

The expansion of the port of Genoa: the Rivalta
Scrivia dry port

Original

The expansion of the port of Genoa: the Rivalta
Scrivia dry port / Caballini, C.; Gattorna, E.. - In: TRANSPORT AND COMMUNICATIONS BULLETIN FOR ASIA AND
THE PACIFIC. - ISSN 0252-4392. - 78:(2009), pp. 73-86.

Availability:

This version is available at: 11583/2834330 since: 2020-06-10T01:46:24Z

Publisher:

United Nations ESCAP - ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Published

DOI:

Terms of use:

This article is made available under terms and conditions as specified in the corresponding bibliographic description in
the repository

Publisher copyright

(Article begins on next page)



Transport and Communications Bulletin for Asia and the Pacific

No. 78

Development of Dry Ports



United Nations
ESCAP

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

ESCAP is the regional development arm of the United Nations and serves as the main economic and social development centre for the United Nations in Asia and the Pacific. Its mandate is to foster cooperation among its 53 members and 9 associate members. ESCAP provides the strategic link between global and country-level programmes and issues. It supports the Governments of the region in consolidating regional positions and advocates regional approaches to meeting the region's unique socio-economic challenges in a globalizing world. The ESCAP office is located in Bangkok, Thailand. Please visit our website at <www.unescap.org> for further information.



The shaded areas of the map are ESCAP members and associate members.

TRANSPORT AND
COMMUNICATIONS
BULLETIN
FOR ASIA AND THE
PACIFIC

No. 78
Development of Dry Ports



United Nations

New York, 2009

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

Transport and Communications Bulletin for Asia and the Pacific

No. 78

Development of Dry Ports

United Nations publication
Copyright © United Nations 2009
All rights reserved
Printed in Thailand
ISSN: 0252-4392
ST/ESCAP/SER.E/78

ESCAP WORKS TOWARDS REDUCING POVERTY AND MANAGING GLOBALIZATION

References to dollars (\$) are to United States dollars, unless otherwise stated.

The designations employed and the presentation of the material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

This document has been reproduced without formal editing. References have not been checked.

The opinions, figures and estimates set forth in this publication are the responsibility of the authors, and should not necessarily be considered as reflecting the views or carrying the endorsement of the United Nations.

Mention of firm names and commercial products does not imply the endorsement of the United Nations.

This publication may be reproduced in whole or in part for educational or non-profit purposes without special permission from the copyright holder, provided that the source is acknowledged. The ESCAP Publications Office would appreciate receiving a copy of any publication that uses this publication as a source.

No use may be made of this publication for resale or any other commercial purpose whatsoever without prior permission. Applications for such permission, with a statement of the purpose and extent or reproduction, should be addressed to the Secretary of the Publications Board, United Nations, New York.

Editorial statement

The *Transport and Communications Bulletin for Asia and the Pacific* is a peer-reviewed journal published once a year by the Transport Division (TD) of the United Nations Economic and Social Commission for Asia and the Pacific (ESCAP). The main objectives of the *Bulletin* are to provide a medium for the sharing of knowledge, experience, ideas, policy options and information on the development of transport infrastructure and services in the Asian and Pacific region; to stimulate policy-oriented research; and to increase awareness of transport policy issues and responses. It is hoped that the *Bulletin* will help to widen and deepen debate on issues of interest and concern in the transport sector.

“Development of dry ports” is chosen as the theme of the current issue of the *Bulletin* given the increasing importance of dry ports for the ESCAP region.

The Ministerial Conference on Transport, held in Busan, Republic of Korea, in November 2006, adopted the vision of an international integrated intermodal transport and logistics system as the long-term objective for transport development in the Asia and the Pacific region. In May 2007, the Commission endorsed this vision in its resolution 63/9 on the implementation of the Busan Declaration on Transport Development in Asia and the Pacific and the Regional Action Programme for Transport Development in Asia and the Pacific, phase I (2007-2011).

Over the past decade, ESCAP member countries have benefited substantially from the processes of globalization and international trade. Closer examination of this regional success, however, reveals that, in general, it is the coastal areas of the region that have benefited the most, with development levels often declining in areas further away from the coastline. In this context, transport infrastructure can act as an effective economic growth pole and bring development from coastal to inland areas.

In order to achieve a long-term vision of an international integrated intermodal transport and logistics system for Asia and the Pacific, both transport links and nodes need to be fully developed. In terms of transport links, in the land transport sectors, the entry into force of the ESCAP-promoted Intergovernmental Agreement on the Asian Highway Network on 4 July 2005 and the Intergovernmental Agreement on the Trans-Asian Railway Network on 11 June 2009¹ have provided the major building blocks for the realization of the vision and opened a new era of rapid development of land transport across the region.

¹ ESCAP acts as the secretariat for both agreements.

As far as transport nodes are concerned, in Asia, seaports have developed rapidly over the past several decades. In terms of container throughput, in 2008, 20 of the top 30 container ports in the world were located in Asia.²

Another complementary and important transport node of the transport network is the development and operation of dry ports, which allow for the transfer of goods between different modes of transport and support the use of efficient and environmentally friendly modes of transport. Such facilities, however, are not well developed in many developing countries of the region.

Despite the importance of dry ports, research on the topic is only beginning and many issues still need to be more comprehensively considered. Against this background, seven papers on dry ports in Asia and other regions in the world are included in this issue.

The first paper examines how inland terminals play a role in the organization of freight distribution in Europe and North America. The paper discusses a number of functions played by inland terminals, from satellite to gateway terminals to inland load centres. The paper also looks at inland terminals as elements of freight distribution systems, gateways and corridors. In this context, the paper investigates various means used by supply chain managers to use inland terminals in their freight distribution strategies. Finally, operational issues on the set-up and exploitation of inland terminal facilities in Europe and North America are considered.

One point highlighted in the first paper is the comprehensive review of alternative definitions of a dry port by the authors (pp. 4-14). Although a universally agreed definition of dry ports is not available in the ESCAP region, the paper provides a useful reference for policymakers and industry to classify and define dry ports.

In the first paper, an interesting question is asked on how the Asia-Pacific region can develop its own dry port strategy, taking into consideration the North American and European experiences. The authors argue that, on the one hand, due to the unique geographical characteristics of the Asia-Pacific region, particularly the high level of coastal development, the export-oriented economies are likely to rely on the satellite terminal concept. In this context, the European example could be more suitable. On the other hand, the development of long-distance intermodal rail corridors across Asia is relevant to the inland load centre system common in North America.

² *Containerisation International*, March 2009.

Although the authors have not answered these questions in the paper, they deserve further investigation.

In the second paper, a comparative study of dry port development in the United Kingdom and Nigeria highlights the different issues arising from dry port development in developed and developing countries. After comparing ownership, regulation and governance of dry ports in the United Kingdom and Nigeria, the paper presents a strength, weakness, opportunity and threat (SWOT) analysis to discuss how dry ports can be effectively developed in both developing and developed countries. The study reveals that dry ports can play important roles for transport and supply chain management in both cases, although approaches for dry port development and promotion might differ due to the level of economic and infrastructure development.

The third and fourth papers discuss dry port development in Italy. Both papers are based on the Port of Genoa and its need to expand in order to cope with increasing transport volumes. The third paper presents some ideas and technical design considerations for an integrated dry port and seaport system, which highlights the process and complexity of a dry port project. The fourth paper is more focused on the operation of Rivalta Scrivia dry port, located 75 km from Genoa port, and the interaction between the dry port and seaport.

In a similar vein, the fifth paper examines the functions of a dry port as an inland extension of a seaport using a case study approach. The paper examines the Virginia Inland Port as a dry port for the Port of Virginia, United States of America, and Falköping terminal as a dry port for the Port of Göteborg, Sweden. The findings of the paper include, among others, that while some seaports need the support of a dry port as their inland extension, this might not be true for seaports that have enough space for business and operation in their immediate vicinity. These ports normally do not gain by moving their storage area to an inland terminal because they might lose a significant portion of their profit. This is the case for the Port of Göteborg discussed in the paper.

In the sixth paper, a grid technique is used to discuss the optimal location of dry ports. It introduces a new approach to explore the optimal location of dry ports and therefore the paper has originality, however, the validity of this approach may need to be further tested in practice. Furthermore, “optimal location” needs to be carefully defined, as different stakeholders often have different priorities and considerations when they define the optimal location of dry ports. In this sense, this technique should be applied cautiously.

The last paper discusses dry port development in Africa and the continuation between road and rail connections in terms of cost/time savings and security.

In summary, this special issue of the *Bulletin* is a collection of papers discussing various issues related to dry port development in a number of selected countries located in Asia, Africa Europe and North America. It is hoped that discussions of dry port development under different economic and political backgrounds will provide policymakers with a better understanding of the relevant issues under consideration.

In terms of further research, it is important to note that most discussions of dry ports in this issue are, in one way or another, related to the interaction between dry ports and seaports, which might not be applicable to dry ports in Central Asian landlocked countries, where dry ports are far from any seaports and the countries have the opportunity to trade with each other using land instead of sea transport. Clearly, in this case, discussions should be more focused on the interaction among dry ports within a network. It is hoped that future research would be directed towards more discussions of issues on dry port development in landlocked countries.

The *Bulletin* welcomes analytical articles on topics that are currently at the forefront of transport infrastructure development and services in the region and on policy analysis and best practices. Articles should be based on original research and should have analytical depth. Empirically-based articles should emphasize policy implications emerging from the analysis. Book reviews are also welcome. See the inside back cover for guidelines on contributing articles.

Manuscripts should be addressed to:

Editor
Transport and Communications Bulletin for Asia and the Pacific
Transport Division, ESCAP
United Nations Building
Rajadamnern Nok Avenue
Bangkok 10200, Thailand

Fax: (662) 288 1000, (662) 280 6042, (662) 288 3050
E-mail: escap-ttd@un.org; quium.unescap@un.org

**TRANSPORT AND COMMUNICATIONS BULLETIN
FOR ASIA AND THE PACIFIC**

NO. 78

CONTENTS

	<i>Page</i>
Editorial statement	v
<i>Theo Notteboom and Jean-Paul Rodrigue</i>	Inland terminals within North American and European supply chains..... 1
<i>Paul Garnwa, Anthony Beresford and Stephen Pettit</i>	Dry ports: a comparative study of the United Kingdom and Nigeria..... 40
<i>Andrea Rosa and Riccardo Roscelli</i>	Innovative ideas and design of an integrated dry port and seaport system..... 57
<i>Claudia Caballini and Enrico Gattorna</i>	The expansion of the port of Genoa: the Rivalta Scivia dry port..... 73
<i>Violeta Roso and Kent Lumsden</i>	The dry port concept: moving seaport activities inland?..... 87
<i>Adolf K.Y. Ng and Girish Gujar</i>	The spatial characteristics of dry ports in India..... 102
<i>Erené Cronje, Marianne Matthee and Waldo Krugell</i>	Trade and transport costs: the role of dry ports in South Africa..... 112

Inland Terminals within North American and European Supply Chains

Theo Notteboom^{*} and Jean-Paul Rodrigue^{**}

ABSTRACT

The growing focus on inland/dry ports is indicative of transport development strategies gradually shifting inland to address capacity and efficiency issues in the light of global supply chains. The complexity of modern freight distribution, the increased focus on intermodal transport solutions and capacity issues appear to be the main drivers. The larger volumes of flows in networks, through a concentration of cargo on a limited set of ports of call and associated trunk lines to the hinterland, have also created the right conditions for nodes to appear along and at the end of these trunk lines. In the light of technological, market and supply chain changes, this paper looks at how inland terminals play a role in the organization of regional freight distribution. The first part aims at discussing the number of functions played by inland terminals, from satellite to gateway terminals to inland load centres. The following sections look at inland terminals as elements of regional freight distribution systems, gateways and corridors. These sections also investigate the various means used by supply chain managers to use inland terminals in their freight distribution strategies.

Keywords: Inland port, terminal, Europe, North America, port, regionalization

I. A NEW ROLE FOR INLAND TERMINALS

In many places around the world, bimodal and trimodal inland terminals have become an intrinsic part of the transport system, particularly in regions having a high reliance on trade. Transport development is gradually shifting inland after a phase that focused on the development of port terminals and maritime shipping networks. There are many reasons for this growing attention. The complexity of modern freight distribution, the increased focus on intermodal transport solutions and capacity issues appear to be the main drivers. While trucking tends to be sufficient in the initial phase of the development of inland freight distribution systems, at some level of

^{*} Institute of Transport & Maritime Management, University of Antwerp, Keizerstraat 64, B-2000 Antwerp, Belgium, E-mail: theo.notteboom@ua.ac.be.

^{**} Department of Global Studies & Geography, Hofstra University, Hempstead, New York 11549, United States, E-mail: Jean-paul.Rodrigue@hofstra.edu.

activity, diminishing returns such as congestion, energy consumption and empty movements become strong incentives to consider the establishment of inland terminals as the next step in regional freight planning. The massification (i.e. economies of scale through larger volumes) of flows in networks, through a concentration of cargo on a limited set of ports of call and associated trunk lines to the hinterland, has also created the right conditions for nodes to appear along and at the end of these trunk lines.

The evolution of inland freight distribution can be seen as a cycle in the ongoing development of containerization and intermodal transport. The geographical characteristics linked with modal availability and the capacity of regional inland access are important in shaping this development. Thus, there is no single strategy in terms of modal preferences, as the regional effect remains fundamental. Each inland port remains the outcome of the considerations of a transport geography pertaining to modal availability and efficiency, market function and intensity, the regulatory framework and governance.

The establishment of global supply chains and the strategy of Asian and Pacific countries focusing on the export-oriented paradigm have been powerful forces shaping contemporary freight distribution. Indirectly, this has forced players in the freight transport industry (shipping companies, terminal operators and logistics providers) to examine supply chains as a whole and to identify legs where capacity and reliability were an issue. Once maritime shipping networks and port terminal activities were better integrated, particularly through the symbiotic relationship between maritime shipping and port operations, inland transport became the obvious focus and the inland terminal became a fundamental component of this strategy. This initially took place in developed countries, particularly in North America and Europe, which tended to be at the receiving end of many containerized supply chains. The focus has also shifted to considering inland terminals for the early stages of global supply chains (outbound logistics), namely in countries having a marked export-oriented function.

In the light of technological, market and supply chain changes, this paper investigates how inland terminals play a role in the organization of regional freight distribution. The first part aims at discussing the number of functions played by inland terminals, from satellite to gateway terminals to inland load centres. The following sections look at inland terminals as elements of regional freight distribution systems, gateways and corridors. These sections also investigate the various means used by supply chain managers to use inland terminals in their freight distribution strategies. The last section looks at operational issues related to the set-up and exploitation of inland terminal facilities in Europe and North America.

II. INLAND NODES: TOWARDS A TYPOLOGY

The nodes in the hinterland networks of ports have been referred to as dry ports, inland terminals, inland ports, inland hubs, inland logistics centres, inland freight villages, etc. When discussing the term “inland terminal facility”, Jaržemskis and Vasiliauskas (2007) and Roso (2005) make a distinction between inland clearance depot, inland container depot, intermodal freight centre, inland freight terminal and inland port (see table 1). In addition, Cardebring and Warnecke (1995), Roso (2006), Roso et al. (2009) and Wiegmans et al. (1999) have proposed various definitions and classifications of inland nodes.

Table 1. Terms used in relation to inland nodes

Source	Term	Definition
UNCTAD (1982)	Inland terminal	An inland terminal to which shipping lines issue their own bills of lading for import cargoes, assuming full responsibility of costs and conditions, and from which shipping companies issue their own bills of lading for export cargoes
UNCTAD (1991)	Dry port	A customs clearance depot located inland away from seaport(s)
UNCTAD (1991)	Inland clearance depot (or inland customs depot)	A terminal located in the hinterland of a gateway port and serving as a dry port for customs examination and clearance of cargoes, thereby eliminating customs formalities at the seaport
Economic Commission for Europe (1998), see also Roso (2005), Jaržemskis and Vasiliauskas (2007), Roso et al. (2009)	Inland clearance depot	A common user inland facility with public authority status, which is equipped with fixed installations and offers services for the 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

Table 1. continued

Source	Term	Definition
Roso (2005), Jaržemskis and Vasiliauskas (2007), Roso et al. (2009)	Inland container depot	A common user facility with public authority status, which is equipped with fixed installations and offers services for the handling and temporary storage of import/export loaded and empty containers
Cardebring and Warnecke (1995), Roso et al. (2009)	Intermodal freight centre	A concentration of independent companies working in freight transport and supplementing services in a designated area where a change of transport units between traffic modes can take place
Economic Commission for Europe (1998), see also Jaržemskis & Vasiliauskas (2007), Roso et al. (2009)	Inland freight terminal	Any facility, other than a seaport or an airport, operated on a common user basis, at which cargo in international trade is received or dispatched
Economic Commission for Europe (2001), see also Jaržemskis and Vasiliauskas (2007), Roso et al. (2009)	Inland port	A port that is located inland, generally far from seaport terminals, and that supplies regions with an intermodal terminal or a merging point for traffic modes—rail, air and truck routes—involved in distributing merchandise that comes from seaports; an inland port usually provides international logistics and distribution services, including freight forwarding, customs brokerages, integrated logistics and information systems
Leveque and Roso (2002), Roso (2005), Roso et al. (2009)	Dry port	An inland intermodal terminal that is directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardized units as if directly to a seaport
Ng and Gujar (2009)	Dry port	A dry port can be understood as an inland setting with cargo-handling facilities to allow several functions to be carried out—for example, consolidation and distribution, temporary storage, customs clearance and connections between transport modes—allowing for the agglomeration of institutions (both private and public), which facilitates the interactions between different stakeholders along the supply chain

Table 1. continued

Source	Term	Definition
Wiegmans et al. (1999)	Transfer terminal	This type of terminal is almost exclusively aimed at trans-shipping continental freight. There is almost no collection and distribution in the region where the terminal is located. The freight arrives at and departs from the terminal in huge flows. The terminal is characterized by large areas that enable direct trans-shipment between trains and/or barges. The corresponding bundling model is the hub-and-spoke network.
Wiegmans et al. (1999)	Distribution terminal	At this terminal, added value is created in the form of an extra service provided by the terminal operator. From locations A, B and C, continental freight arrives at the terminal and is consolidated into shipments for customers X, Y and Z. One or more terminal services is added by the terminal operator to the shipments at the terminal. The corresponding bundling model is the line network.
Wiegmans et al. (1999)	Hinterland terminal	Small continental cargo shipments are brought to the hinterland terminal and consolidated into bigger freight flows. These bigger freight flows are further transported by larger transport means, such as trains or barges. The corresponding bundling model is the trunk line with a collection and distribution network.

Source: Compiled by the authors.

Thus, there seems to be no consensus on the terminology to be used. The reason for this lies in the multiple shapes, functions and network positions these nodes can have. We argue that there are three major types of intermodal terminals, each having their own locational and equipment requirements: seaport terminals, rail terminals and distribution centres.

First of all, *seaport terminals* are the most substantial intermodal terminals in terms of traffic, space consumption and capital requirements. A container sea terminal provides an interface between the maritime and inland systems of circulation. The containerization of inland river systems has led to the development of an array of barge terminals linked with major deep-sea terminals through scheduled barge services. At the maritime container terminal, barges can either use regular docking areas or have their own terminal facilities if congestion is an issue. Although barge-to-barge terminal container services are technically possible, they are not very common.

Second, at the start and end of the inland intermodal chain, *rail terminals* are linked with port terminals. The fundamental difference between

an on-dock and a near-dock rail facility is not necessarily the distance, but rather terminal clearance. While at an on-dock rail terminal, containers can be moved directly from the dock (or the storage areas) to a railcar using the terminal's own equipment, accessing a near-dock facility requires clearing the terminal's gate (delays), using the local road system (congestion) and clearing the gate of the near-dock rail terminal (delays). Near-dock facilities tend to have more space available, however, and can thus play a significant role in the maritime/rail interface, particularly if they are combined with transloading activities. The satellite terminal, the load centre and the transmodal terminal (interchanges within the same mode) all qualify as a form of inland port. The satellite terminal is mainly a facility located at a peripheral and less congested site that often performs activities that have become too expensive or space-consuming for the maritime terminal. Rail satellite terminals can be linked to maritime terminals through rail shuttle or truck drayage (more common) services. A load centre is a standard intermodal rail terminal servicing a regional market area. If combined with a variety of logistical activities, namely freight distribution centres, it can take the form of a freight distribution cluster (or freight village). The surge of inland long-distance containerized rail traffic may also require transmodal (rail-to-rail) operations as freight is moved from one rail network to the other. Eventually, dedicated rail-to-rail terminals are likely to emerge.

Finally, *distribution centres* represent a distinct category of intermodal terminals performing an array of value added functions to the freight, with transmodal operations dominantly supported by trucking. Distribution centres can perform three major types of functions. A transloading facility mainly transfers the contents of maritime containers into domestic containers or truckloads (or vice versa). It is common in North America to have the contents of three 40-foot maritime containers transferred into two 53-foot domestic containers.¹ Sometimes, shipments are palletized as part of the transloading process since many containers are floor loaded. Cross-docking is another significant function that commonly takes place in the last segment of the retail supply chain. With very limited storage, the contents of inbound loads are sorted and transloaded to their final destinations. Warehousing is a standard function still performed by a majority of distribution centres that act as buffers and points of consolidation or deconsolidation within supply chains.

Several dimensions contribute to the above typology. Höltgen (1995) suggested that intermodal terminals can be classified according to a set of functional criteria, including traffic modes, trans-shipment techniques, network position or geographical location. Konings et al. (1995) also proposed a typology of hinterland nodes. We propose seven dimensions characterizing inland nodes, as depicted in table 2.

¹ Two 53-foot domestic containers account for a volume of about 8,180 cubic feet while three high-cube 40-foot maritime containers account for a volume of about 8,100 cubic feet.

Table 2. Examples of typical inland nodes based on different dimensions

	Cross-dock facility (trucks)	Rail hub	Barge terminal as local "extended gate" for seaport terminal	Fully fledged inland port and logistics zone
Examples	UPS Willow Springs Distribution Center (Chicago)	Dry Port Muizen operated by IFB—Belgium Norfolk Southern Rickenbacker Intermodal Terminal (Columbus, Ohio)	TCT Belgium operated by ECT—Belgium Barge Terminal Oss—the Netherlands	Inland ports of Duisburg (Germany), Paris (France), Strasbourg (France), Liège (Belgium)
Transport modes	Unimodal (truck)	Bimodal (rail/truck)	Bimodal (barge/truck)	Trimodal (rail/truck/barge)
Primary function	Transport and cargo handling	Transport and cargo handling	Transport and cargo handling, customs formalities, container repair	Transport and cargo handling, customs formalities, warehousing, value added logistics (VALS)
Size	Vary according to the level of cross-docking	Several rail bundles and a temporary stacking area	Typically, 5 000-50 000 20-foot equivalent units (TEUs) (Europe) Stacking area for full and empty containers	Large, consisting of multimodal terminal facilities and logistics zones

Table 2. Continued

	Cross-dock facility (trucks)	Rail hub	Barge terminal as local "extended gate" for seaport terminal	Fully fledged inland port and logistics zone
Geography	Between distribution centre and final destinations	Intermediacy function in a rail-based hub-and-spoke network	End terminal with a local service area of, for example, a 25-km radius	Combination of end terminal (local service area) and cargo transit point (intermediacy)
Cargo type	Conventional	Containers	Containers	Containers and conventional
Openness of the node	Single user	Single user	Common user	Common user
Operational—technology	Fork-lifts, conveyor belts (parcels), small handling equipment for pallets	Rail-mounted gantry cranes (RMG) and reach stackers	Gantry crane for handling of barges/trucks and managing stacking area	Gantry crane for barge operations, RMG for rail, reach stackers, truck gates, warehouses
Operational—trans-shipment	Indirect trans-shipment, but very short storage time	Direct (between wagons) and indirect (via stack) trans-shipment	Indirect trans-shipment	Indirect trans-shipment with modal separation in time and space

Source: Edited by the authors.

The first dimension relates to the *transport modes* served, ranging from unimodal to trimodal. *Unimodal inland nodes* can be found in the road haulage industry. Good examples are the French "road stations" developed in the 1970s. Unimodal inland nodes also appear in distribution networks in the form of cross-dock facilities, i.e. places where cargo is consolidated in a covered storage area for a short time and moved from one truck to another. Rail networks can also contain some unimodal transport nodes, namely in the case of horizontal and vertical handling of containers in the central node of a hub-and-spoke network. *Bimodal facilities* are equipped to accommodate two transport modes, typically rail and truck or barge and truck. *Trimodal inland*

nodes are designed to handle cargo between three modes: rail, barge and truck. It is important to underline that trimodal terminal configurations do not necessarily shift cargo between all transport mode pairs. In Europe, for example, trimodal terminals handle a lot of cargo between barge-truck and rail-truck combinations, but far less cargo is being shifted from barge to rail or vice versa.

The second dimension encompasses the *primary functions* of the inland node. The *raison d'être* of inland nodes is linked to transport and cargo handling functions. However, inland nodes can develop a range of other functions and services, including customs clearance, warehousing, container repair and value added logistics services (VALS). It is thus common to see a diversification of the primary function with the clustering of logistical activities near the inland node. In North America, inland ports are solely the outcome of an interface between intermodal rail terminals and service areas.

The third dimension of an inland node relates to *size*. This dimension can be measured in the cargo volume passing through the node or the scale of the land area occupied by the node. There is a relationship between size and function, but for many intermodal rail terminals, size is scalable on site or to a new location in the vicinity.

The *geography* of the node constitutes the fourth dimension. This includes the size of its service area, the geographical orientation of the node vis-à-vis its service area and the position of the node in the transport system and modal networks. An inland node can function as end terminal in a network, with the specific role to distribute goods to local destinations in its service area or to consolidate goods from origins in its hinterland. Inland nodes typically act as cargo consolidation and deconsolidation centres with a local service area; load centres. The size of the service area generally depends on the terminal size, the distance to the gateway ports and the proximity to big shippers. Other inland nodes have a strong intermediacy function handling transit cargo moving through from one region to another region.

The fifth dimension relates to the dominant *cargo type*. The transport and cargo handling function of an inland node can relate to a wide range of commodities and cargo flows. While this paper mainly focuses on inland nodes designed to handle containerized cargo, inland nodes can be specifically constructed to deal with other unit loads such as trailers.

The *openness of the node* is another dimension that deserves attention. Quite a lot of inland nodes comprise common user terminals. The neutral management of these terminals allows for accommodating a broad range of customers without discriminating between them. Single user nodes are, however, common, as well, particularly in cases where the terminal has an operational purpose within a network, e.g. a rail hub used by one rail

operator in the framework of the operations within its hub-and-spoke shuttle network. Thus, the nature of ownership changes the competitive setting of the inland node.

Another dimension relates to the *operational characteristics linked to the cargo handling function* of the node. Terminal operations at an inland node can be based on conventional technology (e.g. manned gantry cranes and reach stackers) or follow a (semi-)automated design (e.g. automated guided vehicles (AGV) or automated stacking cranes (ASC)). Automated terminal designs are becoming more common in the world of deep-sea container terminals, as illustrated by the ports of Rotterdam and Hamburg (combined AGV and ASC system), Melbourne (automated straddle carriers) and Hampton Roads (semi-automated terminal and gate access).² The design of inland terminals remains quite conventional, however, notwithstanding plenty of ideas for further automation in this area. We refer in this respect, for example, to the analysis of Kreuzberger (1997) on automated rail cargo handling facilities in Europe, Rodrigue (2008) on a handling concept for large North American rail hubs, and Ballis and Stathopoulos (2002) on automated terminals in the European barging industry. The design and layout of an inland terminal will typically depend on factors such as the expected cargo volumes and the interactions of the terminal with local or regional trucking (this is to anticipate operational peak hours at the terminal). Inland terminal operators often opt for a modular design that allows for a gradual and phased enlargement of terminal capacity in line with demand.

The final operational factor relates to the handling of the transport means. *Simultaneous batch exchange* involves a system where several trains or barges are present at the terminal at the same time and load units are directly exchanged among them without the interference of a storage area (i.e. *direct trans-shipment*). Direct trans-shipment is associated with very short dwell times (the average time the cargo remains stacked on the terminal and during which it waits for some activity to occur), requiring only a small temporary storage area on the terminal. Alternatively, the term *sequential exchange* refers to a system whereby the transport modes pass a terminal sequentially. Load units can only be trans-shipped to a later train, barge or truck. A temporary storage area is needed (i.e. *indirect trans-shipment*). Scale increases in the unit capacities of trains and barges combined with fast handling equipment have led to larger cargo volumes per terminal call and shorter handling times per volume of freight. Both factors have made direct trans-shipment less feasible in modern inland terminals. The result has been a modal separation, particularly at trimodal inland terminals, and the setting of a significant buffer in the form of large storage areas. Each transport mode receives a specific area on the terminal, so that

² See Stahlbock and Voss (2008) for a more detailed discussion on relevant literature on terminal operations.

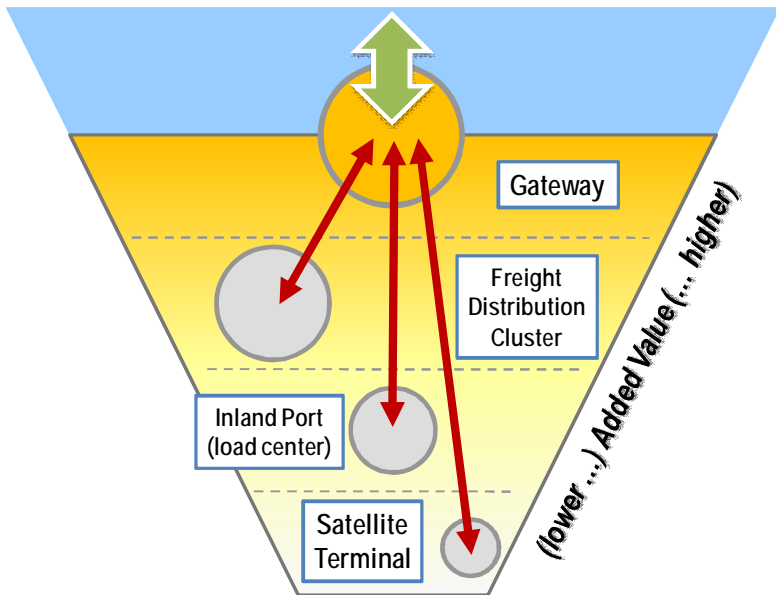
operations on barges, trucks and trains cannot obstruct one another. This modal separation in space is a requirement for setting up a system of indirect trans-shipment whereby each transport mode follows its own time schedule and operational throughput, implying a modal separation in time. For rail terminals, indirect trans-shipment takes the form of containers on chassis parked at an angle enabling for easy drop and pick up by truck. Under the indirect trans-shipment system, the terminal stacking area functions as a buffer and temporary storage area between the different modal operations.

III. FROM INTERMODALISM TO CLUSTER FORMATION: THE RISE OF LOGISTICS ZONES AND FREIGHT VILLAGES

Inland terminals have evolved from simple intermodal locations to their incorporation within co-located freight distribution activities, commonly labelled as logistical parks. Inland terminals (particularly rail) have always been present since they are locations from which specific market coverage is achieved. Containerization has impacted this coverage through the selection of terminals that were servicing a wider market area. This spatial change also came with a functional change as intermodal terminals began to experience a specialization of roles based on their geographical location but also their "location" within supply chains.

A functional and added value hierarchy has emerged for inland terminals, as depicted in figure 1. In many instances, freight transport terminals fit within a hierarchy with a functionally integrated inland transport system of gateways and their corridors:

- Gateway (level 1): A world class gateway should contain the whole range of value added activities related to transport, from financing to modal and intermodal infrastructures. Still, basic gateways can also exist, mainly focusing on trans-shipment between maritime and inland transport systems.
- Freight distribution cluster (level 2): Characterizes a complex of large inland terminals and freight distribution centres that command the distribution of a vast market area. Some like Duisburg, Chicago or Kansas City can have as much added value activities as a gateway.
- Inland port (level 3): Often a single intermodal terminal coupled with an array of distribution activities. Commonly acts as a load centre for commodity chains.
- Satellite terminal (level 4): Perform a very specific function such as transloading, often in the vicinity of a gateway. Some satellite terminals, such as in Los Angeles, are very significant at providing specialized freight distribution activities.

Figure 1. Freight terminal hierarchy and added value

Source: Rodrigue (2009).

It can thus be seen that the functional specialization on inland terminals has been linked with the cluster formation of logistical activities. In many cases, inland terminals have witnessed a clustering of logistics sites in the vicinity, leading to a process of logistics polarization and the creation of logistic zones. They have become excellent locations for consolidating a range of ancillary activities and logistics companies. In the last 15 years, the dynamics of logistics networks have created conditions favourable to a large-scale development of logistics zones, particularly in Europe. The range of functions of inland logistics zones is wide-ranging, from simple cargo consolidation to advanced logistics services. Many inland locations not only have assumed a significant number of traditional cargo handling functions and services, but also have attracted many related services, including distribution centres, shipping agents, trucking companies, forwarders, container repair facilities and packing firms. The concept of logistics zones in the hinterland is now well advanced in Europe. The first such zones were created in France, notably Sogaris and Garonor near Paris. In the late 1960s and 1970s, logistics zones appeared in Italy and Germany, by following the concept of extended inland intermodal terminals. In the 1980s and 1990s, the number of such zones multiplied in France, Germany, Italy, the Netherlands, Belgium and the United Kingdom. Logistics zones are usually created within the framework of regional development policies as joint initiatives by firms, intermodal operators, regional and local authorities, the central Government and/or the chambers of commerce and industry.

Logistics zones comprising intermodal terminals and logistics sites are often referred to as freight villages. Europlatforms, the European Association of Freight Villages (in Italy, France, Spain, Denmark, Portugal, Luxembourg, Greece, Hungary and Ukraine), provides a comprehensive definition of freight villages: “a freight village is a defined area within which all activities relating to transport, logistics and the distribution of goods, both for national and international transit, are carried out by various operators. These operators can either be owners or tenants of buildings and facilities (warehouses, break-bulk centres, storage areas, offices, car parks, etc.) which have been built there. Also, in order to comply with free competition rules, a freight village must allow access to all companies involved in the activities set out above. A freight village must also be equipped with all the public facilities to carry out the above-mentioned operations. If possible, it should also include public services for the staff and equipment of the users. In order to encourage intermodal transport for the handling of goods, a freight village must preferably be served by a multiplicity of transport modes (road, rail, deep-sea, inland waterway, air). Finally, it is imperative that a freight village be run by a single body, either public or private” (see www.freight-village.com).

Depending on the European country considered, freight villages are known under different names: *plateformes logistiques* in France, the *Güterverkehrszentren* (GVZ) in Germany, *interporti* in Italy, freight villages in the United Kingdom, transport centres in Denmark, and *Zonas de Actividades Logísticas* (ZAL) in Spain. The *interporti* in Italy are a variation on the freight village theme (Iannone et al., 2007). The first *interport* was set up in 1966 in Rivalta Scrivia (north-western Italy) with the aim to accommodate the traffic of the port of Genoa. Other *interporti* followed in the 1970s (Bologna, Verona and Padua). The real success came when the Italian parliament voted on Law No. 240 of 1990, which made it possible to financially support the development of *interporti*. Article 1 of the Law gives a clear definition of the term *interport*: “an organic complex of integrated facilities and services providing for the exchange of goods between the various transport modes, including a railway yard capable of composing and accommodating complete trains and linked to seaports, airports, and highways. The main services of an *interport* consist of the transport and sorting of load units, the storage of goods and further services such as customs, the maintenance of vehicles and containers and the provision of service areas”. An *interport* in Italy typically encompasses a land area of 40 to 150 ha, in some cases even reaching up to 500 ha and has direct rail access.

In North America, the emergence of planned logistics zones came later, as governments rarely placed much attention on these activities. The general availability of land and the private nature of rail operations involved a freight distribution industry that was self-regulated in its locational choices. Cluster formation was mainly a “natural process, strongly conditioned by

national and regional market accessibility. A variety of private real estate promoters, often in partnership with local or state governments, built logistics or industrial parks on an ad hoc basis where land was available, inexpensive and in proximity to a major highway. This led to three major forms of North American logistics cluster dynamics:

- Near gateways where logistics clusters are strongly conditioned by warehousing parks in the vicinity of container port terminals as well as in suburban settings near ring roads. This is prone to the usage of satellite terminals.
- Around the inland rail terminals, which were set up at the same time that new facilities were being designed in a suburban setting, away from the more traditional locations near central business districts. This reinforces the emergence of load centres.
- Along major highway corridors that can service a large metropolitan area or a group of metropolitan areas. For instance, in the United States of America, many distribution clusters in the central part of Pennsylvania were established because of the convenient access to large cities along the Boston-Washington corridor, with most of the cities accessible within three to six hours.

Kansas City can be considered the most advanced inland port initiative in North America, as it combines intermodal rail facilities from four different rail operators, free trade zones and logistics parks at various locations through the metropolitan area. It even has the world's largest underground warehousing facility, Subtropolis, where temperature stable space can be leased. Like Chicago, the city can essentially be perceived as a terminal (Hesse, 2008).

IV. COMPETITION BETWEEN SEAPORTS AND INLAND LOGISTICS ZONES

Quite a few logistics zones are competing with seaports for the location of distribution facilities and value added logistics. There is a tendency in the container sector to move away from the deep-sea terminal. Shortage of industrial premises, high land prices, congestion problems, the inland location of the European markets and severe environmental restrictions are some of the well-known arguments for companies not to locate in a seaport. In North America, inland ports mostly compete with gateways in terms of costs and a better level of service to large inland markets. The further integration of intermodal transport and supply chain

management will undoubtedly lead to new value added services in inland locations. This will enhance the provision of logistics services at key transfer points and the organization of distribution patterns around such nodes. The availability of fast, efficient and reliable intermodal connections is one of the most important prerequisites for the further logistical development of inland terminals.

As the hinterland becomes a competitive location, the question of which logistics activities are truly port-related remains. In Europe, the chances of European distribution centres (EDCs) in the traditional processing industries having a location in seaports may be good because of the existence of large industrial clusters in seaports. Next, seaports may be attractive alternative locations for the relocation of EDCs—especially EDCs focusing on sea-sea operations. In the new logistics market environment, the following logistics activities typically find a good habitat in ports:

- Logistics activities resulting in a considerable reduction in the transported volume
- Logistics activities involving big volumes of bulk cargoes, suitable for inland navigation and rail
- Logistics activities directly related to companies which have a site in the port area
- Logistics activities related to cargo that needs flexible storage to create a buffer (products subject to season dependent fluctuations or irregular supply)
- Logistics activities with a high dependency on short-sea shipping

Moreover, port areas typically possess a strong competitiveness for distribution centres in a multiple import structure and as a consolidation centre for export cargo. Many seaports have responded by creating logistics parks inside the port area or in the immediate vicinity of the port. The concentration of logistics companies in dedicated logistics parks offers more advantages than providing small and separated complexes. Five basic types of port-based logistics parks can be distinguished (Buck Consultants International, 1996; Kuipers, 1999):

- *Traditional seaport-based logistics park.* This type of logistics park is associated with the pre-container area in seaports.
- *Container oriented logistics parks.* This is the dominant type with a number of large warehouses close to the container terminal locations and intermodal terminal facilities. It also includes transloading and empty container depots.

- *Specialized seaport-based logistics parks.* This type of park specializes in different functions, often closely related to the characteristics of the seaport. The park may focus on the storage of liquid bulk (chemicals), on trade in which a combination of warehousing and office space is offered to a number of import-export companies from developing countries or on high-value office-related employment in which Fourth Party Logistics Service Providers, logistics software firms, financial service providers to the maritime industry and consultants are located in the park.
- *Peripheral seaport-based logistics parks.* These parks are located just outside the port area which typically offers advantages with respect to congestion, costs of land and labour. These peripheral parks are part of the greater seaport region and may benefit from suppliers and other specialized inputs associated with the seaports.
- *Virtual port-based logistics parks.* These parks are located outside the greater seaport area, sometimes at a distance of more than 100 kilometres from the seaport itself, but have a clear orientation to one or more seaports with respect to the origins of the (containerized cargo).

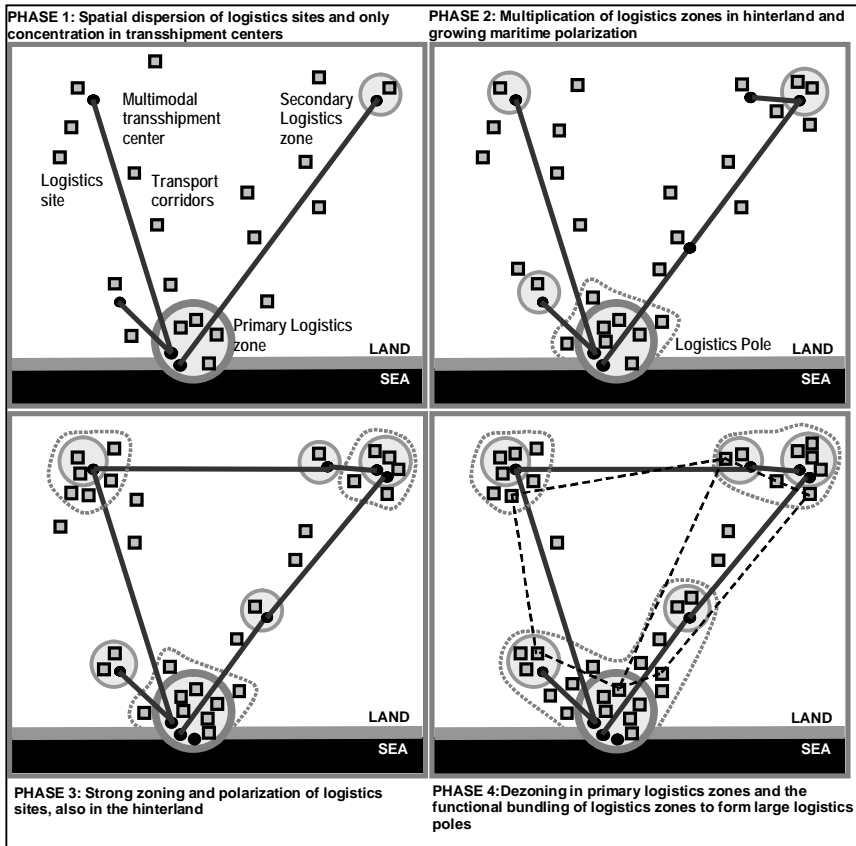
The term “virtual” is associated with a process called “virtual subharbourization”, the rise of port-based activities in the hinterland of the ports together with a stagnation of these activities in the ports itself. Distribution centres are the main example of this activity (Buck Consultants International, 1996). The process of virtual subharbourization is closely linked to the creation of large logistics poles (see section V).

V. PORTS AND INLAND NODES AS TURNABLES IN LARGE LOGISTICS POLES

Logistics companies are frequently set up close to one another, since they are attracted by the same location factors such as the proximity of markets and the availability of intermodal transport and support facilities. The geographical concentration of logistics companies in turn creates synergies and economies of scale, which make the chosen location even more attractive and encourage concentration of distribution companies in a particular area. Corridor development enhances the location of logistics sites in seaports and inland ports and along the axes between seaports and inland ports. The interaction between seaports and inland locations leads to the development of a large logistics pool consisting of several logistics zones (see figure 2). This trend towards geographical concentration of distribution platforms in many cases occurs spontaneously as the result of a slow, market-driven process. But also national, regional and/or local authorities try to direct this process by means of offering financial, regulatory and real

estate incentives. Thus, the relation between ports and inland locations is not only of a competitive nature but also of a complementary nature.

Figure 2. Logistics polarization and the creation of logistics poles



Source: Notteboom (2000) and Notteboom and Rodrigue (2005).

Logistics poles exert a locational pull on logistics sites by combining a strong intermodal orientation with cluster advantages. Geographical differences in labour costs, land costs, availability of land, level of congestion, the location vis-à-vis the service markets, labour mentality and productivity and government policy are among the many factors determining observed (de)polarization of logistics sites. A virtuous cycle is created, producing scale effects, which ensures high productivity from intermodal synchronization and the compatibility of goods flows with the logistics of shippers.

Seaports are the central nodes driving the dynamics in such a large logistics pool. But at the same time seaports rely heavily on inland ports to preserve their attractiveness. For example, the logistics zones in the

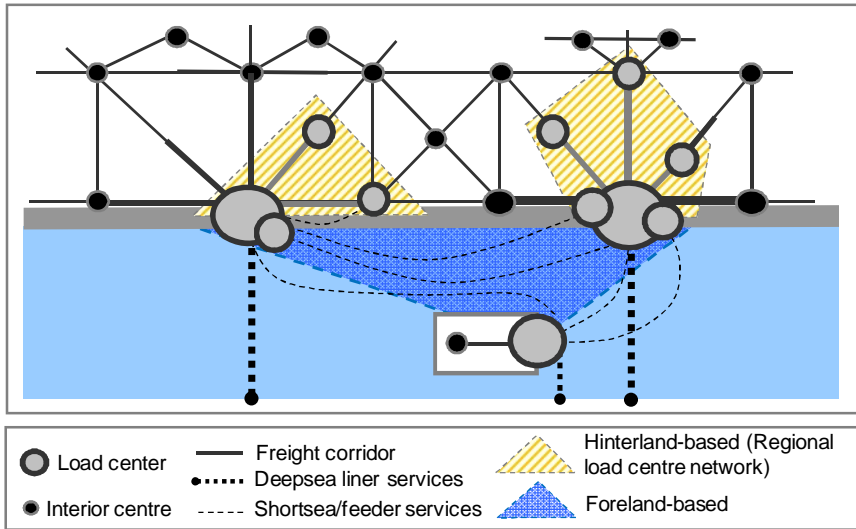
Netherlands are mainly located in ports or around new or existing barge or rail terminals in the hinterland. Dordrecht and Moerdijk are important overflow locations for the port of Rotterdam. There are now large concentrations of logistics sites in and around the port of Liège, along the Geel-Hasselt-Genk axis and the Antwerp-Brussels axis, and in the Kortrijk/Lille border region. The existing geographical concentration of logistics sites has stimulated the development of inland terminals in these areas.

VI. PORT REGIONALIZATION: AN INTEGRATED DEVELOPMENT OF INLAND TERMINALS, GATEWAYS AND CORRIDORS

The creation of large logistics poles poses new challenges in the relations between seaports and inland ports. The performance of seaports is strongly entwined with the development and performance of associated inland networks that give access to cargo bases in the hinterland. To reflect changes in port-hinterland dynamics, Notteboom and Rodrigue (2005) introduced a regionalization phase in port and port system development by extending existing spatial models (as shown in figure 3). Regionalization expands the hinterland reach of the port through a number of strategies linking it more closely to inland freight distribution centres. The phase of regionalization brings the perspective of port development to a higher geographical scale, i.e. beyond the port perimeter. The port regionalization phase is characterized by a strong functional interdependency and even joint development of a specific load centre and (selected) multimodal logistics platforms in its hinterland, ultimately leading to the formation of a regional load centre network. The port system consequently adapts to the imperatives of distribution systems.

An important driver for the creation of regional load centre networks relates to the requirements imposed by global production and consumption networks. No single locality can service efficiently the distribution requirements of a complex web of activities. Port regionalization permits the development of a distribution network that corresponds more closely to fragmented production and consumption systems. The transition towards the port regionalization phase is a gradual and market-driven process that mirrors the increased focus of market players on logistics integration. In the regionalization phase it is increasingly being acknowledged that land transport forms an important target for reducing logistics costs. The responses to these challenges go beyond the traditional perspectives centred on the port itself. Regionalization as such provides a strategic answer to the imperatives of the inland distribution segment of the supply chain in terms of improving its efficiency, enhancing logistics integration and reducing distribution costs.

Figure 3. The regionalization phase in the spatial development of a port system



Source: Based on Notteboom and Rodrigue (2005).

Another factor having a major impact on port development dynamics are local constraints. Ports, especially large gateways, are facing a wide array of local constraints that impair their growth and efficiency. The lack of available land for expansion is among one of the most acute problem, an issue exacerbated by the deepwater requirements for handling larger ships. Increased port traffic may also lead to diseconomies as local road and rail systems are heavily burdened. Environmental constraints and local opposition to port development are also of significance. Port regionalization thus enables to partially circumscribe local constraints by externalizing them.

Many ports are reaching a stage of regionalization in which market forces gradually shape regional load centre networks with varying degrees of formal linkages between the nodes of the observed networks. Port authorities have a role to play in shaping efficient hinterland networks. But they have to start from the knowledge that their impact on cargo flows and on hinterland infrastructure development is limited to that of facilitator.

A large number of port authorities promote an efficient intermodal system in order to secure cargo under conditions of high competition. Port authorities can add value by setting up task forces together with various stakeholders (carriers, shippers, transport operators, labour and government bodies) to identify and address issues affecting logistics performance. These issues can relate to the bundling of rail and barge container flows in the port area and the development of rail and barge shuttles. The market players bear

the market risks. Apart from port authorities, also branch associations are adopting a role as facilitator in dealing with inland transport issues (for example, Alfaport in Antwerp and Deltalinqs in Rotterdam).

Some ports might fear that the creation of logistics poles causes port benefits to “leak” to users in inland locations. This fear and the focus of port users on logistics networks are clear invitations to port managers to consider cooperation with inland ports in the field of traffic management, land issuing, hinterland connections and services, environmental protection and research and development (R&D). A well-balanced port networking strategy should enable a port authority to develop new resources and capabilities in close cooperation with other transport nodes and with mutual interests served. Sometimes very simple coordination actions can substantially improve inland freight distribution, with benefits for all parties involved. Advantages of more cooperation with inland locations include:

- Increasing regional productivity by a more efficient connection with inland locations
- Stronger support for the cargo handling function of the port because of better use of space and increased possibilities for a successful modal shift
- Stronger position to attract investment and subsidies because of an integrated hinterland product
- Expansion in the hinterland, and possibility to capture a market share of competitor ports
- Retention of customers in the hinterland
- Better insight and level of service in the local markets
- Increased potential for intermodal services, even on shorter distances
- More attractive hinterland services because of an increased flexibility, reliability and frequency
- Further strengthening of the geographic concentration of logistics companies, including advantages for both seaport and inland port
- Simplified customs procedures

Still, port authorities are quite reluctant to engage in advanced forms of strategic partnerships with inland ports (through strategic alliances, (cross-)participation, joint-ventures or even mergers and acquisitions) as they fear that they will lose added value and employment by “giving away” activities, that they will lose captive cargo (port-related companies in the hinterland are less dependent on one port for their maritime import and export), or that they lose clients as these might consider the cooperation with one specific hinterland location as a market restriction or distortion. In practice, mainly private market players are involved in setting up these types of cooperative networks. But informal programmes of coordination between port authorities and inland ports are now slowly developing. Marseille (in relation to Lyon), Le

Havre (in relation to Rouen and Paris), New York (in relation to the eastern seaboard) and Antwerp (in relation to Liège) are some examples (see table 3).

Table 3. A selection of initiatives of European and North American port authorities in establishing links with inland ports

Port authority	Project	Aim
Europe		
Antwerp	Triligiport—Liège Other planned locations	Joint development of a 100 ha logistics platform along the Albert Canal. Status: Joint entity under the legal status of an “economic interest grouping”
Lisbon	Puerta de Atlantico—Mostoles	Development of a logistical platform in Mostoles in the outskirts of Madrid. Status: Contract signed, January 2008
Rotterdam	European Inland Terminals (EIT)	Minority shareholding in inland terminals in immediate hinterland via separate holding. Status: abandoned
Barcelona	tm-concept (Terminal Maritima)	Joint partnerships to set up dry ports / logistics zones in hinterland. Status: tmT (Toulouse), tmZ (Zaragoza), tmM (Madrid) are operational. New projects in Perpignan, Montpellier and Lyon
Marseille	Inland port Lyon	Development of Lyon as a multimodal satellite port of Marseille. Status: <i>Société d'économie mixte</i> founded in 1997. Port authority is one of shareholders. Joint barge and rail services between Lyon and Marseille
HHLA—Hamburg	Rail terminals	HHLA ha participations in rail terminals (Melnik, Budapest, etc.) to support its rail products via Potzug, Metrans and HHCE

Table 3. Continued

Port authority	Project	Aim
North America		
New York/ New Jersey	Port Inland Distribution Network	Network of rail and barge services to inland and port terminals. Status: barge service to Albany abandoned in 2006.
Virginia	Virginia Inland Port	Setting of an inland rail terminal at Front Royal. Status: Virginia Inland port operational
Los Angeles and Long Beach	Alameda corridor	Joint governance of the Alameda Corridor Transport Authority. Rail link between the satellite rail terminals of downtown Los Angeles (BNSF, UP) and on-dock and near dock rail facilities. Status: operational with more than 10 000 TEUs per day

Source: the authors

Large load centres generally have a broad financial base to engage in a well-balanced port networking strategy, although substantial differences exist even among the largest container ports. Smaller ports and new ports have to rely solely on very simple coordination actions to substantially improve inland freight distribution, with benefits for all parties involved. In spatial terms this implies that regional load centre networks are most likely to be developed around large load centres, whereas smaller ports either become part of these large regional load centre networks or remain isolated in a spatial and organizational sense.

VII. SUPPLY CHAINS RECONCILING INLAND TERMINALS WITH GLOBAL FREIGHT DISTRIBUTION

In an environment of intense global competition, there are limited options to reduce costs other than through a set of freight distribution strategies. Improving supply chains leads to cost, quality and efficiency improvements, thus freight distribution strategies are a strong factor of competitiveness. Within this framework, inland terminals are becoming a fundamental part in the reconciliation between transport infrastructure, and supply chain management. The development of inland terminals makes sense in a supply chain context for several reasons.

First of all, for a number of supply chains inland locations might possess the best resources to meet the demand linked to some activities (see discussion above). These activities can relate for example to those that cannot be reconciled with a high quality of life, such as distribution activities generating substantial road traffic.

Second, inland terminals can tackle the potential congestion in large gateway ports by shifting a part of the distribution function from seaport terminals to rail hubs and barge terminals in the immediate hinterland. As such, inland terminals can make it easier for load centres to preserve their attractiveness and to fully exploit their potential economies of scale. The corridors towards the inland terminal network in fact create the necessary margin for further growth of the sea-borne container traffic. These inland terminals acquire an important satellite function with respect to the seaports, as they help to relieve the seaport areas of potential congestion. Rodrigue and Notteboom (2009) used the term “*bottleneck-derived terminalization*” in this context. Terminal operators must maintain a level of service to their users, particularly maritime shipping lines. In case of delays and capacity constraints the supply chain adapts with volume, frequency and scheduling changes and may seek alternatives if possible. Inland terminals can serve as an alternative to seaports.

The use of inland terminals to relieve pressure on seaport terminals can take many forms. For example, Rotterdam is planning to develop a series of so-called container transferia in the vicinity of the port near the main transport corridors to the hinterland service areas. At a container transferium, trucks would be loaded and discharged and inland barge shuttles would secure a frequent and reliable connection between the transferium and the large container terminals in the port. The container transferia would also provide space for additional services such as empty depots, distribution centres and customs. The first container transferium would be built near the A15, the main highway to Germany. The concept has been identified by the government of Netherlands as a key project in the so-called urgency programme to relieve congestion in the Randstad, the economic heart of the Netherlands. While the Rotterdam Port Authority and the government of Netherlands are promoting the concept, the eventual operation of a Container Transferium will be the task for private operators. A second example concerns the San Pedro Bay Ports—Los Angeles and Long Beach. These gateways have limited options for expansion and terminal operations are increasingly facing constraining environmental regulations. About one third of all the long-distance freight carried out of the San Pedro Bay ports is carried through the Alameda Corridor, a 20-mile-long rail high-capacity freight expressway linking the port cluster to the transcontinental rail terminals near downtown Los Angeles. Since coming online in 2003, the number of trains going through the corridor has grown relatively on par with the containerized traffic at the port cluster. A significant factor impeding its growth is the transloading function assumed by the nearby distribution centres, an

indication that the terminalization of the concerned continental supply chains cannot be easily by-passed, even with alternative inland distribution opportunities.

Third, inland terminals add value to the market players in different ways. Shippers increasingly integrate inland ports in their logistics planning both for import cargo (integration in the production line) and export cargo (depot function for empty boxes). Shipping lines are increasingly using inland terminals in view of streamlining box logistics (e.g. reduction of empty hauls) and deep-sea terminal operators develop links with inland terminals to increase their impact on hinterland flows.

Leading terminal operating companies are developing diverging strategies towards the control of larger parts of the supply chain. The door-to-door philosophy has transformed a number of terminal operators into logistics organizations and or organizers/operators of inland services. The European case provides a good illustration. Maersk Line wants to push containers into the hinterland supported by its terminal branch APM Terminals and its rail branches. HPH-owned ECT in Rotterdam has followed an active strategy of acquiring key inland terminals acting as extended gates to its deep-sea terminals, e.g. a rail terminal in Venlo (the Netherlands), DeCeTe terminal in Duisburg (Germany) and TCT Belgium in Willebroek (Belgium). DP World is working in partnership with CMA CGM to streamline intermodal operations on the Seine and Rhône axes, while the large terminals of Antwerp Gateway (open since 2005) and London Gateway (future) are both linked to inland centres in the hinterland. DP World has set up Hintermodal as a joint venture with the intermodal transport organizer Shipit to give concrete content to the concept of terminal operator haulage from the Antwerp Gateway terminal to the hinterland. The terminal operator haulage concept is aimed at a more active involvement of the terminal operator in hinterland connections by establishing closer relationships with shipping lines and inland operators. Terminal operators can play an instrumental role in bringing together intermodal volumes of competing lines and as such create a basis for improved or even new intermodal services. Eurogate has created a north-south axis connecting the rail activities of subsidiary Sogemar in the south to its extensive BoXxpress network in the north. The major private terminal of Melzo, owned by Eurogate and located in the suburbs of Milan, is where the Hannibal services between northern Europe and Gioia Tauro and La Spezia are routed. Singapore-based PSA is the only global terminal operator which has not presented a clear inland strategy yet, though they are working on it.

Thus, terminal operators are expected to increase their influence throughout supply chains by engaging in inland transport. They seem to do so mainly by incorporating inland terminals as extended gates to seaport terminals and by introducing an integrated terminal operator haulage concept for the customers. Customs can qualify an inland terminal as an extension of a deep-sea terminal, so customs clearance can be done there. The terminal

operator typically remains responsible en route between the deep-sea terminal and the inland terminal. The advantages of the extended gate system are substantial: customers can have their containers available in close proximity to their customer base, while the deep-sea terminal operator faces less pressure on the deep-sea terminals due to shorter dwell times and can guarantee a better planning and utilization of the rail and barge shuttles. However, the success of both extended gates and terminal operator haulage largely depends on the transparency of the goods and information flows.

With the increasing role of inland terminals in supply chains, a process of *warehousing-derived (buffer) terminalization* is unfolding, where the function of warehousing, in whole or in part, is shifted to the terminal (Rodrigue and Notteboom, 2009). The terminal becomes the main buffer instead of the distribution centre, which functionally makes the terminal a component of the supply chain, no longer as a factor of delay, but as a storage unit. The box 1 provides an example for the EDC of the Japanese firm JVC. It gives the supply chain a higher level of flexibility to lower their warehousing costs as well as to adapt to unforeseen events such as demand spikes or delays. An “inventory in transit” strategy coupled with an “inventory at terminal” one can reduce significantly warehousing requirements at distribution centres.

VIII. INLAND TERMINALS IN EUROPE AND NORTH AMERICA: OPERATIONAL CONSIDERATIONS

The last section in this paper focuses on operational issues and practices in European and North American inland terminals. The discussion on Europe will focus on both barge and rail terminals, while the North American discussion is limited to rail since the barge option represents a very small market in the United States and Canada.

A. Rail terminals and networks in Europe

European rail logistics are highly complex. A geographically, politically and economically fragmented Europe prevented the realization of greater intermodal scale and scope economies (Charlier and Ridolfi, 1994). For a long time, there were no obvious drivers for change in the intermodal rail industry other than the (former) national railway companies. These national railway companies lacked commitment and commercial attitude. Major complaints related to their perceived bureaucratic attitude, unannounced rate changes, long lead time required to make bookings, poor documentation management, limited tracking and tracing possibilities, limited cost-effective integration in door-to-door transport chains and the fact that in most cases no service guarantees were given. Until 1993, cross-border rail traffic of maritime containers in Europe was the exclusive right of

Intercontainer. The rail liberalization process (see, for example, Bologna, 2004 and Debie and Gouvernal, 2006 on this issue) should lead to real pan-European rail services on a one-stop shop basis. All over Europe, new entrants are emerging while some large former national railway companies have joined forces (cf. Railion). The emergence of a new generation of rail operators not only made incumbent firms act in a more commercial way, but also led to an improvement in the endogenous capabilities of the railway sector which in time could make rail a more widespread alternative in serving the European hinterlands, at least if some outstanding technical and operational issues facing cross-border services can be solved.

Box 1. Example: the extended distribution centre system of JVC Belgium

JVC Belgium was set up in 1999 and is responsible for the European distribution of the products of the Japanese electronics producer JVC. The European Distribution Centre is located in Boom, halfway between Antwerp and Brussels in Belgium. JVC Belgium uses inland barges to transport the containers with imported electronics (mostly of Asian origin) to the EDC in Boom. The containers are handled at the inland terminal TCT Belgium, part of ECT/Hutchison. The terminal maintains a daily barge connection to Rotterdam and three daily sailings to Antwerp. Over the years, JVC has developed a simple and effective system for the transport of containers between Rotterdam and Boom. Instead of giving shipping lines a separate transport order for each container, the company follows the four-day rule: each container discharged in Rotterdam should be at TCT Belgium within three days. Every morning TCT Belgium informs JVC of the number of containers that are waiting at the inland terminal or will be arriving later that day. JVC picks the containers they want to have in their warehouse that day and they are subsequently delivered by truck in the morning to the warehouse. Trucks take empty containers on the way back to the inland terminal facility. In the afternoon, the truck bays at the EDC are solely used for supplying the regional distribution centres in the European Union. The warehouse management system of JVC considers full containers stacked at TCT Belgium to be in stock like any other inventory within the walls of the warehouse. If a full container load of a specific product needs to be delivered to a regional distribution centre somewhere in Europe, JVC might leave the stock in the warehouse and send directly a full container stationed at TCT Belgium, since it has to be moved anyway.

The streamlined supply system of JVC Belgium makes optimal use of the free storage time at the deep-sea terminal in Rotterdam and at the inland terminal. Free time in Rotterdam is limited to around 5 days, while free time at TCT Belgium amounts to 21 days. By imposing the four-day rule to shipping lines, JVC Belgium guarantees that the dwell time at the deep-sea terminal never exceeds the free time. In other words, JVC has successfully externalized a significant share of its warehousing costs through an optimal combination of deep-sea and inland terminals.

Source: Based on Rodrigue and Notteboom (2009).

On the operational side, launching new rail services remains very costly and finding the necessary critical mass is not an easy task, especially when facing a fragmented cargo base controlled by many forwarders. This has opened the door to an increasing involvement of major shipping lines, terminal operators (mainly in Italy and Germany) and port authorities (for example, Barcelona and Marseille). Direct shuttle trains constitute the backbone of rail services out of European ports. These shuttle trains can only be exploited in a profitable way on a number of high-density traffic corridors such as the Rhine axis and the trans-Alpine route. Some rail operators have resolved the problems related to the fluctuating volumes and the numerous final destinations by bundling container flows in centrally located nodes in the more immediate hinterland. Numerous hub-and-spoke railway networks emerged in the 1990s (see, for example, Notteboom, 2001 and Kreutzberger, 2005). The nodes within these networks were connected by frequent shuttle trains with capacities for a single train combination ranging from 40 up to 95 TEUs. An example was the Qualitynet of Intercontainer-Interfrigo (ICF) with Metz-Sablon in the north-east of France as a master hub linking up the Rhine-Scheldt delta ports with the rest of Western Europe.

Such hub-and-spoke networks now appear to be vulnerable, as the volumes on the spokes can be affected by: (i) newcomers entering the market in the aftermath of European rail liberalization; and (ii) increasing intermodal volumes in seaports. New railway operators often engage in cherry picking by introducing competing direct shuttle trains on a spoke of an established hub-and-spoke network of a competitor. This has a negative affect on cargo volumes on the spoke and might lead to a collapse of the whole hub-and-spoke system. This is what happened to the ICF Qualitynet in 2004. ICF launched its new strategy in December 2004. The intermodal traffic of the former Qualitynet hub in Metz are now handled by a set of direct shuttles trains to less destinations. For Eastern and South-Eastern Europe, services are centred around the hub in Sopron, Hungary.

At present, a wide array of rail operators together make up the supply of hub-based networks, direct shuttles and inter-port shuttles out of the large load centres. Hamburg's rail connections outperform all other ports in numbers (i.e. more than 160 international and national shuttle and block train services per week) and in traffic volumes by rail (i.e. over 1 million TEUs in 2005). Rotterdam and Antwerp each have between 150 and 200 intermodal rail departures per week. Smaller container ports in the range tend to seek connection to the extensive hinterland networks of the large load centres by installing shuttle services either to rail platforms in the big container ports or to master rail hubs in the hinterland.

Rail terminals in Europe are typically built and operated by large railway undertakings. Before European rail liberalization, the respective national railway companies established national networks of rail terminals.

The entry of new players in the wake of the rail liberalization process means that major rail centres are now witnessing a multiplication in the number of rail terminal facilities, with each terminal being operated by a specific rail operator.

The largest rail facilities have bundles of up to 10 rail tracks with lengths of maximum 800 m per track. The limitation in track length is linked to the existing limitation in the length of freight shuttle trains (max. 750 m). DB in Germany is setting up experiments to increase the length of the trains on certain corridors (up to 1,000 m or even 1,200 m), but this initiative is still in a pioneering stage. Rail hubs are typically equipped to allow simultaneous batch exchanges (direct trans-shipment) through the use of rail-mounted gantry cranes that stretch over the rail bundles. However, rail hubs also typically feature a small stacking area to cope with synchronization problems between rail shuttles and to allow containers to be fed by trucks.

B. Barge terminals in Europe

Barge container transport in Europe has its origins in transport between Antwerp, Rotterdam and the Rhine basin, and in the last decade it has also developed greatly along the north-south axis between the Benelux and northern France (Notteboom and Konings, 2004). Antwerp and Rotterdam together handle about 95 per cent of total European container transport by barge. Volumes on the Rhine have increased from 200,000 TEUs in 1985 to some 1.8 million TEUs in 2006 leading to higher frequencies and bigger vessels (figures from Central Commission for Navigation on the Rhine). At present, the liner service networks offered on the Rhine are mainly calling at three to eight terminals per navigation area (Lower Rhine, Middle Rhine, Upper Rhine). The inland vessels used on the Rhine have capacities ranging from 90 to 208 TEUs, although some bigger units and push convoys of up to 500 TEUs can be spotted occasionally. Rotterdam has a strong position on barge traffic from/to the lower Rhine and middle Rhine, whereas Antwerp and Rotterdam are equally strong on the upper Rhine.

The number of terminals in the Rhine basin is steadily increasing. This is the result of new terminal operators arriving on the market and of new terminals appearing along the Rhine and its tributaries. The growing realization of the potential offered by barge container shipping has led to a wave of investment in new terminals over the past ten years, in northern France, the Netherlands and Belgium. The Benelux and northern France now have more than 30 container terminals, about as many as in the Rhine basin. In 1991, there was still no terminal network on the north-south axis (only two terminals). The next step is to establish a network of liner services connecting the various terminals outside the Rhine basin on a line bundling basis.

Barge services and inland terminals are also being developed outside the Rhine-Scheldt-Meuse basins. The barge container market is booming on the Rhône (55,807 TEUs in 2005) and on the Seine (159,000 TEUs in 2007 via barge services operated by Logiseine, River Shuttle Containers, Marfret, MSC and Maersk). Hamburg is slowly developing barge services on the Elbe, with annual volumes in 2006 exceeding 140,000 TEUs compared to only 30,000 TEUs in 2000. And there are even initiatives to introduce small-scale barge services on the Mantova-Adriatic waterway in northern Italy.

Some have raised concerns regarding a possible over-supply of inland terminals. The cycle theory states that once a phase of maturity is reached, rationalization commonly leads to the closing of the least productive elements. Governments (local, regional, national, supranational) promote the use of inland navigation as an alternative to road (modal shift). Especially in the 1990s and the first half of this decennium, start-up premiums for services and infrastructure subsidies were readily available. For example, the first European Union Marco Polo programme supported modal shift actions and could co-finance up to 30 per cent of the start-up costs for a new service for a period of three years. At present, the market mechanism guides the European barge terminal sector. The decreasing financial support of public authorities has resulted in an increased pressure towards a rationalization phase driven by mergers and acquisitions in the inland terminal business and the consolidation of flows in larger facilities.

The bulk of the barge services are controlled by independent barge operators. They have always shown a keen interest in the exploitation of inland terminals. About two thirds of all terminals in the Rhine basin are operated by inland barge operators or the logistics mother company of a barge operator. The remaining terminals are operated/owned by stevedoring companies of seaports, inland port authorities (e.g. Port Autonome de Strasbourg) or logistic service providers.

The leading barge container carriers are increasingly trying to achieve a functional vertical integration of the container transport chain by extending the logistical services package to include complete door-to-door logistical solutions. In the 1990s, three logistics holdings got a strong grip on the barging market. Wincanton controlled 33 per cent of containers moved by barge in the Rhine basin in 2004. Wincanton is the mother company of Rhenania with subsidiary Rhinecontainer (375,000 TEUs in 2004). Rhenus Logistics, mother company of Contargo (including SRN Alpina and CCS), reached a market share of 22 per cent and Imperial Logistics Group, mother company of Alcotrans, 15 per cent (Zurbach, 2005). Alcotrans transported around 220,000 TEUs on the Rhine in 2006. The Contargo network, comprising of 19 inland container terminals in Germany, the Netherlands, France and Switzerland, handled some 840,000 TEUs in 2006. The integration of leading barge operating companies in the structures of highly-

diversified logistics groups further strengthens the functional integration in the logistics chain.

On the operational side, we address two important issues: (i) the consolidation or bundling of cargo in seaports; and (ii) operational considerations in the development and implementation of inland barge terminals.

As far as the first issue is concerned, in the seaports of Rotterdam and Antwerp, Europe's biggest load centres for inland waterway traffic, barge container transport is increasingly being confronted with operational problems, hampering its image as a reliable transport mode. Due to the enormous increase in deep-sea container traffic in these two ports, coupled with the fact that deep-sea vessels are granted priority over barges when they have to be handled alongside the same quay, barge container transport is confronted with increasing waiting times (waiting times of up to 48 hours are no exception). This results in the disruption of the barges' sailing schedules and unexpected costs. The resulting uncertainty and unreliability of barge services means that trucks are often chosen unnecessarily. Another problem faced by barge container transport is the fragmentation of container flows in seaports. Barge operators sailing between Rotterdam/Antwerp and terminals along the Rhine typically call at a large number of terminals in both seaports (so-called terminal shopping), which results in a low number of container moves per terminal and a significant amount of time spent in port. On the Rotterdam/Antwerp market, the number of terminals called at is lower, resulting in higher call sizes and less time spent in port. A possible solution to the problem of low call sizes and time losses in seaports is the consolidation of barge container flows at a limited number of seaport terminals. This, however, increases inter-terminal transport and handling costs for the stevedore. Given the fact that handling costs take up a large share of the total port-to-door transport costs, particularly for short port-to-door distances, this would significantly hamper inland navigation's competitive position vis-à-vis other transport modes.

A core problem is the lack of transparency on barge flows in seaport areas. Both in Rotterdam and Antwerp, relevant parties are now brought together by the port authorities to obtain a better insight into the barge-related flows moving in the respective ports. The ultimate aim is: (i) to give advice to barge operators through existing barge traffic systems on the optimal terminal loading sequence; and (ii) to create a good market environment for the bundling of small batches of containers so that the average call size of barges increases. In some cases the barge operators or inland terminal operators have taken matters in their own hands. The long barge turnaround times and delays at the port of Rotterdam in 2006 was jointly addressed by deep-sea terminal operator ECT (part of Hutchison Port Holdings, based in Hong Kong, China) and the Dutch association of inland terminal operators VITO. The partnership resulted in the allocation of a barge crane at the ECT

Delta Terminal to the handling of inland ships of VITO members. In return, VITO stationed a planning staffer at the Delta Terminal in charge of a more evenly supply of ships around the clock and provides more advance information to ECT on the containers to be discharged and loaded. VITO ensures that all the necessary information arrives via electronic data interchange (EDI) ahead of time. ECT takes the responsibility for the internal container transport between the deep-sea terminals and the barge terminal.

The second relevant issue relates to operational considerations in the development and implementation of inland barge terminals. The location decision and the associated market analysis are of strategic importance to the success of a terminal. A low bridge along the river or canal between a seaport and the planned inland terminal may limit the stacking height on the vessel (e.g. three layers instead of four), thereby decreasing the profitability of the liner service. Next to these air draft considerations, the draft of the canal or river is obviously also a major concern since it will define the maximum deployable vessel scale. Planners have to follow a realistic approach when estimating the market potential of an inland terminal at a certain location. This implies they should take into account: (i) the "modal shift" potential in the area (i.e. the willingness of companies to shift from truck to barge); (ii) existing and future competing inland terminals that might limit the market potential of the terminal under consideration; and (iii) the traffic evolution and modal split expectations in the associated seaports. A location near a few big shippers which bring in the critical mass has proven to be an important success factor to inland barge terminals. Inland terminal operators need to develop a door-to-door product and an extensive service package for the customers. This requires, for example, good arrangements with shipping lines and local trucking companies. The costs for pre- and end hauls by truck are considerable and explain why the range of the service area of inland terminals is often rather limited. Planners also have to take into consideration that the market for pure continental barge services between two inland terminals is very small in Europe.

The profitability of an inland container terminal typically depends on two factors, namely its throughput and the size of its service area. As far as throughput is concerned, a minimum volume is required in order to be profitable. A high throughput enables a quick recovery of fixed investment costs (in infrastructure, superstructure and ICT systems), which take up a large share of the total terminal handling costs. The size of the service area has a large impact on the competitiveness of an inland terminal. In case the inland terminal is located in the vicinity of the seaport, the service area of the inland port (the market threshold) often covers a range of 10 km or less around the terminal, making the last trucking leg short and time responsive. Far away from the seaports (> 300 km), service areas of inland terminals in some cases stretch up to a range of 60 km. Larger service areas imply high haul costs (pre- and end-haulage), which seriously hampers a terminal's ability to attract new business, confer longer delivery times and increase the

risk of competition with other inland terminals. All this impedes the acquisition of possible new customers. The expected terminal profitability is highest for terminals with a high throughput and a small service area.

Inland barge terminals are advised to follow a low-cost orientation in the start-up phase. In practice this implies that an inland barge terminal can best handle cargo with reach stackers until the terminal reaches a volume between 5,000 and 10,000 TEUs. At these volumes, it is worthwhile to consider buying a gantry crane designed to handle vessels (via the outreach of the crane), stack containers (in between the "legs" of the crane) and handle trucks (via the outreach at the land side of the crane). Terminals on the Rhine typically handle 25,000 to 35,000 TEUs per crane per year, so above this throughput figure the terminal operator will have to consider adding an additional crane.

Most inland terminal operators use individual barges to guarantee frequent services with the relevant seaport(s). For a regular service on a short to medium distance one needs at least two barges (limitation of risk). Barge services that connect to other terminals as well will lead to a lower necessary critical mass per terminal given a desired service frequency and the unit capacity of the vessels. Such line-bundling services are very common on the Rhine and are also slowly developing in other navigation areas (see discussion above).

The utility of providing logistics services on the terminal will depend on the main focus: a terminal with a strong orientation towards shipping lines (carrier haulage) will typically not really need warehousing and other logistics services, while a terminal with a strong focus on shippers (merchant haulage) might have to develop logistics services. A relatively new development is the interconnection of the terminal planning system with the information technology (IT) systems of main customers (shippers and or shipping lines) in view of increasing the visibility of the flows.

C. Rail terminals and networks in North America

Intermodal rail is of primordial importance to support long-distance trade corridors and inland ports in North America. It accounts for close to 40 per cent of all the ton-miles transported in the United States, while in Europe this share is only 8 per cent. Rail freight in the United States has experienced a remarkable growth since deregulation in the 1980s (Staggers Act) with a 77 per cent increase in tons-km between 1985 and 2003. The North American rail transport system shows a high level of geographical specialization with seven large private rail carriers servicing large regional markets. Rail companies have their own facilities and customers and thus have their own markets along the segments they control. Each rail system is the outcome of substantial capital investments occurring over several decades with the

accumulation of impressive infrastructure and equipment assets. However, such a characteristic created issues about continuity within the American rail network. Mergers have improved this continuity but a limit has been reached in the network size of most rail operators. Attempts have been made to synchronize the interactions between rail operators for long-distance trade with the setting of intermodal unit trains. Often bilateral, trilateral or even quadrilateral arrangements are made between rail carriers and shipping companies to improve the intermodal interface at the major gateways or at points of interlining between major networks. Chicago is the largest interlining centre in North America, handling around 10 million TEUs per year. Its location is at the junction of the Eastern, Western and Canadian rail systems, making it, de facto, the main inland port of North America.

The main growth factors for rail activity in recent years have been linked with a growth in international containerized trade, particularly across the Pacific, a growth in the quantity of utility coal moving out of the Powder River basin and a growth of the Canadian and Mexican trans-border trade. Intermodal and coal represent the two most important sources of income for most rail operators; container traffic represented approximately 80 per cent of all rail intermodal moves. Long-distance intermodal rail transport corridors have favoured the setting of what are known as land-bridge serviced originating from major port gateways.

The main North American land-bridge links two major gateway systems: southern California and New York/New Jersey via Chicago. Land-bridges are particularly the outcome of cooperation between rail operators eager to get lucrative long-distance traffic and maritime shippers eager to reduce shipping time and costs, particularly from Asia. The two largest North American railroads, UP and BNSF, derive a sizeable share of their operating revenue from long-distance intermodal movements originating on the Pacific coast and bound towards the eastern part of the continent.

Long-distance intermodal rail corridors are also planned in a latitudinal fashion to Mexico. Kansas City Southern de Mexico (KCSM, a subsidiary of Kansas City Southern (KCS)) is building an \$80 million intermodal terminal next to the port of Lazero Cardenas. KCSM plans to establish a new International Intermodal Corridor stretching 1,300 miles across Mexico to the border crossing at Laredo, Texas. At Laredo, the Kansas City Southern system that connects to major American rail hubs, namely Chicago and Kansas City, takes over (Randolph, 2008). KCS has also invested in the development of a new rail terminal at Richards Gabaur in Kansas City, a project supported by the setting of a logistics pole in a former military base. NAFTA rail corridors and the setting of inland hubs is thus a strategy that goes hand to hand, each element reinforcing the other.

However, due to road congestion, infrastructure capacity issues and a surge in fuel price the advantages of the land-bridge are being challenged,

particularly for long-distance trade. For instance, shipping a forty foot container from New York to the Republic of Korea cost about \$3,000 if the all-water maritime route through the Suez Canal is used and \$9,000 if shipped by rail to a west coast port and then across the Pacific. Thus, this form of rail intermodalism appears to have reached a phase of maturity. Still, the market segment of domestic (North American) rail intermodalism is expected to grow substantially as the only available alternative to long-distance trucking. This will lean on the setting of a variety of inland terminals acting as load centres for the respective market areas.

The United States alone has about 2,270 rail facilities performing some form of intermodalism by being able to move freight from rail to trucks. Although this appears to be a large number, only about 20 per cent of these facilities handle a significant intermodal volume and less than 10 per cent of them are true intermodal container terminals. The rest are local facilities fulfilling specific industrial, resources or manufacturing needs for bulk and break-bulk shipments. Thus, the North American system of operational intermodal rail terminals handling COFC and TOFC traffic accounts for about 206 facilities covering major inland markets.

Most intermodal terminals are clustered around major maritime gateways (Los Angeles, New York) and intermediary locations having strong inland logistical activities and inland ports (Chicago, Memphis, Kansas City). The location of intermodal rail terminals is a balancing act between gateway location, market density, interlining and complementarity with trucking. In spite of a system controlled by only seven major operators, the great majority of inland load centres are serviced by at least two operators, which confers a level of competitiveness and offers options for regional shippers. For the western system, most load centres are serviced by both BSNF and UP, while for the eastern system, most load centres are serviced by both UP and CSX. A similar pattern is observed for the Canadian system with CN and CP. There are, however, a few notable exceptions serviced by only one intermodal terminal and with no nearby competitors, such as Halifax (CN), Salt Lake City (UP), Billings (BNSF), Albuquerque (BNSF), Amarillo (BNSF) and Prince Rupert (CN). On the opposite range of the spectrum several locations, particularly at the interface between regional systems, have three or more rail operators (Detroit, Chicago, St. Louis, Kansas City, Memphis, Dallas-Fort Worth, New Orleans and Atlanta). They are thus particularly prone to a more competitive inland terminal setting offering shipping options to both the east and the west coasts.

In the North American setting, inland ports must provide three fundamental services to containerized trade:

- Repositioning. The American economy has a negative trade balance with most of its major trade partners, implying that it imports more than it exports, both in volume and value. This generates empty

backhauls. Under such circumstances, an inland port must provide the physical and logistical capabilities to insure that empty containers are repositioned efficiently to other markets if local cargo cannot be found.

- **Cargo rotation.** Whether there are imbalances in container flows or not, an inland port must insure that the inbound and outbound flows are reconciled as quickly as possible. A common way involves a cargo rotation from imports activities where containers are emptied to exports activities filling containers. For container owners, let them be maritime shipping or leasing companies, a rapid turnover of their assets is fundamental and will secure a continuous usage of the inland port.
- **Support for trade.** An inland port can also be a fundamental structure promoting the export sectors of a region, particularly for smaller businesses unable to achieve economies of scale on their own. Through lower costs and better accessibility, new market opportunities become possible as both imports and exports are cheaper.

CONCLUSION

The growing focus on inland ports is indicative of transport development strategies gradually shifting inland to address capacity and efficiency issues in light of global supply chains. The complexity of modern freight distribution, the increased focus on intermodal transport solutions and capacity issues appear to be the main drivers. While trucking tends to be sufficient in the initial phase of the development of inland freight distribution systems, at some level of activity, diminishing returns such as congestion, energy consumption and empty movements become strong incentives to consider the setting of inland terminals as the next step in regional freight planning. Also the massification of flows in networks, through a concentration of cargo on a limited set of ports of call and associated trunk lines to the hinterland, have created the right condition for nodes to appear along and at the end of these trunk lines.

Inland terminals have become an intermodal and freight distribution unit that comes into three major functional categories. They can be maritime barge terminals serviced from deep-sea ports, intermodal rail terminals linked to gateways and distribution centres linking supply chains. Inland ports are commonly incorporating terminals (rail, barge or in rarer cases both) with distribution centres in operational characteristics mainly associated with satellite terminals or load centres.

Regional issues, namely how inland ports interact with their regional markets, remain fundamental as they define the modal characteristics, the regulatory framework and the commercial opportunities of these ports. The prospects for inland terminals remain positive with large continental markets like North America and Europe relying on a network of satellite terminals and load centres as a fundamental structure to support hinterland freight movements. This entailed the emergence of a regionalization of distribution and with it extended forms of supply chain management in which inland terminals play an active role. As congestion increases, inland terminals will be even more important in maintaining efficient commodity chains. It can also be expected that commodities, such as grain, chemicals and wood products, will play a greater role within containerized trade with inland terminals, again underlining unique regional characteristics. This implies a set of repositioning strategies where inland terminals play a fundamental role either to improve the efficiency of this repositioning, by providing better cargo rotation opportunities, or by acting as an agent that can help promote containerized exports. Inland ports will take part in the ongoing intermodal integration between ports and their hinterland through long-distance rail and barge corridors. They are likely to be more important elements within supply chains, particularly through their role of buffer where containerized consignments can be cheaply stored, waiting to be forwarded to their final destinations.

Following previous stages in intermodal transport development, such as in port infrastructure, there is a potential of overinvestment, duplication and redundancy as many inland locations would like to claim a stake in global value chains. This appears to be the case in Western Europe where an abundance of inland terminals, particularly within the Rhine/Scheldt delta, is indicative of an over competitive environment and the waste of resources it implies. In North America, because of a different ownership and governance structure, the setting of an inland port, at least the intermodal terminal component, is mostly in the hands of rail operators. Each decision thus takes place with much more consideration being placed on market potential as well as the overall impact on their network structure. The decision of a rail company to build a new terminal or to expand existing facilities commonly marks the moment where regional stakeholders, from real estate developers to logistics service providers, readjust their strategies. In some instances, local governments will come with inland port strategies adjusting to existing commercial decisions in the hope to create multiplying effects.

In the light of the North American and European experiences, the question remains about how Asia-Pacific can develop its own inland port strategy and regionalism. The unique geographical characteristics of the region, particularly a high level of coastal development and its export-oriented economies, are likely to rely much on the satellite terminal concept and inland load centres in relative close proximity. For this context, the European example is more suitable. However, the setting of long-distance intermodal rail corridors within China and through Central Asia is prone to the inland load

centre system common in North America. Yet, there are no clear frameworks in the setting of inland terminals as the region and supply chains they are embedded in dictates much of their functional and operational realities. What is the likely next phase in the evolution of inland freight distribution and which role inland terminals will play?

REFERENCES

- Ballis, A., and A. Stathopoulos (2002). "Innovative transshipment technologies investigated for implementation in the seaports and barge terminals", *Transportation Research Record*, vol. 1782, pp. 40-48.
- Bologna, S. (2004). "Players in the rail transport market and liberalization", in ECMT (ed), *European Integration of Rail Freight Transport*, Round Table 125, ECMT-OECD, Paris, pp. 27-60
- Buck Consultants International (1996). *Seaports and Their Hinterland*, Nijmegen
- Cardebring, P.W. and C. Warnecke (1995). *Combi-terminal and Intermodal Freight Centre Development*, KFB-Swedish Transport and Communication Research Board, Stockholm.
- Charlier J. and G.Ridolfi (1994). "Intermodal transportation in Europe: of modes, corridors and nodes", *Maritime Policy and Management*, vol. 21, No. 3, pp. 237-250.
- Debrie, J. and E. Gouvernal (2006). "Intermodal rail in Western Europe: actors and services in a new regulatory environment", *Growth and Change*, vol. 37, No. 3, pp. 444-459.
- Economic Commission for Europe (1998). *UN/LOCODE—Code for Ports and other Locations, Recommendation 16*, Geneva.
- Economic Commission for Europe (2001). *Terminology on Combined Transport*, United Nations, New York and Geneva.
- Hesse, M. (2008). *The City as a Terminal: The Urban Context of Logistics and Freight Transport*, (Aldershot, Ashgate).
- Höltgen, D. (1995). *Terminals, Intermodal Logistics Centres and European Infrastructure Policy*, Ph.D. Thesis, European Centre for Infrastructure Studies.
- Jaržemskis, A. and A. V. Vasiliauskas (2007). "Research on dry port concept as intermodal node", *Transport*, vol. 22, No. 3, pp. 207-213.
- Iannone, F., S. Thore and E. Forte (2007). Inland container logistics and interports, goals and features of an ongoing applied research, 9th Scientific Meeting, Italian Society of Transport Economists, Naples.

- Konings, J. W., E. Kreuzberger and H. Priemus (2005). *Goederentransportknooppunten: typologie en dynamiek*, PIBVVS, (Delft, Delft University Press).
- Kreuzberger, E., (1997). *New-generation Terminal and Node Concepts in Relation to the Innovation of Bundling Concepts in Intermodal Freight Transport*, (Delft, Delft University Press).
- Kreuzberger, E., (2005). "Hub and spoking in a process of changing bundling concepts of intermodal rail networks: current developments in the light of intermodal efficiency", in: Witlox, F., W. Dullaert and B. Vernimmen (ed), *Proceedings of the BIVEC-GIBET Transport Research Day 2005*, Nautilus, Ghent, pp. 405-436.
- Kuipers, B. (1999). "Liège, Tongeren, Genk or the Maasvlakte: what's the difference? Spatial behavior of European Distribution Centres" In: R.H.J. Rodenburg & A.L. Kruse (eds), *Vervoerslogistieke Werkdagen 1999*. Delft: Connekt.
- Ng, A., and G. C. Gujar (2009). "The spatial characteristics of inland transport hubs: evidences from Southern India", *Journal of Transport Geography*, vol. 17, No. 5, pp. 346-356.
- Notteboom, T. (2000). *De invloed van ruimtelijke en logistieke ontwikkelingen in het voorland-achterlandcontinuüm op de positie en functie van zeehavens*, Ph.D. thesis, Antwerp:RUCA.
- Notteboom, T. (2001). "Spatial and functional integration of container port systems and hinterland networks in Europe", in: ECMT (ed.), *Land Access to Sea Ports*, ECMT-OECD, Paris, pp. 5-55.
- Notteboom, T., and R. Konings (2004). "Network dynamics in container transport by barge", *Belgeo*, vol. 5, No. 4, pp. 461-477.
- Notteboom, T. and J.-P. Rodrigue (2005). "Port regionalization: towards a new phase in port development", *Maritime Policy and Management*, vol. 32, No. 3, pp. 297-313.
- Notteboom, T. (2006). "Port regionalization in Antwerp", in: Notteboom, T. (ed.), *Ports are More than Piers*, De Lloyd: Antwerp, pp. 307-328.
- Notteboom, T. (2008). *The relationship between seaports and the intermodal hinterland in light of global supply chains: European challenges*, Discussion Paper No. 2008-10, OECD - International Transport Forum, Paris: OECD.
- Randolph, D. (2008). *Preparing for the Future Mexican Land Bridge to the United States*, North American Transport Competitiveness Research Council, Paper No 8.
- Rodrigue, J.-P. (2008). "The Thruport Concept and Transmodal Rail Freight Distribution in North America", *Journal of Transport Geography*, vol. 16, pp. 233-246.
- Rodrigue, J.-P. (2009). *The Geography of Transport Systems*, <http://people.hofstra.edu/geotrans/>

- Rodrigue, J.-P. and T. Notteboom (2009). "The terminalization of supply chains: reassessing port-hinterland logistical relationships", *Maritime Policy and Management*, vol. 36, No. 2, pp. 165-183.
- Rodrigue, J-P and A. Hatch (2009). *North American Intermodal Transportation: Infrastructure, Capital and Financing Issues*, The Equipment Leasing and Finance Foundation, Washington, DC.
- Roso, V. (2005), "The dry port concept—applications in Sweden", *Proceedings of Logistics Research Network*, Plymouth: International Logistics and Supply Chain Management.
- Roso, V., J. Woxenius and K. Lumsden (2009). "The dry port concept: connecting container seaports with the hinterland", *Journal of Transport Geography*, vol. 17, No. 5, pp. 338-345.
- Stahlbock, R. and S. Voss (2008). "Operations research at container terminals: a literature update", *OR Spectrum*, vol. 30, No. 1, pp. 1-52.
- UNCTAD (1982). "Multimodal Transport and Containerization", TD/B/C.4/238/supplement 1, Part Five: Ports and Container Depots.
- UNCTAD (1991). *Handbook on the Management and Operation of Dry Ports*, UNCTAD/RDP/LDC/7, Geneva.
- Walter, C.K. and R. F. Poist (2004). "North American inland port development: international vs domestic shipper preferences", *International Journal of Physical Distribution & Logistics Management*, vol. 34, No. 7, pp. 579-597.
- Wiegmans, B., E. Masurel and P. Nijkamp (1999). "Intermodal freight terminals: an analysis of the terminal market", *Transportation Planning and Technology*, vol. 23, pp. 105-128.
- Zurbach, V. (2005). *Summary Mission Rhine Rive*, Internal Memo, INRETS-SPLOT, Paris.

DRY PORTS: A COMPARATIVE STUDY OF THE UNITED KINGDOM AND NIGERIA

Paul Garnwa*, Anthony Beresford* and Stephen Pettit*

ABSTRACT

This paper reviews the development of dry ports in the United Kingdom of Great Britain and Northern Ireland and in Nigeria. In the United Kingdom, P&O developed a group of dry ports at strategic locations close to the main population and industrial centres. They were branded “containerbases” and became widely recognized as models for dry port development elsewhere. Inland Container Depot (ICD) operation in Nigeria started in 1979 and two ICDs have been successful. However, the legislative framework in the 1990s requiring containers to be customs-checked at the port gateway undermined the successful operation of ICDs. More recently, the legal conditions have been changed so that inland terminals can act as the sole point of departure or arrival for containerized consignments. Accordingly, the Government of Nigeria, through the Shippers Council and other relevant bodies, has launched a fresh programme to construct dry ports adjacent to the main inland cities in order to offer modern logistics services to match those available elsewhere.

Keywords: Dry ports, SWOT, United Kingdom, Nigeria

INTRODUCTION

Since the advent of specialization in shipping, especially containerization, the freight transport industry has gradually shifted from the traditional port-to-port concept towards a total system approach. This has stimulated the growth of multimodal transport, and dry ports have emerged as a means of making better use of inland infrastructure and hence improving the overall efficiency of international logistics. The containerized trade has penetrated further inland and volumes have risen substantially with the consequence that cargo traffic through seaports has created congestion in the vicinity of these ports. Dry ports have thus become an integral part of logistics by extending seaport functions inland.

There are three principal reasons for the establishment of dry ports or inland container depots around the world, namely:

* Transport and Shipping Research Group, Logistics and Operations Management Section, Cardiff Business School, Cardiff University, Aberconway Building, Colum Road, Cardiff, CF10 3EU, United Kingdom

- The constant need to improve the efficiency of inland transport
- The ever-growing congestion in the land areas around major ports (and concomitantly, the lack of available backup space for handling the increasing volume of container/cargo flows)
- The transformation of shipping from a port-to-port activity to an integral component of the broader logistics operations

This study highlights the role of dry ports in international trade and logistics with particular focus on the United Kingdom and Nigeria.

I. DEVELOPMENT OF ICDs IN THE UNITED KINGDOM AND NIGERIA

A. United Kingdom

The development of ICDs in the United Kingdom commenced during the early 1960s as a result of the shipping industry's increasing use of containers for general cargo shipments. Examples are the P&O-operated containerbase in Birmingham, which opened in December 1968, and others in Coatbridge, Glasgow, and Barking, London, shortly afterwards (Ingram, 1992).

In the United Kingdom, two major effects arose from the change to containerized shipping:

- Ports in the south-east of the country were more attractive to shipping lines because of their proximity to continental Europe
- The major producers and owners of cargo were often no longer located conveniently near the port at which their cargoes were handled

The exploitation of the intermodal characteristics of the container to overcome problems posed by the separation of ports from manufacturers was clearly one of the main reasons for the development of ICDs. Furthermore, the increase in number of ICDs was hastened by the introduction of roll-on roll-off shipping on cross-channel routes. Another reason was that in the mid-1960s British shipping companies decided to introduce container shipping to their Australian trade circuits. Expensive new shipping dictated the need for minimizing the time spent in port, and so a "one United Kingdom port of call" strategy was designed. Focus was to be on Tilbury, London. This did not mean that the northern industrial cities in the United Kingdom which traditionally had been served by ships calling at their nearest ports would lose out, because by using inland transport, containers could be loaded and discharged at inland centres. Thus, the need for inland depots was brought into focus by the introduction of container ships to Australian trade circuits. While the conversion of the Australian trade to

container shipping provided the stimulus necessary to introduce the containerbase network, many other trades were also catered to, and the containerbase business grew as the advantages of inland clearance depots near centres of production and consumption became apparent (MacDiarmid and Chambers, 1978).

The economics of ICD operations was a serious problem during the early 1960s in terms of double-handling, at the ports for purposes of customs intervention and inspection. These setbacks and delays were recognized by the authorities in the United Kingdom in 1966 when HM Customs laid down guidelines for the establishment of ICDs. Until 1966, almost all customs intervention work in the United Kingdom was carried out at ports but it was recognized that the container revolution required different means of intervention if the economics of the country's trade was not to be affected.

The new customs guidelines effectively meant that approved inland clearances depots were "ports without water". They would have their own permanent customs staff on site and export LCL¹ cargo would be inspected before being packed into containers. Import LCL cargo would be inspected after deconsolidation at the depot. Interventions on FCL² cargoes would be made at the depot, where disruption could be minimized. Security seals would be affixed to containers and inspected at both the depots and the ports to ensure that cargoes were not interfered with during the main leg of the journey. The movements of sealed containers, and depots themselves, were to be under customs control, in order to try to ensure that minimal loss to the treasury of customs dues took place. Effectively the sea border was "moved" to an approved ICDs and they became the points at which goods effectively entered or left the country (Ingram, 1992). The port health authorities were also able to exploit the opportunities offered by ICDs, concentrating activities relating to international trade at the ICDs rather than the ports.

The guidelines laid down by HM Customs for the establishment of ICDs had a significant effect on the establishment of the first facilities. The main restrictions were:

- (i) Depots should be located near trunk roads preferably with access to/from main railway lines;
- (ii) They should be available for use by any international operator using containers or vehicles;
- (iii) They should be set-up by broadly-based consortia;
- (iv) They should be based on a spirit of cooperation rather than competition between modes.

Restriction (i) was one that would be met by any reasonable operator, but (ii) and (iii) meant that single-company ownership ICDs were prohibited

¹ LCL = less than container load (multi-customer) boxes

² FCL = full container load (single customer) boxes

and some of the original plans of the shipping companies had to be severely modified. General guideline (iv) would take time to take root, as deep-seated rivalries between haulage operators and road-rail antagonism would work against the ICD principle in the early years. The involvement of nationalized industries meant that British Rail, the Transport Holding Company (later the NFC) the Port of London Authority, the Clyde Port Authority, the Mersey Docks and Harbour Company and the Manchester Ship Canal Company were all early shareholders in some ICDs (Ingram, 1992).

In the United Kingdom, ICDs were established by various consortia, usually as an extension to existing business operations. The largest group, consisting of six depots, was the containerbase companies, established by P&O, the major deep-sea shipping line (with other shareholders) as a distribution network for its "Through Transport System". Five of these depots were situated next to railway lines, so that they could be linked with the ports of Tilbury and Southampton by overnight trains. These ICDs were clearly transport nodes, as well as cargo clearance depots. Other ICDs, notably the London International Freight Terminal and the Manchester International Freight Terminal, were established by British Rail and grew out of the existing businesses of packing railway wagons for transport by train ferries. These depots continued to pack wagons, but also extended their activities into container packing and unpacking. Some ICDs were established by companies involved in warehousing, such as Greenford ICD (Butlers Warehousing) and Dagenham Storage Co. Ltd., while others were established by property companies with the intention of forming services around which other industries could cluster. An example of this type of depot is Milton ICD in Berkshire. Such depots generally had difficulty initially attracting business because they were not situated near large existing industrial centres. The final category of ICDs were established by Road Transport contractors who were involved in international trading and wanted to by-pass some of the congestion at ports (Lenham International Freight Terminal and Northampton ICD were typical of this type of depot).³ In the United Kingdom, privatization of the ports in the 1980s brought changes to the ownership and management structure of ICDs and, in the 1990s Roadways Container Logistics (RCL) was formed. A combination of takeover and rebranding led to the P&O-operated containerbases becoming part of the AP Moller Group, under the title Maersk Line but retaining the original brand identity of P&O. In December 2008, a further ownership change occurred when RCL was sold by the AP Moller Maersk group to the privately owned

³ It should be noted that, in countries such as the United Kingdom, where concentrations of industry are to be found in most regions and the population is evenly spread, it is appropriate for there to be a relatively large number of small/medium-sized ICDs serving the logistical needs of the country. In other States, e.g. Thailand, Egypt or Kenya, where the population is concentrated into a small number of dominant large cities, the least cost solution for freight distribution is a small number of large ICDs located on the edge of the cities. A full explanation of this is to be found in UNCTAD (1991).

Aegis Transport Ltd. The containerbases were thus taken on by ATL with no change to their operational brief (Anon, 2008). Containerbases play a dual role in providing ICD services for a wide range of shipping lines, container logistics companies and international road haulage operators which were used as regional transport control centres.

B. Nigeria

ICD operations in Nigeria started in 1979 when Elder Dempster lines, a leading member of the United Kingdom West Africa Liner Conference (UKWAL), joined with the Nigeria Insurance Corporation of Nigeria (NICON) to establish ICDs in Kano and Kaduna (northern Nigeria) under the management of a company called Inland Container Nigeria Ltd. (ICNL). The two ICDs were originally conceived to serve the hinterland and its landlocked neighbours (Niger and Chad), and were established as extensions to seaports to operate within the Nigerian Ports Authority guidelines, whereby cargo discharged at the seaports destined for the hinterland is immediately land freighted to the ICDs under customs bond. One of the reasons for the establishment of ICDs was to cater for hinterland shippers in the landlocked countries, particularly those in the northern part of the country, who had to clear their cargoes through customs at the seaports. This constituted a serious bottleneck to their businesses.

Some of the problems faced by northern shippers at the seaports were:

- Cumbersome customs clearance procedures
- Multiplicity of security agencies at seaports
- Additional cargo handling costs
- Excessive travelling and hotels bills
- High inland transport costs
- Persistent congestion at the seaports

A customs transfer document is vital to the operations and is usually approved by customs at the seaport so as to obtain shipping release of the container for transfer to depots in the hinterland.

The management and operational success of the two ICDs in Nigeria was cut short in 1996 when a new port policy, instigated by the Federal Government of Nigeria, required inspections to be carried out only at seaports. The successes and failures of this approach are outlined in the Comparative Analysis section below. In 2000, the Federal Ministry of Transport of Nigeria, acting on the recommendation of the Nigerian Shippers' Council, approved the implementation of a feasibility study for the establishment of a number of ICDs at designated locations across the country. The study was commissioned in early 2002 and, by 7 November

2002, the final report of the feasibility study, conducted by Hamburg Port Consult GMBH Germany in collaboration with Spring Fountain Management Consultants, Nigeria, was submitted to Government. In response to the report findings, the federal Government has embarked on the implementation of these ICDs in a phased manner under the supervision of the Federal Ministry of Transport. The ICD Implementation Committee has been established, with the Nigerian Shippers' Council as the implementing agency. The project is being executed on the build, own, operate and transfer (BOOT) model. The first phase has been completed and preferred concessionaires have been secured in six states: Bauchi, Ibadan, Jos, Isiala Ngwa, Kano and Maiduguri (Nigerian Shippers Council, 2008).

II. COMPARATIVE ANALYSIS OF ICDS IN THE UNITED KINGDOM AND NIGERIA

The locational and commercial relationships between an ICD and its gateway port(s) have a number of implications concerning ownerships, regulation, governance and fit within existing transport infrastructure. These can be summarized in table 1 and as follows:

Table 1. Comparative analysis of ICDs in the United Kingdom and Nigeria

ICD OPERATIONS	STRUCTURE		
	United Kingdom	NIGERIA	
		OLD	PROPOSED
ICD ownership structure	Private (100 per cent)	Private—ICNL/NICON	Private—BOOT model operators
Governing board/approving authority	HM Customs	Nigerian Ports Authority	Implementation Committee—ICD/NSC
Date of commencement	Mid-1960s	1979-1996 (closed)	2009—staged opening
Rail /railhead from port to ICD	Private (100 per cent)	Public NRC	Nigerian Railway Corp. (Public)
Road from port to ICD	Ministry of Transport	Fed. Government	Federal/state government
Inland waterways transport to ICDs	Yes (indirect via road)	No	No
Distance, port to ICD	below 350 km	200 km-1 500 km	200 km-2 500 km
Multimodal transport links from port to ICD	Many alternative routes	Few alternative routes	Limited alternative routes

Table 1. Continued

STRUCTURE			
ICD OPERATIONS	United Kingdom	NIGERIA	
		OLD	PROPOSED
Regional transport development plans/ transport policies	Closely connected to European Union transport policies	No connection to African Union (AU) or Transport Policies	Fits Nigeria's Transport Master Plan (MITI), New Partnership for Africa's Development (NEPAD) and AU charter
Guidelines for ICD operations	HM Customs	Nigerian Ports Authority	Implementation Committee—ICD/Nigerian Shippers' Council
Competition	High	Medium	Medium
Labour (ICD)	Highly skilled/Private	Low-skilled	Low-/medium-skilled
Security for ICDs	Infrared closed-circuit television (CCTV) and alarmed fencing	Police personnel	Police personnel
Computerization of Port/ICD	Highly connected	Low	Detail to be confirmed
Environmental standards	Adhere to European Union standards	No accreditation	Partial environmental control
Cargo flows/ direction from port to ICD	Hinterland (whole of the United Kingdom)	Northern regions (Kano and Kaduna)	Whole of Nigeria plus landlocked neighbours
Quality Assurance	ISO9002	-	-
Services network from port-ICD to final destination	Containerbases, roadway transport and 3PL providers	Rail/ICNL truck	NARTO/private
Seaport delays due to logistics weaknesses	Periodic	Very high	Privatization should reduce delays
Traffic congestion (seaport)	Low	Very high	High—privatization may reduce congestion

Note: Abbreviations: ICNL, Inland Container Nigeria Limited; NICON, Nigeria Insurance Corporation of Nigeria; NSC, Nigeria Shippers' Council; NARTO: Nigeria Association of Road Transport Owners; AU: African Union; BOOT: build, own operate, transfer.

Source: compiled by the authors

ICD ownership structure

In the United Kingdom, a substantial number of public sector ports were transferred to the private sector in 1983, allowing market competition to penetrate ICD operations. The ownership system for ports and ICDs, principally focused on private ownership, has played a major role in increasing the trade volume of the United Kingdom by increasing the efficiency of port operations. The modernization of port facilities, adequate training of personnel and quick ship turnaround time have contributed significantly to ICD development. Additionally, the industry is highly consolidated and much of the trade is concentrated in the largest ports; in 2003, the top 20 ports handled 85 per cent of all the United Kingdom traffic. Out of a total 555.7 million tons, the top 20 ports handled 470.7 million tons. Of the top 20 ports, 15 are privately owned (Baird and Valentine, 2007). In Nigeria, the private sector has recently been allowed to develop ICDs through the BOOT approach. With fewer competitive advantages than other countries and a system where ports serve as providers of cargo, ICDs are still going through the privatization process and presently only terminal operations are privatized in Nigeria.

Governing board/approving authority

In the United Kingdom, the final approvals authority is HM Customs, which issues guidelines to regulate, inspect and declare a place as a designated ICD. HM Customs has ultimate power regarding the enforcement/implementation of all international standards for inspection of ICD operations. This has made the ICD operators abide by the standards and provide adequate logistics arrangements for all operations, including the handling of dangerous or extremely high value cargoes. In Nigeria, for the first generation ICDs, the Nigerian Ports Authority was the approvals authority, but for the newly proposed ICDs, the Implementation Committee-ICD, with a customs representative, is the approving authority.

Railway/railhead

In the United Kingdom, the railway system is largely privatized and is linked with all the main deep-sea ports and hinterland areas. One of the key successes of ICDs in the United Kingdom is that the rail transport system is highly integrated with other modes allowing successful multimodal transport trade-off between cost, time and distance. This has helped to increase the flow of cargo from the deep-sea ports to ICDs. In the case of Nigeria, the coverage is less, some tracks are in poor condition and the load-bearing capability is limited on most routes. These present serious disadvantages to shippers and ICD operators as they attempt to achieve satisfactory cost/time trade-offs. Additionally, the railways in Nigeria are publicly owned and short of funds; key routes need to be upgraded to container carrying standard.

Road networks

The road network in the United Kingdom is comprehensive with many dual carriageway routes enabling road haulage to compete or cooperate with railways for the delivery of cargo. In the United Kingdom this is one of the key successes of ICDs because road haulage invariably performs the first or last leg of door-to-door multimodal transport operations. This is exemplified by the combined road-rail service of Roadways Container Logistics. In Nigeria much of the road network is in poor condition making it difficult to deliver goods on time.

Inland waterway transport to ICDs

In the United Kingdom inland waterways transport is limited, but in areas such as northwest England, east London and Humberside, road-waterway intermodal movements to/from ICDs are possible. In Nigeria, no ICD will be connected to inland waterways, which puts shippers at a potential disadvantage, but in the future, through dredging of the river Niger and Benue channels, sea-road waterway combinations, involving inland customs clearance, could be achieved. , The encouragement of coastal transport is very important in Nigeria, especially with the introduction of the Cabotage Act in 2003; coastal shipping connections to ICDs could be part of the new ICD development strategy in order to increase or facilitate the flow of cargoes.

Multimodal transport links

In the United Kingdom, multimodal transport operators (MTO) use many route alternatives in order to save cost or time for the movement of cargo to ICDs and to final destinations. The advantage of having many alternative routes in the United Kingdom is to have given shippers cost, time or other service opportunities. It has also given them the option to spread risk or to broker price by using several routes. In Nigeria, only a few route alternatives are available making it difficult for shippers to achieve successful trade-offs between cost and time. Increasing the number of alternative routes in the longer term, perhaps by incorporating inland waterways, would provide shippers with a wider range of options.

Guidelines for ICD operations

In the United Kingdom HM Customs issues guidelines to regulate and inspect ICDs. HM Customs has full enforcement/implementation power for all international standards regarding the operation of ICDs; this regulatory system has evolved to suit changing commercial needs and new trading environments and the system works well. In Nigeria, the first closed ICD was regulated by the Nigerian Ports Authority, but for newly proposed ICDs the Implementation Committee-ICD/NSC acts as the ultimate regulator.

Competition

There is a high level of competition in the United Kingdom partly because of competition between ICDs, and partly because of competition from service providers by passing ICDs, e.g. those using clearance facilities at the ports. In Nigeria, competition is extremely low because of the shortage of ICDs and poor infrastructural development such as road and railway connections. Competition in the United Kingdom is strong due to privatized ports and ICD operators being able to compete in terms of cargo clearance with speed, cost and technique. Modern handling equipment and quick ship turnaround times also influence cargo flow to specific ports or ICDs.

Labour

The deregulation of labour in the United Kingdom ports is another factor that has played a positive role in removing restrictive and archaic employment regulations and helped to create an environment which has allowed the introduction of a range of new and flexible employment practices. In Nigeria, deregulation was recently addressed in the ports industry, but lack of trained personnel in ICD operations is, and will be, a serious problem unless provisions are made to train personnel and provide professional advice to ICD operators.

Security for ICDs

Security measures in the United Kingdom involve highly sophisticated systems, including movement sensitive infrared beams, closed-circuit television (CCTV) surveillance and alarmed fencing. Vehicles and containers can also be X-rayed for contents validation. The provision of security measures in the United Kingdom is very expensive but such systems were installed for the protection of general cargoes, especially expensive sophisticated cargoes such as electronics, cigarettes and alcohol which can be the target of organized crime. In Nigeria, such devices were not present in the original ICDs, although provision for police stations and patrol guards is proposed for the newer ICDs.

Computerization of port—ICD links

ICDs in the United Kingdom are fully computerized with radio frequency identification (RFID) technology and on-line cargo tracking for efficiency of cargo flow from ports to ICDs. In Nigeria some such facilities did exist in the original ICDs, but provisions were made in the proposed new ICDs for the private operators to organize their links as required but with emphasis likely to be on transaction facilitation and on-line cargo tracking to build confidence and reduce wastage.

Environmental standards

The upholding of environmental standards is one vital area that is taken into account when developing port or ICD projects in the United Kingdom. Elements such as waste, noise, dust, habitat loss/degradation, air quality and negative perceptions of such developments by interested parties could stop an ICD project from proceeding. In Nigeria, public views are generally not debated regarding the establishment of an ICD.

Service networks from port to ICD

ICDs in the United Kingdom are served by well-organized transport companies, such as third-party logistics (3PL) providers, including Roadways Container Logistics and independent road haulage specialists. The service providers in the United Kingdom have created strong networks with RFID technology and real-time cargo tracking from/to ICDs and ports. The networks are mature and robust, but also flexible to suit customer requirements, and adaptable so that regulatory changes can be easily accommodated. In Nigeria, such organized logistics are lacking and large roadworthy fleets are very few.

Seaport-ICD interface

In the United Kingdom, cargo destined for ICDs is immediately transferred to rail for onward movement, while in Nigeria, the logistics are extremely slow, and delays or congestion are caused by customs bureaucracy, security procedures, inadequate cargo handling equipment and sluggish inland transport. These factors are less of a hindrance in the United Kingdom ports, partly because of privatization and partly because of the maturity of European trading protocols. The United Kingdom ports have modern handling equipment and provide effective and efficient services to meet the challenges of the global trading environment.

Congestion at seaports

The major ports in the United Kingdom operate within a competitive environment such that each port competes for cargo; avoiding congestion is thus incentivized by cost reduction which is positive in terms of flows of goods. In Nigeria, congestion is still a problem, although some port terminals have been privatized, enabling them to streamline systems and take pressure off of shippers. Port operators in the United Kingdom generally seek opportunities to expand or grow their business and the government tends to give support to development projects which are seen to be commercially viable and environmentally acceptable.

III. SWOT ANALYSES OF ICDS IN THE UNITED KINGDOM AND NIGERIA

A strengths, weaknesses, opportunities and threats (SWOT) analysis for United Kingdom and Nigerian ICDS highlights the contrasts in operating conditions between less developed and developed countries in general. A SWOT analysis for ICDS in the United Kingdom and Nigeria is presented in table 2 and table 3, respectively. An interpretation of the SWOT analyses for both countries is as follows:

Table 2. SWOT analysis for ICDS in the United Kingdom

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Privatization - No Government interference or externally imposed budget constraints • High traffic flow to hinterland industrial areas • Competition • Well-developed infrastructure • Comprehensive cargo handling equipment • Economic development • European Union transport policies • Multimodal transport routes • Trained and experienced personnel re ICD Operations • Can attract loan capital for financing terminal investment 	<ul style="list-style-type: none"> • High levels of competition suppressing freight rates and charges • Over-utilization of infrastructure, especially road • Over-reliance on road-transport • Traffic congestion in hinterland areas • Traffic regulations—night-time restrictions and congestion charges
OPPORTUNITIES	CHALLENGES
<ul style="list-style-type: none"> • High revenue to government from trade • Multimodal transport connections/trade-offs • Globalization of trade • Economic growth from International trade • Attraction of loan capital for financing ICD investment 	<ul style="list-style-type: none"> • Volatile or unsustainable freight rates • Control of imported products • Anti smuggling and anti terrorist security measures • Trade imbalance • Increase in freight rate charges • Pressure on terminals in urban areas to be converted to other uses • Environmental legislation • Re-routing of freight to avoid ICDS

Source: the authors

Table 3. SWOT Analysis for Nigerian ICDs

STRENGTHS	WEAKNESSES
<ul style="list-style-type: none"> • Substantial revenues from hinterland shippers' participation • Large volumes of cargo to hinterlands • Control cargoes destined for neighbouring countries, notably Chad, Sudan and Niger • Industrial development encouragement • Locking Nigeria into international trade flows 	<ul style="list-style-type: none"> • Level of Government involvement/interference in ports • Inadequate infrastructural development e.g. railways • Excessive pressure on road transport • Slow implementation of the new ICD project • Lack of an integrated transport system • Lack of trained/experienced personnel on ICD operations • Shortage of computerized cargo tracking systems e.g. RFID technology for road haulage vehicles
OPPORTUNITIES	CHALLENGES
<ul style="list-style-type: none"> • Increased revenue to Government from expanded trade • Multimodal transport connections and positive trade-offs • Consultation on freight rates • Diversified trade • Maritime developments, e.g. expanded shipping activities • Connections to landlocked countries, facilitating trade • Connection to African Union transport policies • Attraction of foreign investors 	<ul style="list-style-type: none"> • Commercialization putting pressure on freight charges • Increase in freight rate charges • Increased security measures to counter terrorist threats and arms smuggling • Excessive imports leading to cargo imbalance • High cost of inland transport • Loss of maritime land due to privatization sales • Port activities and environmental hazards

Source: the authors

A. Strengths

The privatization of the United Kingdom ports played a major role in increasing the efficiency of ports and improving their performance. Competition between ports means that shippers have a number of options for the shipment of their cargoes which can meet the logistics demands of cargo owners. Governmental non-interference has allowed ports to operate effectively in a competitive market. ICDs likewise offer great advantages in terms of customs clearance, cargo security and consolidation of consignments. Importantly, infrastructure such as equipment, road and rail links and commercial frameworks embed ICDs into the multi-modal transport system. This in turn has enabled shippers to make cost-time-service tradeoffs on fine margins.

One of the benefits of privatization has been that ports can attract loan capital for financing investment on a commercial basis. In the recent past, private ports in the United Kingdom have invested significantly in new port capacity, as their existing facilities have been operating close to or beyond designed limits due to trade growth, e.g. Southampton, Liverpool, Tilbury, Hull, Immingham, Forth and Teesport (Baird and Valentine, 2007). This has increased the level of traffic moving to ICDs. The United Kingdom has a rating standard for the training of personnel in all fields of transport operation, which is internationally recognized especially for the handling of dangerous goods. A safety and quality assessment (SQAS) certificate is required and personnel must be ADR trained. Additionally, ICD personnel undergo constant training and re-training to keep abreast of current international shipping activities.

From the Nigerian perspective, the economy benefits from the participation of hinterland shippers and neighbouring countries in the transport of Nigerian import and export cargoes. Shippers will no longer be required to travel to the seaports to take delivery of or ship goods to their overseas partners; these functions will be performed by the ICD operator at the ICD. ICDs, especially those which are to be located near the borders of northern Nigerian states, will be of strategic transit importance to landlocked countries such as Niger, Burkina Faso and Chad, thereby increasing cargo traffic and economic development to Nigeria.

B. Weaknesses

In the United Kingdom, private companies have invested to make a profit through increases in freight charges which are consulted on, and negotiated by, the service providers and users. Although the final result is that such charges are passed on to the final consumer, due to the large number of ports and intense competition freight charges are not a serious issue because shippers have room to negotiate and can go for alternative ports. There is no particular issue with a lack of infrastructure, rather over-utilization of road transport occurs because it is the fastest, and the finishing leg, of door to door multimodal transport. This adds a cost burden to government in terms of repairs and maintenance.

In Nigeria however there is a lack of infrastructure development. An effective, integrated transport system is the bedrock of ICD operations and one of the weaknesses in Nigeria is the condition of road and rail transport infrastructure which needs to be seriously addressed before the final development of the new ICD project. The rivers Niger and Benue, which link Niger and Chad, could serve as additional multimodal transport connections to neighbouring countries. Modern road haulage operations often use radio frequency identification systems to track cargo, which allows for real-time tracking of cargo on the Internet, thereby building confidence for shippers during shipment. Such technology is largely unavailable to road haulage

transport operator vehicles in Nigeria. Nigeria also lacks sufficient trained and experienced personnel for ICD operations, a vital element for the effective operation and delivery of ICD services.

C. Opportunities

ICDs have, in part, facilitated the development of global trade links for the United Kingdom, especially with the opening up of the Far East and developing countries in other areas. Access to a wide range of cheap manufactured goods has become possible through the linking of suppliers, the customer and the seaports. ICDs have allowed the rationalization of cargo movements between seaports, the ultimate consignors and consignees. The further use of ICD by manufacturing industries in meeting “just in time” requirement and global sourcing has increased opportunities for international trade and economic development in general.

In Nigeria, ICDs are regarded important for industrial development, enhancing the export of finished goods, solid minerals, agricultural produce or raw materials due to proximity of ICDs to the source of production. This gives exporters the option of direct routing via the appropriate seaport, with maritime customs clearance, or utilizing the ICD facility where responsibility for the cargo is transferred to the MTO locally. These options can indirectly encourage trade and contribute to regional development. The availability of an ICD with road-rail intermodal capability also gives shippers a modal choice for exports and imports. This choice can be made on customer preference or criteria such as volume. ICDs can also provide greater control over hinterland trade and neighbouring countries shippers. Opportunities exist in Nigeria through an ICD system to control cargo flows from hinterland and landlocked countries thereby increasing trade relations, revenue and economic development. Finally, ICDs will create opportunities for foreign investors to participate in both seaport and ICD development and also industrial development around the ICD facilities.

D. Threats

Following privatization much of the pre-privatization port land bank has been sold for development. The sale of such land may create possible problems in the future, affecting the ability of the government to expand ports operations. Environmental protection is a major consideration for United Kingdom ports and, as they are generally located on the coast or on river-banks, a range of environmental problems exist (including discharge of cargo, cargo handling and storage, port maintenance, development, creeping industrialization) and the development of inland transport infrastructure to ICDs are major problems. There are many European Union policies and regulations in place to protect environmentally sensitive areas, for example article 19 of Council Regulation 797/85, European Commission Council directive 92/43/EEC, Nature 2000 Network of EC Commission, etc.

(Goulielmos, 2000). Such regulations create increased costs for ICD operators.

Private companies are economically strong and have the power to increase freight rates and other charges to increase profits. Although the Nigerian Shippers' Council has some power to negotiate such charges, they are always likely to be a threat to shippers. Since ports and ICDs are gateways for import and export cargoes a security risk exists and adequate security measures need to be in place according to international standard of ISPS code. Finally, as with the United Kingdom, there are concerns about the environmental impact of ICD developments. The construction of any major infrastructure project like a port or ICD has to undergo public investigation, meet international environmental standards, and undergo a full environmental impact assessment before government approval is given, in order to avoid future environmental hazards.

CONCLUSION

The comparative analysis between Nigeria and the United Kingdom reveals that ICDs in the United Kingdom are effective in encouraging the integration of port, road and rail freight operations. ICDs are predominantly private in terms of provision and funding of facilities, with government participation limited to the unfettered role of HM Customs in ensuring cargo security and trade legitimacy. This central role in cargo inspection at all ICDs determines the nature of security measures and operational procedures on site. This approach has worked well and has formed a model for ICD development globally. Inland waterways have not played a major role in encouraging ICD development in the United Kingdom, but there is the possibility that they could in Nigeria. ICD development in Nigeria has been hindered by the continued public ownership, especially of ports and railways, and the limited level of infrastructure development.

In Nigeria, however, long-term public ownership of the ports, railways and other transport facilities, coupled with a shortage of funds for infrastructure improvement, has restricted trade growth through the ports and slowed the full implementation of an ICD network with facilities planned at strategic locations, especially where significant export volumes exist, or in some cases close to large internal markets. The current ICD development programme in Nigeria takes account of earlier experiences and developments within multimodal transport generally.

REFERENCES

- Anon (2008). "Maersk sells Roadways". *World Cargo News - Inland / Intermodal News*, December 2008, p.16.
- Baird, A. J and V. F Valentine (2007). "Port Privatization in the United Kingdom" in: Brooks M.R and Cullinane K. ed. *Devolution, Port Governance and Port Performance Research in Transportation Economics*, vol. 17, pp. 55-76, Elsevier, the United Kingdom.
- Goulielmos, A. M. (2000). *European Policy on Port Environment Protection*, vol.2, University of Piraeus, Greece.
- Ingram, R. A. H. (1992). *The Development of Inland Clearance Depots, 1952-1992*-International Cargo Handling Coordination Association (ICHCA)-40th Anniversary Review. pp 85-87.
- Macdiarmid, K. J. and J. D. C. Chambers (1978). *Inland Ports-The UK Containerbase System Containers-Their Handling and Transport*, National Ports Council .pp 295-(15).
- Nigerian Shippers' Council (2008). <http://www.shipperscouncil.com/nsc/portal/services/support.html>.
- UNCTAD (1991). *Handbook on the Management and Operation of Dry Ports*, Geneva, RDP/LDC/7, pp. 16-18, 59-61.

INNOVATIVE IDEAS AND DESIGN OF AN INTEGRATED DRY PORT AND SEAPORT SYSTEM

Andrea Rosa* and Riccardo Roscelli*

ABSTRACT

The paper discusses an integrated seaport and dry port system for the expansion of the Genoa Voltri container port in Italy. The basic idea is to relocate the land-side port operations to north of the mountains close to the seaport, so as to obviate the lack of space in the seaport and the congestion of the transport connections close to it. The proposal entails both organizational and technological changes. The study also examines the viability of the project idea and the feasibility of a project financing operation to implement it.

Keywords: Integrated system, seaport, dry port

INTRODUCTION

With the constant and very remarkable growth of container traffic experienced so far, and foreseen for the future—although perhaps at a different rate or in different times given the current global economic situation—several ports are getting equipped to accommodate more maritime traffic, ever larger containerships, and therefore larger inland container traffic. Such developments require, among other elements, space for the terminals and efficient inland transport connections with spare capacity. It is not always possible to find available space for development within the port area. This is the case of the port of Genoa (Italy) which, as described in this paper, is enclosed by the city of Genoa and by the mountains that line the coast. The solution for its development, as well as for other ports that have the same space constraints, is to relocate some of the port operations by providing extended gates inland, thus having inland freight terminals where container can be left or picked up as if at the seaport. This kind of development is attracting much attention from researchers (see, for example, the works of Leveque and Roso, 2002 and Roso, Woxenius and Lumsden, 2009) and finding applications in several places in the world (see the examples in the papers just referred to, and -as a further instance- the work being carried out

* SiTI - Higher Institute on Territorial Systems for Innovation Via P.C. Boggio 61, 10138, Torino, Italy.

within the Dryport Interreg project: www.dryport.org). Each application has its own particular features to deal with the distinctive characteristics of the port and territory served. Expanding the port and relocating some of its operations to a dry port also allows for the rationalization of a part of the transport flows in and out of the seaports and an improvement in its connections to the inland transport networks.

This paper outlines some of the main points related to the development of a dry port for the container terminal at Voltri, Genoa, relating some current results along with an outline of the work remaining to be done. The work referred to in this paper was started in 2005 by the Higher Institute on Territorial Systems for Innovation (SiTI), with which both authors of this paper are affiliated, and a group of maritime operators based in Genoa. As recalled by Roscelli (2007) when describing the origin of the study, the idea of directly connecting the Voltri port with inland terminals via a tunnel through the mountains at the back of the port had been put forward in the 1960s by *Istituto Ligure di Ricerca Economica e Sociale*/Ligurian Research Institute for Economic and Social Research (ILRES) when the Voltri terminal had yet to be built. However, at the time, that insight was not followed by operational studies.

The paper aims to give a general idea of the project, as the work carried out would be too broad to be related in a single paper, while also touching upon some of the technical issues and some of the options explored to study them.

I. THE CONTAINER PORT OF GENOA AND THE MOTIVATION FOR THE PROJECT

The port of Genoa is located in the north-west of Italy and is the main container gateway port in Italy. It has several container terminals of different dimension, the largest of which is the Voltri one, located at some distance west of the most urban part of the seaport where the other container terminals are. The Genoa port handled some 1.8 million TEUs in 2007, about 1 million of which in the Voltri terminal. The whole port is enclosed in the urban area of the city of Genoa (approximately 611,000 inhabitants) and both are encircled by the Apennine Mountains which line the coast and limit available space for developments. Road and motorway connections that serve both the port and the city are congested much of the time and the rail network of Genoa, used by some 17 per cent only of containerized goods in 2006, has limited spare capacity.

The immediate hinterland of the port of Genoa, and currently also its main market area, is the Po plain of northern Italy, just north and north-east of the Apennines Mountains that surround the port and the city. Over 24 million people live in the regions of the Po plain, which includes the city of Milan, and almost 50 per cent of the Italian gross domestic product (GDP) relates to them (ISTAT, 2007). Such hinterland is currently contested between Genoa and the Northern European ports: the latter ones are successfully connected to the freight centres of northern Italy by many rail shuttles per week.

Existing plans for Genoa aim at reaching a total container throughput of up to 3.2 million TEUs a year. Yet, lack of space to expand the port along with the lack of spare capacity on the transport connections to the hinterland as well as the current successful penetration from the north into markets very close to Genoa, limit the chances of a further effective expansion, possibly confining the Genoa container port to a minor role in the area.

However, Genoa enjoys an attractive geographical position, both in terms of potential hinterland and of maritime routes. Many of the high-income areas of Italy and South and Central Europe are closer to Genoa than they are to the Northern Range ports (and the Alpine crossings are being further developed). Besides, the maritime journey to Genoa from the Far East via the Suez Canal is approximately four to five days shorter than the journey to the Northern Range ports. Moreover, the Genoa Voltri port may allow, with some dredging, water depths of up to 20 m (65 ft).

The project idea outlined in this paper aims at reaping the potential of such positive features by implementing infrastructural and organizational changes, so as to make the Voltri container terminal, once expanded with a dry port, able to deal with a throughput of up to 10 million TEUs a year.

What the project idea envisages is a port providing a real option also for mega-containerships, thus becoming a true reference point for containerized freight to and from northern Italy, and a Southern European container gateway. In such a scenario, Genoa would be able to capture part of the foreseen general growth in container traffic, the part for which it is geographically competitive, which would otherwise be adsorbed mostly by Belgian, Dutch and German ports therefore loading further, and possibly straining, the railways and motorways crossing Europe in the north-to-south direction. This scenario would entail a sort of competition/cooperation among Mediterranean and Northern Range ports resulting in a rational use of cross European transport infrastructure, particularly of some of the main corridors being upgraded or developed, such as the Genoa-Rotterdam one.

II. THE SEAPORT/DRY PORT CONCEPT AND ITS APPLICATION TO GENOA VOLTRI

The key idea of the redevelopment of the Voltri container terminal is the full implementation of the dry port concept. Only port operations that need to be on the quays remain there (loading and discharging containers onto/from ships), the others are moved to a dry port located where space for the required facilities is available and where such facilities can be efficiently linked to the transport networks, especially the rail network. The dry port becomes the actual land access to the container port, also in terms of customs. In the case of Genoa the location of the dry port would be in the plains north of the Apennine Mountains thus avoiding linking the dry port to the rail and road network of the Genoa area and obviating the space limits due to the urban and mountainous environment along the coast. The dry port for the Voltri terminal could be placed at a distance from the seaport of about 30-40 km, although at present an actual possible location, or set of locations to choose from, has yet to be characterized.

The concept of the transformation being put forward is shown in figure 1. While the working of the present seaport could be sketched as in the top part of the picture, the future dry port plus seaport system would be as shown in the bottom part of figure 1.

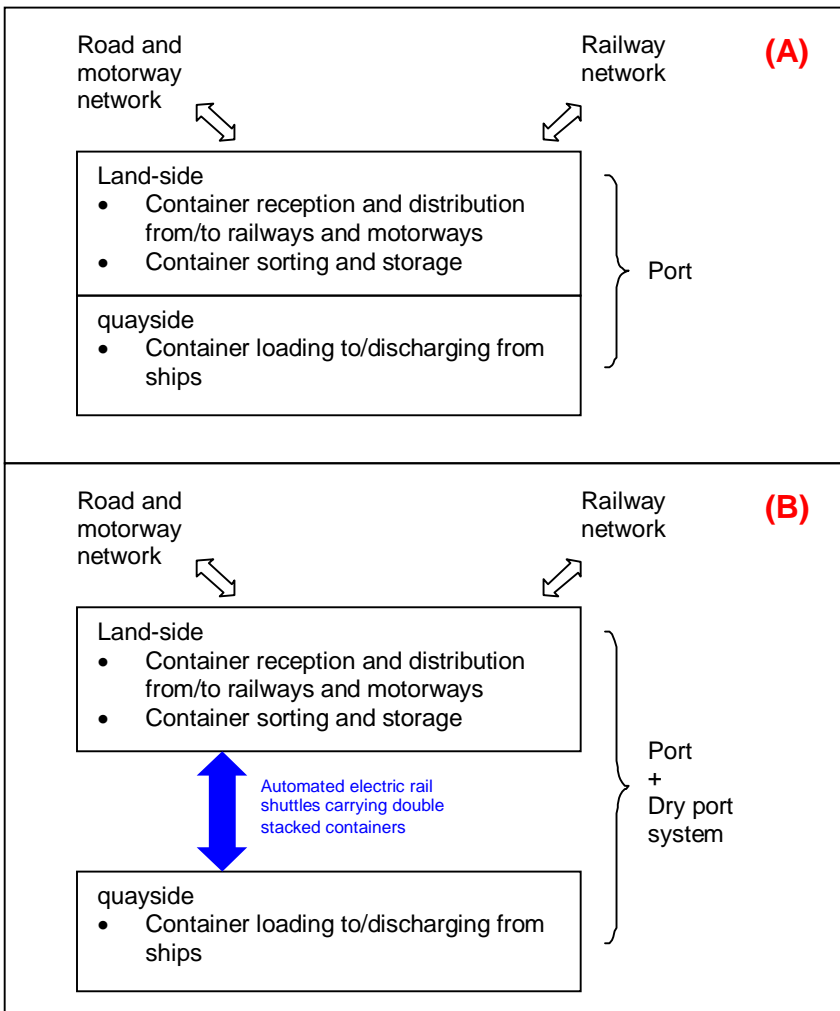
The connection between seaport and dry port is a crucial element and its role is to make the two sections of the port work as a single system, as if they were close to each other. In the Genoa Voltri case the connection would be provided by automated electric rail shuttles taking the containers directly from the foot of the ship to shore cranes to the yards in the dry port, or the other way. The shuttles are not intended for general railway circulation but only for use between the seaport and the dry port and would run on a dedicated line, part of which in a tunnel through the Apennines.

III. FROM IDEA TO IMPLEMENTATION: THE INITIAL STEPS

The work towards the development of the seaport/dry port system idea for the port of Genoa is now at the end of its second phase. The first part of the work ran from early 2005 to mid-2006 and, after a series of presentations to stakeholders, the results have been reported in a book edited by Lami (2007). The aim of that part of the work was to delineate the idea (Roscelli et al., 2007) and start investigating some of the issues that would determine its viability. Among the subjects included in that discussion and investigated were the redesign of the Voltri terminal layout (Belforte and Musso, 2007), elements towards the design of the container loading/unloading system directly between ships and shuttles, the rail shuttles and the layout for their tracks in the port (Belforte et al., 2007), as

well as the geology of the area that would be crossed by the tunnel for the shuttles (Barla and Amici, 2007) and the methodology to carry out an environmental evaluation of such a large and complex system (Bottero et al., 2007). The initial study also included a discussion of the Italian port system (Musso, 2007) and a first investigation of the financial feasibility of the project (Lami, 2007): from the very beginning, the intention has been to put forward an infrastructure and a system which would pay for itself and could be developed within a project financing operation.

Figure 1. The port system (A) and the seaport plus dry port system (B)



Source: SiTI and collaborators (2009).

While only delineating some of the elements of the proposed port system, the results of the first work stage have allowed the working group to take the project into the realm of public debate and to present the idea to different levels of government and to the press.

It should be mentioned that the groups that have worked on the development of the idea, both in the first and second stages of the study, have been made up of professionals and researchers from several disciplines, as well as maritime transport operators.

The second stage of work, which started in mid-2007 and was being finalized as of mid-2009, involves the further development of many of the points already considered as well as work on several new points concerning the general viability of the project. The results of this latter stage of work are being collated, as this paper is being written in SiTI et al. (2009), a detailed internal report which describes the points outlined in the remainder of this paper and explores further ones.

It should be remarked that, although the results obtained during the second stage of work add a further set of building blocks towards the feasibility assessment of the Voltri seaport/dry port system idea, further work would be required to complete a comprehensive feasibility study. This is not simply a matter of resources and time to take the study forward. More importantly, it is a matter of proper and timely involvement of the public administration and, in general, of the stakeholders at local, regional and national level, in the actual development of the idea. The promoters of the Voltri transformation study have so far been private: for instance the second stage of work has been financed mainly by SiTI (the research institute leading and coordinating the project), with the contribution of several maritime transport operators based in Genoa. However, the social and economical effects of the project are so wide that the public decision makers need be involved to steer the project as soon as it goes beyond an initial study. Their involvement will also be warranted during the operative stage of the new port system, when infrastructure and services will need fair regulation and control. Also the public acceptance of the project requires the involvement of public decision makers and stakeholders in the steering and development of the idea.

In fact, the dissemination of the results of the first stage of the project has attracted the attention of the local administrations that encouraged its development in an agreement signed at the beginning of 2008 between the Liguria Region, where the port is, and the adjacent Piedmont Region, where the dry port will be. More recently, at the end of October 2008, a further document signed by the Liguria and Piedmont regions, and by the neighbouring Lombardy Region, fostered the establishment of a promotion agency for the project. The role of the promotion agency should be to take

the idea discussed thus far and refine it so as to reach the preliminary design stage required to start a project financing operation.

IV. THE ENVISAGED SEAPORT/DRY PORT SYSTEM

The proposed redevelopment of Voltri into a seaport plus dry port system is innovative in several ways: for instance, it involves a step change in the container throughput of Genoa, in the role of the port and of its hinterland, in the opportunities for the dry port area; it also involves the development of methods and means to transfer efficiently containers directly between ships and rail shuttles, it will require a rail shuttle system able to deal efficiently and fairly with a very large number of containers per day as well as a new organization of port operations.

A. The seaport and its operation

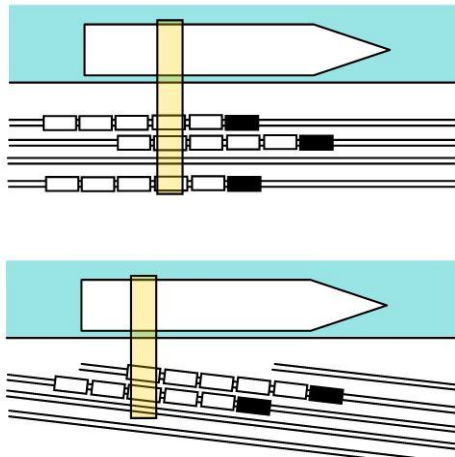
As mentioned earlier, central to the redevelopment is the idea of keeping on the quays only the port operations that need to be there (loading and discharging containers onto/from ships), while the remaining operations (including storage, sorting, reception, and distribution via rail and road links) are relocated inland in the dry port. The latter becomes the actual land access to the container port, even in terms of customs. Therefore, the dry port being planned fits into the dry port framework developed by Leveque and Roso (2002) whereby “a dry port is an inland intermodal terminal directly connected to seaport(s) with high capacity transport means, where customers can leave/pick up their standardized units as if directly to a seaport”. However, an important element that characterizes the dry port considered in this work is that it is intended as an integral part of the port rather than as an intermodal freight centre linked to the port but independent from it.

Much of the work both in the first and second stage of the study has been devoted to the development of the layout of the seaport and of the shuttle tracks within it, and to the study of ways to transfer as directly as possible the containers between ships and rail shuttles. All those issues are strongly connected and condition one another.

According to the initial proposal (Musso and Belforte, 2007) the rail shuttles would automatically move along their tracks on the quays so as to place a wagon with an available container slot under the trolley of the relevant STS crane, which was to transfer the containers directly from the ship to the shuttles in the order they were discharged. Once fully loaded, each shuttle would go to the dry port where the containers would be sorted. When containers were to be loaded onto the vessels, they would be ordered on the shuttles so as to reach the foot of the STS cranes according to the ships' loading plan. The layout of the shuttle tracks on the quays is very

important to make all of the above possible, both the shuttle movements alongside a ship and the traffic of shuttles in and out of the seaport. The possibility of having tracks parallel to the quays or, alternatively, approaching the quay at small angle have been studied (see the sketches in figure 2). To ensure free movements of the shuttles under the STS cranes, the layout entailing loading/unloading tracks approaching the quay at a small angle and main line tracks parallel to the quays (for shuttles moving in and out of the seaport) was chosen (Musso and Belforte, 2007).

Figure 2. Illustration of container movement between vessels and shuttles



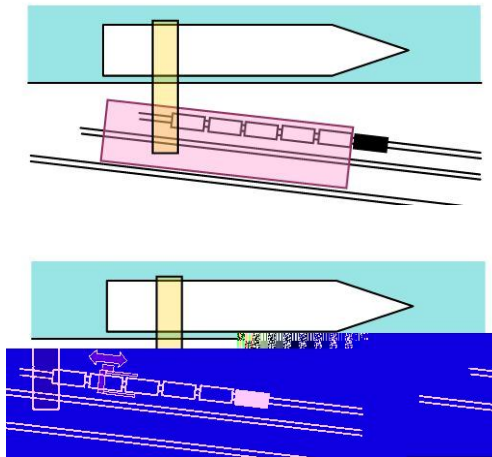
Source: SiTI and collaborators (2009).

Note: Sketches showing the arrangements initially examined to transfer containers directly between vessels and shuttles. The band across vessel and tracks exemplifies the action range of a STS crane. Main line tracks are not shown.

The general idea of port shuttle loading/unloading system described above has been re-discussed in the current part of the study. The plan to have shuttles leaving the seaport and moving to the dry port as soon as they are loaded, carrying containers yet to be sorted, as well as the idea of having shuttles arriving into the seaport with containers prepared according to the loading plan of the container vessels have been kept unchanged since they are part of the leading idea of relocating most “dry” operations to the dry port. However, the loading/unloading system for the shuttles in the seaport has been redesigned so as to have stationary rail shuttles at the foot of the STS cranes and containers taken between cranes and shuttles by either small automated gantry cranes—each one spanning two tracks and a buffer space—or, alternatively, automated straddle carriers (see the sketches in figure 3). The two options are currently compared with each other. Moving the rail shuttles at the foot of the STS cranes to facilitate loading/unloading operations has been shelved due to energy efficiency reasons (with the latest

concept, a single container is moved each time rather than the whole shuttle) as well as for safety and simplicity of operations (obtained especially with automated gantry cranes). Moreover, introducing a further transfer step means having some flexibility and being able to allow for buffer space and operations e.g. by providing buffer space along the tracks where containers being shifted, reloaded, or deserving immediate attention can be placed temporarily.

Figure 3. Illustration of container movement between vessels and shuttles



Source: SiTI and collaborators (2009).

Note: Sketches showing the arrangements examined to transfer containers between vessels and shuttles in the current stage of the study. The band across vessel and tracks exemplifies the action range of a STS crane. On the left, the arrangement entailing a gantry crane across two tracks and a buffer lane (the rectangle over the tracks represents the working area of the gantry crane). On the right, the arrangement with automated straddle carriers loading/unloading the shuttle. Main line tracks are not shown.

Although the organization of container transfers and shuttle operations on the quays has been changed, the idea of having loading/unloading shuttle tracks approaching the quay at an angle—set at 7° with respect to the quay to refer to commercial railway track equipment—has been retained since it allows relative independence of movements among shuttles. Moreover, when automated straddle carriers are assumed to move over the shuttles to load/unload them, that track layout limits track crossings required to straddle carries.

The loading/unloading tracks located on the quays are then connected to the shuttle main lines which lead to a yard within the seaport where shuttles can queue, overtake one another and be stored (e.g. when ready for use) or kept aside (e.g. for maintenance), and manual operations can be carried out in a cordoned area (for instance, the connection and

disconnection of reefers from electric power). The main line connections within the seaport, at present envisaged with two tracks per direction, include also buffer spaces and further allow for shuttle overtaking.

A simulation analysis is planned for the continuation of the study which will clarify the functionality and the efficiency of the track layout being put forward. The simulation will investigate the effects of the intense shuttle traffic foreseen within the seaport system, support the development of possible amendments to the layout and validate the final layout proposal.

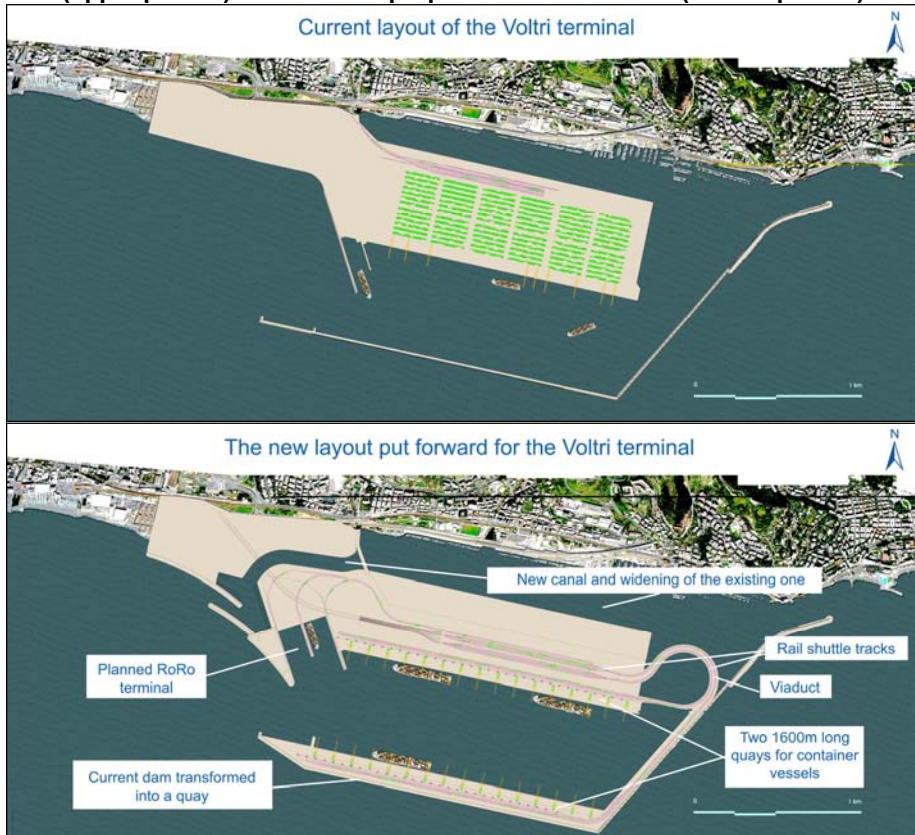
B. The rail shuttles

The possible design for the shuttles has also been reconsidered during the advancement of the study in connection with the operations they should carry out. It is expected that a uniform set of shuttles will run within the system. They will be totally automated block trains, travelling at relatively low speed (30-40 km/h) and consisting of a locomotive and five flat wagons, all derived from standard railway rolling stock with limited changes. Each wagon will carry containers on two tiers (i.e. doubly stacked) on an 80-ft serviceable platform. Thus, the maximum payload for each wagon will be 8 TEUs, resulting in a maximum payload of 40 TEUs per shuttle. The actual payload for a particular mission of a shuttle will be the result of the size and weight of the containers carried. For instance, the shuttles clearly allow for 45-ft or 53-ft containers, but in those cases their full payload would not be exploited. The preliminary dimensioning of the shuttles has considered typical weights of containers so that weight should not be a limiting factor on the actual payload.

C. The new layout and the transformation of the seaport

Figure 4 shows the current layout of the Voltri container port and the new layout being put forward. The latter entails the widening and redevelopment of the current dam into a quay, its connection to the existing section of the terminal with a viaduct and a transformation of the equipment of the current terminal. In the final configuration the port will have two 1,600-m long quays equipped for mega containerships. The work carried out has also involved nautical simulations with an experienced port pilot simulating manoeuvring and berthing very large containerships such as one 400 m in length (comparable, for dimensions, to the Emma Maersk).

Figure 4. Artist's impressions of the layout of the terminal at Voltri as it is (upper picture) and after the proposed transformation (bottom picture)



Source: SiTI and collaborators (2009).

The two quays are designed to work independently in terms of tracks: the shuttle yard shown in figure 4 is actually divided into two identical yards, one for each quay. The main line tracks departing from the yard in the terminal reach the dry port via a tunnel which could begin directly from the seaport, avoiding the need to build a viaduct across the urban area, the motorway and the railway along the coast.

Some of the transformations have been conceived during preliminary discussions of the idea with the urban planners of the city of Genoa. In particular, the idea of widening the canal between the coast and the terminal as well as linking it to the small port planned on the west side of the terminal (see again figure 4) have been put forward in order to obtain a general improvement of the urban environment around the port area. Similarly, the suggestion to link the current terminal to the dam redeveloped into a quay by using a viaduct rather than filling the space comes from the intention of

leaving the area open for the circulation of the water. First investigations on the coastal environment and the circulation of the water within the current and the redeveloped terminal have been carried out while the layout was being drawn.

While outlining and investigating the technical aspects of the Voltri seaport/dry port system once operational, care has also been taken to envisage a viable set of steps for the transformation. For instance, civil engineering work stages have been outlined so as to keep the terminal in operation while it is enlarged. The tunnel out of the seaport may be excavated in stages working from the northern part of the current terminal. The reusable material resulting from the excavation of the tunnel should be transported, at least in part, through the tunnel itself and used in the civil engineering works for the construction of the new quay. Thus, the widening and transformation of the dam to build the southern quay will take place along with the excavation of the tunnel. The construction of the dry port, at least of a first part of it, and of its connection to the rail and road networks, should be carried out at the same time. Once the Southern quay along with a first set of shuttle tracks, including a yard in the seaport, is operational and connected to the equally operational dry port, maritime transport operations would move to the new quay and system and the transformation of the existing one (the northern terminal) would start, again without hindering container traffic in the open part of the new terminal.

D. The tunnel between the seaport and the dry port

Early study of the geology of the mountains to be crossed by the tunnel between the seaport and the dry port have led to assume that it should be possible to use tunnel boring machines (TBMs) to excavate much of it (Barla and Amici, 2007). The final internal diameter of a tunnel for a double track line will be 11 m, due to the loading gauge of the shuttles carrying doubly stacked containers. The underground link is for the exclusive use of the automated shuttle so it is assumed that a double track line can be accommodated in a single tunnel. Actual profile of the tunnel and timing of the excavation will depend on how many excavation faces will be employed.

E. The dry port

When the shuttles reach the dry port, travelling along a dedicated line, they enter yards similar to those provided in the seaport, built for the same purpose (queuing, overtaking and storing of shuttles, performing manual operations) and then proceed to the actual dry port.

Several layouts have been studied, allowing for separate spaces for each terminal operator. All of the layouts explored share similar features such as:

- facilities for unloading and loading the port shuttles to/from container storage yards
- rail yards able to accommodate container block trains assumed, in the first instance, to be 750 m long
- truck loading/unloading area along with customs facilities and services for terminal operators

The possibility of adopting a structured automated container transfer system for the dry port, with automated gantry cranes over the tracks, the truck loading/unloading areas and the yards, is compared in the study with a less structured solution involving automated gantry cranes over the container yards and the railway yards, and straddle carriers to exchange containers among yards, shuttles, and trucks. Thus the two options explored for the dry port are similar to those put forward for the seaport.

Current estimates for the space required by the dry port are of the order of 500-600 hectares, compared to an area of 90 hectares in the seaport. It should be noted that the dry port is intended as a transport facility for container storage, sorting, reception, distribution via rail and road links and does not accommodate value added services. Those are expected to locate nearby, as are production and service industries.

One of the key points of the project is that the dry port is both an extension of the seaport and the land access to it. Containers are delivered or picked up from it as if from a seaport, which hosts customs and similar operations. A similar arrangement, initially as a test trial, is already part of daily activities at Voltri: since November 2008, some of the containers discharged at Genoa Voltri have been taken by conventional trains to the freight centre of Rivalta Scrivia, about 80 km from Genoa, where they clear customs. What is particularly relevant for that train service for the project discussed in this paper is the admission of the inland freight centre as a port of discharge for customs purposes, thus making it effectively a dry port.

The study being finalized involves also non-engineering issues such as an early investigation of the territorial and socio-economic effects of the project and of the reorganization and possible relocation of service and production industries that the project may be expected to bring about.

F. Environmental issues

The first stage of the study included early work on environmental issues with Bottero et al. (2007) looking at the relevant evaluation, regulation and planning frameworks. More recent work includes a preliminary sustainability assessment which has looked at different issues albeit with the level of detail allowed by the early stage of the idea development. Particular attentions have received the environmental issues related to the development of the port, the coastal environment, the water movements and sediments

due to different port layouts as well as the treatment of port refuses. Other issues have been treated, so far, with broader details performing an analysis of the general areas where the dry port might be located and of the possible corridor for the shuttle link.

G. Financing design and construction

As mentioned above, the project idea of the Voltri port extension is taken forward on the principle that it could pay for itself and as such be put forward for project financing. Early estimates indicate a total cost of around 3.7 billion euros, over a billion of which is for cranes and automated shuttles. On the basis of the same early estimates, it has been evaluated that the project could reach the break-even point after 16-17 years from its inception.

CONCLUSION

This paper reviews the progress of an idea to develop the Voltri container terminal, located within the port of Genoa, and expanding it with a dry port so as to make it able to accommodate mega containerships and deal with a throughput of up to 10 million TEUs a year, thus becoming an important gateway port for Southern Europe. The evolution of the study has been reported summarising some of the strands of work carried out so far and some of the options explored as well as mentioning the progress in stakeholders' involvement and, in particular, which steps the public administrations have taken so far to foster the development of the seaport/dry port system idea. It is important that stakeholders are involved in the further development of the study since what it envisages is a transformation so important as to imply a step change for both the port of Genoa and its hinterland.

The points outlined above are documented in detail in the study by SiTI et al. (2009). That report cannot be considered a complete feasibility study, yet. In fact, there are a number of points still requiring investigation, including the following:

- the simulation of the operation of the elements of the port/dry port and of the system as a whole
- an in-depth market/catchment area study for the new port system
- an in-depth analysis of project's effects in terms of economic impact, employment, and local area governance
- the refinement of dry port feasibility study according to possible location(s), and the characterization of the links to rail and road network
- the environmental impact and its mitigation

- the characterization of management and control options for the whole system
- their development will also allow a further refinement of the financial evaluations to draw the general picture towards the case for a project financing operation to implement the project

A point of general interest of the project idea is that, although it is developed with Genoa Voltri as a guiding application, it can be adapted to other situations where there are similar issues: lack of space, congestion of infrastructures in the vicinity of the port and, in general, a need to expand/relocate a section of the port space away from the quays.

REFERENCES

- Barla, Giovanni and Riccardo Amici (2007). Inquadramento geologico del progetto di collegamento ferroviario transappenninico. In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian), Lami I.M., ed. (CELID, Torino).
- Belforte, Guido and Bruno Musso (2007). "Ipotesi di riorganizzazione della banchina". In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian) Lami I.M., ed. (CELID, Torino).
- Belforte, Guido, Terenziano Raparelli and Angelo Costamagna (2007). "Linea di collegamento ferroviaria della banchina con il porto decentrato". In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian), Lami I.M., ed. (CELID, Torino).
- Bottero, Marta, Giulio Mondini and Marco Valle (2007). "Le relazioni tra ambiente e progetto". In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian) Lami I.M., ed. (CELID, Torino).
- Lami, Isabella M. (ed.) (2007). *Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale* (in Italian), (CELID, Torino).
- Leveque, P. and Violeta Roso (2002). *Dry port concept for seaport inland access with intermodal solutions*. Master thesis. Department of Logistics and transportation, Chalmers University of Technology.
- Musso, Bruno (2007). "Il porto di Genova: dalla riforma degli anni novanta alla sfida trasportistica del XXI secolo". In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian), Lami I.M., ed. (CELID, Torino).
- Roscelli, Riccardo (2007). "Origine e finalità dello studio", In: Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian) Lami I.M., ed. (CELID, Torino).
- Roscelli, Riccardo, Bruno Musso, and Isabella M. Lami (2007). "Una nuova logica di collegamento tra il porto a mare ed il porto decentrato", In:

- Genova: il porto oltre l'Appennino—Ipotesi di sviluppo del nodo portuale (in Italian), Lami I.M. ed. (CELID, Torino).
- Roso, Violeta, Johan Woxenius and Kenth Lumsden (2009). "The dry port concept: connecting container seaports with the hinterland", *Journal of Transport Geography*, vol. 17, No. 5, pp. 338-345.
- SiTI and collaborators (2009). *Genova: il porto oltre l'Appennino. Studio di pre-fattibilità fase 2. Internal report* (in Italian).

THE EXPANSION OF THE PORT OF GENOA: THE RIVALTA SCRIVIA DRY PORT

Claudia Caballini* and Enrico Gattorna*

ABSTRACT

There are two main ways for a port to face the long-term increase in freight demand: a better usage of the current available port land or an enlargement to new port areas. Within this second solution is included the movement outside of the port's borders of some activities currently carried out in the port, but not directly connected with the loading or unloading of goods. This relieves the territory and the port itself of the negative consequences (represented by the occupancy of scarce resources, such as the port areas) resulting from increased time and costs due to the handling of goods taking space and time from more value added activities and from the negative externalities associated with the presence of the port industry highly impacting the city fabric (such as congestion, atmospheric and acoustic pollution and space taken away from the city). This is the situation of the port of Genoa, where the particular orographic configuration of the territory and a large urbanization of the immediate proximity of the port property have forced the Genoa Port Authority to look for more space in the hinterland in order to manage the import/export of goods in the most efficient and effective way possible. This paper examines the case study of the Rivalta Scrivia dry port, located 75 km from Genoa along the railway line that links the Ligurian capital with the reference market. The need for more space at the service of Genoa port is confirmed by the analysis of the port demand, including both current and forecasted container traffic.

Keywords: Genoa, Rivalta Scrivia dry port

* C.I.E.L.I. – Italian Centre of Excellence in Integrated Logistics, University of Genoa, Via Bensa 1, 16124 Genoa, Italy.

INTRODUCTION

In order to face a long-term increase of freight demand, with the aim of maintaining—or better enhancing—its market share, a port can put into place two different types of solutions: intensive, based on technology, or extensive, based on space enlarging. The first case involves a radical change of the technologies utilized in the manufacturing process, allowing a more efficient use of the available areas. The second hypothesis, instead, implies the maintenance of the existing technology against an enlargement of the port areas. This latter solution often appears to be hardly feasible, especially for those ports that are strongly embedded in the city fabric, unless it is decided to develop waterfront areas or an area beyond the port borders. So, frequently the shifting of some port activities outside the port borders appears to be the best answer for allowing the increase of a port's handling capacity. This is also the solution chosen by the Genoa port in order to face the global freight traffic increase.

In fact, the demand for maritime transport in the containerized segment in the Mediterranean has grown by 126 per cent in the period 1995-2004 and by 40 per cent in the last five years, exceeding the 77 million TEUs handled. The more significant growth of freight demand in this area has allowed the Southern European ports to partially reduce their gap in respect to the higher market shared by the Northern European ports.

Italian ports, having registered a container handling of 82.4 per cent of the total throughput in 2004, in comparison to 80.4 per cent in 1995 and 83.6 per cent in 2000, represent the heart of the central Mediterranean port region. Even if separated by the Alps, the urban centres of southern Germany and Central Europe are closer to the ports of the Mediterranean than to those of the North Sea and the sea distance from the Far East to Europe is obviously shorter if a stop is made in the Mediterranean ports (a savings of three to five days of navigation is estimated). In this sense, the Italian ports of the Adriatic and northern arch of the Tyrrhenian have made efforts to develop intermodal connections capable of enlarging their traffic basin thanks to a reduction of delivery time.

The demand forecasts made by important consulting companies of the sector indicate continuous growth through the years, even if the current economic crisis will slightly slow it down. In this context of growth, a port sets the objective of at least keeping its market share stable, if not enlarging it, and it needs solutions that tend to increase its handling capacity. In these cases, the port can respond to that need by changing the technologies used and the productive processes, or even by enlarging the available spaces.

The case of the port of Genoa is an example of a port situated in the heart of an urbanized centre and, for this reason, it is difficult to find additional space to be assigned to port operations.

Taking into consideration the perspectives of port development, the solution to the problem of lack of space has been found in the location of a dry port beyond the Apennines. The area of Rivalta Scrivia has been chosen, which is situated 75 km away from Genoa in the Po valley. The desire of creating a dry port to aid the port of Genoa dates back to 1966 but, due to various reasons, only in the last few years the idea of creating a real dry port has been put in practice. However, some dry port activities have been already going on in the Rivalta Scrivia Inland Terminal (RSIT), for more than 40 years. So it can be said that currently, waiting for the building of the new areas, the dry port is utilizing some inland terminal spaces. Therefore, for a matter of completeness, hereafter we will include the inland terminal history.

I. THE HISTORY OF THE RIVALTA SCRIVIA DRY PORT

The Rivalta Scrivia dry port was created in 1966 with the goal of representing an ideal “appendix” to the Genoa port. In the 1960s, a common scene of the Genoa landscape included ships in the harbour waiting to be unloaded. In fact, the first containers were overlooking the market and pallets were a novelty, so the loading and unloading of cargo in ports were done manually, with long time periods and high tariffs, and vessels had to remain a long time outside of the port before being discharged.

The idea of Giacomo Costa, the founder of the company, was to clear the port of the goods sorting operations, loading goods from the holds of ships directly into the wagons that, with block trains, could quickly reach the hinterland. Here, the space available was greater and therefore times and costs were much lower, all the goods sorting and maintenance activities could be carried out and goods could be stored and protected in depots (or warehouses), if necessary.

On 11 November 1966, invoice number 1 was issued. “Rivalta, the city of goods” was off and was becoming an important reference point—also in terms of employment—for the development of trade and activities in the Scrivia Valley. By the 1980s, Rivalta had become a fully operational reality, offering its services to the biggest shipping companies and freight forwarders. Furthermore, the handling of containers had put into crisis the operation and development of the Ligurian ports and Rivalta provided a valid alternative for that.

In 1986, the registered office and headquarters were transferred to Rivalta Scrivia and, in 1986, Rivalta was classified as a first level inland terminal by presidential decree.

The great success of the inland port, however, spread the fear that a structure like this might alter the competitive relationships among the various players in the sector, reducing the political and economic weight of the Ligurian ports. For this reason, the Ligurian entrepreneurial class did not facilitate the development of the company.

On 4 April 1989, a fire completely destroyed some sections of the inland port, where liquors, synthetic fibres, mineral oil, footwear, industrial machinery, roasted coffee and bales of cotton were stored, and Rivalta had to reconstruct the lost sections. Luckily, in 1992, a law in support of intermodal facilities and inland terminals enabled it to be provided with the first modern logistics warehouses.

Meanwhile, the market required more and more integrated services and sophisticated software solutions for the computerized control of the depots. So between 1995 and 2000, the entrepreneur Alessandro Fagioli transformed Rivalta into a company able to offer logistics services with levels of efficiency and quality in line with the highest market standards, and comparable to the international context.

Rivalta today is a consolidated reality, strongly rooted in the territory and present in the world markets. It occupies an area of 2,250,000 square metres, aligned on the north-south and east-west axes and connected with port infrastructures and existing highways. Its warehouses are devoted to the most different types of goods, for an integrated management of logistics: receipt, storage, customs clearance, rework, and fragmented distribution. The railway siding tracks, integrated with the national network, penetrate inside the depots ensuring a full intermodality.

In February 2007 the Rivalta Terminal Europa S.p.A. (RTE) dry port was founded, which will operate over an area of 900,000 square metres, for the development of port terminal activities. It will be able to handle 500,000 containers annually, against the previous 60,000, thanks also to a new railway link of 900 metres and new dedicated depots of 100,000 square metres.

II. THE GENOA PORT FACING THE TRAFFIC INCREASE

The presence of a dry port to serve the port of Genoa must be supported by the growth—historical and foreseen—of the port's traffic and of

its capacity—present and future—to receive the incremental traffic deriving from an increased demand. In fact, in this paragraph we want to verify if the foreseen increase in traffic is in line with the perspective of the development of the Genoese port. The basic assumption guarantees that containers can effectively reach a dry port.

The historical trend of the demand of containerized transport highlights that the port of Genoa has closed 2008 with traffic of about 1.7 million TEUs registering an average yearly growth from 1995 of approximately 7.7 per cent (as shown in table 1). The movement of containers has more than doubled in the considered period, moving from 615,242 TEUs in 1995 to 1,766,605 in 2008. The world economic crisis of 2008 has made it extremely difficult to foresee the future container traffic increase for the Genoa port.

Table 1. Trend of the container traffic in the port of Genoa
(1000 TEUs)

1995	2000	2001	2002	2003	2004	2005	2006	2007	2008	Average yearly rate (percentage)
615	1 500	1 526	1 531	1 605	1 628	1 625	1 657	1 855	1 766	7.7

Source: Genoa Port Authority, 2008.

Regarding the increase in the handling capacity planned for the port of Genoa, new interventions will regard its three main container terminals:

- in the Voltri Terminal, PSA Sinport won the concession to develop a sixth module at the terminal that aims to boost terminal capacity to 1.5 million TEUs/year by 2009
- in the SECH terminal, the filling of Calata Bettolo will lead to the construction of a new terminal operated by MSC and SECH that will allow for a further handling capacity of 0.5 million TEUs/year
- in the Messina terminal, the filling between the Ronco and Canepa piers and the seabed's reduction of up to 14 metres of depth will allow for the enlargement of the terminal itself and a better use of the port infrastructure
- The handling capacity increases for the port of Genoa, consequent to the actions listed above, for the years 2010 and 2015 will amount to 3.05 and 3.55 million TEUs/year respectively.

It is emphasized that the additional capacity, even under the most optimistic scenario, leaves room for the future traffic growth that puts the

economic basis for the realization of a dry port in the service of the port of Genoa.

III. THE RIVALTA SCRIVIA DRY PORT

The previous section explained the reasons why the port of Genoa should be provided with a dry port at its service. This need became a fact in February 2006 when the Rivalta Scrivia Inland terminal S.p.A. set up, as a branch, the Rivalta Terminal Europa S.p.A. (RTE) with the goal of constructing a container terminal to handle the Genoa port activities.

The ambitious goal of creating a dry port coincides with the same one that, forty years ago, led to the creation of the Rivalta Scrivia Inland Terminal (RSIT): to be the “dry quay” of the port of Genoa.

However, the Rivalta Terminal Europe S.p.A. has intentions that go beyond the nature of a dry port terminal. In particular, the goal is the integration of a container terminal and an intermodal logistics platform for the national and international re-shipping via rail and road of the import containers and for the export containers consolidation.

For such an ambitious project, the following priorities and strategies emerge:

- a proper infrastructure system for intercepting the future maritime traffic of the Genoa port
- a daily train service (shuttle service) connecting the dry port with the Genoa port in order to really and effectively “lengthen” its docks

As a matter of fact, RTE has the goal of achieving this sort of “expansion” without physical and customs interruptions, so that a greater portion of the Genoa port traffic will be able to “land” directly in Rivalta.

As introduced in the first paragraph, even if the brand new dry port areas are now still under construction, dry port activities at the Genoa port service are currently performed in the Rivalta Scrivia Inland Terminal, which is located in the vicinity and has been active for over forty years. RSIT is a multifunctional logistics hub, able to offer integrated solutions and customs terminal services oriented to transport and distribution. It includes 400,000 square metres of covered areas, 300,000 square metres of container terminal, 150,000 cubic metres of cold storage facilities and operates as part of a group belonging to the “Fagioli S.p.A. Finance” holding. RSIT is one of the most important Italian collection and sorting hubs for cocoa beans, coffee, sugar, walnuts, and food raw materials. The operational structure is responsible for all the activities regarding goods loading/unloading, transfer, customs clearance, and warehousing.

A. The corporate structure

With respect to the partners of the project, as shown in table 4, Rivalta Scrivia Inland Terminal S.p.A.—that belongs to Fagioli Group S.p.A. - and Gavio Group hold the major shares of the investment, with 47.87 per cent each.

Moreover, the Piedmont region, Genoa and Savona port authorities have shown interest in taking part in the initiative.

In general, shipping companies, freight forwarders, maritime terminals, logistics operators, port authorities, public bodies, auto carriers, and railway operators represent the main dry port *stakeholders*.

Table 2. RTE dry port partners

Partners	Percentage
Rivalta Scrivia Inland Terminal—Fagioli Group	47.87
Gavio Group	47.87
Alessandria Province	2.95
Tortona Municipality	0.88
Alessandria Municipality	0.43

Source: RTE S.p.A., www.interportors.it.

B. The territorial context

RTE dry port is located 75 km from the Genoa port in the Province of Alessandria and in an area representing the intersection of the two future European commercial backbones: Corridor 24 and Corridor V.

The terminal is directly connected to the Novi Ligure/Tortona railway line through the Rivalta Scrivia station, and it will be the first terminal for the traffic of goods in transit on the Third Pass, which is the planned railway line that, starting from Genoa and passing through Milan along the Po valley-Rhine axis, should connect the north-west Italian regions to the heart of Europe.

The terminal, which is now being implemented, is physically located in continuity with the Rivalta Scrivia Inland Terminal, over an area of approximately 900,000 square metres.

The area is connected to the Novi Ligure/Tortona highway through two existing routes: on the west side of the Terminal with the road connecting with the city of Savona and with the provincial road No. 148. on the south side.

The link to the national motorway network is at the tollgate of Tortona, about 3 kilometres from the terminal at the crossroads of the A7 highway (Milan/Genoa) with the A21 (Turin/Piacenza/Brescia).

C. Support infrastructures and service facilities

With respect to the infrastructures, the railway siding at the Rivalta station will consist of a group of five receiving and delivery tracks—separated for import and export goods—with a parking capacity of about 1,000 metres each; there will be two entrances or links to the track, from the north and south of the group of tracks respectively, so as to ensure the same operability in both Milan/Genoa directions and so to avoid the shunting activities for the locomotive's turning.

After the preliminary phase (from 2006 to 2008), three phases of the project have been scheduled. Phase A (from 2008 up to 2009) will increase the area to 230,000 square metres, that will be more than doubled with the phase B completion, in 2010. At the end of phase C, which should end in 2011, the dry port will have a total area of 670,000 square metres, including all the services for means and human operators.

It is also worth underlining a very particular characteristic of the terminal: the set of tracks inside the terminal (at the end of phase C, when the new terminal will be completed, there will be five tracks of about 900 metres each will be perpendicular to those for collection and delivery. This will have an impact in terms of better management of train scheduling and, at the same time, it will speed up operations.

The link will be north of these tracks and it will mark the boundary between the area for electric trains—the tracks for collection and delivery—and the area for diesel trains.

In the long run, the group of tracks inside the terminal will be operated by two or three transtainer cranes; 12 trucks, including 6 for full containers and 6 for empty ones, will ensure the yard operation.

From the current collection and delivery tracks of Rivalta Scrivia Inland Terminal there will be a track connecting the Rivalta station tracks directly to the inland terminal. In the future this track will supply about 80,000 square metres of warehouses.

South of the group of tracks inside the terminal, there are plans to build: a workshop for the maintenance of the containers (3,000 square metres), a container washing plant and some containment tanks for dangerous goods. Further south of the tracks there will be a track connecting with a locomotive storage depot.

The gateway will consist of eight tracks; four incoming and four outgoing. Close to the gateway, centrally located between the entry and exit routes, a warehouse of about 3,000 square metres, dedicated to customs inspections, will be built.

All of these gateway tracks will be equipped with an optical reading system for the containers' codes and for customs inspections. The same system will be installed in the internal tracks' link in order to input the container code directly during the railway shunting phase for entering the terminal; in the link, or where deemed appropriate, a system to scan the containers entering or leaving the terminal will be installed.

The terminal will be provided with the following services:

- a truck park of about 40,000 square metres, capable of handling 500/600 trucks per day
- facilities for human operators like a residence, a cafeteria, a bar, an ATM, which are currently present in the inland terminal areas

The truck park will be directly connected with the gateway of entry/exit to/from the terminal, from which it will be able to remotely manage the reservation for the maritime terminals.

The availability of a truck park, in addition to being functional to the operation described above, will constitute a relief valve both for traffic peaks and for the port closure due to strong wind or other causes.

The coordination with the maritime terminals, the port authority and the Prefecture of Genoa and timely information to the road haulage system, will lead to use of the truck park as a way to improve traffic circulation in the city of Genoa.

D. The shuttle service

The terminal will be connected with the Genoa port docks by a daily shuttle service executed by Serfer Servizi Ferroviari S.r.l., a company of the Trenitalia Group (which is the Italian State-owned railway company). The composition of the shuttle and its operations are closely related to the siding configuration above described.

Currently the shuttle service is characterized by one round trip train but, starting from June 2009, there will be three round trip trains whose operations will be assured by three sets of wagons and only one locomotive. More in detail, the current modality is the following:

- the first shuttle train (composed of the first set of wagons) arriving from Voltri Terminal Europe—(VTE) in the Genoa port stops on the first south collection and delivery tracks; the locomotive at the head is dropped and continues on the north tracks, where it has to hook up in front of the second set of wagons ready to leave for Genoa.
- a diesel locomotive collects the first incoming set of wagons and brings it in the terminal for the unloading operations.
- once the incoming set of wagons is inside, the second set of wagons can leave for Genoa. The time required for the exchange of the sets of wagons at the Rivalta station is estimated to be 15-20 minutes
- upon arrival in Genoa, the shuttle leaves the second set of wagons and collects the third one to bring it to Rivalta.

The goal for the next few years is to have 6 return trains in 2010 and 15 in 2012, thereby increasing the service to the Genoa port—possibly including the “old” Genoa port—and, if the conditions are right, to Savona as well.

E. Import cycle management and organization

Since November 2008 the import cycle started directly from the quays of VTE in the Genoa port. Up to that date the shuttle service handling the import from VTE was based on a more time consuming cycle. Containers unloaded from ships were put in stacks in the yard according to their final destination. If the Multimodal Transport Operator (MTO) did not provide the cargo list with the transport mode (rail or road) for each cargo unit, containers were unloaded in stacks according to the relative ship (all the containers unloaded from a ship were stored in a particular area in the yard) and then they had to be sorted according to their final destination. This operation required lots of shifting—which involves non-productive movements—to search for the required containers in the different stacks for the train composition, with a consequent loss of time and relative costs.

The new procedure proposed to VTE foresees the possibility of placing containers, according to their unloading order, in a single interim storage area rather than in separate cargo bays, one for each final destination. In addition, this storage area is divided into many different stacks, each one containing approximately 45 TEUs to form a single shuttle train and so respecting the ship unloading order. This interim storage area empties according to a first-in first-out (FIFO) logic as the shuttle trains are formed; the recomposition of the final destination and thus the shipment by

truck or train, is made in Rivalta, in the dry port, where it is easier to manage the forwarding priorities, also thanks to the larger available spaces.

This new way of operating means working with a “bulk” logic instead of a “scheduled blocked train” one. The main implications for the port terminal of such a modality are:

- a reduction of the space needed
- a decrease of the number of shifts, with a consequent improvement in terms of total time required for performing all the operations

Moreover, all the customs clearance operations and inspections are carried out in the Rivalta areas. In fact, this new management procedure has been made possible thanks to a relevant customs simplification procedure. The advantage of customs simplification is quite evident. Two steps are skipped, with consequent benefits in terms of time saved and relative costs.

More specifically the new customs procedure is applied to shipments of containers that, arriving via sea with a single transport contract (with the indication on the bill of lading of “Genova Rivalta Scrivia” as port of discharge) and disembarked at VTE Genoa Voltri port, must be transferred through shuttle trains from the Voltri territorial customs section to the Rivalta Scrivia one, where they will be put into the temporary custody warehouses managed by the Rivalta Scrivia Inland Terminal.

Regarding the import procedure after the customs simplification, upon arrival in the VTE terminal, the manifest manager, which is usually represented by the maritime agency or the ship freight forwarder, arranges and submits the arrived cargo manifest (ACM), so that containers can be unloaded.

After the submission of the manifest and the unloading of containers in the customs area of the Voltri terminal, while waiting to receive a customs destination, goods acquire the status of “cargo under temporary custody” and they are already virtually regarded as having been put in the temporary custody warehouses managed by the Rivalta Scrivia Inland Terminal S.p.A, which assumes responsibility for them.

The ACM is then processed by the customs system that gives back the list of all the A3 numbers (container clearance numbers) generated. The manager submits it to the manifest office of the customs section of Rivalta Scrivia, together with the ACM, for their validation. For each container clearance number there will be a warehouse temporary custody code where it will be stocked.

An extract copy of the manifest is submitted to the border control police officers that give permission for exiting the terminal. Another two

copies of the manifest extract are given to the customs section of Rivalta and to the railway carrier. The packing list, containing all the information of the containers clearance numbers, accompanies the containers during their entire trip up to their destination warehouse and it is considered an important document for transport (as is the manifest extract).

Once the shuttle train arrives in Rivalta Scrivia, the relative customs section, through the packing lists and the manifest extract, can check the results of the procedure.

The goods placed in the Rivalta Scrivia temporary custody warehouses must receive a customs destination within 45 days of being assigned the containers' clearance numbers (A3). Moreover, during this temporary custody storage, goods cannot be tampered with, apart from the operations required for granting the storage status in which they were originally.

The whole procedure of a customs cycle in which all the cargo transfers from the Voltri port dock to Rivalta dry port take place without providing a customs declaration of transit for each container, but simply on the basis of the data of the ship's cargo manifest. This new way of operating allows the streamlining of the customs inspections without decreasing their quality but speeding up times.

However, such operations require the following:

- the direct involvement of the shipping companies, both in providing the ship's cargo manifest at least 24 hours before the ship's arrival, including the indication of the containers that will be shipped by rail, and in changing the return conditions of the bills of lading from Genoa CIF modality (insurance and freight paid) to Rivalta Scrivia CIP (transport and insurance paid)
- high safety standards in terms of route integrity, which implies the absence of intermediate stops, and cargo integrity, which means that each container is traceable during the transfer

Once a certain traffic volume is reached, a manifest office will be opened at the new RTE terminal, streamlining the quay operations.

F. Export cycle management and organization

The export cycle begins at the dry port, in appropriate separate cargo bays distinct per ship (first, second and thjrd ship, if possible) and, within each bay, per bill of lading. Containers, once the customs formalities are carried out, are forwarded directly from Rivalta to VTE for boarding, thus avoiding any stops in the port.

Also in this case the benefits in terms of space management and time reduction are evident: Genoa Voltri port gains space by avoiding the storage in its yard of containers that do not require immediate boarding, but receiving only export cargo for the next incoming ship. These advantages have become even more noticeable in the light of the VTE decision to reduce, from November 2008, the number of days of free storage in the terminal from 10 to 6. After the day of ship berthing, and considering an average of 2 days needed for ship unloading, only 4 days are now available to complete all the customs procedures and any checks and proceed to the containers forwarding without paying the yard storage costs.

Moreover, with regard to the new European code that will be coming into force soon, there will be some benefits for the goods landing in Rivalta Scrivia dry port. According to this code the export packing lists will have to be processed where the maritime customs are executed. Giving Rivalta Scrivia the label of "maritime customs", will make it possible for the export procedures to take place directly in the RTE dry port with obvious advantages for speeding up the export cycle.

CONCLUSION

The particular geographic conformation of the Genoa territory, with the mountains located a few hundred metres from the sea, and the foreseeable development of maritime trade within the Mediterranean basin clearly shows the current infrastructure situation of the port of Genoa.

The shortage of space within the port domain, which is necessary both for the movement of containers and for the creation of high value added integrated logistics operations, forces the Port Authority to look elsewhere beyond the port border to find new areas at the service of the Genoa port's logistical needs.

The initiative of the Rivalta Scrivia Inland Terminal that has sought to pursue the dry port cause since the 1970s was born in an analogous context. Recently, the Rivalta Terminal Europe S.p.A. was created, as a business segment of RSIT, with the aim of collecting all the container traffic coming from the port of Genoa and directed towards all of northern Italy and Europe, and vice versa. Thus the final objective for RTE is to create a logistics platform beyond the Apennines very similar to an inland terminal, but with a marked maritime vocation which is testified, among other things, by the use of the same technological systems and procedures typical of the Genoa port terminals.

In conclusion, it can be said that the convenient infrastructural location along the main south-north European communication lines, the already current high handling capacity, the presence of the maritime customs office within the dry port borders together with the recent implementation of an important customs simplification procedure in terms of time saved and, finally, the enormous opportunities of growth with reference to land and handling capacity, make RTE and RSIT the natural extension of the Genoa port quays beyond the Apennines.

ACKNOWLEDGEMENTS

Special thanks go to Dott. Giovanni Gommellini, General Manager of RTE—Rivalta Terminal Europa, for his useful information and support to this work.

REFERENCES

- Bode, S., S. Stiller, J. Wedemeier (2007). *Klimawandel, Strategie 2030—Vermögen und Leben in der nächsten Generation*, No. 5, Berenberg Bank & HWWI (ed.), Hamburg.
- Genoa Port Authority (1999), *Port Regulatory Plan*, available at <http://www.porto.genova.it>
- Genoa Port Authority (2006). *Three-year Operational Plan 2007-2009*, available at <http://www.porto.genova.it>.
- Rivalta Terminal Europa S.p.A. (undated). available at <http://www.interportors.it>.
- Agenzia delle Dogane (undated). available at <http://www.agenziadogane.it/wps/wcm/connect/ee/>

THE DRY PORT CONCEPT: MOVING SEAPORT ACTIVITIES INLAND?

Violeta Roso* and Kent Lumsden*

ABSTRACT

This paper aims to develop the dry port concept and to analyse and compare physical flows and administrative activities at the seaport terminal from the time perspective in the transport system with and without a dry port. The data for the analysis were obtained through literature review and interviews with relevant actors in the transport system. The conclusions indicate that the implementation of a dry port in the seaport's hinterland can enable the seaport to increase its terminal capacity and therefore manage the problem of lack of space. However, ports that do not face lack of space at their terminals will not gain anything by moving their storage area to an inland terminal; on the contrary, they might lose a significant portion of their profit.

Keywords: Virginia Inland Port, Falköping terminal

INTRODUCTION

Intermodal container transport is the dominant technology for container transport overseas. The shipping companies strive towards economies of scale for the maritime part of their transport chain and that derives a demand for efficiency, capacity and short lead time in the transit through the seaports (Culinane and Khanna, 2000; Mourão et al., 2002), and further transport to the seaports hinterland. To stimulate the development of those seamless intermodal transport chains and to meet market demands on seaports, the concept of dry ports is established. The dry port concept is based on a seaport directly connected by rail to inland intermodal terminals, where shippers can leave and/or collect their standardized units as if directly at the seaport (Rosó, Woxenius and Lumsden, 2009). The incentive is to

* Logistics and Transportation, Chalmers University of Technology, 412 96 Göteborg, Sweden.

channel freight volumes to fewer transport corridors in order to enhance the opportunities to utilize economies of scale in the hinterland corridor and to increase the capacity in the system, as well as decreasing transit time through the seaport. This improves the seaport's access to areas outside its traditional hinterland and therefore expands its hinterland (Roso, Woxenius and Lumsden, 2009).

As container transport volume continues to grow, the links with the hinterland will become a critical factor for the seaports' competitive advantage; therefore, progress only in the maritime part of the transport chain and in seaport terminals, without improvements in seaport inland access, is not sufficient for the entire transport chain to function. The efficiency of the railway is increasingly needed for the execution of the constantly growing cargo quantities. The demand for seamless hinterland connections to the inland terminals is increasing with the steadily increasing container volumes in the European ports. European hinterland transport market share for road increased for about 5 per cent; while for rail it decreased for 4 per cent. Furthermore, with a 76 per cent market share, road transport dominates the inland freight transport market in EEA member countries (European Union Road Federation, 2008). The modal share of rail and road diverged due to the removal of trade barriers and liberalization of markets, which resulted in increased utilization of road transport. A change in the geographic orientation of trade (from east to west) has also contributed to the shift because the new markets are not suitably connected by rail links and offer much more flexible road transport connections (European Environmental Agency, 2003). Therefore, the only strategic decision would be the implementation of rail for connecting seaports with hinterland through inland terminals. Those inland terminals are of major importance for the efficiency of intermodal transport, as well as for efficient access to and from seaports. Transport policies at different levels advocate rail and barge as being more sustainable traffic modes than road (European Commission, 2001), and therefore propose a shift of volumes from road to more energy-efficient traffic modes, which are less harmful to the environment and reduce congestion at seaport terminals and in seaport cities. The problems related to the substantial growth of containerized maritime transport in the last 20 years should be approached from a joint seaport and hinterland perspective (Slack et al., 2002).

This paper emphasizes the importance of functional seaport inland access that might be obtained through implementation of advanced inland intermodal terminals - dry ports, which would make goods handling more efficient, and a shift of freight volumes from road to more energy efficient traffic modes that are less harmful to the environment. The purpose of the paper is to develop the dry port concept and to analyse the same through comparison of physical flows and administrative activities at the seaport terminal from time perspective in the transport system with and without a dry port, theoretically and through case studies. Consequently, the following research question is created: How does implementation of a dry port into a

seaport's transport system influence physical and administrative flows at the seaport and, by that, the system?

The literature review allows analysing the concept and giving an overview of the same. However, the data for the analysis of physical and administrative flows at a seaport is obtained mainly through interviews with relevant actors of the transport system. The empirical evidence for the assessment of existing dry ports, i.e. advanced intermodal terminals that play a dry port role for their seaports, is based on case studies.

The scope of the paper is the seaports' inland access with dry ports, i.e. advanced intermodal terminals, as a part of the intermodal transport chain. Considering intermodal transport as transport of standardized units involving at least two different traffic modes, only transport processes involving containers were analysed in the studies.

I. FRAME OF REFERENCE

Transport systems are characterized by transfers of goods between points of origin and destinations through the transport network. The transport network is made of links and nodes where links represent transport and transfer activities connecting nodes. Activities such as consolidation, sorting, storage and trans-shipment between vehicles and traffic modes, are carried out in nodes. From this point of view a node is equivalent to a stop in the flow or to a point where the flow can be stopped. To ensure that the network will function when it comes to exchanging goods between the different links it is necessary that the links converge in a specific node at certain times or within certain time intervals.

Transport systems have always been designed according to geographical conditions, as well as the demand for the transport, which is determined by the goods quantity and service quality. Currently, environmental issues play an important role in the design as well. One way to accomplish those demands is to employ rail through intermodality. There is no generally accepted definition of intermodality. Intermodal transport, according to the European Commission (2000), is defined as the following: "There is a consensus that intermodal transport constitutes a transport process in which two following conditions are fulfilled: Two or more different transport modes are deployed; and the goods remain in one and the same transport unit for the entire journey." Reduced energy consumption, optimization of the usage of the main strength of different modes, reduction of congestion on road networks, and low environmental impacts are considered as the advantages of intermodal (road-rail) transport (European Commission, 2000; Rutten, 1998).

Seaports are important nodes in the intermodal transport; their earlier narrow focus on cargo handling has been replaced with a wide range of logistic activities giving the seaports a more active role in the transport chain. However, there has been a trend in organizational and technological changes towards offering door-to-door transport solutions rather than port-to-port (Robinson, 2002; Paixão and Marlow, 2003). This has enlarged the seaports hinterland and therefore created a competition among neighbouring seaports.

The main problems seaports face today, as a result of growing containerized transport, are lack of space at seaport terminals and increased bottlenecks in the land-side transport system serving the seaports. For some seaports the weakest link in their transport chain is their back door, where congested roads or inadequate connections cause delays and raise transport costs. Therefore, the strategic decision would be the implementation of rail and improved inland intermodal terminals serving seaports.

The concept of hinterland changes constantly and it is generally accepted today that serving seaport hinterlands is more competitive than before containerization and intermodality (McCalla, 1999). There is a strong interdependency between a seaport's foreland and hinterland, which is particularly apparent in intermodal transport. Seaports are not competing only with seaports in their local area but also with distant seaports attempting to serve the same hinterland. Many seaports, as well as shipping lines, also integrate vertically to control hinterland transport (Notteboom, 2001; van Klink and van den Berg, 1998).

Inland intermodal terminals have gained substantial attention in transport literature; considerable research has been conducted on how to find the optimal location for inland intermodal terminals (Rutten, 1998) and how to improve the efficiency of road-rail terminals (Ballis and Golias, 2002). Earlier research by Slack (1990) on inland load centres shows the importance of their development for intermodal transport; in the later research (Slack, 1999), the author emphasizes the inland terminal's—the satellite terminal's—role in reducing environmental effects. Seaports are among the most space-extensive consumers of land in metropolitan areas and their expansion often generates environmental and land use conflicts; therefore, satellite terminals (inland intermodal terminals in remote areas) are seen as an alternative to seaport expansions (Slack, 1999). Despite their important role in transport networks, terminals sometimes impede the development of intermodal transport with additional trans-shipment costs at road-rail terminals or due to a shipper's lack of freedom in choosing traffic modes once they move their business to intermodal freight centres (Woxenius, 1997).

The basic problem of differentiation between “conventional” trans-shipment terminals and the various types of large-scale intermodal logistics centres is addressed by Höltgen (1995). The problem is that the concept of intermodal logistics centres varies from country to country, although there is a

common background: they should contribute to intermodal transport, promote regional economic activity, and improve land use and local goods distribution. Furthermore, the author suggests classification of intermodal terminals according to some basic functional criteria like traffic modes, trans-shipment techniques, and position in the network or geographical location. Nevertheless, the trans-shipment between traffic modes is the characterising activity.

A dry port definition by Roso, Woxenius and Lumsden (2009) is: "A dry port is an inland intermodal terminal directly connected to a seaport, with high capacity traffic modes, preferably rail, where customers can leave and/or collect their goods in intermodal loading units, as if directly to the seaport." Moreover, the authors state that services such as trans-shipment, consolidation, depot, track and trace, maintenance of containers, and customs clearance should be available at dry ports. The authors' simplified interpretation of the concept of dry port would be "a movement of seaport interface further inland". Dry ports are distinguished from conventional inland terminals by the services offered at dry ports, as well as by their functionality (Roso, Woxenius and Lumsden, 2009). Furthermore, the authors divide them into three different categories: close, mid-range and distant dry ports.

Implementation of a dry port in a seaport's immediate hinterland increases the seaport's terminal capacity and with it comes the potential to increase productivity since bigger container ships will be able to call at the seaport. With dry port implementation, a seaport's congestion from numerous trucks is avoided because one train can substitute for some 35 trucks in Europe. With a reduced number of trucks on the roads, congestion, accidents, road maintenance costs and local pollution are reduced as well. A dry port may also serve as a depot, empty containers storage. Road carriers would lose some market share but in some countries where long trailers are not allowed to pass through cities for safety reasons, a dry port implementation is a good solution, if not indispensable, from their perspective as well. The benefits of distant dry ports derive from the modal shift from road to rail, resulting in reduced congestion at seaport gates and their surroundings, as well as reduced external environmental effects along the route. Apart from environmental benefits, a distant dry port also brings a competitive advantage to a seaport since it expands the seaport's hinterland to the area outside its traditional hinterland by offering shippers quality services. New logistics solutions created by the establishment of dry ports in rural areas make the areas more attractive for the establishment of new businesses, resulting directly in the development of the area and in new job opportunities for the local inhabitants (Roso, Woxenius and Lumsden, 2009). The benefits of dry ports are summarized in table 1.

Table 1. Potential benefits from a dry port implementation

	Potential benefits from dry ports
Seaports	1). Less congestion, 2). Increased capacity, and 3). Expanded hinterland
Seaport cities	1). Lower road congestion, and 2). Land use opportunities
Rail operators	1). Economies of scale, and 2). Gain market share
Road operators	Less time in congested roads and terminals
Shippers	1). Improved seaport access, and 2). Green marketing
society	1). Lower environmental impact, and 2). Job opportunities

Source: Adapted from Roso (2009).

II. METHODOLOGY

The data collection method for this paper was a literature study on seaports and their inland access as well as on inland intermodal terminals. The primary purpose of the literature studies was to generate an understanding of the research field, to provide insight into the research that has already been done related to the problem being studied and to identify areas of interest for further investigation. Observation as a data collection method was also used, mainly through unstructured participant observation and interviews. The interviews were mainly face-to-face, open-ended interviews with people directly involved in terminal management, at both inland and seaport terminals. The interviews were of crucial importance in understanding the cases; however, data collection also included secondary sources, such as internal reports and archival records, which, according to Stuart et al. (2002), should strengthen the reliability. Two case studies were done primarily to draw conclusions from their comparison, not to generalize, which would not have been appropriate based only on two cases. However, the conclusions make a very good base for further research that might lead to generalization.

The choice of these two case studies is a result of the previous research on dry ports. Virginia Inland Port was chosen due to its reputation as a successful inland port for the Port of Virginia but also because it fits into the concept of dry port according to Roso, Woxenius and Lumsden (2009). On the other hand, Falköping terminal is still in the process of developing into a dry port for the Port of Göteborg, and therefore is still not in its full bloom. The idea behind the study is, partially, to learn from the best and apply locally. This may be described as best practice case versus beginner. According to Abrahamson (2003), in logistics, proof that a certain case is a best practice case can be done both in qualitative descriptions of what they have done and with quantitative key figures such as logistics cost or delivery

service. In this study, cases are discussed from both perspectives, qualitative and quantitative. The study took a systems approach to understand the whole picture as well as the components. This approach is often used in logistics to understand how the different components in the system interact in order to improve the effectiveness and efficiency for the system as a whole; the content of the each element and how they are put together is important (Abrahamson, 2003). The system is a seaport transport system consisting of different actors-elements of the system such as seaport terminals, rail and road operators and inland terminals; however, the same is the subsystem of a whole origin-to-destination transport system. The attention here is on one node in this transport chain, i.e. the element named "inland terminal interface", whose development would influence the system.

III. SEAPORT ACTIVITIES SHOWN ON AN EXPORT CASE

A container's physical and administrative flows at a seaport's container terminal may be divided into three interfaces: land-side interface (delivery/receipt), container terminal interface (transfer, storage and internal transport) and marine-side interface (ship/shore transfer) (Holguin-Veras and Walton, 1997), where the effectiveness of one interface affects the performance of another. Delivery/receipt represents movements of containers through the gate, i.e. land gate entrance and external vehicle transport. The gate is an interface between external modes of transport and a container terminal. Movement of containers from the gate to the storage area, usually with straddle carriers or fork-lifts, is identified as loading/unloading and internal vehicle transport. Storage is the area for short or long time storing of units waiting to be loaded on a ship or a train; in the case of ship loading/unloading the same may be identified as transfer ship/shore.

Regarding customs clearance, the same is done almost entirely on line; in other words, physical inspection of the goods is rarely performed. Within the European Union, a special customs clearance IT system is implemented in order to simplify the activity.

IV. CASES

A. Virginia Inland Port for the Port of Virginia

The Port of Virginia, state-owned and established in 1952, is the second largest volume port on the east coast of the United States in terms of general cargo, with more than 2 million TEUs handled in 2006. The seaport inland access is divided into three different traffic modes; 65 per cent of the cargo is moved by trucks, 25 per cent by rail and 10 per cent by barge (Virginia Port Authority, 2007).

The idea of expanding into new market areas, in particular to capture the Ohio Valley area through an inland port, came about in 1984. An inland port was supposed to be an extension of the seaport's existing way of handling cargo and the first and most important step was the selection of the site. After numerous studies, the site was chosen due to its connectivity and potential new market. To adjust the terminal into the surrounding area, the site was dug so that the terminal was not noticeable from the roads nearby and therefore did not destroy the landscape. Virginia Inland Port (VIP) started operations in 1989 on a facility on 65 ha, with 5,346 m of on-site rail. Rail service operates five times a week between the facility and the seaport; however, Mondays and Tuesdays are the busiest. VIP is situated 350 km from the seaport and the total transit time is 12 hours. The procedure at the seaport terminal is rather fast from a vessel by straddle carrier to rail crane to rail. At the beginning, 9,000 TEUs a year were carried by the Detroit train from the seaport but also for other destinations. With increased volumes and involvement of new customers, another train was introduced. In 2006 the facility handled approximately 30,000 TEUs (Virginia Port Authority, 2007) although the preliminary study showed potential for 100,000 TEUs.

VIP is also known as a United States customs designated port of entry where a full range of customs services is available to customers. However, a physical inspection of containers, only 5 per cent of the total TEUs, is currently done at the seaport. Customs clearance does not take long time since customs receives information about containers for import about 24 hours prior to unloading of the ship and therefore decides about inspections in advance. There is a so-called 24-hour manifest rule for the clearance but officially, customs has 10 days to do the clearance.

B. Falköping terminal for the Port of Göteborg

The Port of Göteborg is the largest container seaport in Scandinavia, handling more than 840,000 TEUs a year, about 60 per cent of which was transported by truck to inland destinations in 2007 compared to 70 per cent in 2006 (Port of Göteborg, 2008). The Port works on increase of its container rail volumes by cooperating with other actors of the transport systems; today,

there are 24 rail shuttles for different destinations that run daily services to/from the port.

In early 2000, the Falköping municipality submitted a proposal for the implementation of an intermodal terminal in the area at a rail distance of 124 km from the port due to existing volumes already being transported to the port by trucks. The very first and expected problem, apart from financing, which always seems to be a problem, was a suitable location for the terminal. However, it was not until the end of 2006, when the largest Swedish forest products company, StoraEnso, showed an interest in establishing a terminal in the area, that tangible work on building the terminal started. Once the location was chosen and the terminal built, in 2007, new problems—this time unexpected—arrived. Such problems were deficient volumes, further development issues, competition with another terminal in the area and collaboration with the Port.

The rail shuttle operates four times a week in both directions, reaching up to 11,000 TEUs a year. After further development and extension of rail sidings, an increase in volumes is expected and therefore one more shuttle a week should be introduced. So far, the terminal offers services of trans-shipment between rail and road, road haulage and storage of containers. Future plans are to develop the terminal from a conventional one to one serving as a dry port, which means offering further services, such as customs clearance, maintenance of containers, warehousing and some extra services for the forest products company. Customs clearance is feasible since there is usually no need for physical inspections of containers and, therefore, no need for the presence of customs officers at the site, except in special circumstances. However, extra security measures must be provided at the terminal.

C. Synthesis

Two ports, very different in size but very similar when it comes to their road market share, transport containers to inland destinations—about 60 per cent of the total TEUs. One big difference is in ownership of their inland terminals. While the Port of Virginia initiated and financed the implementation, and also owns and operates VIP, the Port of Göteborg had no influence on implementation of Falköping terminal, neither financially or by initiative.

Table 2 shows that the average time needed to handle one container does not differ significantly between the ports in the study. Average internal transport and loading/unloading times at the seaports' terminals are rather short, are measured in minutes, and therefore cannot influence the internal flow significantly, and by that the whole transport chain.

Table 2. Average time needed to handle one container at the seaports' terminals

Activities	Average time for container handled at:	
	Port of Gothenburg	Port of Virginia
Land gate entrance/exit	Varies	Varies
Loading/unloading truck or train	1.5 minutes	2 minutes
Internal vehicle transport	1.5 minutes	2 minutes
storing	5.5 days	3.5 days
Internal vehicle transport	1.5 minutes	2 minutes
Loading/unloading ship/shore	1 minute	2 minutes

Source: the authors

However, land gate entrance time varies notably, from a few minutes to a few hours, depending on both the day and the time of day. Although a few hours are only a small part of the whole transport chain time scale that might take up to a few weeks, one should keep in mind that those are queuing hours for road carriers which, apart from financial loss for the road carriers, also increase the risk of road accidents (Roso, 2007). On the other hand, storage takes up to a few days, on average 5.5 days at the Port of Göteborg and 3.5 days at the Port of Virginia. This segment of the transport chain might be influenced by moving the storage further inland closer to the final customer, leaving valuable space at the seaport terminal. The storage of containers would not be eliminated by that, but could possibly be shortened due to faster administration inland (Roso et al., 2008), and it would be at a lower cost.

V. DISCUSSION

A. Cases

Ports that do not face lack of space at their terminals will not gain anything by moving their storage area to an inland terminal; on the contrary, they might lose a significant portion of their profit, as in the case of the Port of Göteborg. The Port of Göteborg is located outside the city centre and has a sufficiently large storage area with the possibility for expansion and, at present, the storage of containers brings in significant revenue for the Port. This usually is not the case with big container ports, and using a dry port as a depot is seen as the solution for the problem of lack of space (Roso, 2008). Since Falköping terminal is not owned by the Port, moving the storage from the Port to the dry port would imply giving away the profit. Therefore, the Port was not involved financially in the establishment of Falköping terminal; however, the administrative part of the establishment and some adaptations at the port terminals were necessary in order to introduce one extra shuttle

train. This is not the case with the Port of Virginia, which owns the inland terminal; therefore, moving activities inland does not imply loss of profit, but the contrary. An inland port with direct rail to the seaport means gaining valuable space at the seaport terminals, i.e. increased capacity that results in increased productivity. There were no obstacles prior to VIP implementation; the infrastructure and market existed, and the municipality approved the arrangement since the implementation of the terminal implied new jobs in the area.

When it comes to the time savings that result from the implementation of a dry port into a seaport transport system, one can see that the same can be obtained by eliminating queues at the seaport's gates or by eliminating storage at the seaport. The latter does not represent a certain gain for the actors of the system since the containers need to be stored anyway; whether at the seaport terminal or at the dry port makes no difference as long as seaport does not face a lack of storage space. The former, on the other hand, makes significant gains, not only for the seaport that would perform better with no congestion at the terminals, but for the carriers who suffer from financial loss due to delays caused by the congestion. At the Port of Göteborg gates there are several hours of long queues at peak times (Roso, 2007). Furthermore, there is an increased risk of road accidents since truck drivers become anxious and might also avoid regular rests during transport in order to arrive at the destination on time. VIP can have trucks in and out in just 30 minutes; truck drivers never have to leave their vehicles.

Society gains from the movement of containers from road to rail through reduced environmental impact. In Sweden, approximately 95 per cent of state railway transport is by electric trains; as the electricity used for the trains comes from hydro power, emissions from the electric trains are reduced to an absolute minimum (Roso, 2007). One train substitutes for about 35 trucks in Sweden; consequently there are 35 fewer trucks on the roads per full train and there are more than 70 trains a day passing through the Port (Port of Göteborg, 2008), resulting in approximately 2400 trucks less on the roads daily. However, in the United States, trains are run by diesel locomotives, but double stacking of containers is feasible and widespread. Double-stack container trains consist of 20 to 25 cars, each carrying 10 TEUs, with a total train length of 2,000 to 2,500 metres, not counting the locomotives (DeBoer, 1992). Currently, about 25 per cent of 2 million TEUs a year are transported by train from the Port of Virginia to inland destinations; considering double-stacking it might result in up to 2,000 fewer trucks on the roads daily.

B. Deduction

In the transport system, the node is equivalent to a stop in the flow and although a dry port is a node in the system, the idea behind the concept

is to make the flow smooth; in other words, not to stop the flow in the node but to make all node activates seamless, and by that to make the intermodal transport chain seamless.

Features of a dry port concept:

- Seamless transport and trans-shipment points
- Scheduled and reliable rail connection between a seaport and a dry port
- Dry port equipped for the handling of standardized units
- Services at a dry port: trans-shipment between road and rail, customs clearance, maintenance of containers and long and short time storage

Finally, to summarize how the implementation of a dry port into a seaport's transport system influences physical and administrative flows at the seaport and by that system, one does not need a case study to realize that some activities like ship loading/unloading cannot be moved to an inland terminal. However, there is a whole range of administrative activities that would be moved inland with the implementation of a dry port, specifically those related to handling truck related paperwork. Moreover, some physical activities would take less time, such as storage, while some could be reduced completely, such as inevitable queuing at the seaport gates. Implementation of a dry port could create seamless seaport inland intermodal access, i.e. smooth transport flow with one interface in the form of dry port concept instead of two, one at the seaport and the other one at the inland destination.

CONCLUSION

Regarding the assumption on which seaport activities could or should be moved to an inland terminal, there is no general answer. The Port of Virginia is ready to invest in development of inland terminals because the competition between neighbouring ports is the fact, and expansion inland into new markets brings competitive advantage. Faster movement of containers from the port to the final destination also increases the port's capacity. On the other hand, the Port of Göteborg has sufficient volume with no fierce competition and does not strive towards the expansion of its hinterland; problems of congestion at seaport gates and potential delays have not reached a critical point yet. Therefore, the port does not invest in inland transport development as long as there are others such as rail operators, terminal operators and belonging municipalities eager to do so. However, the Port of Göteborg's role is of a supportive nature when it comes to the development of inland terminals and rail shuttles by other actors of the transport system.

Implementation of a dry port into a seaport transport system, that is the seaport's hinterland, should create a seamless transport chain, smooth transport flow with one interface in the form of dry port concept instead of two interfaces, one at the seaport and the other one at inland destination. In other words two nodes in the transport chain, seaport and inland terminal, should be replaced with one "dry port concept" node. However, significant time savings, as well as financial savings, could be made only by avoiding the queues at seaport gates and by moving container storage inland. Evidently, expansion inland into new markets improves seaport's access to areas outside its traditional hinterland, resulting in new customers generating more profit and promoting the regional economic activity. The question is whether this expansion is going to be in the form of ownership or collaboration; if it is the latter, then on which level? Therefore, this paper also serves as a basis for further research on the concept, focusing on practical experience of the concept in the world.

ACKNOWLEDGEMENTS

The author would like to thank James Davis, the Virginia Inland Port manager, for his generous help with the data collection. The research reported here was sponsored by the European Union Interreg IVb North Sea project.

REFERENCES

- Abrahamson, M. (2003). "Best practice case studies", in *Case Study Research in Logistics*, Publications of the Turku School of Economics and Business Administration, pp. 19-29.
- Ballis, A, and J. Golias (2002). "Comparative evaluation of existing and innovative rail-road freight transport terminals", *Transportation Research Part A: Policy and Practice*, vol. 36, No. 7, pp. 593-611.
- Cullinane K. and M. Khanna (2000). "Economies of scale in large containerships: optimal size and geographical implications", *Journal of Transport Geography*, vol. 8, pp.181-195.
- DeBoer, D. J. (1992). *Piggyback and Containers—A History of Rail Intermodal on America's Steel Highway*, Golden West Books, San Marino, Ca.
- European Commission (2000). *IQ—Intermodal Quality Final Report for Publication*, Transport RTD Programme of the 4th Framework Programme—Integrated Transport Chain.
- European Commission (2001). *European Transport Policy for 2010: Time to Decide*, White paper, Office for official publications of the European Communities, Luxemburg.
- European Union Road Federation (2008), *European Road Statistics 2008*, International Road Federation, Brussels Programme Centre.
- Holguin-Veras, J. and C.M. Walton (1997). "Implementation of Priority Systems for Containers at Marine Intermodal Terminals", *Transportation Research Record*, No. 1602, pp. 57-64.
- Höltgen, D. (1995). *Terminals, intermodal logistics centres and European infrastructure policy*, Dissertation, European Centre for Infrastructure Studies.
- Hultén, L., L. Källström, and C. Warnecke (1998). *Euroborder*, Final report for publication, Transport Research Institute, Sweden.
- McCalla, R. J. (1999). "Global change, local pain: intermodal seaport terminals and their service areas", *Journal of Transport Geography*, vol. 7, pp. 247-254.
- Mourão, M. C., M. V. Pato and A. C. Paixão (2002). "Ship assignment with hub and spoke constraints", *Maritime Policy and Management*, vol. 29, pp.135-150.
- Notteboom, T. E. (2001). "Spatial and Functional Integration of Container Port Systems and Hinterland Connections", in *Land Access to Sea Ports*, Report from European Conference of Ministers of Transport, Round table 113, Paris, 10-11 December 1998, pp. 5-55.
- Paixão, C., and P. B. Marlow (2003). "Forth generation ports - a question of agility?", *International Journal of Physical Distribution & Logistics Management*, vol. 33, No.4, pp. 355-376.
- Port of Göteborg AB (2008), *Rail, Road & Logistics*, February 2008, Göteborg, Sweden.

- Robinson, R. (2002), "Ports as elements in value driven chain systems: the new paradigm", *Maritime Policy & Management*, vol. 29, No. 3, pp. 241-255.
- Roso, V. (2007), "Evaluation of the dry port concept from an environmental perspective: A note", *Transportation Research Part D: Transport and Environment*, vol. 12, No. 7, pp. 523-527.
- Roso, V. (2008). "Factors influencing implementation of a dry port", *International Journal of Physical Distribution & Logistics Management*, vol. 38, No. 10, pp. 782-798.
- Roso, V. (2009). "The emergence and significance of dry ports: the case of the Port of Göteborg", *World Review of Intermodal Transportation Research*, vol. 2, No. 4, pp. 296-310.
- Roso, V., Woxenius, J. and K. Lumsden (2009). "The dry port concept: connecting container seaports with the hinterland", *Journal of Transport Geography*, vol. 17, pp. 338-345.
- Rutten, B. C. M. (1998). "The design of a terminal network for intermodal transport", *Transport Logistics*, vol. 1, pp. 279-298.
- Slack, B. (1990). "Intermodal transportation in North America and development of inland load centres", *Professional Geography*, vol. 42, pp 72-83.
- Slack, B. (1999). "Satellite terminals: a local solution to hub congestion?", *Journal of Transport Geography*, vol. 7, pp. 241-246.
- Slack, B., C. Comtois, and R. McCalla (2002). "Strategic alliances in the container shipping industry: a global perspective", *Maritime Policy and Management*, vol. 29, pp. 65-77.
- Stuart, I., D. McCutcheon, R. Handfield, R. McLachlin, and D. Samson (2002). "Effective case research in operations management: a process perspective", *Journal of Operations Management*, vol. 20, No. 5, pp. 419-433.
- van Klink, H. A., and G. van den Berg (1998). "Gateways and Intermodalism", *Journal of Transport Geography*, vol. 6, pp. 1-9.
- Virginia Port Authority (2007), *The Port of Virginia Results 2007*, Norfolk, United States.
- Woxenius, J. (1997), "Terminals—A barrier for intermodality?" Nordic Transport Research conference on Intermodal Freight Transport, Ebeltoft, Denmark, 22-23 September.

THE SPATIAL CHARACTERISTICS OF DRY PORTS IN INDIA

Adolf K.Y. Ng^{*} and Girish Gujar^{**}

ABSTRACT

Using the case of India, this paper investigates the spatial characteristics of dry ports. By applying the grid technique, an attempt is made to identify the optimal location of dry ports for three major industrial regions in southern, central and northern India, namely Tirupur, Nagpur and Ahmadabad, respectively. Attention is paid to whether the simulated optimal locations correspond to the real situations, as well as the reasons for and impacts of such similarities and/or differences.

Keywords: dry port, spatial characteristics, location, proximity, grid technique, India

INTRODUCTION

Developing economies often rely upon exports of agricultural and non-high value, often labour-intensive, manufactured products in sustaining their economic development. The values and competitiveness of such products within the global market are often influenced by value added activities such as grading, sorting, packaging, labelling, marking, refrigerating, processing, distributing and retailing. Such requirement, together with the development of multimodal supply chains, have gradually triggered the development of dry port, which often plays an important role in suiting the need for market development, seamless integration and closer collaboration between different participants of supply chains.

Generally speaking, a dry port can be understood as an inland location where the consolidation and distribution of cargoes takes place, with functions similar to those of seaports, including the handling of cargoes, the provision of intermodal transport connectivity, information exchange and other ancillary services, such as customs inspections, storage, the

^{*} Department of Logistics and Maritime Studies, The Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China.

^{**} Centre for Maritime Economics and Logistics, Erasmus University Rotterdam, Rotterdam, the Netherlands.

maintenance and repair of empty containers, and tax payments. The establishment of dry ports allowed shippers to undertake consolidation and distribution activities at inland locations relatively closer to their production facilities, resulting in the reduction of transaction costs and accompanying risks, and leading their products to become competitive in the global markets. In some cases, the existence of a dry port even acts as a prerequisite for the export of certain products, especially in developing economies where the logistics sector is often not only disorganized and inefficient, but also highly fragmented, thus resulting in high logistics costs. In this case, a dry port can play indispensable role, which can have various positive impacts on export potentials, including: (i) the preservation (and even improvement) of a product's quality, thus sustaining (or even increasing) its value; and (ii) the reduction of transport costs (through consolidation) and damage to cargoes.

By early 2009, about 200 dry ports had also been established throughout India. In view of the proposed establishment of special economic zones throughout the country and the simplification of customs procedures, further development in transport infrastructures and superstructures by way of capacity augmentation and mechanization/automation is imperative to realize the true potential of containerization in India.

With such understanding, the geographical location of dry ports is pivotal for efficient and cost effective freight movements between production bases and gateway seaports. The locational decisions of dry ports have significant bearings on the efficiency and competitiveness of the whole supply chain. Here the fundamental questions concern not only the nature, origins and destinations of cargoes but, more importantly, how they are moving and which particular transport hub(s) should be used. While strategies and decisions relating to capacities and networks are usually short-term by nature and can be altered in the intermediate term in response to market demand and the availability of land and capital, location decisions are fixed and difficult, if not impossible, to reverse in the short or medium term. Simply speaking, making inappropriate location choices can result in massive financial wastage, which can ultimately affect the price, and thus the competitiveness, of the country's merchandise within the global market.

I. SOME THEORIES ON LOCATION

While deciding upon the suitable locations for transport hubs, geographical consideration is essential because economic activities are organized within chosen areas, as well as the underlying processes leading to the creation of spatial patterns. One of the offshoots was the location theory, of which its core concern was not just related to the optimal usage of available spaces, but also the precise locations where particular facilities should be settled.

In this context, two concepts should be highlighted - centrality and intermediacy (Fleming and Hayuth, 1994; Fujita and Krugman, 1999). Centrality could be understood as the ability of the centres concerned (often cities and industrial bases) in generating their own traffic. Subsequently, such centres assumed some of the qualities of intermediacy (of which the concept will be discussed later in this section) and became gateways to distant places outside the region. Apart from being nodal points for cargo consolidation and distribution, these centres also become the foci of economic and transport activities (Chakravorty and Lall, 2005). Thus, centrality, be it local, regional, national or continental, would have significant impacts on the centre's size, functions and traffic-generating potentials. Indeed, it was not surprising that many central places are also the natural seats of political power, as well as important transport intersection points (Losch, 1967). However, it should be noted that identification of a central place, to a certain extent, also depended upon the perceptions of facility users.

Intermediacy is a spatial quality which could be identified in the context of the transport system, and could generate additional traffic if favoured by users (usually carriers) as connecting hubs. At such locations, services were often connected with national and international services, as well as transfer between different transport modes. As pointed out by Fleming and Hayuth (1994), some locations had nothing else, but simply geographical advantages, to be recommended as transport hubs. A number of container ports nowadays gained their trans-shipment centre status mainly due to the strategies of liner carriers like Gioia Tauro (Ng, 2009).

Similar to centrality, intermediacy does not necessarily only imply direct measurement of geographical distance, of which its criticality is also perceived by users who might decide to take its significance away, e.g. the introduction of alternatives, technological improvements, changing trade patterns, etc. While any favourable sites could often create potentials and opportunities to flourish into transport hubs, they do not necessarily create genuine demands to ensure their survival and/or competitiveness. Thus, similar to centrality, the significance of intermediacy also possesses subjective elements.

The above analysis clearly indicates that centrality and intermediacy serve as major spatial qualities in deciding the optimal locations of transport facilities. These concepts, however, are not always clear-cut and, sometimes, they might overlap with each other (Fleming and Hayuth, 1994). For instance, while many seaports started as gateways due to intermediacy (and favourable physical conditions), they gradually developed into central places as business started to move into surrounding areas so as to exploit the potential competitive advantages, while also mutually assisting each other through agglomeration. In turn, enhanced centrality could trigger further improvements in accessibility, between the seaports and other regions, leading to further increases in cargo flows. As noted by Notteboom and

Rodrigue (2005), this process could be exemplified by the case of the United States, where a number of dry ports started to attract service agglomeration around and gradually developed themselves in local/regional logistics centres. To a certain extent, most transport hubs nowadays possessed certain degrees of both centrality and intermediacy so as to maintain their survival, and the degree of influences of these forces could change overtime.

II. CASE STUDY

Three major industrial regions located in southern, central and northern India will be investigated. In this section, a brief introduction to these regions will be introduced.

A. Case one: southern India—Tirupur

With a population of 400,000 spreading over 30 km², Tirupur is located in central part of the southern state of Tamilnadu and is a suburb of Coimbatore. Known as the “Manchester of the south” due to its prosperous textile industries, Tirupur is connected by road and rail and generates apparel exports worth \$1.5 billion annually, equivalent to nearly 40 per cent of India’s total garment export values. There are about 3,000 knitting, stitching, dyeing, bleaching, printing units in the region manufacturing all kinds of garments and hosiery which is exported mainly to Western Europe and the United States.

Almost all the cargo is exported by sea, mainly through the gateway seaports of Tuticorin and Cochin. Tirupur’s local dry port, Tirupur Inland Container Depot (TICD), commissioned in January 2005 and operated by CONCOR, spreading over 0.7 hectares, is located about 7 km away from the core production bases. TICD has a covered warehouse admeasuring 300 m² with custom clearance facility. Until now, however, TICD is not connected by railroads to any of the seaports and all cargoes have to be carried by trucks, and it is understood that neither the national nor the Tamilnadu state government has any concrete plans in constructing any railway lines connecting between TICD and the gateway seaports in the foreseeable future. Apart from TICD, a small amount of cargoes will also be cleared at Kudalnagar ICD (KICD) located at Madurai.

B. Case two: northern India—Ahmadabad

With a population of 5 million spreading over 50 km², Ahmadabad is located in north-western India and is the capital of the Indian state of Gujarat. The city is famous for its textile mills dated back to the last century. Also, apart from textiles, there are several other industries, notably pharmaceuticals, paper, sheet glass, chemicals, as well as agricultural products such as oilcake and edible oil.

Its local dry port, Sabarmati Inland Container Depot (SICD), located about 4 km from its core production bases, spreads over ten hectares and is well connected by road and rail to the gateway ports of JNPT, Mundra and Pipavav. According to industrial information, 67 per cent, 20 per cent and 13 per cent of the cargoes are shipped out through the ports of JNPT, Mundra and Pipavav respectively. Apart from SICD, a small amount of cargoes will also be cleared at Ankleshwar ICD (AICD) and Gandhidham CFS (GCFS), both located within Gujarat.

C. Case three: central India—Nagpur

Nagpur is an old city located at the Indian state of Maharashtra, with a population of 3 million spreading over 40 km². It is a market centre located in a region which is rich in mineral and forest resources. Hence, the major industries located in this region are mainly agricultural and mineral (or directly-related) products, e.g. cotton, soya, rayon, paper, iron/steel, aluminium, etc.

Nagpur's local dry port, Nagpur Inland Container Depot (NICD), is located about 12 km from the core production bases. Despite the fact that the gateway port of Vishakhapatnam is equidistant from Nagpur (and also connected by railroads), nearly all cargoes from Nagpur are shipped out through JNPT, of which it is also connected with NICD by road and railroads. Apart from NICD, a small amount of cargoes will also be cleared at Bhusawal ICD (BICD) and Daulatabad ICD (DICD), both located within Maharashtra, approximately midway between Nagpur and JNPT.

III. RESEARCH METHODOLOGY

One of the foremost concerns of spatial analysis is the "friction of distance" (i.e. impediments to movement occurring due to spatial separation), which often involves an economic and/or financial cost. In this study, analysis has been undertaken with the application of the grid technique, a heuristic approach in determining the optimal location of fixed facilities (in this case, dry ports) based on the least-cost centre in moving in- and outbound cargoes within the geographical grid concerned. The grid technique assumes that the originating sources and outbound destinations for in- and outbound cargoes respectively are fixed, and that the operator (in this case, dry port operator) has concrete ideas on the approximate volumes of cargoes that it is likely to handle. This technique also integrates both spatial and non-spatial data for solving transport engineering problems, with the shortest path analysis being a precursor to this technique. In other words, the optimal location simulated by the grid technique is the place with the minimum transport cost. A detailed explanation of the grid technique, including the mathematical formulations, can be found in annex 1.

During the analysis, several further assumptions have been made, including the following: (i) there are no significant variations between different dry ports in terms of efficiency; (ii) the unit transport cost has a linear relation with distance; (iii) unacceptable or inaccessible routes do not exist; (iv) only local cargoes (within 100 km from the production bases) are considered; (v) not calling a dry port is not an option—as mentioned earlier, a dry port is more than just a cargo distribution centre, as it also serves additional necessary functions in facilitating the shipment process, and given that Indian shippers largely consist of medium- and small-sized firms, it is practically impossible for most of them to get around dry ports and ship their cargoes to the gateway seaports directly; (vi) analysis is based on existing transport infrastructure and facilities; and (vii) only one dry port will be called each time. Furthermore, it is assumed that freight trains, instead of trucks, would be used, as long as the route concerned can fulfil two criteria: (i) the annual cargo size along this route reaches a minimum threshold volume of 32,400 TEUs; and (ii) this route is supported by railroads to gateway seaports. Given the existence of significant overcapacities in all three cases (see table 1), simulation here is based on a single- (rather than multi-) facility location model.

In order to provide a clear picture on the choice of dry ports by shippers, a number of existing dry ports have also been included in table 1, including Kudalnagar, Bhusawal, Daulatabad, Ankleshwar and Gandhidham ICDs/CFS. All these dry ports share common characteristics, i.e. they are all closely located (≤ 20 km) from the simulated optimal dry port locations of respective case studies. With such understanding, it means that under the current situation, nearly all the cargoes generated from the production bases (≥ 90 per cent) are exported via their respective local dry ports, i.e. TICD, NICD and SICD.

IV. SIMULATION RESULTS AND DISCUSSIONS

A. Case one: southern India—Tirupur

The current and simulated solutions of Southern India (Tirupur) can be indicated as.

Current Solution:	[Tirupur] → [TICD/KICD] → [Cochin/Tuticorin]
Simulated Solution:	[Tirupur] → [Optimal dry port] → [Cochin/Tuticorin]

By applying the grid technique, the optimal location of dry port in serving Southern India (Tirupur) should be near Madurai which is approximately midway between the production base and the gateway seaports. This location is about 105 km away south from TICD (which is located only 20 km from Tirupur's major production base).

Table 1. Capacities and container throughput of selected dry ports in India

Dry port	Paved area in 2008 (m ²)	Capacity in 2008 (TEUs)	Throughput (TEUs)	
			2005	2006
<i>Southern India—Tirupur</i>				
Tirupur ICD (TICD)	7 000	64 600	5 005	3 795
Kudalnagar ICD, Madurai (KICD)	8 580	79 200	1 438	438
<i>Central India—Nagpur</i>				
Nagpur ICD (NICD)	53 250	327 700	58 914	75 452
Bhusawal ICD (BICD)	20 230	186 700	3 204	2 534
Daulatabad ICD (DICD)	12 576	116 100	5 236	5 774
<i>Northern India—Ahmadabad</i>				
	128			
Sabarmati ICD (SICD)	428	1 185 500	96 113	112 616
Ankleshwar ICD (AICD)	6 650	61 400	341	1 568
	121			
Gandhidham CFS (GCFS)	406	1 120 700	917	4 032

Source: edited by the authors

B. Case two: northern India—Ahmadabad

The current and simulated solutions of northern India (Ahmadabad) can be summarized as:

Current solution: [Ahmadabad] [SICD/AICD/GCFS]
[JNPT/Mundra/Pipavav]

Simulated solution: [Ahmadabad] [Optimal dry port]
[JNPT/Mundra/Pipavav]

By applying the grid technique, the optimal location of dry port in serving northern India (Ahmadabad) should be approximately 170 km to the south west of Ahmadabad's production base, which are significantly more proximate to the major gateway seaports of JNPT, Mundra and Pipavav.

C. Case three: central India—Nagpur

By applying the grid technique, the optimal location of dry port in serving central India (Nagpur) should be approximately 150 km to the southwest of Nagpur's production base, towards the direction of JNPT.

D. Discussion

All the simulated optimal dry ports share common locational characteristics, of which all of them are situated in locations with significant distances away from both the production bases and gateway seaports. In other words, in accordance with the simulated results, existing dry ports which are located proximate to the optimal dry ports, i.e. Kudalnagar, Bhusawal, Daulatabad, Ankleshwar and Gandhidham ICDs/CFS for Tirupur, Nagpur and Ahmadabad, respectively, should possess the best potential in attracting most cargoes from the production bases. Nevertheless, as indicated by the distribution of cargoes between different dry ports (see table 1), the simulated phenomenon is significantly different from the realistic situation, where local dry ports, i.e. TICD, NICD and SICD respectively, have significantly higher throughputs than their counterparts. It is clear that all the simulated optimal locations have failed to reflect the realistic situations.

Based on empirical analysis, it is clear that only dry ports of which their locations are proximate to the production bases can attract cargoes of any significance (TICD, NICD and SICD are only located 7, 12 and 4 km away from their respective production bases). The existence of significant variations between the simulated optimal and realistic locations (which the latter is often proximate to their respective local production bases) has highlighted the importance of “centrality” in the decision of shippers in using dry ports, where the pulling force of intermediacy is virtually non-existent. In other words, in India, shippers have clearly chosen to sacrifice transport cost savings in return for other benefits, for example, convenience, relation, better control, etc. Such results complemented with earlier works by Ng and Gujar (2009) who pointed out that convenience, local relations and better local control often served as equally, if not more, important considerations on shippers’ decisions on which particular dry ports should be used.

CONCLUSION

This paper investigates the spatial characteristics of dry ports in India and reveals that locations of dry ports are, in many ways, the outcomes of interaction and compromises between competing forces, and that reliance of natural and/or geographical and/or economic forces in explaining how a dry port should be located is inadequate. Even within a market economy, the choice of dry ports is often restricted by exogenous factors and as a result of other players, which in turn seriously restrict the options of decision makers. As illustrated in the Indian context, the degree of centrality and intermediacy a dry port possesses is often more “artificial” than simply by natural economic forces. Locating a dry port at a particular place often reflects a balanced, as well as compromising, solution which at least partially satisfies the influence

and competition between different forces, explicit and implicit, subject to a number of economic, social and even political constraints.

Lessons from India seem to indicate that dry ports in developing, rising economies should locate within the proximity of central places so as to enable them to become commercially viable and become catalyst for regional development. Hence, it is necessary for governments to executive relevant policies so as to provide more centrality to the areas around dry ports and their facilities, and perhaps the establishment of logistics parks dedicated to value addition industries can be a good first step.

REFERENCES

- Chakravorty, S. and Lall, S. (2005). "Do local economics matter in cluster formation", *Environment and Planning*, vol. 37, pp. 331-353.
- Fleming, D.K. and Y. Hayuth, (1994). "Spatial characteristics of transportation hubs: centrality and intermediacy", *Journal of Transport Geography*, vol. 2, No. 1, pp. 3-18.
- Fujita, M. and Krugman, P. (1999). *The Spatial Economics: Cities, Regions and International Trade* (Cambridge, MIT Press).
- Losch, A. (1967). *The Economics of Location* (New York, John Wiley & Sons).
- Ng, A. (2009). *Port Competition: The Case of North Europe*. VDM Verlag, Saarbrücken.
- Ng, K.Y.A. and G. C. Gujar (2009). "The spatial characteristics of inland transport hubs: evidences from Southern India", *Journal of Transport Geography*, vol. 17, No. 5, pp. 346-356.
- Notteboom, T. E. and J. P. Rodrigue, (2005). "Port regionalization: towards a new phase in port development", *Maritime Policy and Management*, vol. 32, pp. 297-313.

ANNEX 1. INTRODUCTION TO THE GRID TECHNIQUE

The grid technique superimposes a grid upon the geographic area containing the cargo originating sources and final destinations. The grid's zero point corresponds to an exact geographic location, as do the grid's other points. Every source and destination can then be determined by its grid coordinates. The technique defines each source and destination location in terms of its horizontal and vertical grid coordinates. It is possible to visualize this technique's underlying concept as a series of strings to which are attached weights corresponding to the weights of in-/outbound cargoes of which, in this case, dry port operator handles.

It is important to note that the application of the grid technique is based on the normative view of location, where: (i) land is isotropic and uniform in resource ability without any significant barriers to movements; and (ii) population is uniform in all respects. Finally, it is assumed that perfectly competitive markets exist and both producers and consumers possess perfect knowledge of the market. The grid technique can be expressed as the following formulations:

$$C_{(x,y)} = \frac{\sum (r * d * S) + \sum (R * D * M)}{\sum (r * S) + \sum (R * M)} \quad (1)$$

s.t.

$$C, M, S, r, d \geq 0 \quad (2)$$

Where C is the centre of mass, i.e. the optimal location, D is distance from 0 point on grid to the grid location of outbound cargoes, d is the distance from 0 point on grid to the grid location of inbound cargoes, M is the weight (volume) of outbound cargoes, S is the volume of inbound cargoes, R is the outbound cargo transport rate/distance unit for the cargo and r is the inbound cargo transport rate/distance unit for the cargoes. R and r are the transport rates per distance unit.

In order to determine the least- cost centre on the grid, it is necessary to compute two grid coordinates, one for moving the commodities along the horizontal axis and one for moving them along the vertical axis. Both coordinates are computed by using the grid technique formula for each direction. Last but not least, based on industrial information, the unit shipment costs of cargoes carried by trucks and rail service (provided that the minimum threshold is reached) are assumed to be \$0.25 and \$0.15 per metric ton per km, respectively.

THE ROLE OF DRY PORTS IN SOUTH AFRICA

Erené Cronje*, Marianne Matthee** and Waldo Krugell**

ABSTRACT

This paper presents a case study of the City Deep dry port terminal in Johannesburg, South Africa. The findings show that City Deep functions well in terms of service delivery and providing extra services to both exporters and importers. However, a number of potential problems regarding City Deep's infrastructure were identified. It was found that train and truck congestion within City Deep is an everyday phenomenon. Importers and exporters prefer road transport to rail transport. This affects not only the infrastructure at City Deep, but also that of South Africa. More trucks on the roads exacerbate air pollution and road accidents, and overloaded trucks damage South African roads. Therefore, City Deep and the South African logistics system should focus on promoting rail transport to the seaports, so exporters and importers will rely on both modes for the transport of goods.

Keywords: transport costs, containerization, port efficiency, dry ports, inland terminals, South Africa, City Deep

INTRODUCTION

From across the world there is clear evidence that exports can drive economic growth and development. The African continent, however, faces significant challenges of growth and development while its countries have not been able to connect successfully to the world economy. Exporters from African countries face adverse geography and poor institutions. In a 2001 study Elbadawi et al. (2001) found that domestic transport costs act as a strong constraint to exports from Africa—a constraint that is even stronger than that of international transport costs. Lowering domestic transport costs in African countries can therefore contribute to exports and, more generally, to economic growth and development. One way of lowering domestic

* Demacon consulting, Pretoria, South Africa.

** School of Economics, North-West University (Potchefstroom Campus), Potchefstroom, South Africa.

transport costs is to establish dry ports (or inland terminals) closer to exporters and importers.

This paper presents a case study of the City Deep dry port terminal in Johannesburg, South Africa. It is an interesting case for a number of reasons. First, South Africa opened up its economy in 1994 and has since implemented policies meant to encourage export-led growth. Second, transport costs are relevant as South Africa trades mostly with countries in the global north, which implies significant international transport costs. Also, the majority of South Africa's exports originate in the Gauteng region, which is located 600 km from the nearest seaport, thus incurring significant domestic transport costs. Therefore, for South African exports to remain competitive and for the country to achieve export-led growth, it is imperative to reduce the higher than average domestic transport costs (Ramos, 2005).

As suggested above, the establishment of dry ports can lower domestic transport costs. The aims of this case study are to: (i) evaluate South Africa's current inland terminals, with a specific focus on City Deep, located in Johannesburg, Gauteng; and (ii) determine whether or not the Government of South Africa should invest in more dry ports. The remainder of the paper is structured as follows: section 2 provides an overview of South Africa's spatial economy and the significance of transport costs for exports, section 3 contains the case study of City Deep and section 4 concludes with recommendations.

I. THE CASE OF SOUTH AFRICA

A particular characteristic of economic activity across South Africa and across the globe is its density. Geographically, economic activity tends to be unequally distributed and concentrated. In South Africa, 70 per cent of gross domestic product (GDP) is produced in only 20 per cent of places. What makes the South African case more interesting is that 37 per cent of GDP and 60 per cent of exports originate in cities in the landlocked Gauteng province (Regional Economic Explorer, 2006). This can be explained by examining trade and extraction along with the social engineering of apartheid.

South Africa has six "large" cities. Johannesburg, the East Rand (Ekurhuleni metro) and Pretoria (Tshwane metropo) are located inland in Gauteng province. Durban, Cape Town, and Port Elizabeth (Nelson Mandela metro) are the major port cities. Cape Town and Durban were first developed in the seventeenth and eighteenth centuries as trading posts on the shipping route between Western Europe and Asia. During the nineteenth century, this role changed with the discovery of diamonds and gold in the interior. The port cities developed from being stop-over and service points providing shipping services, to being ports through which commodities were handled. Today this dominance continues due to the importance of sea transport for South

Africa's international trade. Approximately 98 per cent of the volumes of South Africa's exports are conveyed by sea. The mineral wealth determined the location and growth of the inland cities, Johannesburg, the East Rand and Pretoria. The distances of the location of mining commodities, as well as the extraction technology required in mining then influenced the pattern of South Africa's inland development. Where railways and electric power were provided for mining, they also contributed to the development of the manufacturing sector. Industries such as steel and mining, which are heavy consumers of electricity, are predominantly located in the historic mining areas whilst chemicals are concentrated heavily around Durban from where the majority of the country's crude oil imports are obtained (Matthee and Naude, 2008).

In the twentieth century, apartheid reinforced the historical regional development patterns induced by the emerging mineral-energy complex of the nineteenth century with its homeland policies and Group Areas Act. Support of inefficient industries in the homelands and the segregation of cities created a spatial economy characterized by inefficient land use, excessive transport costs, and underinvestment in transport infrastructure, telecommunications and electric power. It also resulted in segmented labour and consumption markets and created artificial internal barriers to trade (Krugell & Naudé, 2005).

The cost of unequal development was paid particularly by the manufacturing sector. Nel (2002) showed that, by 1970, South African had a relatively advanced and diversified manufacturing sector but thereafter output stagnated and employment declined. Contributing factors included: declining gold exports and gold prices, a reduction in global commodity demand from the early 1980s, the debt crises of the 1980s, depreciation of the value of the Rand, the imposition of sanctions, foreign exchange shortages, and skill- and capital shortages. By the 1990s job losses occurred in places and deindustrialization took place.

Against this background of spatial inequality, the new democratic government has, since 1994, been opening up the economy. This transition again changed the spatial structure of economic activity in South Africa (Naudé et al., 2000). South African industries were now exposed to international competition. Subsequently, industries that could not cope with increased levels of competition closed down (for example, the textile industry in the Western Cape contracted significantly). Other industries that were able to move into new markets thrived (for example, the motor industry in the Eastern Cape) (Naudé et al., 2000). The majority of manufactured exports originate in the vicinity of one of the major export hubs, namely the City Deep dry port (situated in Gauteng), Durban harbour (situated in KwaZulu-Natal), Port Elizabeth (situated in the Eastern Cape) and Cape Town harbour (situated in the Western Cape) (Matthee and Naudé, 2008).

South Africa's transport costs accounted for around 13 per cent of GDP in 2003, which is high in comparison with other emerging markets. Brazil's transport costs, for example, are only 8 per cent of their GDP (Ramos, 2005). Transport costs increased by 11 per cent over the last five years and the overall logistics costs remained flat at 15.2 per cent of GDP (CSIR, 2004). According to the CSIR (2001), the biggest driver of logistics costs in South Africa is transport costs. Transport costs make up 78 per cent of the secondary sector's total logistics costs and 60 per cent of the primary sector's (CSIR, 2001). Logistics rely heavily on multimodal transport and containerized freight transport to help decrease logistics cost, and thus transport costs, in South Africa.

II. THE CASE STUDY OF CITY DEEP

Intermodal transport has been proven to reduce domestic transport costs, as it utilizes different transport modes in a productive manner (Rodrigue et al., 2006). For an intermodal transport system to exist, it needs the necessary infrastructure which is provided by inland terminals. Moreover, inland terminals act as inland ports for container traffic transferring containers between rail and truck for either import or export purposes (DoT, 1997).

South Africa has six major inland terminals and nineteen satellite depots that are strategically located to connect with its seaports. Each of these terminals handles containers, cars and bulk traffic (Transnet, 2009). South Africa's inland terminals include City Deep (Eastcon and Kazcon), Belcon (Saldanha, Ashton, and Dalcon), Deal Party (East London and George), Pretcon (Phalaborwa, Witbank, Polokwane, Nelspruit, and Piet Retief), Bayhead (Newcastle), and Bloemfontein (Kimberly, De Aar, Kroonstad, Kakamas, and Bethlehem). These inland terminals and satellite depots are controlled by Transnet Freight Rail, the largest division of South Africa's public transport company, Transnet Limited (the sole shareholder is the South African government), specialising in the transport of freight (Transnet, 2009).

City Deep Inland Container Terminal was the first inland container terminal built in southern Africa in the 1970s. It is situated in Gauteng, just to the south of the Johannesburg Central Business District (CBD) and is close to the industrial areas of Johannesburg and the greater Gauteng province (DoT, 1997). City Deep is centrally located, as most inland exporters of manufactures are located within a 50 km radius. The nearest seaport to City Deep is the port of Durban (at a distance of approximately 600 km). City Deep is the largest container terminal in South Africa and handles three categories of containers, namely import traffic, export traffic, and domestic traffic. Import traffic includes the management of containers that enter through a South African port, such as the Port of Durban, with a domestic or cross-border destination further into Africa. Export traffic includes the

management of containers leaving South Africa through national ports, and domestic traffic includes the management of containers transported within South Africa's borders (Transnet, 2009).

Although South Africa has six inland terminals mentioned above, City Deep is the only inland terminal that functions as a dry port, as it is the only inland terminal where customs clearance of goods takes place. The other inland terminals handle only domestic traffic, whereas City Deep handles container traffic both from abroad and domestically.

Although City Deep's infrastructure is owned and operated by Transnet Freight Rail, privately owned companies are allowed to use City Deep's infrastructure and facilities. Examples of these include companies at Kaserne and SACD (South African Container Depot). This case study of City Deep is based on an interview conducted within one of these privately owned companies, who for confidentiality reasons, wishes to remain anonymous. The purpose was to gather information on the service delivery of South African inland terminals, with specific focus on City Deep. A questionnaire was used during the interview with a number of open-ended questions that asked the following information: the current economic performance of the terminal, the terminal's location in relation to the spatial allocation of the production and consumption centres, operation areas of the City Deep container terminal and the general flow of transport. The information gathered is discussed in terms of the promotion of inland container transport as a means through which domestic transport costs in South African can be reduced.

A. Functions of the terminal

Intermodal transport is used to connect City Deep with South Africa's seaports and other inland terminals. The first part of the interview was to establish how the private companies operated within the City Deep terminal.

Transport

The City Deep container terminal handles approximately 1,500 containers of imports and 2,600 containers of exports per day. Both trucks and trains are used to transport goods from City Deep to the ports and vice versa. Transnet Freight Rail handles the private operators' rail transport of goods and containers to and from City Deep.

Trains arriving in Johannesburg are split into five different sidings. Each siding is allocated to one of the companies operating in City Deep. The containers carried on the trains belong to the shipping lines and usually contain imports. The trains deliver the containers at the siding of the company that is to handle the containers on behalf of the importer. The company then unloads the container with its content. Afterwards the

container is filled with goods on behalf of an exporter. These goods are to be exported on the shipping lines to which the container belongs. The container is loaded onto the train and railed to the harbour.

If road transport is preferred, then clients may choose their own freight hauler for the delivery of containers and goods. City Deep is also connected to other types of terminals (e.g. airports) via road transport. The nearest international airport connected to City Deep is OR Tambo International. City Deep only delivers the containers and or goods, the clients have to arrange for the loading of the container at the airport themselves.

Other functions

Several other functions are also performed by the companies operating at City Deep. These functions include wagon storage, providing trans-shipment tracks for train loading and unloading operations at the terminal interchange zone, from/to a hauler, or when lifted from or placed on a rail wagon at the railhead, conveyance between the interchange zone or railhead and the stacking area, providing storage and buffer lanes for intermodal transport units, storage of containers, the handling of containers by means of a container crane and/or gantry crane, loading and driving lanes for the trucks, providing an internal road network and custom clearance.

Customs

Customs clearance is conducted by the border police at City Deep who operate on a twenty-four hour basis to control illegal trade in drugs, stolen vehicles, firearms and counterfeit goods. The terminal has three gates: one is for the entry of trucks delivering containers, one is a rail track gate for the entry and exit of trains, and the third gate is an exit gate for trucks. The gates are only opened when a train or truck enters or leaves the terminal. Every gate has a twenty-four hour security guard. Containers of imports arriving at City Deep are subject to a number of import controls. The City Deep border police and customs must inspect all the necessary documents, description codes, seals on the containers, and check that imports comply with the import/export regulations pertaining to South Africa to ensure that no fraud or any other irregularities have occurred.

Value added services

The companies operating at City Deep also offer specialist services. For example, the client is offered confirmation that the goods are packed in the correct container before the container is loaded onto the train or truck. Goods arriving from Africa to South Africa for further exporting are usually not packed in containers. The companies' personnel pack the containers and take a photograph of the container before it is sealed. The photo is then sent to the client. As soon as the client gives the go-ahead, the container is

shipped. Quality control functions may also be performed on behalf of the clients. Samples of raw materials are taken to check the quality of the goods. The report is sent to the importer ensuring him that goods of the correct quality have been shipped. Another specialist service is one provided to the shipping lines. The private companies have maintenance divisions equipped to repair broken containers on behalf of the shipping lines they belong to.

B. Problems and challenges

The second part of the interview asked the private operator about what they regarded as the problems and challenges facing their operations in City Deep. The biggest obstacle for the effective operation of City Deep is infrastructure. Train and truck congestion within City Deep is an everyday phenomenon. The existing infrastructure cannot handle the number of trains and trucks entering City Deep. Container blockages of approximately 5,400 containers can take up to six weeks to clear. As a result, shipping lines may impose a port congestion surcharge on imports and exports because of blockages caused by container delivery hold-ups. Also, clients prefer road (truck) transport to rail transport. Therefore, the number of trucks entering and leaving City Deep causes congestions and delays. This not only affects the infrastructure at City Deep, but also that of South Africa. Roads are rapidly deteriorating (in many cases trucks are overloaded) and congestion on the national roads increase the amount of air pollution, road accidents and collisions. Another reason that clients prefer to make use of road (truck) transport is because transport by rail takes much longer to deliver the goods than by road.

Theft is also a major problem of rail transport. When cargo is transported from Johannesburg to Durban by rail, regulations require that the drivers on the train have to be changed every two to three hours. This implies that the train stops at a pre-determined station and the driver leaves the train. In many cases the train stands at that particular station for hours at an end before the next driver commences the next leg of the journey. The cargo is left unprotected at these stations and risk of theft and pilferage is high. A client or freight forwarder cannot check the location of the cargo during its journey to the container depot in Durban. In comparison, when the cargo is transported by vehicle from Johannesburg to Durban, the cargo is also at risk, but the risk is lower. The drivers are also legally required to stop every 3 to 4 hours of the journey. The driver stops at a designated rest stop for a few hours before carrying on to the next rest stop. The difference here is that the driver of the vehicle generally does not leave the vehicle without supervision. The driver usually has an assistant driver and they take turns at guarding the vehicle. Most transport companies also protect their vehicle fleets by satellite tracking and protection services. This implies that the vehicle is under 24 hour a day security and can be tracked at any time during the journey (Matthee, Grater and Krugell, 2007).

Thus, the question becomes whether the establishment of another dry port would alleviate the problems faced by City Deep. The answer appears to be no. The respondents indicate that although there is currently congestion, the volumes of trade do not justify the costs involved in developing a new dry port. They believe that the Government of South Africa, via Transnet, should rather invest in upgrading the existing infrastructure. The upgrading of infrastructure should include adding a sufficient amount of wagons for trains to minimize time delays. This type of upgrading would also serve the overall purpose of promoting rail transport in South Africa.

The role of the government in customs clearance also has to be more hands-on. Transnet Freight Rail must also become a more active partner interacting with the private companies in City Deep. For example, Transnet Freight Rail could establish an undertaking that, as the carrier of freight, it will require a declaration from the client that the contents of the container are as described on the form. The Transnet Freight Rail document could then be compared with the customs declaration, and these two independent systems could then be used for cross-referencing and profiling.

CONCLUSION

The purpose of this study was to gather information on the service delivery of South African inland terminals. City Deep is South Africa's major dry port and is linked with an intermodal transport system to the major seaports in South Africa. City Deep could reduce transport costs in South Africa, as it provides the transport infrastructure for containerization. City Deep seems to function successfully in terms of service delivery and extra services provided to both exporters and importers. It was found that it would benefit City Deep to focus on making Transnet Freight Rail a more active partner in both the logistics and operational processes. They could act as the third party in the logistics process, leading to a reduction in transport costs. As for the establishment of additional inland terminals or dry ports, the government needs to invest more in the existing infrastructure, as the export volumes do not justify the cost of building a new inland terminal.

This answers the question of whether dry ports can lead to a reduction in transport costs. Dry ports have the benefits of the modal shift from road to rail. Therefore, City Deep and the South African logistics system must focus on promoting rail transport in order for exporters and importers to focus on both transport modes for the transport of goods. This will also enable South Africa to take its place in better and more competitive global value chains.

REFERENCES

- Council for Scientific and Industrial Research (2001). "Analysis of transport costs in southern Africa could assist regional integration and development", available at http://www.csir.co.za/plsql/ptl0002/PTL0002_PGE038_ARTICLE?ARTICLE_NO=4880144.
- Department of Transport (1997). "Moving South Africa", <http://www.transport.gov.za/projects/msa/msareport/msadraft10.html>.
- Elbadawi, I., T. Mengistae, and A. Zuefack, (2001), "Geography, supplier access, foreign market potential and manufacturing exports in developing countries: an analysis of firm level data", available at <http://info.worldbank.org/etools/bspan/PresentationView.asp?PID=405&EID=206>.
- Krugell, W. F. and W. A. Naudé (2005). "The geographical economy of South Africa", *Journal of Development Perspectives*, vol. 1, No. 1, pp. 85-128.
- Matthee, M., S. Grater, and W. F. Krugell (2007). "On exports and domestic transport costs: an industry viewpoint", Paper presented at the Biennial Conference of the Economic Society of South Africa, Indaba Hotel, Johannesburg, South Africa, 10-12 September 2007.
- Matthee, M. and W. A. Naudé (2008). "The determinants of regional manufactured exports from a developing country", *International Regional Science Review*, vol. 31, No. 4, pp. 343-358.
- Naudé, C. et al. (2000). "Global climatic change, developing countries and transport sector options in South Africa", available at <http://repositories.cdlib.org/itsdavis/UCD-ITS-RR-00-12/>.
- Naudé, W.A. and M. Matthee (2007). "The significance of transport costs in Africa", United Nations University, Policy Brief, No. 5, pp. 1-7.
- Nel, E. (2002). "South Africa's manufacturing economy: Problems and performance". In Lemon, A. & C.M. Rogerson, eds., *Geography and economy in South Africa and its neighbours*, (Aldershot, Ashgate).
- Ramos, M. (2005). "Ramos to cut transport cost", *The Star Newspaper*, 5 May 2005.
- Regional Economic Explorer (2006). *Regional Economic Explorer Database*, available at <http://www.globalinsight.co.za>.
- Rodrigue, J., C. Comtois, and B. Slack (2006). *The geography of transport systems*, British Library Cataloguing in Publication Data, New York.
- Transnet (2009). <http://www.transnet.co.za/FreightRail>.