclusion of a few items related to what information is shared through the ICS such as cargo tracing and inventory management etc (see Appendix 19.1).

'Value-added logistics services' (VAL) was defined by Panayides and Song (2008) as 'the ability of the port to add value to the services that it provides in the context of facilitating further the objectives of the supply chain system' and 'intermodal transport services and systems' (IMT) as 'the existence of systems to facilitate efficient and effective multimodal operations'. Beresford *et al* (2004) suggest that since the 1980s ports have diversified into the emerging field of logistics and have offered value-added services as they became increasingly integrated into the transport chain to varying degrees depending on cargo and customer requirements. Notteboom and Winkelmans (2001) also emphasize that since the maritime container battle will be won on land, the role of port authorities in the 21st century includes the promotion of an efficient intermodal system. VAL and IMT are undoubtedly core components of PSCI since the PSCI concept itself means the activities undertaken by terminals to expand their service range from fragmented physical transport to integrated logistics which includes multimodal transport and adding value activities.

Researchers suggest that the development of 'long-term relationships' (LTR) is an important feature of supply chain integration and a well-developed long-term relationship can have a positive effect on the competitiveness of supply chains (eg Mentzer *et al,* 2001; Shin *et al*, 2000). The development of LTRs between customers and logistics service providers has been viewed as a strategic choice rather than the transactional type of collaboration (Doney and Cannon, 1997). This was also supported by the researchers (eg Bowersox *et al*, 2000; Panayides, 2002) as well as the interviewees, demonstrating that the evolution of the relationship with supply chain members from the contractual to the long-term and strategic cooperative relationship is the essence of PSCI. A TOC seeking long-term relationships with supply chain members may view port users as strategic partners and try to develop cooperative relationships rather than contractual relationships, which may result in reduction of channel complexity and more customized service with higher quality (Min and Mentzer, 2004; Shin *et al*, 2000; Tongzon *et al*, 2009).

Researchers suggest that business practices of TOCs in the global supply chain era should evolve from 'being reactive, fragmented and intra-organizational' to 'being proactive, integrated and inter-organizational'

(Bichou and Gray, 2004) Particular features of 'supply chain integration practices' (SCIP) may be planning and organizing processes and procedure beyond its boundaries; comparing and benchmarking performance of services; scrutinizing more efficient route and process; and producing new service packages and marketing them to customers (Bichou and Gray, 2004; Notteboom and Rodrigue, 2005).

PSCI and port performance (PP)

In port research, empirical work on the interrelationships between the integration of ports into supply chains and port performance has been very limited. Song and Panayides (2008) identified seven parameters for evaluating the extent of the integration and selected variables for port performance. They analysed the interrelationships between the parameters and the variables using multiple regression analysis. Their results showed that: information and communication technology positively influences the service quality of ports; the relationship of ports with shipping companies has beneficial effects on the reliability and responsiveness of ports; and value-added service is positively related to both port service customization and port service price. However, they tested the relationships between the parameters for evaluating the degree of integration and the variables for performance rather than the higher level concepts, ie the integration of ports in supply chains and port performance. Tongzon *et al* (2009), while they could not find a clear-cut positive relationship between supply chain integration and performance, observed significant percentage increases in terminal efficiency-related measures such as container throughput and ship calls in the terminals with a higher level of supply chain integration.

Carbone and De Martino (2003), from their fieldwork interviewing the French car company Renault, logistics providers and port operators, found that Renault outsources some significant parts of the outbound logistics to logistics providers and port operators so as to benefit from the higher reliability and minimized total logistics costs, while the inbound logistics is vertically integrated into Renault. This implies that those services integrating some logistics functions, eg inventory management, with physical transportation, including inland transport and port cargo handling, may produce a higher level of certain aspects of port performance. Many conceptual and descriptive works also associate the integration of ports with competitiveness or performance issues. De Martino and Morvillo (2008) assert that the integration of a port is concerned with intermodality and organizational integration and aims at responding to the changing requirements of industrial and commercial enterprises and, at the same time, improving its own internal efficiency. Paixão and Marlow (2003) also demonstrate that the internal and external integration of a port based on the agility concept can increase competitive advantage of the port, enabling the port to provide additional value-added and intermodal services, to decrease the transit and lead-times of cargoes and to reduce the total cost derived from port services.

Antecedents to PSCI

TOCs may have different attitudes to SCM practices and characteristics which facilitate or impede the implementation of the integration strategy. It would be very useful to terminal operators to investigate which organizational characteristics and attributes contribute to facilitating the implementation of integration strategies. TOCs' organizational characteristics and attitudes towards PSCI are adopted as antecedents to PSCI in this research, and are termed as port supply chain orientation (PSCO). This term was adapted from supply chain orientation (SCO) which is used as an antecedent to SCM. Studies on the factors or organizational characteristics facilitating the integration strategies of ports are more limited. The features this research attempts to identify can be interpreted as the 'resources' or 'capabilities' of a firm from the resource-based view. This view considers the tangible and intangible aspects of a firm's resources enabling it to implement strategies that improve its efficiency and effectiveness (Barney, 1991). Such resources can encompass physical capital resources, human resources such as knowledge, and organizational resources such as inter-organizational relationships.

Effective PSCI requires a TOC to have 'orientation to inter-organizational relationships' through sharing similar goals and philosophies with supply chain members and building up and maintaining trust and cooperative norms (McAfee *et al*, 2002; Mentzer *et al*, 2001; Min and Mentzer, 2004; Panayides and So, 2005a; 2005b). According to McAfee *et al* (2002), relationship orientation is required for the establishment of long-term relationships with supply chain members and is characterized by mutual trust, interdependence, shared attitudes and beliefs. De Martino and Morvillo (2008) demonstrated that the willingness to establish relationships with supply chain members having collaborative spirit and mutual trust entails a higher level of involvement of ports in supply chains. Bichou and Gray (2004) also indicated that the ability of TOCs to interact with supply chain members improves the level of integration along the supply chain. Wu *et al* (2004) showed that higher levels of behavioural determinants such as trust and commitment result in higher levels of supply chain integration.

In addition, a TOC is required to appropriately manage 'human and financial resources' to implement PSCI strategy (De Martino and Morvillo, 2008; McAfee *et al*, 2002; Paixão and Marlow, 2003). Gowen and Tallon (2003) suggested that HRM practices such as employee training and support enhance supply chain integration by providing better trained and enthusiastic employees, which is consistent with other SCM studies (eg Dooly and Fryxell, 1999; Dow *et al*, 1999). Scarbrough (2000) demonstrated that for tighter supply chain integration more effective HRM is required by securing necessary skills and capabilities of employees. Human resources need to have knowledge and experience to develop the concept, to set up appropriate strategies depending on their capabilities, and to create new services tailored for particular shippers' sophisticated demands (Notteboom and Winkelmans, 2001). It is especially important to provide training and support to make human resources see beyond the traditional practices implemented in the fragmented physical transport era to integrated logistics in the global supply chain era (Bichou and Gray, 2004). Relationship-oriented firms, in contrast to transaction-oriented firms, make a long-term investment in their employees such as training and compensation and the employees invest in the establishment of long-term relationships with supply chain members (McAfee *et al*, 2002). As human resource management and the establishment of relevant systems to implement PSCI strategy such as information and communication (ICS), intermodal transport and value-added logistics require a considerable investment, financial resources are necessary to manage the desired strategy (ie PSCI) (McAfee *et al*, 2002; Marlow and Paixão-Casaca, 2003). The importance of financial resources is also supported by the interviewees: in terms of how willing a TOC is to invest for supply chain practices and how high a priority the TOC has in investment for supply chain practices. The 'top management team' of the TOC should also have leadership and commitment to change their strategic direction and support the implementation of the strategies (Mentzer *et al*, 2001; Min and Mentzer, 2004). The team has a critical role in transforming an organization towards the new approach in that it shapes an organization's values, orientation and direction (Lambert *et al*, 1998; Loforte, 1991).

Logistics performance of ports (LPP)

Measures for port performance should also be developed appropriately for the objectives and contexts of this chapter. Port performance has traditionally focused on the internal aspects of port operations primarily as shown in Table 19.10 because the role of ports has been recognized as merely being nodes between land transport and sea transport and the virtue of ports was understood to be a cost- and time-efficient operation.

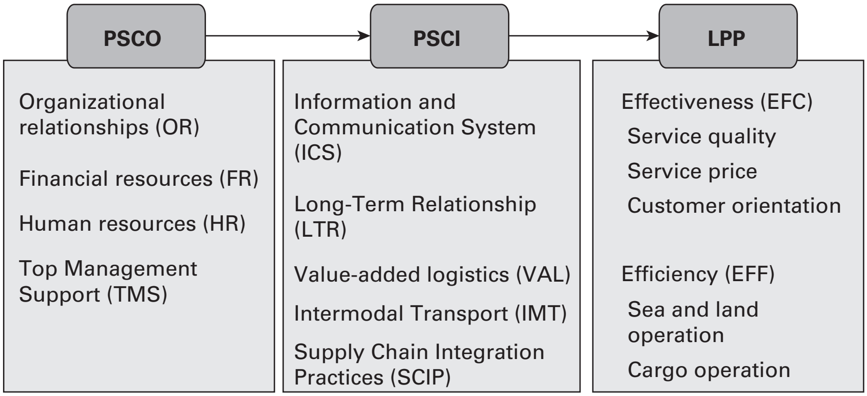
Brooks (2007) indicates that the port literature has focused on measuring efficiency while other transport modes such as air, road and rail put a greater emphasis on external perspectives such as customer orientation, reliability and service. Bichou (2007) also demonstrates that port performance measurement systems are hardly ever used to capture both efficiency and external effectiveness, and a single focus on either efficiency or effectiveness does not seem to be the only way to increase performance. In addition, Panayides (2006) suggests that ports in the supply chain era may have other measures of performance, apart from cargo throughput, such as leanness, agility, time compression as well as the performance of other parties in the supply chain. Another criticism of traditional port performance measures is that the traditional measures are fragmented and biased towards sea access. Most port performance literature focuses solely on sea access, overlooks other processes of the port operating system and ignores the interests of other members of the port's supply chain network. In this regard, some researchers propose new port performance measurement concepts and frameworks based on different recognition about the environments ports are embedded in and the functions of ports in the supply chain (eg Marlow and Paixão-Casaca, 2003; Bichou and Gray, 2004).

TABLE 19.10 Traditional port performance measures/indicators

Literature	Category	Indicators
Metrics and indicator approach		
UNCTAD (1982), De Monie (1987)	Output Service Utilization Productivity	Berth output, ship output, gang output Ship waiting time, ship's time Berth occupancy, berth working time Cost per tonnes of cargo handled
Tongzon and Ganesalingam (1994)	Operational efficiency Customer-oriented measures	Capital and labour productivity, asset utilization rates Direct charges, ship's waiting time, inland transport, reliability
Talley (1994)	Shadow price	Cargo handling rate, average delay to ships waiting berths, average delay to ships while alongside berths, truck time and queuing
Frontier approach		
Roll and Hayuth (1993)	Output	Cargo throughput, level of service, users' satisfaction, ship calls
	Input	Manpower, capital, cargo uniformity
Cullinane *et al* (2002)	Output Input	Turnover from container terminal service Terminal quay length, terminal area, number of equipment
Cullinane *et al* (2006)	Output Input	Cargo throughput Terminal length, terminal area, number of quayside gantry, yard gantry and straddle carrier
Wang and Cullinane (2006)	Output Input	Cargo throughput Capital (terminal length), labour (equipment cost), land (terminal area)

Mentzer and Konrad (1991) defined logistics performance as effectiveness and efficiency. The following studies suggested logistics performance is multi-dimensional by validating logistics performance measures comprising efficiency and effectiveness (Fugate *et al*, 2010; Lai *et al*, 2002). In logistics, effectiveness is considered as the extent to which the logistics function's goals are accomplished and efficiency is considered as the ability to provide the logistics function to manage resources wisely (Menzter and Konrad,

FIGURE 19.5 Complete research model



1991; Fugate *et al*, 2010). Adopting the definition and constructs developed by these studies, Woo *et al* (2008) and Beresford *et al* (2011) developed measures to evaluate port performance in aspects of both efficiency and effectiveness using confirmatory factor analysis (CFA). This study used port performance measures consisting of effectiveness concerning external aspects of port operation such as service quality (reliability, timeliness, information provision), customer orientation (responsiveness, flexibility etc) and service price (level of cargo-handling charge, etc), and efficiency concerning internal operational aspects such as sea and land operation and cargo operation (ship waiting time, ship turnaround time, cargo-handling time, time from entry to exit of port, etc) (see Appendix 19.1 for details).

Research model and data collection

The reseach model developed through a literature review and interview study in this chapter is shown in Figure 19.5 and an empirical study was conducted with the research model. In this research model, components (first-order factor) for each constructs (higher-order factor) are hypothesized to represent corresponding constructs in measurement models and causal relationships between PSCO, PSCI and LPP are also hypothesized in structural models. PSCO, PSCI and LPP are higher-order factors, while their components are called first-order factors. The first-order factors are measured by their observed variables which are measurement items in Appendix 19.1.

A preliminary step for this task was to collect data used in the empirical analysis and this was collected through a questionnaire survey conducted in two ports (ports A and B) and across a range of TOCs and port users (PUs). Measurement items were designed through a literature review and

TABLE 19.11 Questionnaire response details

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

NOTE * Percentage in 'responded' column stands for proportion of response of each group in subtotal responses.

interviews with practitioners and academics. A large pool of items for PSCO, PSCI and port performance was generated from the relevant literature. During the interviews with 21 industry and academic experts, the theoretical framework of this study and the generated measurement items were discussed, completing the first draft of the questionnaire with a 5-point Likert scale. Subsequently two practitioners and an academic reviewed and commented on the draft version of the questionnaire, which was re-structured and re-worded. Appendix 19.1 provides the full list of measurement items and their sources. The questionnaire package was distributed to 191 target respondents. The survey questionnaire asked TOCs to evaluate their terminals, responding to the items in the questionnaire. In contrast, SCs and FDWs were asked to evaluate the terminals they frequently use in both the selected ports. Accordingly, the maximum possible number of responses that this study could obtain was 311 (71 from TOCs and 240 from SCs and FDWs). 127 responses were received (52 from TOCs and 75 from SCs and FDWs), with a response rate of 40.8 per cent (see Table 19.11).

Empirical analysis and results

Structural equation modelling (SEM), using AMOS 6.0, was the main statistical analysis tool combining the measurement model (CFA) and the structural model (regression or path analysis) into a statistical test (Garver and Mentzer, 1999). In the measurement model phase, the three measurement models (PSCO, PSCI and LPP) are validated. PSCO and PSCI were proposed as second-order constructs which contain two layers of latent constructs, and LPP as a third-order construct with effectiveness and efficiency, which are second-order constructs. Model validation in a measurement model examines overall model fit and construct validity comprising unidimensionality, reliability (scale and composite), convergent validity and discriminant validity. For structural models, overall model fit is assessed to make sure how well the structural model fits into the collected data. Structural coefficients are then examined in terms of statistical significance, which decides whether proposed hypotheses are rejected or not. Nomological validity, defined as the extent to which measures of different but related constructs correlate to each other in theoretically predicted ways (Min and Mentzer, 2004), is also assessed.

Measurement models

Prior to the analysis, the collected data were screened and no missing data were found. Some extent of multivariate non-normality was shown and bootstrapping was successfully applied as a remedy to non-normality as suggested by Byrne (2001). The CFA results for PSCO, PSCI and LPP presented in Table 19.12 show that the overall model fit for the three measurement models is reasonably acceptable. The Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI) are marginally higher than 0.90 except for TLI value for PSCI which is 0.89. Standardized root mean square residual (SRMR) values are all lower than 0.08. The normed fit chi-square statistics for PSCI equals 2.0 while those for PSCO and PP are greater than 2.0. The acceptable model fit indices also confirm unidimensionality. The values of Chronbach's alpha (>0.7), composite reliabilities (>0.7), and the average variance extracted for each of the constructs indicates (>0.5) that construct reliability was confirmed for the measurement models. All items' loadings on their corresponding constructs were high (ranging from 0.66 to 0.95) and significant at the 0.001 significance level (t > 3.29) except for an item in the EFF 1 construct, of which loading is 0.52, but significant at the 0.001 significance level, and does not appear to harm the overall model fit. This demonstrates adequate convergent validity.

Discriminant validity was evaluated with the method suggested by Kline (2005) and Fornell and Larker (1981): 1) the correlation between latent variables is lower than 0.85; 2) the AVE of each construct is higher than 0.5; and 3) the AVE of each latent variable is higher than the squared inter-construct correlations. The comparisons for PSCO and PP met the criteria presented in the previous section. Two inter-construct correlations in the PSCI model were higher than 0.85 (VAL-SCIP 0.87; OR-TMS 0.89) and their squared values (0.75; 0.79 respectively) were also higher than the relevant AVEs (VAL 0.67 SCIP 0.71; OR 0.69 TMS 0.73). The details of this test are provided in Appendix 19.2. Considering that this method applies very conservative criteria and the higher-order measurement model requires high correlation among

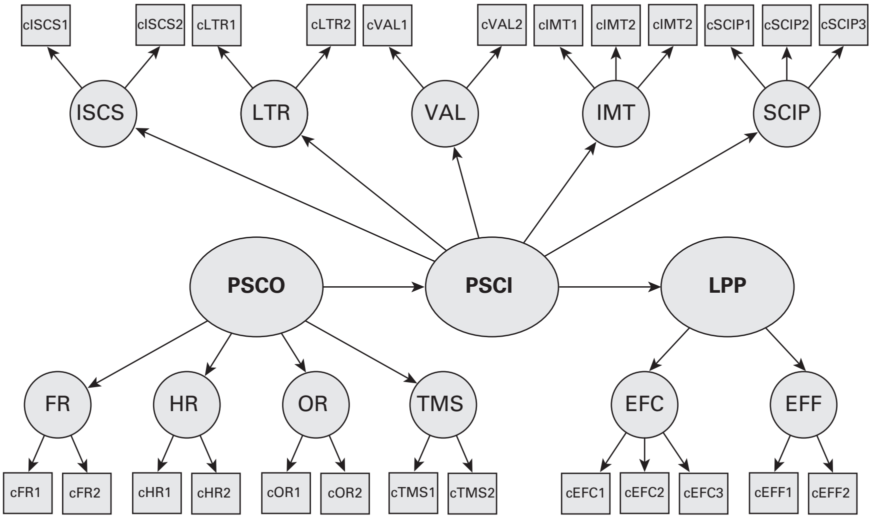
TABLE 19.12 CFA results for the first order constructs of PSCO, PSCI and PP

Constructs	No. of items	Standardized loadings range	Range of t-values	CRs	AVEs	α-values
Port Supply Chain Orientation (PSCO)						
OR	7	0.72–0.89	9.40–12.91	0.94	0.69	0.94
HR	3	0.77–0.89	10.13–12.14	0.87	0.69	0.87
FR	3	0.67–0.90	8.37–10.79	0.86	0.68	0.87
TMS	5	0.74–0.91	9.91–14.66	0.93	0.73	0.93
χ^2=306.65 (df=124); χ^2/df=2.4. CFI=0.92; TLI=0.91; SRMR=0.056						
Port Supply Chain Integration (PSCI)						
ICS	8	0.67–0.86	8.31–11.19	0.88	0.56	0.89
LTR	4	0.66–0.90	10.83–15.73	0.90	0.67	0.89
VAL	5	0.65–0.93	7.41–13.33	0.91	0.67	0.92
IMT	6	0.72–0.88	8.40–12.14	0.90	0.61	0.92
SCIP	6	0.71–0.90	9.79–14.99	0.94	0.71	0.93
χ^2=617.85 (df=305); χ^2/df=2.0; CFI=0.91; TLI=0.89; SRMR=0.058						

Logistics Performance of Port (LPP)						
EFC						
Service quality (EFC1)	6	0.72–0.90	9.39–13.18	0.93	0.70	0.93
Customer orientation (EFC2)	4	0.84–0.91	12.90–15.46	0.93	0.77	0.93
Service price (EFC3)	3	0.91–0.97	18.45–22.38	0.95	0.88	0.95
EFF						
Sea and land operation (EFF1)	5	0.52–0.92	8.48–9.03	0.90	0.65	0.90
Cargo operation (EFF2)	3	0.76–0.92	11.40–11.51	0.94	0.81	0.90
χ^2=373.124 (df=177); χ^2/df=2.1; CFI=0.93; TLI=0.92; SRMR=0.069						

NOTE CR: composite reliability; AVE: average variance extracted; α-value: Chronbach's α.

FIGURE 19.6 Structural model



first-order constructs, those cases not meeting the suggested criteria can be considered to be acceptable. Based on the acceptable validation of the first-order constructs, validation of the three hypothesized higher-order measurement models was attempted. The results were successful since the overall model fit indices were acceptable ($2.0<\chi^2/df<2.4$; $0.90<CFI<0.93$; $0.89<TLI<0.91$; $0.57<SRMR<0.70$) and all the factor loadings from the higher-order constructs to the corresponding first-order constructs were high (ranging from 0.73 to 0.97) and statistically significant at the 0.001 significance level.

Structural model

The structural model was constructed for testing the hypothesized causal relationships as shown in Figure 19.6. In constructing this model, a partial aggregation method, which uses composites of 2–4 measurement items as observed variables for their corresponding latent variables, was applied to reduce model complexity and identification problems (Bagozzi and Heatherton, 1994; Leone *et al*, 2001).

The SEM results in Table 19.13 showed that the proposed model achieved acceptably good fit. The normed chi-square statistics are higher than 2.0 but below the recommended value of 3.0 suggested by Bollen (1989). CFI (0.90) and TLI (0.89) do not indicate excellent fit but reasonable and acceptable fit, and SRMR (0.057) is far below the suggested threshold. The individual paths were also evaluated. Path PSCO-PSCI was statistically significant at the 0.001 significance level with the critical ratio of 9.90. The standardized regression weight was 0.96 indicating the impact of PSCO on PSCI is both

TABLE 19.13 SEM results: Structure model with higher-order factors

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

NOTE *** P<0.001.

positive and very strong. Path PSCI-LPP was also significant at the 0.001 significance level and the standardized regression weight was 0.95. This also indicates PSCI influences PP positively and very strongly. All the factor loadings of first-order factors on the corresponding higher-order factors were significant and high, ranging from 0.7 to 0.96. In addition the factor loadings did not show substantial difference from those in the measurement models, demonstrating the measurement models' validity and stability (Hair *et al*, 2010). The SEM results also supported nomological validity of PSCO and PSCI measurement models because the PSCO-PSCI path was theoretically expected to make a positive contribution to LPP.

Conclusion

With regard to the results and findings of the empirical research, first, the three constructs, PSCO, PSCI and PP, were successfully validated with the components identified from the literature review and interviews indicating that the three constructs are multi-dimensional concepts. Secondly, the empirical research showed that PSCO has a strong contribution to PSCI, and PSCI has a strong and positive impact on LPP. Considering the LPP construct encompasses both effectiveness and efficiency of terminal operations, the consequences of PSCI are not limited to improving either internal efficiency or external effectiveness. Both aspects of port performance can be improved by seeking PSCI. Additionally PSCO, in turn, was found to influence positively and indirectly on LPP through implementing PSCI.

In conclusion, this chapter suggests that the integration strategy of ports along supply chains (PSCI) should be firmly based on a strong orientation to supply chain integration (PSCO) within individual seaport terminals, and the successful implementation of this strategy necessarily involves significant improvement of the logistics performance of terminals (LPP).

Appendix 19.1

TABLE 19.14 Latent and observed variables for PSCO

Measurement items	Source
FR (Financial Resources)	
Having the financial resources to invest for supply chain integration when necessary (FR1)	Interview findings
Being willing to invest for supply chain integration when necessary (FR2)	
Playing a high priority on investment for supply chain integration (FR3)	
HR (Human Resources)	
Workforce has a good understanding of new logistics environments (HR1)	Interview findings
Workforce has the capabilities to develop new logistics services (eg integrated logistics services) (HR2)	
Offering constantly education opportunities about supply chain integration to enhance the workforce's capabilities (HR3)	
OR (Organisational Relationships)	
Goals and objectives are consistent with those of our supply chain members (OR1)	Min and Mentzer (2004) Min *et al* (2007) Panayides (2007) Interview findings
CEO and the CEOs of our supply chain members have similar operating philosophies (OR2)	
Being willing to make cooperative changes with our supply chain members (OR3)	
Believing our supply chain members must work together to be successful (OR4)	
Our supply chain members trust each other (OR5)	
Keeping promises with our supply chain members (OR6)	
Dealing with supply chain members with honesty (OR7)	

(*Continued*)

TABLE 19.14 Latent and observed variables for PSCO (*Continued*)

Measurement items	Source
TMS (Top Management Support)	
Top management repeatedly tell employees that our continued success depends on its adapting to new logistics environment such as supply chain integration (TMS1)	Min and Mentzer (2004) Min *et al* (2007) Interview findings
Top managers repeatedly tell employees that building, maintaining, and enhancing long-term relationships with supply chain members are critical to our business's success (TMS2)	
Top managers repeatedly tell employees that sharing valuable strategic/tactical information with supply chain members is critical to business's success (TMS3)	
Top managers repeatedly tell employees that sharing objectives and philosophy is critical to our business's success (TMS4)	
Top management offers various education opportunities about supply chain management and integration (TMS5)	

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

TABLE 19.15 Latent and observed variables for PSCI

Measurement items	Source
ICS (Information and Communication System)	
Providing information concerning shipment and cargo tracking (ISCS1)	Vickery *et al* (2003)
Sharing information concerning inventory management with supply chain members (ISCS2)	Min and Mentzer (2004)
Exchanging information concerning supply and demand forecasts with supply chain members (ISCS3)	Min *et al* (2007)
Exchanging information concerning marketing strategy with supply chain members (ISCS4)	Panayides and Song (2008)
Using integrated EDI (Electronic Data Interchange) to communicate with partners in the supply chain (ISCS5)	Interview findings
Using integrated information systems to share data/information with partners in the supply chain (ISCS6)	
Adopting computerized service systems for supply chain operations (ISCS7)	
Using the latest IT technology to support supply chain goals (ISCS8)	
LTR (Long-Term Relationships)	
Reducing channel complexity to closely work with a selected set of supply chain members (LTR1)	Shin *et al* (2002)
We have facilitated a strong and long-term supply chain relationship fostering cooperation with each other (LTR2)	Min and Mentzer (2004)
Relationships with supply chain members are based on trust rather than contractual obligations (LTR3)	Min *et al* (2007)
Having guidelines for developing and maintaining long term relationships with supply chain members (LTR4)	Interview findings
VAL (Value-Added Logistics)	
Having adequate facilities for adding value to cargoes (VAL1)	Panayides and Song (2008)
Capable of adapting a service to meet the customers' specifications (VAL2)	Interview findings
Capable of launching new tailored services should the need arise (VAL3)	
Capable of delivering services tailored to different market segments (VAL4)	
Capable of handling different types of cargo (VAL5)	

(*Continued*)

TABLE 19.15 Latent and observed variables for PSCI (*Continued*)

Measurement items	Source
IMT (Inter-Modal Transport)	
Having the capacity to convey cargo through the most diversified routes/modes at the least possible time (IMT1)	Panayides and Song (2008)
Having a variety of services to handle the transferring of cargo from one mode to another (IMT2)	Interview findings
Having adequate connectivity for the multimodal interface (IMT3)	
Having reliable service operations for the multimodal interface (IMT4)	
Providing cost-effective multimodal operations (IMT5)	
Evaluating alternative routes for the more efficient multimodal transport of containers via our Terminal (IMT6)	
SCIP (Supply Chain Integration Practices	
Collaborating with other supply chain partners to plan for greater supply chain optimization (SCIP1)	Panayides and Song
Seeking to identify other competing supply chains for containers that might flow through our terminal (SCIP2)	(2008)
Comparing the cost and time of cargoes flowing through our port and those of the cargoes flowing through other competitive ports (SCIP3)	Interview findings
Benchmarking the logistics/supply chain options available for cargoes that will flow through our port vis-a -vis alternative routes via competing ports (SCIP4)	
Seeking to identify least cost options for the transport of cargoes to hinterland destinations (SCIP5)	
Constantly evaluating the performance of the transport modes available for linking our port/terminal to its hinterland destinations (SCIP6)	

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

TABLE 19.16 Latent and observed variables for LPP

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

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

Appendix 19.2

TABLE 19.17 Port supply chain orientation (PSCO)

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

NOTE *** P<0.001; ** p<0.01; * p<0.05

TABLE 19.18 Port supply chain integration (PSCI)

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

NOTE *** P<0.001; ** p<0.01; * p<0.05

TABLE 19.19 Port performance (PP)

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

NOTE *** P<0.001; ** p<0.01; * p<0.05

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PART FOUR
Conclusion

Looking ahead

20

PHOTIS M PANAYIDES AND DONG-WOOK SONG

In the first edition of this volume of readings in maritime logistics our aim was to propagate further the development of this interesting area that combines maritime transport and logistics management. Evidence suggests that this aim has been achieved bearing in mind the considerable interest that was shown for the first volume. On this basis the aim for the second volume remains strong and clear, bearing in mind the need for further empirical research and development of scholarly thought in maritime logistics. The combination of the two concepts is a natural consequence of the convergent managerial and physical objectives in the transportation of goods and commodities from production to consumption. The combination is also evident from the contributions in this volume. This concluding chapter provides an overview of the contributions from two perspectives. The first perspective reviews the chapters by highlighting the topics of investigation as well as their importance. The second perspective focuses on what we have learned from the contributions in the volume and highlights topics that may be the subject of future scholarly investigation.

Topics of investigation and their importance

The importance of the concept of maritime logistics is underlined by virtually all authors in this volume. In addition, the topics that the authors chose to investigate and analyse provide important signals as to the areas that science and practice need to focus on in order to develop the boundaries of knowledge further.

Chapter 2 by Veenstra addresses the relationship between ocean shipping and trade, by examining to what extent shipping is still a facilitator to trade. For this purpose, the author introduces the approach of the trade facilitation school of thought in shipping and port management. This is followed by a detailed description of the mechanism of international trade, as well as the specific role of shipping within this mechanism. These concepts are connected to the ongoing work on non-tariff barriers, both theoretical and empirical, that has taken place in recent years.

In Chapter 3, Yercan and Yildiz provide an overview of international maritime trade and logistics, focusing on the development process of maritime trade. The authors use the liner shipping connectivity index to highlight the importance of links and networks in facilitating international trade by carriers.

In Chapter 4, Lee Nam and Song provide an in-depth understanding of key concepts in maritime logistics including the definition, the main activities and a guideline for value creation of maritime logistics systems. The authors define maritime logistics and maritime logistics value in terms of the integration of maritime transport and logistics management to create value through the reduction in costs and improvement in service quality. By integrating the literature the authors highlight the difference between maritime logistics and maritime transportation, emphasizing the importance of the managerial function in maritime logistics management. The chapter also highlights strategic implications for maritime logistics operators.

Hinterland logistics incorporates the hinterland transportation system and related logistics activities. Bergqvist in Chapter 5 argues that hinterland logistics should not be dealt with in isolation from the overall supply chain; rather, hinterland logistics has the important role of effectively and efficiently connecting large and more global, primarily sea-based transport networks with hinterland transport systems. The author provides an informative review of the hinterland transportation concept and describes the evolution and development of hinterland logistics including transport system design, intermodality and intelligent system design as well as hinterland logistics strategy. The concepts are manifested in an analysis of how the hinterland logistic system in Scandinavia, related to the functions of the Port of Gothenburg, was developed. Through the case study of the Scandinavian Railport system, important implications for hinterland logistics and its influence in global supply chains are presented.

The development of technology and technological advances may have made some aspects of human work redundant but brought about several other issues that need to be addressed in an efficient supply chain, not least the interface between humans and technology in the various man–machine systems that make up the global supply chain. The most significant concepts are reviewed by Österman and Osvalder (Chapter 6).

Hayashi and Nemoto (Chapter 7) emphasize the importance of intermodal freight transport for multinational manufacturing companies that operate globally and require door-to-door services. The configuration of liner shipping networks and the design of liner services are analysed by Ducruet and Notteboom (Chapter 8). Recognizing that the extensive worldwide container shipping networks are key to globalization and global supply chains, the authors analyse liner service networks as configured by container shipping lines by using global vessel movement data, the position of seaports and the changing geographic distribution of main inter-port links. The importance of maritime logistics is epitomized in the propensity of shipping companies to become actively involved in the business of logistics or inland transportation. Such an involvement may take the form of diversification or integration in the supply chain. The concept is thoroughly investigated by Panayides *et al* (Chapter 9) who also carry out an empirical investigation into the valuation effects from the diversification of shipping companies.

In Chapter 10, Baird attempts to investigate and provide a wider picture concerning what liner shipping competitors are doing with regard to the provision of logistics and value-added activities, to assess the extent of these activities in terms of logistics services provided, and to offer an indication as to how this might evolve in the future. The chapter includes several brief case studies which seek to review and analyse the specific logistics activities and strategies within several of the top 20 container lines. The author seeks to establish the performance implications from the provision of logistics-related added-value services and to offer an indication of future evolution using the case study approach. The case studies offer a more detailed insight into the different approaches adopted by major global container lines with respect to the development and provision of logistics services. The chapter concludes that over half of the top 20 carriers, and not just the smaller lines, actually offer little in the way of logistics or added-value services. Conversely, several top 20 carriers maintain a wide portfolio of logistics investments and capabilities and hence derive considerable income from these activities. Yet there seems to be plenty of room for liner operators to expand their logistics services, although whether they would wish to do so remains a key question. Moreover, there appears to be scant evidence of ocean carriers earning high profits from logistics.

Sea transport is not limited to containerized cargoes and the developments taking place in international trade render the application of logistics concepts essential in non-containerized commodities. This is recognized by Desrosiers (Chapter 11) and Comtois and Lacoste (Chapter 12).

Desrosiers (Chapter 11) discusses tanker shipping logistics with a focus on cargo operations in particular, as well as commercial issues that pertain to the arrival and discharge of a cargo of crude oil at a terminal. Comtois and Lacoste (Chapter 12) highlight the importance of understanding dry bulk shipping logistics on the basis of certain key salient features including the need for efficiency improvements in cargo handling and transportation. The chapter provides a thorough understanding of developments in dry bulk shipping logistics by looking at such issues as the dry bulk fleet and route patterns, the dry bulk supply chain and inventory management, and challenges in dry bulk shipping logistics.

Ports play a crucial role in the maritime logistics chain; hence Roso and Rosa (Chapter 13) discuss the concept of the dry port and investigate its application to practice. As an inland intermodal terminal that is directly connected by rail to seaports, the aim of dry ports is to rationalize transport in and out of a port by bundling the flows of cargo, thus reducing congestion and other externalities. Case studies of dry ports in Europe are presented.

In a chapter titled 'Port-centric logistics in concept and practice' (Chapter 14) Valantasis-Kanellos and Song begin by outlining the contemporary business environment of ports and its effects on those ports. The evolutionary development of ports on a global scale is thereafter discussed from three different perspectives. The first perspective is involved with the port generations model, the second with the privatization of ports, while the third with the emergence and expansion of global port operators (GPOs). Finally, before the main theme of this chapter, the development of port-centric logistics (PCL) in the UK over the last decade, is discussed, the unique paradigm of UK ports regarding their ownership and management mandates is framed.

The concept of the hub port has been at the centre of maritime practice for a good part of the last two decades. Despite this it seems that defining exactly what a maritime logistics hub is has been an elusive concept, according to Nam and Song (Chapter 15). They identify several empirical analyses that use rather abstract definitions of maritime logistics hubs generally proxied to container hub ports. Therefore, the authors attempt to tackle this gap by not only defining the concept of the logistics hub but also by describing its application to container ports. The chapter concludes by providing implications as to policy and strategy that will enhance the ability of aspiring ports to become hub ports.

Chapter 16 by Parola aims to provide an exhaustive overview of the container port business state of the art and evolution, depicting mainstream trends and common managerial practices. For this purpose, extant academic literature has been scrutinized in depth and critically discussed. The chapter conceptualizes the nature and typology of stevedoring services, enlightening the differences between dedicated and multi-user facilities. In addition, it introduces business models of leading market players, exploring the main drivers of growth. The chapter provides an analysis of spatio-temporal dimensions of container port MNEs' internationalization, illustrating the timing and the geographic scope of overseas expansion. There is also a description of the most common firms' entry patterns and expansions of the understanding of inter-firm partnerships, which originate 'hidden families' of cooperation across multiple locations.

In Chapter 17, Lam, Parola and Panayides add value to the body of port literature by focusing on the growing trend in port public–private partnerships (PPPs). The study aims to perform an exploratory investigation of the impact of PPP on port logistics performance through the discussion of examples from the port industry and the respective countries' situation. In particular, the authors identify relevant institutional factors to frame the discussion and draw inferences. Based on the examples from various ports, PPPs could improve port logistics performance primarily attributed to the private sector's operational and managerial expertise. However, there are also examples showing the capability of the public sector in achieving a high level of port logistics performance.

Centin (Chapter 18) provides an organizational view of ports and logistics chains. In particular, the author examines improvements in organizational effectiveness that can be achieved by organizational developments by important stakeholders and specifically by port authorities. The study deals with the changes in the roles of ports and port authorities as a result of the new trends in logistics chains. It also deals with the importance of port authority strategies and activities for re-positioning the ports in these chains. The fact that ports should seek to become more integrated in supply chains through an increased supply chain orientation has been rigorously advocated in this book. Woo *et al* (Chapter 19) aim to investigate the effect of supply chain integration of seaports on port performance by examining the causal relationships among the integration strategies of seaport terminals along the supply chain, and the antecedents and consequences of the integration strategies. The integration strategy is termed 'port supply chain integration' (PSCI) and the antecedents of PSCI are identified as 'port supply chain orientation' (PSCO). Logistics performance of ports (LPP) is considered as consequences of PSCI because it is suggested that traditional performance measures such as cargo throughput is not sufficient for a proxy of port performance in a global supply chain context. In particular the authors examine the influence of PSCO (defined by the latent constructs of 'organizational relationships', 'financial resources', 'human resources' and 'top management support') on PSCI (defined by the latent constructs of 'information and communication system', 'long-term relationships', 'value-added logistics', 'intermodal transport' and 'supply chain integration practices'). They also examine the influence of the latter on logistics port performance defined by 'service quality', 'customer orientation', 'service price', 'sea and land operations' and 'cargo operation'.

Outcomes and implications

Veenstra in Chapter 2 indicates that further research may incorporate bottlenecks related to container shipping operations into formal trade barrier measurement efforts such as the Enabling Trade Index. An extension of the UNCTAD Liner Shipping Connectivity Index seems to provide a good basis for this. The author also suggests the development of gap measures for pairs of countries based on the LPI, GDB or ET, and the use of these gap measures as determinants for trade patterns or trade costs. Especially gap measures based on some of the detailed transport-related elements of the LPI should shed more light on the way the quality of transportation between countries plays a role in explaining trade patterns or trade costs between those countries.

Lee, Nam and Song (Chapter 4) explain that maritime logistics is a concept developed from the study of maritime transportation in a logistics context and as such it includes the managerial functions that pertain to logistics management. Maritime logistics has significant value in the context of contemporary maritime operations. The significance of combining maritime operations and logistics lies in the fact that value is created in the context of this combination and this is where further research may focus. Value includes improved efficiency and effectiveness, but also strategic value from the expansion and offer of additional services.

Bergqvist (Chapter 5) concludes that the hinterland transport system is a crucial part of the supply chain of shippers and logistics service providers. An in-depth understanding and knowledge of hinterland logistics and its unique conditions in each situation are a crucial part of effective design and strategy regarding transport systems and ultimately of efficient global supply chain management.

In developing logistics systems and infrastructure, one must not overlook the human element as highlighted by Österman and Osvalder (Chapter 6) who focus on the maritime domain, identifying causes of occupational hazards and their physical as well as company-related economic effects.

Hayashi and Nemoto (Chapter 7) conclude that under a globalized environment, more varied alternative intermodal transport routes are required in order to fulfil the changing and growing needs of the shippers. Shippers are also interested in optimization of the global supply chain, cost and quality as well as service frequency. In order to achieve such goals the authors state that cooperation is required between countries, especially developing countries, to plan on international intermodal transport infrastructure requirements.

The development of liner shipping networks and the design of liner services in a maritime logistics context are analysed by Ducruet and Notteboom (Chapter 8). The chapter breaks new ground by discussing the drivers of liner service design and by exploring the changing geographic distribution of main inter-port links in light of liner network configurations and in also considering the network position of seaports by referring to the concepts of centrality, hierarchy and selection factors.

Panayides *et al* (Chapter 9) in their study of the supply chain integration of shipping companies and the valuation effects thereof provide preliminary confirmation that the supply chain integration trends in shipping companies and liner shipping in particular are value-creating. They conclude that studies in the general literature indicating a diversification discount do not necessarily apply in the unique setting of the maritime logistics industry. Of course, bearing in mind that at a strategic level not all companies choose to be diversified in the supply chain, the authors highlight the need for further studies to distinguish between the performance implications of supply chain integrated (diversified) and non-integrated shipping companies. Bearing in mind the key question for management decision makers of whether or not to integrate supply chain within maritime logistics, the area is very promising for further empirical investigation.

Baird (Chapter 10) reveals some interesting findings with respect to the involvement of liner shipping carriers in offering logistics services. In particular, he found that several top 20 carriers maintain a wide portfolio of logistics investments and capabilities and hence derive considerable income from these activities. Despite this, the size of a carrier is not directly related to the degree of involvement in offering logistics services. In addition, the author casts doubt on the belief that ocean carriers earn higher profits from offering logistics services. This was particularly true during the period prior to the economic crisis of 2008 where carriers were making significant profits from ocean shipping and were focused on this core business activity. According to Baird, the key question that future research may seek to answer is to specify the volume of additional business that can be generated for the core ocean transport service though investment in logistics services.

With respect to cargo operations in a tanker logistics setting, Desrosiers (Chapter 11) indicates that the logistics of transferring bulk petroleum is subject to a variety of uncertainties and potential losses in quality, quantity as well as time. It is on this basis that tanker operations need to pay increasing attention to logistics issues in order to ensure that they reach the standards of security and environmental and fiscal requirements and considerations.

Comtois and Lacoste (Chapter 12) conclude that bulk movements provide an important market for the impacts of global economic processes and therefore bulk shipping must be analysed in the broader context of overcoming vulnerability in the bulk shipping supply chain to achieve traffic fluidity. In this context the challenges for bulk shipping logistics are similar to those faced by container and liquid bulk shipping logistics operations. There is great scope for applying concepts of container maritime logistics in the context of bulk shipping operations and professional practice suggests that this stream of research should be given additional emphasis.

Following a case study examination of dry ports in Europe, Roso and Rosa (Chapter 13) conclude that the advantages dry ports bring to all operators render their further development necessary. In particular, they identify improvements in green logistics and environmental aspects, cost and time savings due to reduced road congestion as well as the efficient interface of the port and inland terminals and economies of scale through the bundling of container flows and the use of intermodal transport. Obviously the dry port concept is receiving increasing attention but still there is a lot to be done in terms of empirical investigations.

Intermodal transport invariably uses the services of logistics hubs, a concept that is defined in Chapter 15 by Nam and Song. According to the authors 'A maritime logistics hub is i) *a nodal point* of cargo transit or transhipment assuring flawless door-to-door cargo movements, ii) a *principal distribution centre* functioning as a temporary storage and sorting, and iii) *a place* creating and facilitating value-added services on the regional and/or international scale.' Nam and Song apply economic and social network theories and develop conceptual frameworks that examine the evolutionary development of container hub ports. The conceptual frameworks provide ample opportunity for empirical investigation of the concepts.

In Chapter 16, Parola indicates that despite the fruitful academic debate on the topic of multinationalizing container ports, many promising streams of research are still under-explored and deserve more attention by scholars.

First, future studies have to achieve a more sophisticated understanding of the objectives and strategic attitudes of financial operators. In addition, the unique internationalization drive of some container port MNEs makes this industry a meaningful empirical context for expanding traditional internationalization theories and adopting innovative perspectives. Moreover, the accelerated resort to EJVs and the formation of cliques still require a massive analytical effort in a number of directions. Clique leadership and governance, intra-clique management ties, geographic scope of cliques, role and functions of domestic members in clique organizational structure, and clique evolution and survival are just a few of the cutting-edge themes to address. Finally, the academic literature must also include economic and financial performance into the mainstream analytical frameworks of container port MNEs.

In Chapter 17, Lam, Parola and Panayides provided an extensive analysis of major institutional factors that would affect the impact of PPPs on port logistics performance, based on the institutional framework and empirical data provided by the World Bank. This chapter contributed to increasing awareness of the complexity of this theme, and raised the urgency of performing extensive empirical research for a clearer understanding of these arguments. In particular, it could be worth investigating other analytical dimensions and carrying out cross-industry comparisons among various types of PPP transport infrastructures which might be affected differently by institutional factors.

Centin (Chapter 18), through a theoretical and conceptual discussion, identifies the effectiveness criteria of port organizations in the context of the increasing importance of logistics-related developments. The criteria include port-logistics chain integration, adaptability to the changes in the environment, customer orientation and satisfaction, information and communication management, service quality, provision of value-added and intermodal services, and innovation and resource acquisition.

Woo, Pettit and Beresford (Chapter 19) validate the three measures of port supply chain orientation, port supply chain integration and logistics port performance and found that port supply chain orientation influences positively the integration of ports in supply chains and that such integration has a positive causal impact on port logistics performance. The scales developed by the authors provide the opportunity for further empirical investigation, not just to validate them in different settings but also to use them in examining other relationships between the integration of supply chains in ports and specific causal outcomes that may be conceptualized.

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