

# Preface

As international trade continues to grow rapidly and supply chains become more globalized, many operations have been outsourced and moved offshore. About 90 % of the international trade volume was facilitated by ocean transportation. If we assume that half of China's exports by value in 2013 were moved by ocean transport and on average it takes one month for the goods to reach the consignee, then about 85B\$<sup>1</sup> worth of goods would have been caught up during the transportation. Due to environmental and bunker cost considerations, international air cargo transport has been reduced from 3.1 % in 2010 to 1.7 % in 2013<sup>2</sup>, with a shift towards more economic transportation modes, especially ocean transport. Hence, ocean transport logistics has played a very significant role in global supply chains.

Although ocean transport logistics has been well studied in maritime economics and operations research/management science, many important issues have yet to receive the attention they deserve. In this book, we reveal the interaction among parties along the chain, including shippers, terminal operators and line carriers. We examine the impact of ocean transport logistics on global supply chains and address many important topics to shed new light on the subject.

This book is organized into three parts. The first part talks about the innovative development of terminal operators and the competition they face. The second part delves into the many tactical and operational aspects of managing shipping liners, including empty container repositioning, disruption management, slow steaming, bunker purchasing, ship route schedule, and transport network design, and evaluates their corresponding challenges and opportunities. The third part studies the impact of ocean logistics transport on global supply chains. The 18 chapters of the book all highlight the immediate effect of ocean transport logistics on global supply chains.

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<sup>1</sup> <http://www.funggroup.com/eng/knowledge/research/ChinaTradeQuarterly1Q13.pdf>.

<sup>2</sup> International Air Transport Association.

## Part I: Container Terminal Operation: Innovations, Trends, Competition and Business Models

According to a survey by Notteboom<sup>3</sup>, about 65 % of delay in ocean shipping is due to port congestion. Clearly, terminal operation efficiency is crucial to improving ocean shipping reliability. Due to bunker and emission cost reduction considerations, carriers tend to use huge vessels (capacity up to 18,000 TEU) and also adopt slow streaming. On the other hand, the strong demand for on time and/or fast delivery from shippers forces the carrier to cut the turn-around time in the terminal to allow time for slow steaming. All these have put huge pressure on terminal operators to improve their efficiency and have also made terminal competition fiercer than ever before. Hence, in Part I, we have five chapters that examine the innovations, trends, competition and business models of container terminal operations.

In the **first chapter**, Jiang, Chew and Lee study innovative container terminal designs. They first examine the issue of how to measure the port connectivity by proposing a new connectivity framework from a network perspective that can be used to generate a quantifiable measure of port connectivity. They also discuss the management of storage yards in transshipment ports. They further discuss innovative terminal designs that can serve as potential solutions for transshipment ports. Instead of using AGVs or ALVs to transport the containers in automated container terminals (ACTs), they introduce two innovative ACT systems: the “frame bridge system” designed by Shanghai Zhenhua Heavy Industries Co. Ltd., and the “GRID system” designed by BEC Industries. These revolutionary ideas aim to achieve a quantum leap in handling efficiency and productivity to support future shipping in an economically and environmentally sustainable manner.

In **Chap. 2**, Kim and Lee study the current trends and future challenges of container terminal operations. They review various planning and control activities in container terminals and define decision-making problems for operation planning and control. They also discuss new trends in the technological development for each decision-making process. They then describe the functions of terminal operation systems (TOS), the software used to implement the decision-making processes. Commercial TOS, including Navis SPARCS N4, CATOS, Mainsail Vanguard, TOPS, and OPUS, plus two famous noncommercial TOS, PortNet for PSA and nGen for HIT, are introduced and compared. Finally, they highlight recent trends of TOS responding to changes in the technological and market environment.

In **Chap. 3**, Notteboom and de Langen report an up-to-date and detailed analysis of the dynamics of the European container port system—the second most important container port system in the world. Their discussion and conclusion section summarizes very nicely their findings and also provides clear insights into the current drivers of the container port competition in Europe. They identify a number of key

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<sup>3</sup> Notteboom, T.E. 2006. The time factor in liner shipping services. *Maritime Economics & Logistics*, 8 (1), 19–39.

success factors, including capacity, proximity to a hinterland with strong cargo generating and receiving capacities, access to sea and hinterland, strong sea and land connectivity, port and terminal efficiency, right pricing and a supply chain approach.

**In Chap. 4,** Lee and Lam examine whether major Asian ports have evolved into fifth generation ports (5GP) or if they remain fourth generation ports (4GP) to this day. They use the revised concept of 5GP to evaluate inter-port competition among four Asian ports—Shanghai, Singapore, Hong Kong and Busan—in a comprehensive way to reflect the cross-sectional, longitudinal and horizontal aspects of the port evolution. A novel approach with an empirical test combining a description method and a quantitative method is employed to study port competition and competitiveness.

**In Chap. 5,** Lu and Chang study the selection of a business model for container terminal operations. Recently, the Taiwan International Ports Corporation (TIPC) was set up to replace the former port authority of Kaohsiung, Keelung, Taichung and Haulin in Taiwan. They use TIPC as a case study to empirically identify the crucial criteria for choosing a business model for container terminal operations. An analytical hierarchy process approach was adopted to assess the relative importance of these criteria. Their results show that benefit and operational capability are the two most important criteria.

## Part II: Shipping Liners: Tactical and Operational Management

According to a survey by Merge Global<sup>4</sup>, the biggest portion (around 50 %) of the revenue in the whole ocean transport logistics service provider chain goes to carriers. There are many important issues in the shipping liner industry that are worth studying. In Part II, we report some studies on tactical and operational management issues, including empty container repositioning, disruption management, bunker purchasing, ship route schedule, slow steaming, and transport network design.

**In Chap. 6,** Song and Dong provide a comprehensive and critical survey on empty container repositioning for container shipping liners. After analyzing the main reasons for empty container repositioning operations, they provide a literature review with an emphasis on modeling empty container reposition problems from the network perspective. They then discuss possible solutions to the empty container repositioning problems from the logistics channel perspective followed by solutions from the methodical modeling technique perspective. Finally, they present two specific models aiming to tackle the empty container repositioning problems in stochastic dynamic environments considering both laden and empty container management.

**In Chap. 7,** Tsang and Mak further formulate the empty container repositioning problem for liner shipping as a multistage stochastic programming problem. Their model specifically handles the stochastic nature of demand and long transportation lead time. As they are able to reformulate the computationally intractable stochastic

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<sup>4</sup> Merge Global. 2008. *Insomnia: Why challenges facing the world container industry make for more nightmares than they should*. American Shipper, July, 68–85.

program into a tractable cone program, a commercial solver can be used to find a solution. They also demonstrate that the robust model outperforms other simple policies.

In the shipping liner business, the route schedule is usually planned, fixed and announced either three or six months in advance, and then at the operational level, the vessel will stick to the schedule as closely as possible. But vessels will often encounter unexpected disruptions, such as port congestion, severe weather conditions, or even port closure. **In Chap. 8**, Qi studies the problem of how to dynamically revise the operation plan at the execution stage when a disruption occurs. Problem modelling and formulation are provided and a few key results of the solution scheme and managerial insights are derived. This is a rather new research area in ocean transport logistics, though it has been well studied in the airline industry. The chapter concludes by suggesting a few interesting topics for future research.

**In Chap. 9**, Plum, Pisinger and Jensen investigate an important optimal bunker purchasing problem in container shipping lines because the bunker cost constitutes a major component of the daily operating cost of a liner container ship. They first explain the bunkering issue in the liner container shipping industry. A base model for a single-containership bunker purchasing is built taking into account the practical operational constraints. They further present a mixed-integer programming model with a novel solution approach for the bunker purchasing with contracts and discuss possible extensions of the model. Numerical experiments are carried out, and further research directions are highlighted.

**In Chap. 10**, Wang, Alharbi and Davy address the tactical-level interactions between container port operators and container shipping lines. They examine, in particular, a practical route schedule design for tactical liner ships that involves the interaction between container shipping lines and port operators on the availability of port time windows at each port of call. With some mild assumptions, they formulate the problem as a nonlinear non-convex optimization model and design an efficient dynamic-programming-based solution algorithm. A case study based on a trans-pacific ship route is conducted to assess the efficiency of the designed solution algorithm. Four specific future research directions are discussed.

**In Chap. 11**, Psaratis and Kontovas comprehensively examine the slow steaming strategies adopted by shipping lines. They present taxonomy of sailing speed models and analyze the main trade-offs. A decision model combining sailing speed and route choice is developed. Some examples are presented to introduce the main issues related to slow steaming. They point out that solutions for optimal environmental performance are not necessarily the same as those for optimal economic performance. A private operator of shipping lines would most certainly choose optimal economic performance as a criterion if policy-makers intend to influence the operator's decision to achieve a social optimum.

**In Chap. 12**, Wang and Liu contribute a comprehensive overview of existing studies on global container transport network design. After introducing the fundamentals and unique features of a container liner shipping network, a framework for container transport network design is proposed. They discuss the four special network design problems examined in the literature—ship route design with or without

container transshipment operations, feeder shipping network design, hub-and-spoke shipping network design and general shipping network design. Five model formulations for the general shipping network design are presented. They end the chapter with suggestions for future research.

### Part III: Shippers and Global Supply Chain Management

In Part III, we study the impact of ocean transport logistics on global supply chains. We shed light on this issue by investigating several related topics. These topics are purchasing transportation services from the shipper's viewpoint, ocean transport and the facilitation of trade, modelling global container transport demand, cooperation and competition in logistics operation, hinterland transportation as well as green corridors in the supply chain.

Shippers are the major service users in ocean transport logistics. Clearly, minimizing transportation costs is very important for global shippers who need to move their cargo containers all over the world. **In Chap. 13**, Xu and Lai introduce a general optimization model for the transportation service procurement problem (TSPP). After reviewing various existing solution methods for different variants and their extensions, they formulate a new general optimization model and discuss extensions to the existing results. Further research topics are also discussed, such as stochastic setting of the problem, trade-offs between transit time and freight cost, contract coordination and mechanism design.

**In Chap. 14**, Veenstra investigates the ocean transport part of international trade transaction. In particular, he highlights a number of processes related to ocean transport that generate uncertainty and costs in logistics chains. He concludes that certain ocean transport processes incur time loss and uncertainty and affect the efficiency of logistics and supply chains. He predicts that "if such frictions exist, there will be a tendency to move from a market relationship to a more hierarchical relationship between parties involved in the transaction." Examples from the Port of Rotterdam and its European hinterland are also provided.

**In Chap. 15**, Tavasszy, Ivanova and Halim examine the methods and techniques used in the analysis of the global container transport demand. Although the modeling of the global container transport demand can follow the generic architecture available for freight transport modeling, they find that few studies in the literature focus on global container transport modeling. They first model the global container demand between regions as the outcome of the process of production, consumption and trade. Based on the region-to-region demand, they proceed to model container demand for transport services by mode and route, including the container demand for maritime and inland port services.

**In Chap. 16**, Lee and Song examine the environmental challenges recently faced by maritime logistics operators, and investigate ways in which these operators can effectively manage competition and co-operation with their rivals to better respond to those challenges and thus achieve their strategic goals. They establish a theoretical

framework to show the positive relationship between co-operative networks, knowledge acquisition and the value of maritime logistics. A comprehensive survey of existing literature reveals that a high level of co-operation in a co-operative network facilitates knowledge acquisition, and competition promotes the positive impact of co-operation on knowledge acquisition. The acquired knowledge helps to increase the value of maritime logistics. They conclude that this outcome will certainly provide maritime operators with strategic insights into the identification of determinants and/or sources of competitive advantage and greater organizational performance from inter-organizational coordination and knowledge-based perspectives.

Hinterland transportation is increasingly important for ocean transport logistics, especially in the European container port system. In **Chap. 17**, Bouchery, Fazi and Fransoo analyze the most important features of such container transportation systems for the hinterland supply chain. In addition to reviewing the current state of the art and identifying avenues for future research at the network design level, they also characterize those important factors influencing the trade-off between intermodal transportation and truck-only deliveries. A case study of coordination at an intermodal barge terminal in the Netherlands is also provided. A better information system has been identified as a crucial component of efficient hinterland intermodal transportation. This is an interesting area worth further investigation by the operations management community.

Finally, in **Chap. 18**, Panagakos, Psaraftis and Holte present the concept of green corridors and analyse their possible impact on the supply chain. A green corridor was introduced by the European Commission in 2007 aiming at reducing the environmental and climate impact of freight logistics. This chapter mainly focuses on surface freight transport, including maritime transport. It is well known that consolidation of large volumes of freight transport over long distances can reduce transport cost and emission and hence rail and waterborne transport have certain advantages if arranged effectively. They report the analysis performed under the SuperGreen project. They also provide an example that compares the deep sea service linking China to Europe (Shanghai – Le-Havre – Hamburg range) and the trans-Siberian rail link between Beijing and Duisburg/EU. They conclude that in terms of costs and CO<sub>2</sub> emissions (on a per tonne-km basis), deep sea shipping has significant advantages over rail transport although the latter is faster.

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