



# PORTS AND NETWORKS

STRATEGIES, OPERATIONS AND PERSPECTIVES

EDITED BY HARRY GEERLINGS, BART KUIPERS AND ROB ZUIDWIJK



# PORTS AND NETWORKS

Written by leading experts in the field, this book offers an introduction to recent developments in port and hinterland strategies, operations and related specializations. The book begins with a broad overview of port definitions, concepts and the role of ports in global supply chains, and an examination of strategic topics such as port management, governance, performance, hinterlands and the port-city relationship. The second part of the book examines operational aspects of ports, and maritime and land networks. A range of topics are explored, such as liner networks, finance and business models, port-industrial clusters, container terminals, intermodality/synchromodality, and handling. The final section of the book provides insights into key issues of port development and management, from security, sustainability, innovation strategies, transition management and labour issues.

Drawing on a variety of global case studies, theoretical insights are supplemented with real world and best practice examples. This book will be of interest to advanced undergraduates, postgraduates, scholars and professionals interested in maritime studies, transport studies, economics and geography.

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Strategies, Operations and  
Perspectives

*Edited by Harry Geerlings, Bart Kuipers  
and Rob Zuidwijk*

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# ABBREVIATIONS

ABP2020	Algeciras BrainPort 2020
AEO	Authorised Economic Operator
AGV	Automated guided vehicle
AIS	Automatic identification systems
ALV	Automated lifting vehicle
API	Application programming interface
APS	Advanced planning and scheduling
ASC	Automated stacking crane
ATC	Automated transfer crane
AVI	Automatic vehicle identification
BAP	Berth allocation problem
BAU	Business-as-usual
BIMCO	Baltic and International Maritime Council
BOO/BOT	Builds, (owns) and operates
CAAP	Clean Air Action Plan
CARB	California Air Resources Board
CCS	Carbon capture and storage
CFC	Chlorofluorocarbon
CH <sub>4</sub>	Methane
CITOS	Computer Integrated Terminal Operations System
C-MAT	Centre for Maritime and Air Transport
CO <sub>2</sub>	Carbon dioxide
COP21	Conference of Parties #21
CSR	Corporate social responsibility
DGPS	Differential GPS
DPM	Diesel particulate matter
ECA	Emission control area

ECT	Europe Container Terminals
EDI	Electronic data interchange
EEDI	Energy Efficiency Design Index
EIS	Efficiency Incentive Scheme
EMAS	European Union's Eco-Management and Audit Scheme
EMS	Environmental management systems
EPA	Environmental Protection Agency
ERP	Enterprise resource planning
ESI	Environmental Ship Index
ESPO	European Sea Ports Organisation
EU	European Union
EUR	Erasmus University Rotterdam
EURECA	Effective use of reefer containers for conditioned products through the port of Rotterdam
FCD	Floating car data
FCL	Full container load
FDCA	2,5-Furandicarboxylic acid
FDE	Foreign direct investment
FOB	Free on board
GCI	Global Competitiveness Index
GDP	Gross domestic product
GHG	Greenhouse gas
GNP	Gross national product
GPS	Global positioning system
GRI	Global Reporting Initiative
GTO	Global terminal operators
HC	Hydrocarbon
HFC	Hydrofluorocarbon
HPA	Hamburg Port Authority
HPH	Hutchinson Port Holdings
IAME	International Association of Maritime Economists
IAPH	International Association of Ports and Harbours
ILO	International Labour Organization
IMO	International Maritime Organization
IoT	Internet of Things
IPCSA	International Port Community Systems Association
ISO	International Organization for Standardization
IT	Information technology
ITF	International Transport Forum
ITS	Intelligent transport systems
ITT	Inter-terminal transportation
ITTRP	Inter-terminal truck routing problem
IUCN	International Union for Conservation of Nature and National Resources

## xx Abbreviations

KPI	Key performance indicators
LBS	Location-based services
LCL	Less than container load
LIVRA	Logistical Chain Information Waterways Rotterdam–Antwerp
MARPOL	International Convention for the Prevention of Pollution from Ships
MEL	Maritime economics and logistics
MEPC	Marine Environment Protection Committee
MIDA	Maritime industrial development area
NCMS	National Center for Manufacturing Sciences
NDRC	National Development and Reform Commission
NGO	Non-governmental organisation
NIOD	Netherlands Institute of War Documentation
NO <sub>x</sub>	Nitrogen oxides
NWO	Dutch Science Foundation
OCR	Optical character recognition
OECD	Organisation for Economic Co-operation and Development
PA	Port authority
PCS	Port community systems
PDC	Port development companies
PEF	Polyethylene furanoate
PET	Polyethylene terephthalate
PFC	Perfluorocarbon
PI	Performance indicators
PIANC	World Association for Waterborne Transport Infrastructure
PM	Particulate matter
PPI	Port performance indicator
PPP	Public private partnership
PRISE	Port River Information System Elbe
PSBR	Public sector's borrowing requirements
PVE	Preparatory Vocational Education
QC	Quay crane
QCAP	Quay crane assignment problem
QCSP	Quay crane scheduling problem
QoL	Quality of life
RFID	Radio frequency identification
RMG	Rail mounted gantry
RMGC	Rail mounted gantry crane
RoI	Return on investment
RoRo	roll-on/roll-off
RSC	Rail Service Centre
RSM	Rotterdam School of Management
RTG	Rubber-tyred gantry
RTGC	Rubber-tyred gantry crane

RTLS	Real-time location system
RU	Railway undertakings
SaaS	Software-as-a-service
SBA	Social Benefit Analysis Framework
SC	Straddle carrier
SD	Sustainable development
SEEMP	Ship Energy Management Efficiency Plan
SEPA	State Environmental Protection Administration
SME	Small and medium-sized enterprises
SO <sub>x</sub>	Sulphur oxides
SOE	State-owned enterprises
SPL	Smart Port logistics
SSTL	Smart and Secure Trade Lanes
STS	Ship-to-shore
SVE	Secondary Vocational Education
TBL	Triple Bottom Line
TEN-T	Trans-European Transport Network
TEU	Twenty-foot equivalent unit
TIR	Third Industrial Revolution
TOS	Terminal operating systems
TRAIL	Transport, infrastructure and logistics
TU Delft	Delft University of Technology
UNFCCC	United Nations Framework Convention on Climate Change
UPRM	University of Puerto Rico–Mayagüez
VAL	Value-added logistics
VANET	Vehicular ad hoc network
VMRS	Vessel movement reporting systems
VOT	Values of time
VTIS	Vessel traffic information system
VTS	Vessel traffic service
WCED	World Commission for Environment and Development
WEF	World Economic Forum
WIRA	Waterfront Industry Reform Authority
WPCI	World Ports Climate Initiative





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# INTRODUCTION

*Harry Geerlings, Bart Kuipers and Rob Zuidwijk*

Much of the world's welfare today has been produced, or is facilitated, by sea ports and their related activities. Ports are the locations where trade, logistics and production converge. Ports and their network connections have experienced unprecedented growth over the last decades: many ports in the world have benefited from the increase in international trade. This growth can be primarily explained by the flourishing economies of the Asian countries and to the related process of globalisation; with the integration of the world market, economic growth and higher levels of income, transport has become a major economic activity. In this context, an efficient transport system is a crucial precondition for port development and an asset in local, regional and international mobility.

This book starts with presenting the development of ports over the last decades, where we see that ports grew, together with the emerging global economy, into global hubs for large-scale efficient trade and shipping. From this perspective, ports play an important role in modern societies and make a substantial contribution to the GDP of cities and hinterland regions. For many products, production and consumption are scattered worldwide, and ports play an important role in connecting these points of production and consumption and establishing global supply chains. As such, ports can be considered as nodes in global logistics networks, where maritime transport and hinterland transport meet. The accessibility of ports is an important indicator of economic performance. To connect with the hinterland, ports make use of different modalities, such as trucks, trains, vessels and pipelines. Therefore, both excellent infrastructures and logistic systems are required to serve businesses and consumers, but also to support the competitive position of the port.

At the same time, all these activities generate negative effects, such as emissions and noise, which need to be addressed as well. This challenge is best described as the 'need for a sustainable development' in ports and their related networks. For many

ports, growth has gone hand in hand with the emergence of large-scale fossil-based industries in port areas, which has made these ports dependent on fossil fuel-based trade and efficient bulk logistics. However, the fossil fuel-based production, trade and logistics have started to erode. This requires a more fundamental change than can be achieved only through technological innovation, optimisation or planning: a transition towards sustainable port activities is required. This will be addressed in the book as well.

While there is a rich literature on ports, port management, logistics and sustainable transport, this is the first book that provides a multidisciplinary introduction to these domains in an integrated way. The idea behind this textbook is to present an introduction to ports and their hinterland related networks, but also to present the related side effects. The case studies and illustrations within the book have a slight bias towards Western European ports (Rotterdam, Antwerp, Hamburg), but the theories are of use for ports in general. Therefore, the cases can be understood as an inspiration for port development in emerging economies and also in economies in transition. It contributes to a port environment that is fit for the new challenges that ports are facing today.

The book contains 22 chapters and is structured around three themes:

- Part 1: Ports and networks: strategies
- Part 2: Ports and networks: operations
- Part 3: Ports and networks: perspectives

The chapters in these three parts are briefly discussed next.

## **Part 1 – Ports and networks: strategies**

The first part of the book not only provides an introduction to the different fields, but also forms the basis for Parts 2 and 3. In a way the chapters of Part 1 ‘set the scene’ and deal with the ‘rules of the game’.

In Chapter 1, Nijdam and Van der Horst provide the basic knowledge of port definitions, main actors, functions and concepts and the role of ports in global supply chains in their overview contribution.

Ports are increasingly seen as nodes in global supply chains. Zuidwijk deals in Chapter 2 with the dynamics in supply chains that are strongly experienced in the port business. Understanding the functioning and priorities in supply chains offers a first perspective in the operations of ports. Zuidwijk sees ports as enablers of green and secure shippers’ global supply chains. The ‘Environmental Ship Index’ and ‘Customs Data Pipeline’ are presented as examples of those enablers.

Ports cannot be seen as stand-alone phenomena, but are part of a network and have a function for forelands and hinterlands. This hinterland is to a large extent related to the national economies and the regional economic (production- and services-based) logistic systems; ports have a ‘strategic connectivity’ with other ports and nodes. This implies that seaports have a strategic importance and a wider impact

on the regional, national and European economy. Van den Bosch, Hollen and Volberda provide in Chapter 3 insight into the strategic value creation of ports for national economies, illustrated by the port of Rotterdam and the Dutch economy.

The management of ports is an essential function. Because of the changing (power) relationships between important stakeholders in ports, the role of port authorities is challenged. Examples are the ongoing formation of new forms of cooperation in container liner networks, such as new alliances (2M, THE Alliance, Ocean Alliance), and the equal important development of global terminal operators. At present there are different institutional arrangements: state owned, privatised and so forth. In addition, national and regional governments become shareholders in port authorities. In Chapter 4 Van der Lugt explains the different institutional arrangements and illustrates what these dynamics mean for the functioning of port management and port authorities. She presents a new strategic scope for port authorities, like becoming a cluster or chain manager or (international) entrepreneur.

Haralambides continues in Chapter 5 with the subject of port management and relates it to institutional reform. After explaining the driving forces behind port reform, he presents different forms of public involvement in the port industry and explains some major issues related to government retrenchment in ports. The chapter presents a broad and rich overview of 30 years of port reform and includes relevant theories and measures. The examples presented of his own experience as president of the Italian port of Brindisi make this contribution even more valuable.

Ports are often located in cities, close to consumers and producers. This proximity of port and city can bring conflicts, but can also provide unique development opportunities. Merk presents in Chapter 6 an overview of the port-city interface and of the effective management of this interface. He pays attention to issues like how to manage port-city conflicts, how to arrange for 'peaceful co-existence' between ports and cities, and how to create synergies between ports and cities by coupling their respective strengths. How to mitigate the environmental impacts of ports? How to mobilise the port as a driver for the urban economy? As the lead author of the OECD publication 'The Competitiveness of Global Port-Cities', Merk presents insights from this influential research program.

The assessment of a port is increasingly presented in term of port performance indicators. Port performance indicators are important statistical tools to measure the performance of different port activities and to enable a clear assessment of the performance of port activities within a port and between different ports. Port performance indicators are usually used in focus areas like economics and finance, operations and development needs. In Chapter 7 Yahalom and Guan present a broad overview of port performance indicators for a wide range of port activities. They present general indicators for ports, operational indicators especially aimed at terminal operations, and in addition analysis, financial and economic indicators. They also pay attention to social-economic, environmental and government issues.

As ports are increasingly confronted with congestion (on the road as well as on rail and on the water), accessibility has become a key port performance indicator. Policies

related to guaranteed accessibility of ports are increasingly focused on management issues (orgware and software), instead of on the building of new infrastructure (hardware). Policies focusing on modal shift and variabilisation of costs for the users of infrastructure are receiving increased attention. The accessibility of the port by means of dynamic traffic management and the measures is an important issue.

In Chapter 8, Corman and Negenborn present an overview of different approaches to increase accessibility. Per hinterland modality they present a number of approaches to improve accessibility by means of hardware, software and orgware solutions. They illustrate these solutions with examples from the port of Rotterdam.

Public authorities in particular invest in port infrastructure and hinterland connections. The connection of the port with the hinterland is vital for the functioning of a port. An important question with respect to investment of most ports in hinterland connections is, who benefits from the return on investment: the port region or the hinterland? Often a social cost-benefit analysis is executed to answer the question with respect to the return on investment. In Chapter 9, Sys and Vanelslander present such a social cost-benefit analysis framework for a specific port hinterland project, a road project improving the hinterland links of the port of Zeebruges.

In their research on coordination issues between port stakeholders, Van der Horst and De Langen illustrate in Chapter 10 the importance of bottlenecks in coordination issues between parties responsible for the functioning of maritime transport chains. Increasingly coordination issues are seen as the key for solving bottlenecks in hinterland accessibility. In their chapter they present an overview of the most important coordination issues and some of the initiatives in maritime transport chains to overcome bottlenecks in coordination; examples of horizontal and vertical integration are illustrated. Special attention is also paid to the issue of extended gates for the port of Rotterdam.

## Part 2 – Ports and networks: operations

In Part 2, material is provided on the operational aspects of ports and networks. The main subsystems are maritime networks, port networks, and land networks. Maritime networks involve the worldwide transport services offered by shipping liners.

The main players and their services and different types of networks are considered in Chapter 11 by Mulder and Dekker on liner networks. A variety of planning problems are reviewed, and the development of maritime networks is illustrated by means of a case study of Indonesia.

Particular attention is given by Veenstra to the business model of the shipping liners in Chapter 12 by considering the revenues and costs of maritime shipping.

Maritime networks interface with land networks via ports. Maritime logistics not only considers transportation activities, but also transshipment, handling and storage of freight. An increasing portion of freight is handled in a standard loading unit, the container. More specifically, in Chapter 13, Vis, Carlo and Roodbergen focus on design, planning and operations in container terminals.

In Chapter 14, information management in ports is considered by Heilig and Voß. They provide a framework to categorise the various systems for port-centric information management.

Land side operations are studied with a focus on the new concept of synchronomodality in Chapter 15 by Tavasszy, Behdani and Konings. This concept brings the use of various transport modes to the next level by combining the use of road, rail and inland waterway networks in a dynamic and integral way. Ports do not only act as global hubs, but also as industrial clusters.

The operational aspects of the industrial seaport are considered in Chapter 16 by Kuipers. He presents the different forces underlying the location of industrial complexes in seaports and also presents different types of seaport industrialisation, with most attention given to the ‘modern’ port industry and the chemical industry. The greening of port business and the potential the biobased and circular economy are offering, together with current practices like industrial ecology, co-siting and the realisation of crossovers between port and city, are issues addressed in this contribution. The port region of Teesside (UK) is presented as a case study for the general issues addressed.

### **Part 3 – Ports and networks: perspectives**

Part 3 offers an overview of different perspectives relevant for port studies. This part starts with a contribution by Klemann, who presents in Chapter 17 a historical perspective on ports and shipping. This perspective is very important for the understanding of the current functioning of seaports. Why did the port of Rotterdam become the largest port of Europe, and why was it the largest port in the world for nearly four decades? What are the underlying dynamics responsible for important changes in the position of ports amid their forelands and hinterlands?

Sustainability might be the perspective on ports that has received most attention during the past few years because of the heavy impact of port and port-related issues on the climate and on the local environment. Ports, and especially industrial ports, are heavy producers of CO<sub>2</sub>, fine particles and other emissions and noise. Geerlings and Vellinga present in Chapter 18 an overview of sustainability issues in seaports and current policies as practiced by the port of Rotterdam and some other important ports in Western Europe to increase the sustainability performance of ports.

The attacks on the World Trade Center and on other targets in the USA on 9/11 resulted in maximum attention on safety and security in intercontinental flows of goods and persons. The tragic events provoked a long list of safety and security measures, increasing the visibility and transparency of international logistics operations, especially in the container business. These measures had a big impact on the underlying supply chain management practices, related to the increased transparency of chains. Guan and Yahalom give an overview of the safety and security perspective in Chapter 19, combining this perspective with the most important supply chain issues. Trade and transport are not able to function optimally without a proper information infrastructure. The complexity and scale of modern container

operations is dependent on information systems, and the safety and security perspective depends on the information infrastructure.

Geerlings and Wiegmans present an overview of recent innovations shaping the port business in Chapter 20. They pay attention to recent trends and actual developments in port and hinterland innovations and the nascent phenomena of ‘the Internet of Things’.

In Chapter 21, De Koning, Zandvliet and Gelderblom give an overview of current issues from the labour perspective. The impact of major historical transitions is very visible in the seaport environment. From an innovation perspective, the impact of containers and of oil and related petrochemical industries is mentioned.

These innovations resulted in a system change in the global economic organisations. This type of system change is often called a ‘transition’. It is clear that these transitions have a big impact on ports. The current transition that is changing the port landscape is the transition to sustainable economic activities related to renewable sources of energy and feed stocks, like biomass. But how to realise and manage this much-needed transition? Loorbach and Geerlings present in Chapter 22 the latest insights in transition management aimed at the port business. This transition perspective means a strategic move for the total port business, having implications for ports and networks as well as port operations. The transition perspective therefore places the total of the presented port perspectives ‘into perspective’.

The book is written primarily for educational purposes, for use either in courses at universities or in other education programs or self-study. Each chapter contains a general introduction on the topic and the structure of the sections, an introduction to the discipline, a case study/illustration and an inside perspective about the expected future developments in the specific study domain. We purposely limited the number of references in each contribution and added suggestions for further readings.

We think the book can also be beneficial to researchers, practitioners (from the private and public sectors) who are engaged in ports, logistics and related research and practice, because the main aim is to provide insights into the integrated approach that is needed in this domain.

If you have any suggestions related to this book in general or parts of it or have questions, please contact us.

Harry Geerlings, Bart Kuipers  
and Rob Zuidwijk (editors)  
Rotterdam, 2017



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