Australian Government

Department of Infrastructure and Regional Development

Bureau of Infrastructure, Transport and Regional Economics

RESEARCH REPORT 139

bitre

Rail

Why short-haul intermodal rail services succeed

Bureau of Infrastructure, Transport and Regional Economics

Why short-haul intermodal rail services succeed

Report 139

Department of Infrastructure and Regional Development
Canberra, Australia

ISSN: 1440-9569
ISBN: 978-1-925401-15-8
March 2016/INFRA2776

Cover photograph: Qube's Deniliquin – Port of Melbourne train, carrying containerised rice products for export, pictured in September 2014. Photograph courtesy of John Hoyle.

Ownership of intellectual property rights in this publication

Disclaimer

Creative Commons licence

Use of the Coat of Arms

An appropriate citation for this report is:

Bureau of Infrastructure, Transport and Regional Economics (BITRE), 2016, *Why short-haul intermodal rail services succeed,* Research Report 139, BITRE, Canberra ACT.

Contact us

This publication is available in PDF format. All other rights are reserved, including in relation to any Departmental logos or trade marks which may exist. For enquiries regarding the licence and any use of this publication, please contact:

Bureau of Infrastructure, Transport and Regional Economics (BITRE)
Department of Infrastructure and Regional Development
GPO Box 501, Canberra ACT 2601, Australia

Telephone: (international) +61 2 6274 7210
Fax: (international) +61 2 6274 6855
Email: bitre@infrastructure.gov.au
Website: www.bitre.gov.au

Foreword

The shipping container has revolutionised freight transport over the last half-century. The container revolution is a pivotal factor in the world growth of trade outpacing growth in output. With goods moving more cheaply and more quickly around the globe, the box has, indeed, "changed the shape of the world economy".[1]

That overwhelming success is bringing challenges. Seaborne trade is funnelled through the ports, which are typically located at the hearts of our cities so landside container movements impact on communities around the ports. Road traffic congestion along those arteries also undermines port efficiency.

In response to these issues, planners and policymakers worldwide seek to transfer box movements from road to rail; and to use rail to shift port activities away from constrained maritime sites. However, road haulage stubbornly predominates in port–hinterland box movements because economics work against operating trains over shorter distances.

That said, in spite of the odds being stacked against the operations, port–hinterland rail services do exist.

In that context, then, this report considers the circumstances that can make short-haul urban and regional rail port shuttles viable and whether the circumstances are able to be replicated. Such insights can then provide guidance on the elements needed to enhance port access operations and port efficiency.

The research was undertaken by Peter Kain, with assistance from Jeremy Dornan, under the supervision of Dr David Gargett. Preliminary research by Lyn Martin and Carlo Santangelo is acknowledged along with comments by John Hoyle, and by Dr Darrell Bowyer. Louise Oliver provided invaluable editorial guidance. While BITRE is grateful for this assistance, the views expressed in this report are those of BITRE and should not be attributed to any other individual or organisation.

Gary Dolman
Head of Bureau
Bureau of Infrastructure, Transport and Regional Economics
March 2016

1 The impact of the container — also known as "the box" — is described in the seminal study by Marc Levinson, *The box. How the shipping container made the world smaller and the world economy bigger.*

At a glance

- Using rail to move containers between ports and the hinterland can reduce road congestion, noise and air pollution. The provision of rail services can also complement the strategy of transferring activities away from constrained port areas.
- Usually, moving containers by truck over short-and medium-distances is far cheaper than using intermodal–rail. Despite this, short-haul rail services do operate, for reasons outlined below.

Why does short-haul intermodal rail work?

- To be sustained, short-haul rail requires at least the following three elements:
  - » minimised road access and egress — drayage — costs between hinterland and intermodal terminal;
  - » low rail linehaul costs and high road costs; and
  - » interest groups with motivations to encourage short-haul and viable hinterland terminals.

How the hinterland terminal helps to minimise drayage costs

- Drayage is minimised when the value-adding activities are undertaken at the hinterland terminal. Value-adding increases the attractiveness of hinterland terminals. In those circumstances:
  - » shippers are encouraged to co-locate around the facility, thereby minimising drayage; or
  - » shippers are encouraged to route their business via the terminal for processing. When that is done the drayage is not considered an element associated with intermodal freight but, rather, a part of the wider logistics task.

Hinterland terminal activity attracts the traffic volumes that lower rail linehaul costs

- Hinterland terminals attract volumes through cargo consolidation and deconsolidation.
- Vibrant hinterland terminals and logistics areas attract international traffic volumes that provide the necessary volumes of containers to capture rail's linehaul economics.
- Hinterland terminals based around large dominant shippers and logistics operators provide the fundamental anchor traffic that is essential for the terminal vibrancy and, thus, for sustainable short-haul rail.

- Large, dominant-shipper flows can enhance individual train volumes, which can be maximised to meet an individual ship, rather than small, multiple-shipper volumes being splintered over several ships.
- Terminal–rail sustainability is enhanced when operations commence with solid mature businesses—especially with a large dominant anchor customer—when traffic flows are steady rather than seasonal and when traffic imbalances (backhaul issues) are minimised.
- Rail linehaul costs can be reduced markedly when the terminal offers a container rehiring service and can attract export custom: cargo in imported containers is unpacked and the container is reused for exports.

Rail short-haul benefits from deficiencies in road haulage

- Rail benefits from unproductive road haulage, such as caused by road and terminal congestion.
- Truck productivity is undermined especially by road congestion over extended distances, as this reduces truck utilisation markedly.

A coalition of agents have an interest in viable hinterland terminals and, hence, short-haul rail

- The report illustrates how logistics systems have fostered a broad group of agents with an interest in developing vibrant hinterland terminals, and with that vibrancy comes sustainable short-haul rail.
- These agents include
  - shippers—that is, growers, processors, manufacturers—requiring good hinterland access and egress;
  - logistics companies working with shippers to manage high-volume consolidation and deconsolidation;
  - port owners, stevedores and shipping lines, using hinterland terminals, with reliable rail connections, to provide a service as a competitive edge and incursion into other port catchment areas; and as a mechanism to shift operations from scarce and inefficient—constrained—port amenities.
  - government and other public agents, to pursue hinterland local development policies, to enhance port environment, and to reduce road and port congestion.

In a nutshell

- Vibrant value-adding hinterland terminals can secure the traffic volumes that are required for short-haul rail to have competitive linehaul costs. That relative competitiveness is strengthened when there are deficiencies in truck haulage. A coalition of diverse interest groups may seek, and thus support, vibrant terminals and complementary rail services.

Contents

List of figures

List of tables

List of boxes

CHAPTER 1
Introduction

A broad set of interest groups promote the mode shift from road to rail for the task of moving freight between the hinterland and container ports. However, container terminal market catchments are largely clustered within the urban area surrounding the port, resulting in relatively short distances between the port and import–export shippers.[2] This makes it more challenging to accomplish the desired mode shift because rail is relatively uncompetitive over those short distances.

Against that background, this report explores the reasons why some short-haul rail container flows between hinterland terminals and ports are sometimes sustained, despite rail's handicaps. The report seeks to inform policy-makers and industry analysts as to the factors that are necessary to initiate and support the rail services.

What is short-haul?

We define short-haul as being a distance that is less than the linehaul distance that intermodal–rail is normally considered viable. As a rule-of-thumb the reader should consider this to be a distance of around 1 000 kilometres, a distance that we refer to as the "sweet spot", where rail's lower line haul costs counter road's advantage of lower drayage and terminal costs.

Box 1 Sweet Spot distance estimates

There are various citations for the "Sweet Spot" linehaul distance, ranging from 320 kilometres through to 1 500 kilometres. For example, the Inter-State Commission (Australia) cited a 350 kilometre minimum distance for shifting containers (Inter-State Commission 1987, p. 61). Similarly, in 1988 Virginia Port Authority was a pioneer of inland ports in the USA, with an inland port at Front Royal (Virginia), operating shuttle trains between that terminal and the Port of Virginia; the rail distance is "just long enough to hit the 200-mile [320 kilometres] sweet spot needed to give rail an advantage over trucking".[3] (Payne 2013, p. n/a) Other suggestions have been that intermodal is viable once the linehaul length approaches 800 miles (1 280 kilometres) or longer. (Prince 2012, p. n/a)

As will be evident from later discussion, there are a range of factors that contribute to the diverse estimates.

2 For example, 85 per cent of containers passing through Port Botany travel within 40 kilometres of the port and 90 per cent of Melbourne's container imports travel within a 50 kilometre distance of the city's port.

We note, therefore, that there are numerous short-haul urban and regional rail flows in Australia and overseas that lie well below this conventional 1 000 kilometres, indeed to distances under 30 kilometres. (See Box 1.) In essence, then, this report considers the factors that reduce the international rail–intermodal sweet spot.

Setting the scene

A theme that runs throughout this report is the appreciation of adoption of the container, the evolution of the intermodal terminal, and the application of logistics systems. Each of these elements is inherently favourable to the use of rail services. Rail transport is demanded as a derivative of other activities; the economics of short-haul rail is driven by the demand for inland (or hinterland) terminals. For this reason the report has a strong emphasis on the rationale for inland terminals and the agents (entities) supporting those facilities.

The container — "box" — has changed the economics of intermodal freight, greatly enhancing the prospects for non-bulk freight, and redefining systems for specialist bulk haulage. With an estimated tonnage of 0.1 billion tons carried by containers internationally in 1980, the task in 2012 was estimated to be 1.5 billion tons.[4] Maybe the container revolution has matured, but the changes wrought are yet to be played out to the full. The following is a succinct verdict on these early years:

> *The container has substantially contributed to the adoption and diffusion of intermodal transportation which has led to profound mutations in the transport sector. Through reduction of handling time, labor costs, and packing costs, container transportation allows considerable improvement in the efficiency of transportation. (Rodrigue and Slack 2013, p. 3)*

Intermodal rail using containers has improved the viability of rail freight. In North America, many flows of non-bulk traffic that were long lost to the road competition have returned to the railways. In making railway services viable again the container has increased options for moving freight with multiple modes; often freight movements are no longer just truckage.

The key characteristic of the shipping container that makes it indispensable to modern international trade is the ease with which goods can be packaged and conveyed across transport modes. This ease provides the prospect that railways can be one stage of a multi-modal flow.

What is of interest in this report is the environment in which rail can be used in multi-modal flows through ports. Our interest is with both regional terminal — port flows and urban terminals — port flows. Regardless of which of these flows are considered, if the port lies in an urban area then both regional and urban terminal flows result in movements through urban areas.

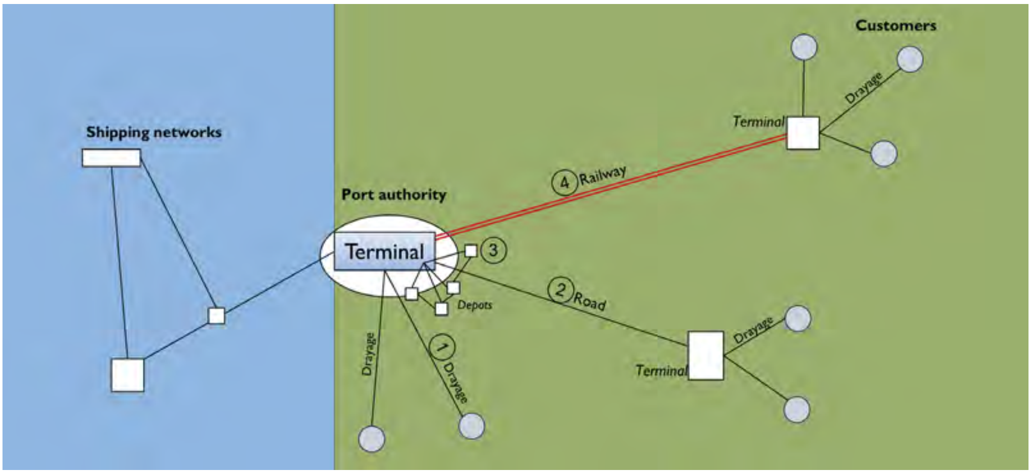
The primary transport links between hinterland and port are illustrated in Figure 1, where the Port of Melbourne linkages are presented. Three out of the four links involve exclusive road

3 A description of this term is provided in the Definitions and abbreviations section of this report. A diverse set of alternative terms are used to describe these facilities, including dry ports, hinterland terminals, freight gateways and freight hubs.

4 http://www.statista.com/topics/1367/container-shipping/ . While the containerisation of trade drove much of the early growth in box usage, the container growth was also driven by, and fuelled, the growth in international trade. (See United Nations Economic and Social Commission for Asia and the Pacific 2007, p. 5.) The more recent growth in moving bulk commodities by shipping containers should also be noted.

movements. This is not surprising as the road-only services would appear to be always superior as the one mode provides a door-to-door service: road haulage clearly has superior distribution. Thus, not only it valid to question the cost-competitiveness of intermodal operation but also whether intermodal can compete on service quality.

Figure 1 Elements in landside operations



Note: The four primary landside transport options numbered here are:
(1) direct link between port terminal and the customer
(2) a road link between the port terminal and an inland terminal, with onwards road links to customers
(3) road-linked container storage, off-hire terminals
(4) rail link between port terminal and hinterland intermodal terminal, with road links to customers.

Source: Based on the original presented in Robinson 2006, p. 51.

Before proceeding further, we should state what we mean by **"intermodal freight"** and why it is used. There is no single, agreed, definition.[5] However we consider the following to be the key features:

- **Use of multiple modes.** Intermodal freight involves using multiple modes. Shifting cargo between road and rail is undertaken at terminals. The physical action of transferring goods between modes results in costs that are not incurred when cargo is shipped door-to-door. Thus the benefit of shifting goods across modes must allow for those transhipment costs.
- **Transhipment costs must be small.** Historically, freight transfers across vehicles/modes have imposed heavy efficiency penalties, leading to lost time, reduced reliability, and increased effort. The use of unit packaging — particularly by bundling the goods so that only one large lift is required rather than the multiple lifts of unbundled goods — has reduced those transfer costs. While maritime transport costs could once have been between five and ten per cent of the retail price, containerisation has reduced this to about 1.5 percent. (Rodrigue and Slack 2013, p. 4) Steady advances in container-handling equipment, with a degree of standardisation of container dimensions, has improved the economics of transferring containers between modes. A contrast in the control of these costs is the break-of-gauge in canal and railway networks. In this context, the non-unitisation of goods

5 See the Definitions and abbreviations section at the rear of this report for a definition of "intermodal".

meant there were very high transhipment costs. This led to those rail services becoming uncompetitive once the road infrastructure and road vehicles improved.[6], [7]

- **Use of unit packaging can ensure that transhipment costs are small.** The cost of shifting goods between modes is highly dependent on simplified unit packaging. Freight can be packaged into standardised unit loads that facilitate the fast, cost-effective and damage-free transfer of the goods between the modes; goods with common origins/destinations can also be bundled. Depending on the form of logistics, the packaging may be a cardboard box, a pallet — with goods being packaged in cardboard boxes or plastic-wrapped — or a container. At the local level, the packaging of the cardboard box and the pallet facilitate transport collection and deliveries. The container provides the equivalent larger-scale packaging. Depending on the pattern of logistics, handling costs might be reduced when bundling at this level rather than bundling at the smaller cardboard box or pallet level.[8] Using standardised box sizes and external-lifting fittings enables the application of simple mechanised loading and unloading systems. That unit packaging (based around square and rectangular units) also enables safe and effective warehouse storage.

Thus, while there is no specific definition of intermodal freight, then, it is associated with multiple modes, transhipment between those modes, and standard packaging.[9]

We define the short-haul task as involving a connection with the "port" or with its "maritime terminal". By and large we use the term "hinterland terminal" to describe the inland facility, while noting that that facility may undertake a range of tasks. Thus, depending on those tasks performed, that hinterland terminal may be known variously as an intermodal terminal, dry port, inland port, inland terminal, freight hub or extended gateway. We use the term "hinterland terminal" except where we wish to make a clear distinction as to its functioning. Beyond the simple mode-transfer functioning, the terminal itself is co-located with storage, processing (including packing and unpacking) functions, as well as logistics tasks for export and for imports (notably, distribution centres).

Finally, in explaining why short-haul rail succeeds, we note once more that the container is now much more than a simple receptacle to shift freight. Its use is now intertwined with value-added activities at hinterland terminals for a broad range of interest groups. As we illustrate throughout the report, the container is now central to a logistics supply chain system, "becoming a transport, storage and management unit". (Notteboom and Rodrigue, quoted in Zumerchik, Rodrigue and Lanigan 2009, p. 60) This evolution reflects the change in the role of hinterland terminals themselves. They have evolved from simple box transfer points, to complex organisation systems (such as warehouses, export-assembly nodes, and import distribution centres) undertaking a broad range of services.

6 For example, the South Australian Railways had multiple breaks-of-gauge. In the 1930s the SAR used containers to ease transhipments at the Wolseley break-of-gauge, for its Adelaide–Mount Gambier traffic.

7 BTRE 2006 (p. 19) introduced the concept of "bridging costs", which arise because each wagon's goods normally has to be transhipped in a laborious fashion. The aggregate operating costs are typically higher with higher volumes and with less mechanisation. While technical solutions may be possible, they may involve high capital costs.

8 While the economics of handling seem to suggest that shifting non-bulk goods will be undertaken by container, this should not be presumed. Depending on the situation and the complex economics, palletised goods will be conveyed in conventional rail or road equipment rather than in containers. For example, in Australia in rail freight, SCT Logistics and Sadleirs Logistics typically move goods in vans, not in containers.

9 For intermodal-rail operations there are two primary forms of goods transfer systems: containers, which is the focus of this report; and rail's conveyance of part or all of the road vehicle itself—that is, the trailer or the trailer plus prime-mover—as a "piggyback" movement. The European definition of a piggyback movement usually relates to circumstances where the prime-mover (that is, the full truck) is shifted as well as the trailer. We make no specific distinction between these operating practices.

Figure 2 Regional intermodal train between Griffith and the Port of Melbourne

Note: Pacific National's Griffith to Melbourne intermodal service on the outskirts of Leeton. This service normally operates five days a week and hauls products such as wine and rice for export through the Port of Melbourne.

Source: Photograph courtesy of John Hoyle.

The structure of this report

The body of this report is comprised of three primary components: trends and strategies, land haulage economics, and motivations for the intermodal systems.

The first component reviews the freight trends and subsequent policy and commercial strategy responses.

In the second component we look at the economics of land haulage, looking at intermodal–rail and road haulage and then specifically at the port landside haulage economics. For intermodal–rail the economics are defined by the costs arising from the three core intermodal tasks:

- drayage — this being the term used to denote the local road haulage of the container between warehouse or distribution centre and the rail terminal, or between the maritime terminal and the rail terminal;
- terminal handling; and
- linehaul movement.

The factors that determine the costs and efficacy of each of these tasks is then considered and then applied to interpreting the report's case studies (Appendix A).

The third component of this report considers the different agents in the supply chain and how they are motivated to use and develop intermodal systems.

The report then has a chapter that outlines the key findings as to why short-haul rail services are sustained. A series of supporting appendixes are supplied. The first appendix sets out a number of case studies of experiences of rail services between hinterlands and ports. Appendix B sets out the development of container systems and the trend to logistics. In Appendix C there is a review of past and present public schemes to develop intermodal–rail in Australia, Great Britain and the USA. Appendix D presents an overview of findings from port–hinterland link inquiries that have been undertaken in the last decade. Finally, in Appendix E, we present maps showing the port–hinterland terminal links in each State.

CHAPTER 2

Freight trends and policies

Key messages

- In the last half-century the international container traffic has all-but-replaced traditional non-bulk freight movements. Containerisation has been integral to the now-pervasive logistics supply chains. The container has also been a lifeline to non-bulk rail freight, with intermodal movements providing competition with road freight.
- The rising size of container ships has delivered substantial savings in hauling containers between ports. Such benefits can be readily offset unless landside container handling efficiency is also improved. Indeed, unless those landside issues are resolved then port activity can be choked, adversely affecting the national economy.
- Port activity also adds to road congestion, to noise pollution and to vehicle emissions around the port and road corridors to the port.
- Government and port entities have therefore pursued policies to improve port efficiency while shifting the ever-increasing volumes, from road haulage onto rail.
- Rising box volumes have led to port land becoming increasingly scarce. This has led to some activities being shifted to hinterland terminals located some distance from the port. The key to this report is that the terminal activities can generate consolidated traffic volumes that are consistent with sustainable rail operations between the facility and the port.
- Intermodal terminal operations in the port hinterland have transformed from being simple transfer points between modes, to being vital zones of diverse logistics activities.
- Port owners, stevedores, shipping lines, logistics companies, freight forwarders, shippers and railway companies represent a broad spectrum of entities whose self-interests support viable hinterland terminals.
- That hinterland terminal viability supports, and is supported by, complementary rail services. Indeed, it is the viability of the hinterland terminal zone that drives the sustainability of the short-haul rail service.

In this chapter we consider the changes in the business environment that have altered the sustainability of maritime short-haul rail services. These changes have generally been favourable to operations—or at least not adverse to rail conveyance. Equally, the trends increase the impetus for such rail services to be undertaken.

Trends

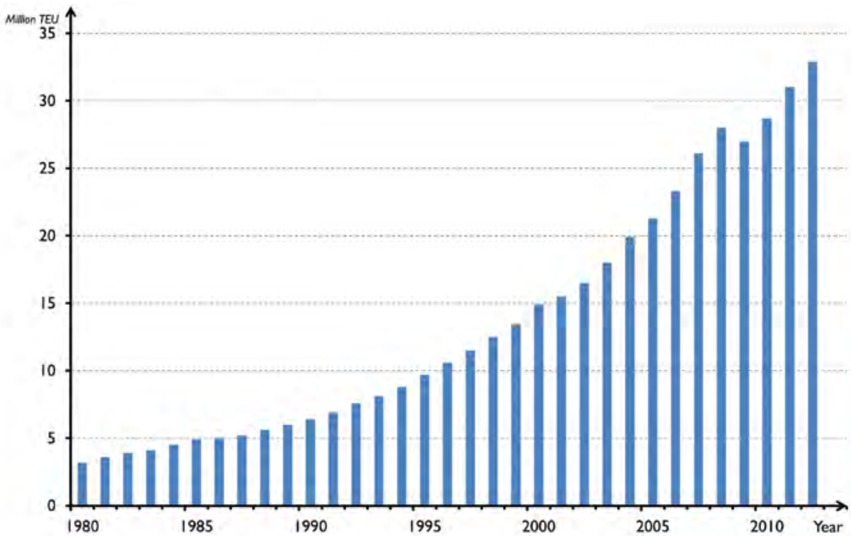
Some changes to the freight market that are country-specific are not considered here. For example, road freight patterns and competitiveness in the USA have been influenced strongly by hours-of-work reforms, which have reduced truck drivers' maximum hours of work.[10]

The general trends are presented here as discrete issues but in reality they are complementary trends (such as logistics and containerisation) as well as causal trends — such as the impact of larger vessels on the need for efficient hinterland links.

A. Introduction and use of unitised freight: containers and pallets

The container, and the logistics systems that rely upon it, has been adopted because conveying goods in the box is less costly than the alternative break-bulk systems. While the magnitude of cost reductions arising from the adoption of the container is unclear, those costs must be consistently lower given the near-universal adoption of containers for non-bulk shipments. Gans concluded that improvements in output per worker hour "have been phenomenal" and notes reports that the output increase "at over fifty times pre-container levels". The savings of the task of loading and unloading of cargo in a standardised box has driven the cost savings. (Gans 2006, p. 3)

Figure 3 World container fleet, 1980–2012



Source: SEC 2014, p. 82.

10 The USA's Federal Motor Carrier Safety Administration oversees the Hours of Service Regulations, https://www.fmcsa.dot.gov/regulations/hours-of-service

Echoing that uptake of containers, the world container fleet — which was essentially non-existent before 1956 — has grown dramatically in the last quarter-century, as illustrated in Figure 3.

The unitisation of freight has developed around the container, but also on the parallel — and complementary — growth in palletised cargo. In an ideal world pallets should fit inside international containers like a Russian nesting (matryoshka) doll. Arguably, the logistics industry is yet to converge the diversity of pallet sizes to an optimal level, and certainly not to sizes that optimise space within international containers[11]. See World Bank 2005, DOTARS 2002.

The value of unitised freight to rail, based around the container, is that it facilitates door-to-door services, what is otherwise the Achilles heel of its service quality: shifting goods between rail and road is far more efficient with containers than with unbundled cargo. The growth in container movement has improved the prospect for shippers using multiple modes in conveying freight. This means that rail may be chosen, in an environment where otherwise truck attributes would almost always be preferred. Particularly since the Second World War the industrialised western countries have developed good road networks to complement high-performance trucks. The truck is generally highly suitable for land-based domestic freight distribution, giving excellent door-to-door service, using rigid and curtain-sided vehicles with palletised non-bulk goods. Rail can still compete in the palletised domestic freight market. An example of this is the success of the SCT Logistics "model" of palletised rail freight—but this is usually movement over longer distances and using strategic bundling of the commodities conveyed.

Because seaborne unitised freight is usually containerised, rail is more competitive in the multi-modal market. This applies to maritime container movements such as international containers, and to Bass Strait (mainland–Tasmania) traffic. The trend to greater containerisation of goods — both non-bulk and bulk — has therefore been relatively favourable to rail.

Figure 4 Empty containers stack

Source: Photograph courtesy of Brad Hinton.

11 Even amongst the six ISO-standard pallet sizes, the wasted floor space within a 40 foot ISO container ranges from 3.7 per cent for a North American (1.016 metres wide by 1.219 metres long) pallet to 15.2 per cent for a European pallet (with dimensions of 0.8 metres wide by 1.2 metres long). See http://www.uship.com/ultimate-freight-guide

B. *Falling unit transport costs*

A wide range of factors has contributed to the decline in unit transport costs.[12] Clearly, the container itself is a critical factor that has brought about that decline. The consequence of this decline has been the growth in trade generally, and in spurring the development of international logistics systems. Following this has been the development of discrete production and warehousing centres, with greater distances between the centres and with additional interaction between the centres: this has led to increases in consolidated cargo flows.

C. *Container traffic levels*

The development of containerisation since the 1960s has been favourable to intermodal–rail. The adoption and universal use of the container both facilitated and propelled the surge in international trade and, hence, increased ports' activity. Since the early 1990s, the rate of container traffic growth has been almost three times the growth rate of world GDP.

The wave of container traffic through sea ports is mirrored by land flows of those containers, with road freight generally capturing most of the landside mode-share. Nonetheless, with strongly-growing port throughput, some of the extra freight flows will be suitable for rail even if rail captures a shrinking proportion of a larger volume.

D. *Growing vessel size*

Accompanying the growth in containerisation has been the increase in container ship size: the average size of container ship delivered in the early 1970s was 900 TEU compared with a 2003 order book average of 3 100 TEU.[13] (Stopford, 2002, p. 2). A related measure is that the average container ship size, measured in dead weight tonnage, has risen by over 90 per cent between 1996 and 2015 (OECD 2015, p. 16).

Management at the Port of Long Beach note that it is the "cargo surges" that is the manifested trend arising from the larger vessels. With these large vessels being operated by carrier alliances, it means that the ships are moving in containers of multiple shipping lines; the result is that it is more difficult for containers to be block-stowed on the vessel. This trend is leading to less systematic discharge of boxes and, so, more challenging landside distribution. One implication is that, in handling and sorting those higher volumes, it becomes more challenging to use on-dock rail facilities on constrained sites.[14] (Mongelluzzo 2015, passim)

Rail is inherently more suited to large clusters of traffic as the individual vessel flows are more likely to involve volumes of individual collections or deliveries that are at sizes suitable for the high volumes required by rail. Offsetting this, the increased randomness of unloaded (import) boxes that results from larger vessels will work against the assembly of large trains. (Mongelluzzo 2015, passim)

12 See, for instance, OECD/ITF 2011, p. 38.
13 Twenty-Foot Equivalent Units.
14 See Box 20 for a discussion of the terms "on-dock", "near-dock" and "off-dock".

E. *Intermodal freight*

The perception today is that containerisation equates with intermodalism. However, the initial development of containerised maritime containers was largely detached from landside activity. As noted by Muller,

> *The first decade of the container revolution constituted mostly just that—a container revolution, with few land–sea intermodal aspects. Intermodality was confined primarily to local pickup and delivery of containers by trucks. (Muller 1999, p. 27).*

"There are certain lanes where a railroad can perform at near trucklike service. Before, shippers were forced into those intermodal situations. But now they're finding they can bring good value." Bill Matheson, Schneider National, in 2005 (USA's second-largest road haulier) (Cited in Shultz 2005, p. 1)

The subsequent pattern has been for a greater linkage between container volumes and intermodal usage. Indeed, as noted elsewhere here, the greater volumes and capacity to consolidate that have arisen with the growth of international container traffic, has facilitated rail–intermodal operation.

Figure 5 The world's first purpose-built container ship, Australia, 1964

Note: The photograph shows a container being transferred between a truck and the MV Kooringa, the world's first fully cellular purpose-built container ship. The Kooringa operated between Western Australia and the Eastern States.

Source: Photograph courtesy of National Archives of Australia. Reference: NAA A1200/18, L47969.

F. *Containerised bulk freight*

A development in uptake of containerisation has been to use the box to convey bulk commodities. Such commodities include raw and processed agricultural output (cereal crops, sugar, malted barley, stock feed — hay — and wood items) and even ores and minerals. This trend has arisen for a number of reasons:

- transient high tariffs for conveyance by bulk vessels.
- specific ports may have equipment for handling containers but not for handling bulk commodities.
- the box can be used to shift relatively small quantities of specific commodities or specific classes or qualities of commodities, such as specialised cereal grains.
- the box can be used for conveyance for small suppliers and customers.
- the box provides a secure form of transfer and it is complemented by ready transfer between the maritime and landside modes.
- the container may be available for backhaulage, for instance if it has entered the country full and would otherwise leave the country empty.

Rail is suitable for hinterland haulage where there are large, consolidated freight movements between an inland centre and the maritime port. This is more likely to arise where containerised bulk freight is moved than with containerised non-bulk goods, the latter more likely involving goods that are more dispersed. Indeed, some containerised bulk goods arises because it opens the opportunity for intermodal rail haulage. Russnogle (2008, p. 81) provides an example of where containerised handling of grain has opened new markets and that the ability to handle the goods using nearby rail facilities and in shifting small quantities.

Figure 6 Grain containerisation, Coonamble, NSW

Note: The photo shows a vertical inverter for packing grain in containers. The grain storage silos are on the left side of the picture. To the right of the silos is the inverter, with grain being loaded into the upended red container. The loading involves installing a false bulkhead within the container to prevent leakage of the grain through the container doors and to support the stowed grain independently of those doors. (Shipping Australia 2012, pp. 3, 6.)

Source: Photograph courtesy of John Hoyle

G. Industries consolidation

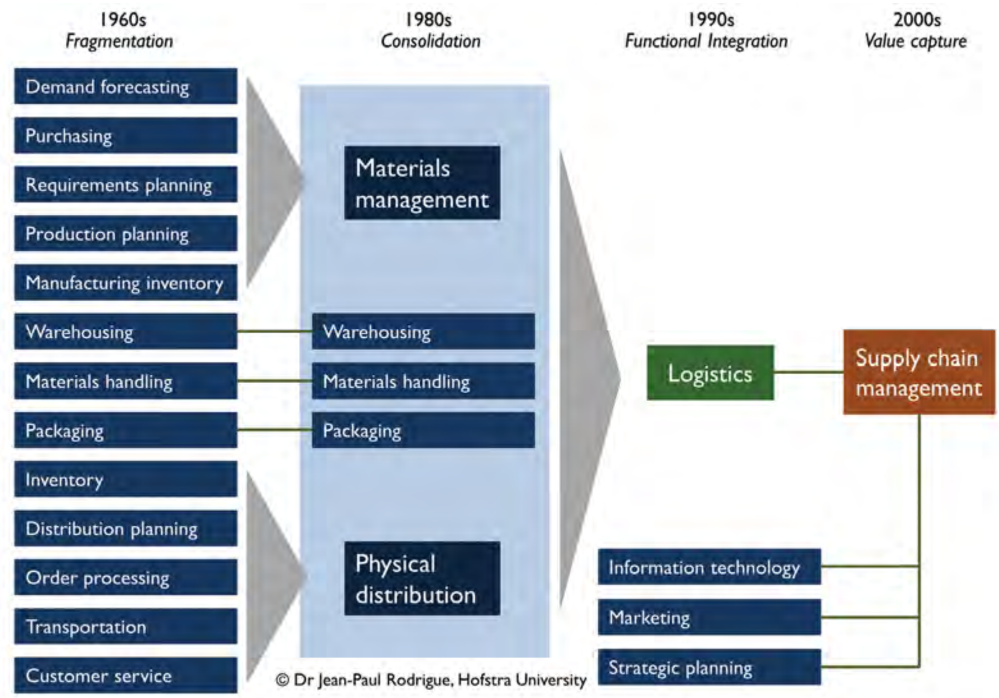
To some extent, industry has moved in paradoxical directions: deconsolidation as well as consolidation. The deconsolidation has arisen with the specialisation of manufacture and services. The consolidation has arisen in terms of the scale of given manufacturing and distribution activities. Trends in ownership of these activities have moved in the direction of consolidation. Decisions on movements of volumes are more likely to be made by fewer and larger organisations. These include terminal providers, carrier groups and third-party logistics providers. (Notteboom 2010, p. 569)

As before, to the extent that centres of activity are consolidated, this lends itself towards the high volumes to which rail is suited.

H. Logistics

Since the 1950s, three important elements have converged to bring a revolution in the way that products are planned, developed, manufactured, distributed, and retailed. The all-embracing term for this system is "logistics". The pattern and trend in this evolution is illustrated in Figure 7, from Rodrigue (2013). With transport being a derived demand of this broader logistics system—and certainly not a free-standing operation—it means that there will be a need for changes in relationships in transport operations.

Figure 7 The trend to logistics systems



Source: Redrawn from Rodrigue 2013—copyright.

As noted by Rodrigue, the result of the convergence of erstwhile fragmented activities is that:

> *…all the elements of the supply chain became part of a single management perspective. However, only with the implementation of modern information and communication technologies did a more complete integration become possible with the emergence of supply chain management. It allows for the integrated management and control of information, finance and goods flows and made possible a new range of production and distribution systems. (Rodrigue 2013, p. n.p.)*

The principal feature of the new production system is disintegrated production (replacing integrated production at a single location). "Each supplier, specializing in a narrow range of products, could take advantage of the latest technological developments in its industry and gain economies of scale in its particular product lines." (Levinson 2006, p. 265)

The shift to this system has been achieved with three key developments:

- information technology;
- deregulation of transport in the USA (see below, p. 51); and
- in the complementary embracing of containerisation systems.

The information technology provides the linkages between the separate productions, in the transport flows that link those components, and in the distribution systems that accumulate and disperse the products. Levinson proposes that the precision needed for such flows would have been unattainable without containerisation. (Levinson 2006, p. 267)

Some elements of the logistics revolution work against railways. The system works on time minimisation and on reliability—the latter being exemplified by the system's mantra of low product inventories using "just-in-time" deliveries. Railway services generally offer less frequent and longer transit times and tend to be less reliable—particularly relative to truck time and reliability.

However, new production and distribution systems can favour rail operation, particularly where freight is consolidated at major nodes, with large consolidated flows between those nodes. Freight distances between nodes are also longer.

Those freight consolidations work in favour of rail, where economies of density in train operation, and in track infrastructure, can bring about cost-competitive haulage.

Consequences of the trends

The trends in international trade and handling patterns have consequences for the organisational and physical linkages within the supply chain, and between that supply chain and the wider transport system. The major changes are summarised below.

A. Railway economics

As noted, the trends in freight systems and freight volumes have generally been favourable to railway economics, reliant as it is on large regular volumes between transport nodes. The development of the container as a universal freight receptacle spurred greater intermodalism and this has enhanced railway economics, reducing non-linehaul costs and exploiting rail's linehaul economics:

> *Intermodalism maximizes efficiency by exploiting the comparative advantage of each of the modes in handling different types of freight movements (e.g., line haul versus pick-up and delivery). Each transfer, however, interrupts the flow and introduces inefficiencies into the system. The virtue of container transportation is that by simplifying and speeding up the cargo-handling process at each transfer point, it minimizes these interruptions and restores as many efficiencies as possible. [The unitised and modular container]… lends itself to mechanized, even automated, handling. It is this standardization and mechanization that has vastly improved the efficiency with which ships, trains, and trucks, as well as terminals and warehouses, are loaded and unloaded and cargo is transferred from one mode to another. … The combination of containerization and intermodalism had been synergistic—containerization increased the feasibility of intermodalism, and intermodalism helped containerization achieve greater efficiency. Transportation Research Board 1992, pp. 12–13.*

The vital aspect here is that the international shipping industry's use of the container has spurred processes and volumes suitable for relatively low-cost use of multiple modes, including railways.

B. *Organisational structure*

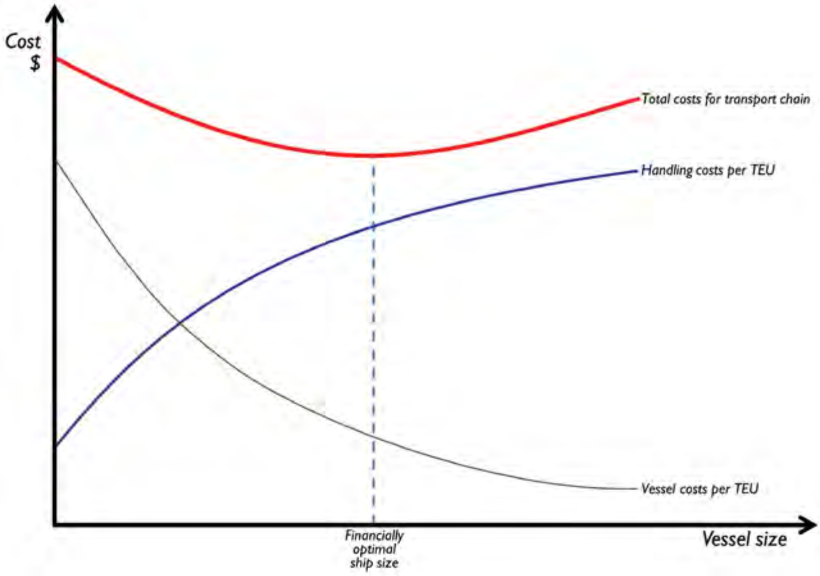
The aforementioned logistics trends have resulted in increasing importance of physical and organisational links within the supply chain, notably between supply chain players in the hinterland. Logistics requires a greater degree of interplay or interaction between players within the supply chain, rather than the discrete and uncoordinated actions that previously existed. The result is large organisational structures with disparate production, storage and distribution systems.

C. *Physical systems*

As vessel sizes increase, the vessel costs of moving containers have been falling — vessel economies of density. Conversely, the overall pattern is for dockside and hinterland handling costs to rise in response to larger vessels. This is illustrated in Figure 8. The overall direction of the trend in those schematic costs is generally not debatable even if we can debate the precise scale at which the break points (inflections) occur.

The consequence is a presumption to upward trends in landside handling costs; we should note that these are financial costs, not economic costs, and so externalities imposed by landside handling (such as road congestion) are not considered. The handling costs consist of dockside handling costs and the more general maritime handling costs; and the transport costs between maritime terminal and the hinterland origin or destination. As shown in Figure 8, the increase in the hinterland handling costs as vessel size grows will ultimately outweigh the economies of density of larger vessels.

Figure 8 Schematic relationship between vessel size and overall transport costs



Source: Based on OECD 2015, p. 19, which was derived from the original in Jansson and Shneerson 1982, p. 224.

The impact of the trends is to place increased importance on landside efficiency. Anderson notes that Australia has relatively low integration of its production activity into world supply chains, noting that the country has "imported inputs contributing less than 10 per cent of exports by value, the lowest level of global integration" in an OECD survey. One reason that Anderson ascribes for this difference arises from "inefficient landside connections to our ports" (Anderson 2013, p. 90).

As container vessel sizes grow — the largest examples of the new-generation builds being dubbed "mega-ships" — landside bottlenecks rise and this has costs for the logistics chain as well as the wider community and economy.[15] These larger vessel sizes results in stronger hinterland container flows, however, which improves intermodal-rail opportunities (subject to available rail capacity).

> *A typical mega-ship call is associated with a large volume of cargo that has to arrive or leave the port. This could provide opportunities for modal shift from trucks to rail or inland waterway transport, considering the volumes that can be consolidated. (OECD/ITF 2015, pp. 56–7)*

D. Externalities

The increased freight task and the broader logistics industry activity generate adverse effects on the wider community. Indeed, the increased container shifts are cumulative with other, concurrent, changes. These are changes in levels of personal and commercial travel activity, and residential and retail developments.

Cumulatively, increased landside freight and residential activity have had consequences for traffic congestion, particularly near the port and on arterial roads linking the hinterland with

15 See Franc and Van der Horst 2010, p. 560.

the port. Increased port activity has also resulted in higher levels of air and noise pollution around the port. This affects neighbouring residential developments.

E. *Port functioning*

With rising port throughput, the landside freight activity has increasingly created its own congestion within the port precinct. Similarly, the efficient functioning of the ports can be compromised when increasing port activity is constrained within a finite area of adjoining land. Technological systems can be applied to manage the activities within the site but such solutions can require considerable financial investment.

Functions at and around ports have expanded and Paixão and Marlow argue that competitive ports play a key role in the development of international logistics. (Paixão and Marlow 2003, p. 357) A consequence of ports' expansion (intended or otherwise) into logistics is that the "ports' operations demand high coordination, as what used to be simple loading and discharging operations have become very complex ones". (Paixão and Marlow 2003, p. 359)

Thus, if port functioning is compromised by land constraints and high land prices, then there are incentives to look inland to lower constrained and priced locations, especially where those sites have supplementary activities that improve overall supply chain functionality.

F. *Hinterland terminal functions*

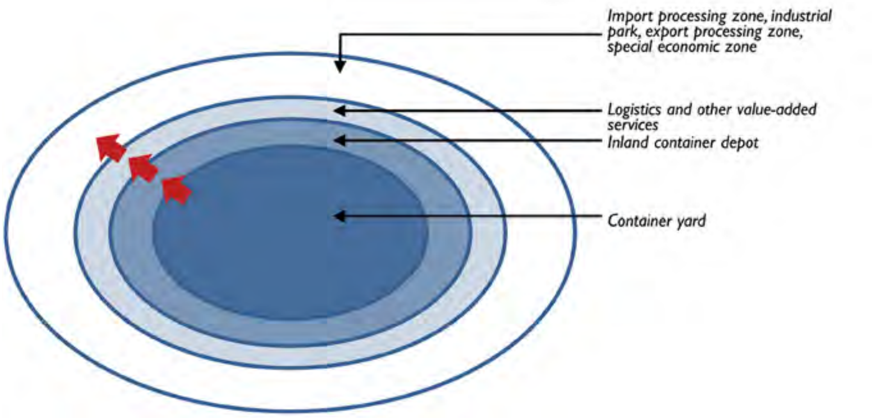
As noted earlier, evidence from around the world suggests rail–intermodal's minimum viable distance, or Sweet Spot, is 1 000 to 1 500 kilometres. This is what is required for the combined freight movements of trucking a box to a terminal, then the rail haulage and finally a second truck move.

Thus far, this report has assumed that the role of the terminal is based simply around the transfer of the box between road and rail modes. As with port functions, the development of logistics systems often means that activities in the hinterland terminal precinct involve considerably more than modal transfer.

Indeed, it is essential for us to invert the discussion, to see short-haul rail as the derived demand. That is, the demand results from the operation of a hinterland terminal rather than the short-haul operation justifying the provision of the terminal. When seen in this light, the sustainability of the short-haul rail service is driven by the hinterland terminal.

The agents (or interest groups) seeking viable hinterland terminals consolidate traffic and use railway services to shift those volumes between hinterland and port. As we have noted in this report, the maturing of logistics systems has widened the role of the hinterland terminal. It has gone from being simply a ramp to move boxes between road and rail, to where the hinterland terminal and adjoining entities fulfil multiple tasks. This is illustrated in Figure 9, which illustrates the broadening role of the hinterland terminal zone.

Figure 9 Evolution of hinterland intermodal terminal zone



Source: Derived from a United Nations Economic and Social Commission for Asia and the Pacific report, reproduced in Beresford, Pettit, Xu and Williams 2012, p. 75.

Generally, the intermodal terminal has evolved from a simple stand-alone location to transfer boxes between road and rail, to an extended zone that has taken on additional logistics tasks, which sometimes include port-related activities such as customs and quarantine. Reflecting this change is the growth in agents seeking to encourage terminal viability. Broadly, these entities have grown to include:

- port owners;
- shipping lines;
- stevedores;
- logistics companies, freight forwarders and shippers; and
- train or railway operators.

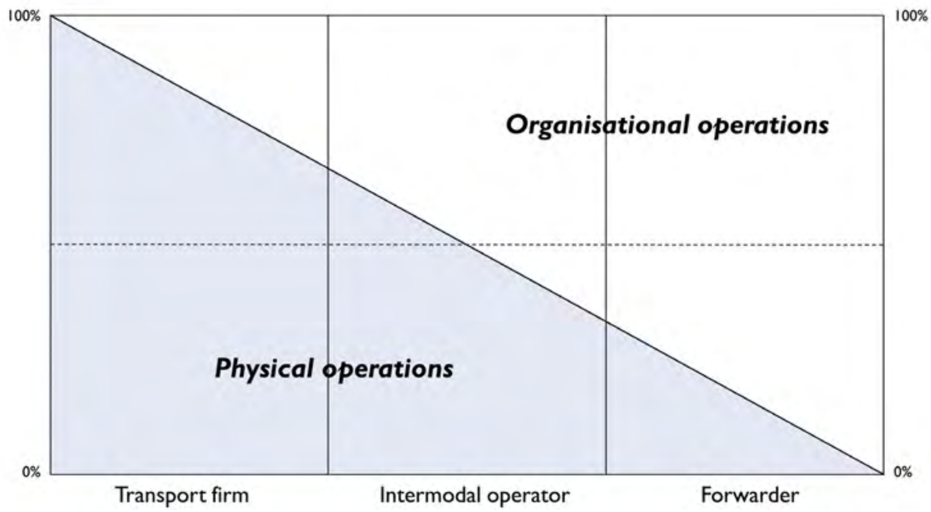
Beyond these operational entities we can add governments and councils, seeking viable terminals to the benefit of local enterprise, and to achieve mode shift for port links for the economic benefits previously stated.

Multiple players are involved in logistics operations. The dramatic growth in international trade—facilitated and driven by containerisation—has increased the number of parties involved in freight movements. Logistics companies — such as intermodal operators and freight forwarders — add value as much, or more, from their organisational roles in linking the transport stages as from moving the goods themselves. This is illustrated in Figure 10.

Ducreut and van der Horst argue that intermodal operators exist in order to overcome different forms of transport separation such as separation in time, space and ownership (Ducreut and van der Horst 2009, p. 126). The freight forwarder takes this organisational aspect to a further stage, organising the movement of goods between door-and-door. Ultimately, as a "4PL" entity, that forwarder undertakes none of the transport task itself.[16] With these latter entities, then, the operator or forwarder is somewhat mode-blind, organising a given path based on time, cost, reliability and security.

16 A "4PL" is a Fourth Party Logistics provider—see Definitions and abbreviations, p. 179.

Figure 10 Role and task of freight firms



Source: Redrawn from an original figure presented in Ducreut and van der Horst (2009, p. 126).

Ports and shipping lines sometimes offer an integrated maritime and landside capability to enhance their competitiveness. Shipping lines have introduced rail shuttles in Great Britain with this objective. Mærsk Line established its own intermodal train operation, ERS Railways. Then, in 2013, Mærsk entered into a long-term haulage contract with Freightliner Group when the latter acquired the train operation. Mærsk also owns its own terminal operations, APM Terminals, providing maritime and inland facilities. A related example is the long-term rail-haulage contract between Freightliner (UK) and the Mærsk shipping line. Mærsk offers dedicated rail services for its shipping containers between the port at Felixstowe and the inland terminal at Widnes, a distance of around 320 kilometres. (European Railway Review 2011) A similar long-term haulage contract exists between Freightliner and the Orient Overseas Container Line, OOCL. Crucially, however, such operations are viable only if the maritime logistics provider — in this case, Mærsk and OOCL — are sufficiently large as to garner the levels of container movements that can justify the regular train services. Large operators also have the advantage of being able to negotiate the best terms in their negotiations with train service providers. (Gouvernal and Daydou 2005, p. 569)

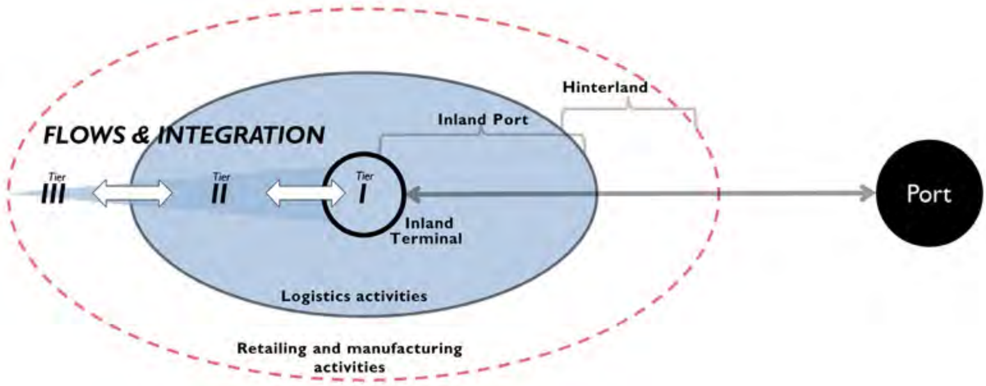
The port and shipping-line involvement in landside activities also includes involvement in the related inland terminal, "in order to control and optimise a larger part of the intermodal transport chain". (Woxenius, et al, 2004, p. 7) The Virginia Inland Port, at Front Royal, 330 kilometres from the Port of Virginia, is one such example. It has been consciously developed by the Port to increase the hinterland of the port. (Woxenius, et al, 2004, p. 10) A similar strategy is evident for the Port of Tauranga in New Zealand, which is considered further as a case study in Appendix A. The Front Royal container flows are supported by nearby distribution centres that have developed in response to the terminal.

What are the circumstances that lead shippers and freight forwarders to channel their goods through an intermodal terminal? Two broad responses can be given. First, an intermodal terminal is used because a break of mode is physically necessary. The best example here is of the maritime intermodal terminal. For instance, to shift goods from Asia to Australia requires the use of a ship. When the goods arrive at the port in Australia, a maritime intermodal terminal is used to convey the goods onwards to their inland destination— which can rarely be reached by that ship.

The second reason why shippers and freight forwarders shift their goods through an intermodal terminal is that it is the most cost-effective option, for logistics purposes, such as consolidation/deconsolidation of contents. This chapter concentrates on this second reason and seeks to establish the principal circumstances that lead to intermodal terminals being the most cost-effective option.

The focus here is on situations where at least one of the modes serving the terminal is the train. The chapter considers the parameters that determine whether the train is the most cost-effective mode.

Figure 11 The functional relations between hinterland terminals and their precinct



Note: Tiers I, II and III relate to the transport, supply chain, and hinterland manufacturing and retailing activities.
Source: Based on Rodrigue, Debrie, Fremont and Gouvernal 2010, p. 521.

Figure 11 illustrates the functional linkages between the hinterland terminal and the adjoining precinct.[17] Three tiers of functions, or activities, are presented:

- **transport functions** [Tier I] are the hinterland terminal activities. Those functions vary. The terminal may be a satellite terminal located relatively near the port and has low value-added functions, such as an empty container terminal and other activities that might otherwise occur at the port. The terminal may be a load centre, where goods are consolidated or deconsolidated and linked to the port by rail. Finally, the terminal may be a transmodal terminal, where goods are transferred between rail services.
- **supply chain functions** [Tier II] are serviced by the transport functions, where an array of value-added (logistics) activities is performed. Such activities include consolidation and deconsolidation, transloading, temporary storage (or inventory management) of goods, and light transformations of the goods (such as packaging, labelling or customisation of goods to national, cultural or linguistic market characteristics).[18]
- **hinterland functions** [Tier III] are retailing and manufacturing activities within that hinterland that are handled/processed/managed by the second-tier logistics activities and flowing

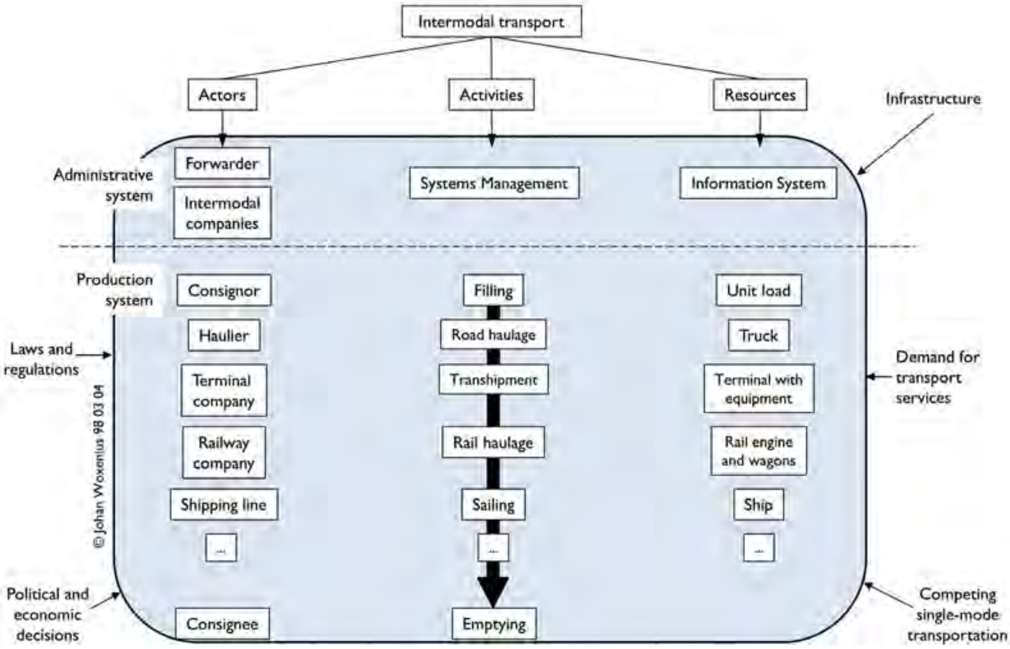
17 The concepts outlined here are drawn from Rodrigue, Debrie, Fremont, Gouvernal (2010), and these authors use the tier concept outlined by Wakeman (2008).
18 See Definitions and abbreviations for an explanation of this term.

> through the hinterland terminal. (Rodrigue, Debrie, Fremont, Gouvernal 2010, pp. 520–22 *(passim.)*)

Crucially for short-haul operations—where there are extensive supply chain functions around the hinterland terminal—that co-location minimises the drayage costs between the transport-terminal activities and the logistics activities.

Woxenius (1998, p. 96) has developed an illustration that presents the inter-relationship between the actors, activities and resources involved in intermodal transport—see Figure 12. Intermodal involves somewhat more actors, activities and resources than involved in a direct road transfer. The need for coordination of tasks — including that of timely and consistent investment — is evident.

Figure 12 Actors, activities and resources in intermodal transport



Source: From Woxenius (with slight re-wording) 1998, p. 96.

Policy objectives and commercial strategies

Government policies and commercial strategies have responded to these freight and logistics trends. The responses include the uptake and growth of containerised traffic, the increasingly lumpy hinterland flows (as vessels have got larger) and the altered patterns of production and distribution.

In response to these trends, governments and commercial entities have sought to:

- reduce the adverse externalities—traffic, and air and noise pollution—associated with port activity;
- increase the beneficial externalities—for example by enhancing links with international trade links—associated with port and hinterland port activity;
- to use the hinterland facility to divert industrial and warehousing usage from sites where land could potentially be used for potentially more valuable uses.[19]
- capture train and railway haulage business;
- increase hinterland terminal throughput, by third-party terminal owners;
- use hinterland terminals as a competitive strategy to expand catchment and service quality — shipping lines, stevedores, ports; and
- improve the supply chain efficiencies, ensuring that appropriate levels and forms of hinterland transport provision are consistent with new supply chain systems.

19 See, for example, NZIER 2015, p. 34.

There is a range of approaches that can be adopted to achieve these objectives. However, a common approach is to foster hinterland terminals and complementary rail services.

From the late 1980s railway reforms have sought to foster on-track competition, either by train operators offering competing freight services, or by train operators competing to win specific long-term haulage contracts. The opportunities for new train haulage operators to enter the industry is likely to have increased the responsiveness of the railway industry to policy change and to commercial opportunities. Deregulations of rail, road and shipping activities in the USA have provided business flexibility.

Governments may also use regulations to pursue efficiency goals. In some countries, governments have regulated the rail industry structure, notably by legislating the vertical separation of train and infrastructure activities. This is complemented by new regulations that mandate terms on open- and third-party access. These regulations, and railway privatisations, have brought additional parties into the logistics task that have broadened the opportunities for new maritime–hinterland transport systems.

Sometimes government may regulate to achieve goals when it perceives that there is market failure that prevents the competition that would lead to a fair price. For example, this arose when the stevedore, Patrick, raised its rail service charge at Port Botany from $15 per container lift, to $42 per container lift. Already, in the previous year, Patrick had raised that charge from $10, to $15. In capping the charge for stevedores' rail lifts at $15, the government concluded that "…an optimal price was not likely to be achieved through reliance solely on competition". Stevedores would also be given a productivity incentive—a payment of $30 for every lift over 36 lifts per hour, as well as a required minimum rate. In evaluating the impact of the regulation it was noted that a benefit would be to prevent a shift away from using rail. (Transport for NSW 2012, pp. 21, 34–35)

Governments identify rail haulage as a way to alleviate the tensions between port vitality and the negative externalities generated with that activity. For example, NSW Ports' Master Plan for the next 30 years relies on rail having a much-increased role in hinterland transport with the increased container throughput. (NSW Ports 2015) In this case, if containers can be railed then it transfers short- and longer-haul freight from road. It is unsurprising that an emerging trend in cities across the world "…has been the significant focus on increasing urban rail freight as a key aspect of a general traffic congestion remedial approach". (Booz Allen Hamilton 2006, p. 28)

In a related way, port entities also see rail services that link ports with hinterland terminals as an efficient method that ports and container terminal operators can use to transfer port activities to the hinterland. Similarly, rail services can form part of the strategy for linking logistics operators' production and distribution centres with the port.

The efficacy of policies to transfer freight from road to rail, or to shift activities away from the port, has fundamental implications for wider community acceptance of the port activities and for port vitality itself. Indeed, the expansions of the San Pedro Bay ports (the Ports of Los Angeles and Long Beach) are conditional on significant reductions in port-activity pollution:

> *Port expansion is largely frozen in Los Angeles/Long Beach, for example, until levels of particulate pollution from trucks are significantly reduced and air quality improves in the city because of the risk to health from pollution and the perceived contribution of port activity to the problem. (Brooks, Pallis and Perkins 2015, p. 27)*

Governments and port operators pursue rail-based container flows, but their success should not be judged on the basis of relative rail mode shares, which is heavily dependent on port catchment characteristics. Rail is more successful in capturing port traffic when that port has an extensive catchment area with concentrated flows to distant areas. Again, the San Pedro Bay Ports illustrate contrasting outcomes:

- The Ports succeed in capturing long-haul rail access–egress traffic because there are considerable long-distance container flows, particularly to Chicago—well beyond the Sweet Spot. These relative railway strengths have been pursued in the USA since the turn of the century: railway corridor upgrades have been undertaken with the financial backing of a range of entities — with different motivations — to pursue these long-distance linehaul train economics.[20]
- The Ports fail in capturing short-haul traffic. There is considerable road volumes between the Port and the Inland Empire, 80 kilometres inland from the ports of Los Angeles/Long Beach. This large flow has encouraged policy makers to pursue the idea of shuttle trains along the same corridor.[21] (Ashar 2004, p. 60) As is discussed in Appendix A, however, despite the large corridor volumes, the catchment area is considerably dispersed and this works against short-haul economics.

The catchment characteristics therefore play a role in the efficacy of policy and commercial strategies for serving the port's hinterland. With projections of continued growth in container trade, and in vessel size — with consequences for facilitating complementary landside strategies — it becomes more important to understand the impetus for intermodal-rail operation through hinterland terminals when policy-making relies on the success of such systems. As the National Transport Commission notes:

> *Understanding when rail intermodal terminals are likely to succeed could improve investment decision making and reduce resources devoted on failed projects. It could also assist in identifying possible types or locations for successful terminals which might otherwise be overlooked, increasing rail's modal share, with attendant environmental, amenity and safety benefits. (NTC 2006, p. 110)*

Thus, vibrant hinterland terminals and short/long-distance rail-shuttles are sought in response to the trends. Establishing why existing shuttles have succeeded will help to frame consequent government policies and commercial strategies.

20 These corridor upgrades include the east-coast Heartland Corridor, Crescent Corridor and Meridian Speedway and the west coast Sunset Corridor and Transcon Corridor.

21 See further discussion about the mooted Inland Empire shuttle below, p. 60.

CHAPTER 3

The economics of landside haulage

Key messages

- The key attribute of railways is that freight can be moved between terminals with considerably less energy and labour resources than road freight.
- The main deficiency of moving freight by rail is that to move non-bulk goods from door-to-door typically requires using trucks for the first and last leg of the journey (the "drayage"). The terminal costs of transferring the goods between road and rail, and the costs of the road leg, undermine rail's linehaul cost advantage. When the linehaul distance is short then that cost advantage is quickly overwhelmed by the terminal and road costs.
- The development and widespread use of containers has lowered intermodal costs at terminals but the "sweet spot" distance where rail can compete with road is often assumed to exceed one thousand kilometres.
- Maritime rail–intermodal has a relatively lower sweet spot than domestic intermodal because it incurs drayage costs only at the hinterland terminal: rail serves maritime terminals, albeit that container shifts between the rail terminal and the port container yard can be longer and involve more container manoeuvres than roaded containers.
- Port–haul rail economics are determined, then, by suppression of drayage distances and terminal activities, and by low-cost linehaul operation.
- Because of the impact of haulage distance on rail competitiveness, it follows that rail's mode share is strongly influenced by the distribution of a port's catchment across urban, regional and long-distances.

This chapter reviews the economic fundamentals of landside — intermodal–rail and road — haulage.[22] We begin by exploring the purpose of *intermodal* freight. This is followed by a review of the parameters that determine intermodal viability, and the alternative road haulage. Understanding the intermodal market, and the intermodal-rail niche within that market, helps to explain why intermodal-rail works. This provides the first element of our understanding the challenges in delivering viable short-distance intermodal-rail haulage.

Intermodal–rail economics

The key attribute of freight railways is that potentially a linehaul movement of large volumes of goods can be undertaken very efficiently, using relatively low energy and labour resources. In principle, if there are sufficient freight volumes being shifted along the tracks, it can make the railway operations very competitive with other modes.

We stress that the economics of moving these large volumes is undermined when there are empty, that is, back-haul, movements. Having balanced freight flows is a key, but often-unstated, element of efficient haulage.

Rail's economics depend on its ability to provide a door-to-door capability. Bulk rail freight haulage is commonly undertaken door-to-door, for example, from a loading point to a mine, a processing plant or a port.

However, it is now unusual for rail to provide a door-to-door service for non-bulk cargo. It is now typical for railway freight movements to involve using a second mode to get the goods between the railhead and the point of origin or destination. This was not always the case. When railways were first built the railways commonly provided door-to-door services as non-bulk goods were conveyed between sidings or goods yards adjacent to factories or warehouses. However, with increasingly competitive road services, it became uneconomic to shift the low rail volumes between sidings or goods yards, which eventually closed. In addition, shippers moved away from co-located railhead sites. Eventually, only very large shippers had private sidings or were co-located near railways.

Railways' linehaul efficiency is an essential feature of the economics of (non-bulk) freight railways. However, there is also a presumption that typically there is a component of road conveyance that needs to be incorporated into the overall door-to-door journey. For the purposes of simplicity, the North American term "drayage" is used to explain the road element of this journey between railhead and factory or warehouse.

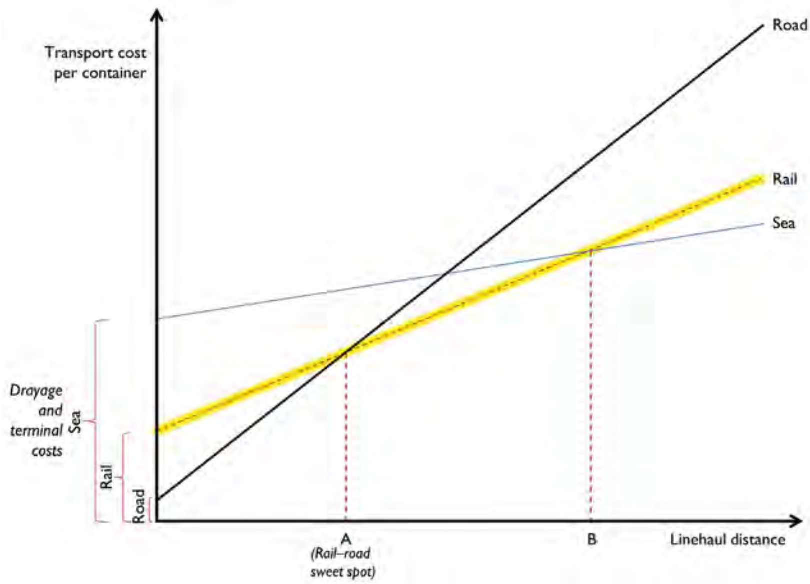
We should also note that such drayage and terminal transfers involve additional time relative to a direct road service. Further, as these are extra activities they bring the potential for reducing reliability.

The transfer of non-bulk goods between road and rail at rail terminals adds an additional task for rail–road movements relative to when cargo is shifted directly by road.

22 In this report the terms intermodal and multimodal have the same practical effect, with more than one mode being used. There are a range of different interpretations of the terms, with multimodal sometimes being interpreted as meaning that a single contract for conveyance is used to convey the goods across multiple modes but with intermodal refers to multiple contracts with different agents. This distinction is not directly considered here, although it is implied in the discussion of 4PLs, p. 15. The term "transmodal" relates to transfers of goods within the same mode, such as between one rail service and another rail service. It is notable that seemingly successful rail shuttle services are actually explained by their transmodal operation—see San Pedro Bay Ports case study, Appendix A.

Thus, where rail services incorporate a road component, the additional drayage and terminal tasks add costs to the operation relative to road. The impact of these additional tasks on the costs of rail–intermodal compared with road — and with maritime journeys, where relevant — is illustrated in Figure 13, with position "A" representing the Sweet Spot.

Figure 13 Traditional underlying door-to-door costs, by linehaul mode



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Figure 13 presents the notional costs of shifting containers by rail, road and sea. The interpretation is as follows:

- **terminal costs.** The relative up-front drayage and terminal costs vary across modes in reflection of the additional effort involved in using rail and sea relative to road. While containers sent by road are shifted without intermediate tasks between door and door, the containers sent by rail and sea incur the additional terminal tasks of unloading, stacking and reloading.
- **drayage costs.** The up-front drayage costs are also relatively high for rail and sea. The short drayage journeys between warehouse/factory and terminal involve up-front administration costs (and, so, fees). The drayage may also be less productive and, so, more costly, where the road movement is through congested urban areas. Return drays may also be empty movements. Thus the short-distance drayage cost relatively higher than the equivalent per-kilometre linehaul distance.
- **linehaul costs.** Once the containers are being shifted, the road costs per container are far higher than the rail and sea costs. A single road driver and traction engine can typically move up to three TEUs.[23] However, a rail driver and traction engine might move twenty times that payload while using only a minimal amount of extra fuel. Similar, but stronger, economics apply to ships, which have very strong economies of density in linehaul operation. This rail linehaul attribute is discussed in more detail in Chapter 6.

23 TEU: Twenty-Foot Equivalent Units of containers.

Historically, the non-bulk terminal costs between modes were very high. Unitising the goods within a container substantially reduced the resources required to trans-ship the goods across modes. That is, containerisation reduced the terminal costs and so improved the economics of intermodal transport.

Road-haulage economics

The elements at play that determine intermodal–rail economics are also at play in road-haulage economics, albeit inevitably in different proportions. In addition to the comparative factors discussed with rail economics—particularly road's door-to-port operation that save on drayage and terminal costs—the following factors distinguish the two modes in ways that affect their relative competitiveness:

- **back haulage.** Both road freight and rail freight suffer from back haulage issues, where freight-flow imbalances lead to empty return movements. However, it affects road freight more due to that mode having higher linehaul costs.
- **driving hours.** The large scale of train movements makes it both imperative and practical for relays of crewing to be undertaken for freight to reach its destination. Crew changes are often less practical for individual trucks, with truck movements being operated within the maximum hours-of-service envelope.[24] Where a single driver is concerned, the truck haulage operates within those daily driving thresholds. The operating hours affect vehicle utilisation.
- **capital base.** Entry and exit in the road haulage industry is relatively easy, compared with railways, due especially to the relatively low up-front capital costs involved.

Network congestion affects both truck and train driver and equipment utilisation, on the effective network capacity and on the reliability of the service. Both road and rail have benefited from new engine technology. Road networks have been upgraded and permitted truck payloads have been increased.

Port–haul rail economics

Three characteristics of port–haul rail economics distinguish the market from other intermodal activities:

- **low drayage.** The rail operation typically involves drayage at the hinterland terminal only—there is essentially no, or minimal, drayage at the maritime terminal.
- **higher terminal costs.** Rail marine terminal costs remain higher than road marine terminal costs because additional box lifts, and, thus, costs, are usually incurred at the port terminal for railed containers than for road-based containers.[25]

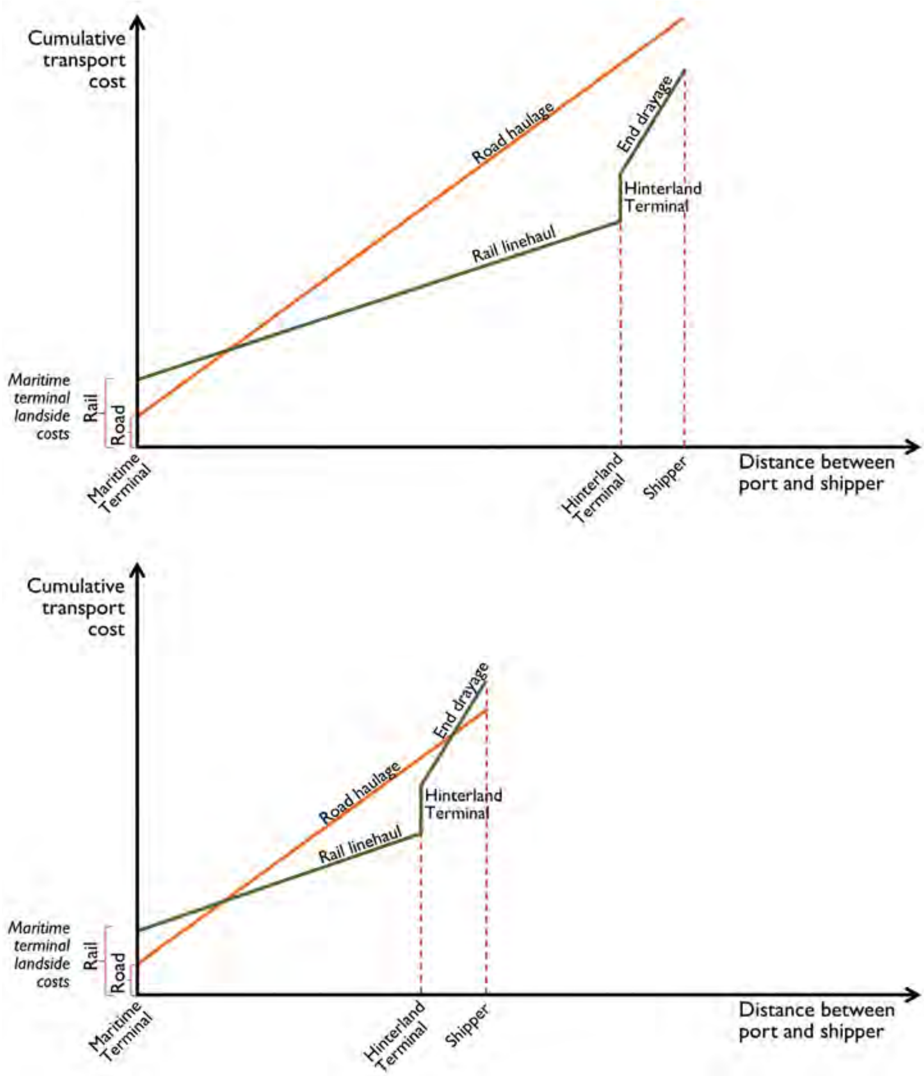
24 Different truck crewing systems include point-to-point (where one driver stays with the cargo throughout the entire transit), hub-and-spoke (where the driver takes less-than-full cargo loads to a hub), and relay networks (where the cargo stays with the truck but drivers change). These are also known as "solo shipments" and "team shipments". Arguably the practical challenges to truck relaying are greater than those for rail.

25 The reasons for this arise from the greater number of container lifts that are normally required for positioning rail containers between the dockside and the rail wagon. See further discussion, p. 53.

- **short linehaul.** The port's freight task is defined by its catchment area. However, this can often be tightly constrained within the urban area surrounding the port. This influences rail's ability to contribute to landside container movements.

These characteristics are illustrated in Figure 14. Of note are the distinguishing features of rail's higher maritime terminal landside costs, and the absence of drayage costs. Further, in the first diagram the longer distance between the port and the shipper's factory or warehouse defrays rail's higher maritime costs and hinterland terminal/drayage costs. By contrast, in the second diagram, the shorter rail linehaul distance is insufficient to offset those higher costs.

Figure 14 Road and intermodal shipper—port haulage costs



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Source: Adapted from chart in OECD/ITF 2011, p. 67 (and which was sourced from Netherlands Organisation for Applied Scientific Research).

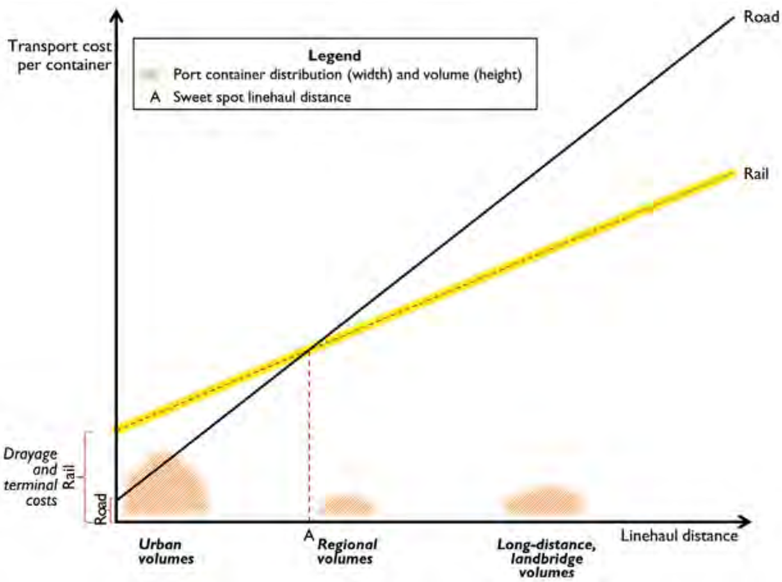
The distribution of costs is very specific to each short-haul operation. The cost distribution that is provided in Figure 64 is therefore illustrative, rather than representative. Perhaps more instructive is the relative distribution between the items and levels of rail costs, and the road costs.

The distribution of the port catchment is an important factor that influences a port's mode-share profile. Port throughput is often tightly constrained around the maritime facilities, resulting in dispatch or receival points that are considerably below the sweet spot distance. This is illustrated in Figure 15. Increasing railed maritime containers is more difficult to achieve to the extent that the port catchment is largely urban, short-distance, volumes. The ability to use rail is strengthened when the port's catchment extends well beyond the Sweet Spot. A prime example of this is the San Pedro Ports in California, where the ports' catchment extends well across the nation, with rail operations linking with markets in Chicago and central-eastern cities. The ports' intermodal–rail mode share is about 43 per cent (Box 13). However, this is almost entirely long-distance traffic. However, where the port catchment is shallow or, indeed, based in the port's urban hinterland then, given sweet spot distance estimates, it would seem that intermodal–rail services could not be sustained.

As discussed earlier, the shorter the rail haulage, the lower the linehaul cost savings that can be offset against the relatively high drayage costs and the terminal costs that are incurred in assembling the train (irrespective of the distance that the train subsequently moves). The Inter-State Commission noted thus:

> *The results of the various constraints operating on intermodal carriage of goods is that intermodal transport is not economic over short hauls. The length of haul must be sufficient for the benefits from the cheaper linehaul by rail, when compared with road, to outweigh penalties such as the cost of handling the goods through the terminal and the time involved… (Inter-State Commission 1987, p. 61)*

Figure 15 Port container receival–discharge distribution



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Concluding comments

Intermodal viability relies on good management of freight flows and goods transfers at intermodal terminals. To succeed, intermodal-rail's linehaul efficiency must be sufficiently superior to road to exceed the additional drayage/terminal financial and time costs that is incurred by rail. Those costs are fixed, irrespective of the linehaul distance travelled, making short-haul relatively less competitive.

Although intermodal–rail may have relatively low drayage costs at a port, it still incurs terminal and drayage cost disadvantages that are substantial relative to rail's linehaul cost advantage — which is modest when the linehaul distance is short. As long as the terminal and drayage costs remain substantial, a high sweet spot distance between rail and road modes will impede the transfer of container traffic from road to rail. This will increase the challenge for achieving public and private mode-shift goals.

Despite these apparently insurmountable odds, however, short-haul services do operate. The following chapters therefore consider the relevant railway cost components—drayage, terminal and linehaul costs—that apply to this traffic as well as the motivations of the major players in the freight task.

CHAPTER 4

Reducing the sweet spot distance: drayage costs

Key messages

- Drayage costs are a far greater concern for viable short-haul than for longer-distance haulage.
- Options for reducing those costs include:
  - improving rail vehicle productivity, such as upgrading terminal-access roads and raising permitted drayage-vehicle standards, and improving systems of vehicle turnaround at hinterland terminals;
  - better siting of terminals and adding terminals (while noting that this has to be balanced with train economics considerations)
  - having the hinterland terminal as part of the production and logistics chain, so that the drayage is perceived as part of the wider value-adding process than as a pure intermodal transport cost.
  - value-adding at or around the terminal also encourages shippers to co-locate near the rail terminal, which also reduces drayage.
- Rail intermodal freight essentially incurs no drayage at maritime rail terminals—a distinct advantage over domestic intermodal freight.
- Substantial value-adding processes at hinterland terminals can remove shipper–hinterland drayage costs—no matter how large they are—from the intermodal operation and can provide invaluable freight consolidation that boosts rail's viability. This changes the economics of intermodal in a fundamental way.

Following on from the discussion of the previous chapter, we conclude that the drayage, terminal and linehaul tasks should be examined when reviewing the circumstances where intermodal–rail is viable. In this chapter, we consider the drayage costs between warehouse/ distribution centre or factory, and the hinterland terminal.

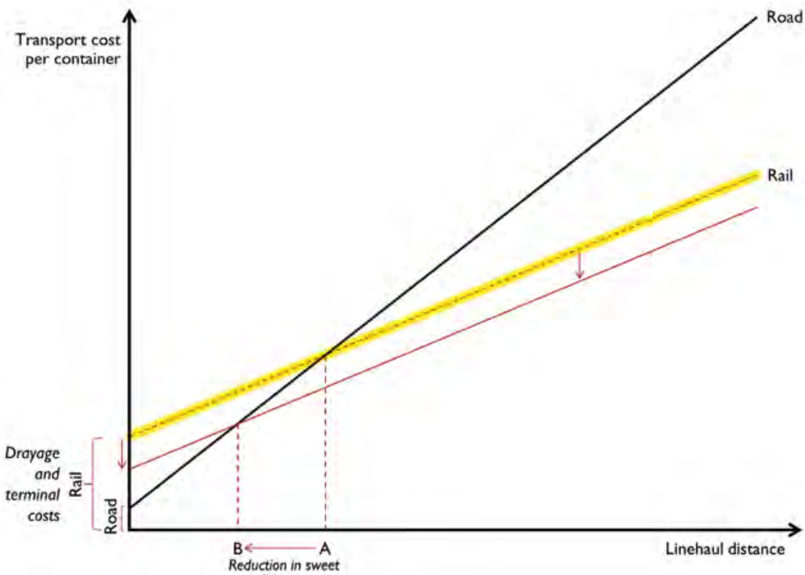
Note that much of this discussion is applicable equally to domestic, that is, to land-based intermodal movements as to maritime intermodal movements.

Drayage in the intermodal task

The sustainability of rail–intermodal operations depends on using the attribute of rail's linehaul cost advantage along with using the flexibility of truck pickup and delivery in drayage movements. Those intermodal movements incur additional costs, which arise at hinterland terminals and from undertaking drayage between those terminals and the shippers' premises. Note that the drayage costs arise from both shifting containers between shipper and hinterland terminal, and the costs to the drayage entity arising from its activities at the shipper facilities and at the hinterland terminal.

The linehaul distance at which intermodal rail can become competitive thus depends upon the three cost elements of linehaul, drayage and terminal costs. Depending on the individual circumstances, drayage may be the largest cost element. Morlok (2004, n.p.) assesses a case study where, for a linehaul distance of 322 kilometres, the drayage was 75 per cent of the intermodal cost. In the example, the drayage cost continued to dominate over much longer distances, being 66 per cent of intermodal costs at 805 kilometres and 50 per cent of costs at 1970 kilometres. Another estimate of drayage cost is that it represents as much as 40 per cent of the total cost of a 1 440 kilometre rail movement. (Muller 1999, p. 74)

Figure 16 Impact of reducing drayage costs



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Drayage is far more of a concern for short-haul distances. The president of intermodal at Schneider National, the USA's largest truckload carrier, observed that "As the length of haul on the railroad is reduced, proximity to the ramp [intermodal terminal] from a dray standpoint is critical." (Kulisch 2009, p. 40)

Figure 16 illustrates the impact of reducing the drayage costs—incorporated here with terminal costs. As can be seen, the drayage costs are up-front, that is, fixed costs that do not vary with the haulage length. Those same drayage costs are incurred whether the container is shifted 50, or 500, kilometres.

In this case, the sweet spot falls from position A to position B, following a decline in the upfront fixed drayage costs.

When railways were first built the drayage distances between shipper and railhead were modest. This reflected the limited economic development in aggregate and spatially. Where feasible, the activity was undertaken close to the railhead due to the poor standard of roads and road vehicles. Those impediments were removed as economies grew, and the road transport systems developed. As a result, a growing level of drayage was required to reach the railhead, compounded by the rising productivity of road haulage.

It should be noted, however, that this trend to longer dray distances was offset by a decline in the per-kilometre cost of drayage as trucks and road networks improved. Conversely, rising road congestion has worked against this trend. Similarly, while those per-kilometre costs fell, so too did direct road-only freight movements.

Drayage costs are relatively high compared with linehaul road movements. On a per-kilometre basis, drayage costs are higher than long-distance truck costs. This is because the drays have relatively lower productivity. The dray movements are slow where (typically) the intermodal terminals are located in congested urban areas. Dray operators also face the costs involved in processing the delivery of the container within the terminal. Finally, the drayage often involves dead-running — that is, truck movements without revenue-earning containers. (Gross 2009, p. 7) Indeed, it has been noted that to get to an intermodal terminal a truck may even have to drive to terminals that lie in the wrong, that is, opposite, direction to the ultimate destination of the box. (Bergqvist, Falkemark and Woxenius 2010, p. 288)

Morlok and Spasovic apportion the major problem as arising from empty running:

> *The main reason for the high drayage cost is undoubtedly the high percentage of tractor [truck] and tractor–trailer non-revenue movements (called respectively bob-tailing and deadheading) that are typically required to achieve a high LOS [level of service] quality of trailer pick ups and deliveries. (Morlok and Spasovic 1994, p. 12)*

Morlok and Spasovic also note that improving the efficiency of drayage tasks at the terminal can also be impeded by the fragmentation of control between various agents, of the drayage-related tasks at the hinterland terminal. (Morlok and Spasovic 1994, p. 13)

The essence, then, for short-haul rail is how that drayage — or, more accurately, the drayage cost — can be reduced.

Lowering drayage costs

The areas that we identify for lowering effective drayage costs in intermodal–rail operations include the following:

A. improving drayage productivity on the road;

B. improving drayage productivity within the terminal;

C. value-adding at the hinterland terminal; and

D. reducing drayage distances—attracting businesses to co-locate in the vicinity of the hinterland terminal.

Each of these aspects is now considered.

A. Improving drayage productivity on the road

Drayage productivity on the road can be enhanced by a range of policy levers, and by optimal terminal siting.

Policy levers

The principal examples of efforts being applied to improve drayage productivity on the road have focused on policy levers. In particular, to facilitate intermodal operation, European governments focus on the drayage component; this recognises the importance of drayage to intermodal-rail competitiveness. The levers used include:

- exempting, or reimbursing, the road vehicle tax for vehicles deploying their truck for intermodal drayage services;
- increasing the maximum gross weight of those drayage vehicles; and
- relaxing week-end/holiday pick-up and delivery bans on road freight operations. (Union Internationale des Chemins de fer 2009, p. 100)

In 1993, the British Government increased the maximum gross weight for six-axle lorries and drawbar trailer combinations, with "road-friendly" suspensions that shift goods to and from railheads. In 1999, this approach was adopted for international traffic within the European Union. The movements are subject to the requirement that the goods are shifted by rail for the long-haul element of the journey and that operators use the nearest suitable intermodal terminal for collection and delivery. (Butcher 2009, p. 2)

In the USA, the Federal government has upgraded designated Intermodal Connector roads, which link national highways and intermodal terminals.[26] These roads are intermodal's "first and last mile" and are funded to ensure that that that mile is of a sufficient standard that the drayage is not impeded. One Australian example was the development of Hub Road, connecting to Ettamogah Rail Hub, outside of Albury, NSW. Similarly, when the Fletcher International intermodal hub was established in Dubbo in 2009, the company worked with council and government to enable the terminal to be accessed with quad-axle semi-trailers.[27] Conversely,

26 http://www.fhwa.dot.gov/planning/national_highway_system/intermodal_connectors/ ; http://intermodal.transportation.org/Documents/8-36(30)connectors.pdf

27 http://freight.transport.nsw.gov.au/strategy/action-programs/casestudies/case-study-17.html

the absence of a higher-axle weight access road to the Victorian rail hub at Mooroopna, near Shepparton, has been argued to have impeded using rail–intermodal to the Port of Melbourne (Parliament of Victoria 2014a, p. 4)

Also in the USA, road entities focus on drawing down drayage costs through productivity improvements in the road leg. Hitherto-road hauliers, who now use railways extensively — such as J B Hunt, Schneider National, Hub Group, US Xpress — have road-utilisation systems. They are applying these "…advanced methods to the management of drayage and equipment utilisation". (Perry 2010, p. 5)

Terminal siting

The choice of the terminal site influences the accessibility of the facility. Its proximity to good transport links is important but so too is its proximity to markets — that is, where the goods are flowing to and where the goods are flowing from. This is important especially when the terminal functions with rail-transfer and with value-adding activities. A well-sited terminal therefore reduces drayage due to its strategic location relative to the road, and sometimes rail, network and to the markets they serve. This is the case, for example, where the terminals are co-located with distribution centres. It has been noted that:

> *The locational advantage of [clusters of distribution centres] is less their position in an important infrastructure intersection, but rather their combination of short- and long-distance accessibility and also to major distribution areas… [T]his movement out of the cities has become stronger because the core cities and their traffic congestion create more and more obstacles to flow-oriented distribution. (Rodrigue and Hesse 2010, p. 488)*

Thus, terminal siting is important for overall terminal functionality and, specifically, for suppressing drayage distance and time.

B. Improving drayage productivity within the terminal

As discussed earlier in this chapter, the principal reason for high drayage costs arises from low productivity within the hinterland terminal, particularly due to non-revenue movements of the road vehicles. This is compounded by poor coordination of the drayage-related tasks between the various agents. It follows, then, that efforts should be made to improve these areas of performance.

Resor and Blaze cited calculations that suggested that the implementation of a centrally-managed drayage operation at one given hinterland terminal could reduce drayage costs by between 43 per cent and 62 per cent. They estimated that applying the lower reduction estimate to their cited intermodal case study would bring that sweet-spot down to 240 kilometres. (Resor and Blaze 2004, p. 11)

C. Reducing drayage distances

The basic tenet of intermodal–rail is to minimise drayage distance. It has been observed that

> *A basic characteristic of intermodal economics is the closer the terminals are to where freight originates and terminates, the more efficient intermodal is because rail line haul constitutes a greater percentage of the trip. (Zumerchik, et. al. 2009, p. 6)*

The two primary approaches to achieve this drayage reduction are to add intermodal terminals so that they are closer to shippers; and to re-locate the terminals closer to shippers.

Adding intermodal terminals

If additional terminals are constructed then it reduces drayage by bringing the terminal to the shipper. There are important trade-offs in terminal provision however:

- Each terminal adds to the capital investment requirements, thereby stretch the capital budget, and weaken the ability to finance optimal terminal equipment. Similarly, to the extent that traffic is dissipated across additional terminals it reduces the justification for higher-productivity equipment.
- Adding terminals reduces the rail service standard. The provision of multiple terminals along a route adds train stops for attaching and detaching wagons. This slows down the operation and those additional activities inevitably reduce reliability.
- If the additional terminals are served instead by dedicated trains then that absorbs track capacity, and requires additional land and capital for equipment. Further, such dedicated trains may be shorter and this leads to a loss of economies of density.

Given these trade-offs it is pertinent to note that the number of North American intermodal terminals declined by 68 per cent between 1981 and 1990, even though this has led to an increase in average drayage length.[28] (Evers 1994, n.p.)

Conversely, a case could be made for adding additional terminals where terminal capital costs are modest, where train priority is not high, and where there is sufficient track capacity. This can be particularly important when the terminals can be served by existing trains, which improves the viability (through economies of density) of those trains. Our case study of the Port of Tacoma and Port of Seattle rail operations (p. 152) illustrates such an operation, where the port traffic is served by stopping an existing (domestic) intermodal train. Similarly, international and domestic containers shifted through the Ettamogah (NSW) terminal are added to existing trains (p. 101).

Re-location of intermodal terminals

A second approach to improve drayage distance is to re-locate the terminal to a site that is closer to existing markets, or which enables new markets to develop around the new terminal. Establishing new sites might mean that the terminal is better located for transport links and better designed. Resor and Blaze note, however, that US railway terminal rationalisations have shifted operations from badly-sited city-centre locations. However, the re-location may

28 With other improvements in intermodal efficiency, however, the intermodal loadings in USA almost doubled in the same time.

sometimes involve additional drayage distances and times, with new road movements on already-congested highways. (Resor and Blaze 2004, p. 12)

D. *Value-adding at the hinterland terminal*

The functions of the hinterland terminal have a strong bearing on drayage. There are two elements of this. First, value-adding activities can change the perception of how the drayage costs are perceived. In particular, if value-added activities are undertaken around the terminal then the drayage cost may be attributed to the production process and not to the cost of intermodal operation. The second key impact of terminal functions on drayage is that if the terminal's functions facilitate the shipper's logistics then it encourages co-location at or around the terminal and this reduces drayage.

The terminal as part of the logistics task

From origins as a simple modal-transfer point—this being discussed in more detail in Appendix B—intermodal terminals now incorporate a range of value-adding activities, including:

- as a consolidation and distribution node, where containers are held until required for shipment or hinterland delivery — a part of the "extended gate" concept (which is discussed in more detail in the Port of Rotterdam case study, Appendix A;
- as a facility to undertake "devolved" port activities such as customs and quarantine, which is also a component of the "extended gate" concept; and
- as a node to undertake logistics activities, such as distribution centres, for packaging goods, preparing goods for export, and repackaging — consolidating and deconsolidating — goods for onwards movement.

The main message is that, when such value-added activities are undertaken, the hinterland drayage and the rail–shuttle roles are part of that broader supply chain rather than an independent, or piecemeal, activity. For that reason, the drayage costs are apportioned to the overall production and supply chain task and not separately applied to transport. This is illustrated with the Peaco intermodal terminal and processing plant at Donald, Victoria, in Figure 17; hinterland drayage has essentially been eliminated.

However, Resor and Blaze warn that individual supply chain parties can undermine this benefit, if the transport component is considered in isolation rather than inter-linked:

> *Because any import or export move must move through a port, on-dock rail can essentially eliminate one dray charge. Unfortunately, some port operators view their rail intermodal terminals as profit centers. That view results in relatively high prices for container movement and works against the competitiveness of rail. (Resor and Blaze 2004, p. 50)*

Why should the activities be inter-linked? One reason is that the transport component between the terminals is an integral part of the overall supply chain, and that the choice of linehaul mode affects the terminal performance. In particular, consolidation of containers at terminals, and subsequent rail transport, may involve less effort or logistics management in aggregate than road once the value-added activities are also considered. Put another way, assessing the rail cost in isolation to the other supply chain elements may overstate those rail costs relative to road costs. That is, the value-adding tasks can influence the net value of each linehaul mode.

Figure 17 Donald Intermodal Terminal and Peaco processing plant

Note: At Donald Intermodal Terminal, in Victoria, the Peagrowers Co-Operative — Peaco — have established their processing mill, container-filling equipment and storage facilities for the export of pulses. This on-terminal operation essentially eliminates the hinterland-end drayage task. The yellow frame in the photo is the crane that shifts containers between rail wagons and road vehicles. The crane meets the needs for the modest annual terminal throughput of around 1 400 TEU. The wagons are attached and detached from Merbein – Port of Melbourne intermodal trains serving the Iron Horse Intermodal Terminal near Mildura. The Merbein train makes it feasible to undertake the Peaco intermodal operation, while the Peaco traffic makes the Merbein operation more sustainable.

Source: Photo courtesy of John Hoyle

Encourage shippers to co-locate near intermodal terminals

A key approach to achieving drayage reduction is to stimulate terminal users to locate their own facilities near to the terminal. Where intermodal terminals have developed with broader value-adding functions, shippers are attracted to co-locate near the facility, bringing with it a fall in drayage lengths.

Over time, the activities around intermodal terminals have expanded to encourage co-location. The intermodal terminal is no longer a simple transfer station between modes. It has evolved to being a hub that also includes value-added activities such as processing, consolidation, distribution and storage—that is, logistics.

From the early 1980s, a revolution in global freight handling brought logistics management as the mainstream system for the coordination and management of goods flows.[29] Three elements converged at that time. First, container-based handling had become the standard form of handling non-bulk cargo, complementing the system of palletising goods. Second, computer technology developments enabled vital systems for practical coordination of devolved activities. Finally, the logistics revolution was made possible in the USA — where the adoption of logistics was key to worldwide usage — due to easing of key transport regulations. The three key reforms were railway deregulation (enabled through the Staggers Act of 1980), road freight deregulation (through the Motor Carrier Act of 1980) and shipping deregulation (through the Shipping Reform Act of 1984).[30] The Acts enabled flexible freight service provision and

29 Transport is one of five logistics activities: transport, network design, information, inventory, and warehousing (with packaging and material handling).

30 Carriers were then "freed the shipping lines to directly and confidentially pursue rail contracts for intermodal service. This provided the ingredients for railroads to be competitive with trucking, and for the paradigm shift from trailer-on-flat-car rail service to doublestack landbridge service". (Port of Los Angeles 2004, p. 2)

management, where coordination and cross-ownership had hitherto been prohibited.[31] While logistics was not "born" in the USA, its embracing by that economy has led to its widespread adoption across the world.

The trend for large companies in the USA is now to site their distribution centres alongside rail intermodal terminals if for no other reason than to minimise the costly drayage. For example, Walmart's new distribution centre in Bethlehem, Pennsylvania, adjoins the rail terminal such that boxes are conveyed by private road between the facilities. (Solomon 2014, n.p.) Such attractions inevitably mean that land prices around the terminals are higher than further afield. There is now a trade-off between higher land costs around the intermodal terminal but lower operating drayage costs.

The terminal's supply of a range of value-added activities — including good rail connections — is the key to drawing the shippers towards the intermodal terminal. Indeed, a solid base of shippers attracts even more shippers. The co-location creates "logistics clusters, where shippers can tap multiple third-party service providers and even attract their own suppliers". (Szakonyi 2014, n.p.) The myriad of names for co-located facilities, such as "inland port" and "freight village", reflect the value-adding. In the USA, there has been a trend to co-locating distribution centres and manufacturing plants, with reports of up to one-third of new distribution centres being located near an intermodal centre.

Given the critical drayage cost, the co-location brings about the near-elimination of drayage distances, altering the intermodal economics. Matheson has argued that:

> *If you have a very concentrated area, such as a logistics park, then you basically have no dray on one end. So that pretty much changes the equation pretty drastically. (Kulisch 2009, p. 40)*

Evidence from the case studies

This section considers evidence about drayage that is drawn from the case studies included with this report. The case studies are provided in Appendix A while the maps showing Australia's regional and urban port–rail intermodal services are in Appendix E.

Three key points emerge from the case studies:

- successful short-haul operations involve short drayage between shipper and hinterland terminal. Drayage length is the key factor in short-haul intermodal;
- short drayage is achieved by shippers co-locating around the terminal because multiple value-adding tasks are performed around the terminal; but
- flows of goods by road to those co-located facilities (for subsequent processing and consolidation) can be conveyed over long-distances.

Achieving short drayage requires that shippers are attracted to the site. Shippers will not be attracted if the terminal functions as a mere rail-head for the transfer of containers between road and rail.

Thus, terminals must necessarily incorporate value-adding activities. In the case studies, we have identified three primary forms of value-adding facilities draw in the shippers:

31 These regulatory changes are arguably the principal influences on intermodalism and logistics, however they were not the only major changes. See Shashikumar and Schatz, 2000, for further detail.

- distribution centres, such as at Venlo (in The Netherlands), Front Royal (in Virginia), and English inland terminals, all therefore being dominated by import flows;
- port-devolved activities, such as China's inland dry ports, Duisburg in Netherlands, Portland in Oregon, MetroPort in Auckland and the freight Transferium in Rotterdam; and
- Logistics centres for consolidation and handling of dominant commodities for export, such as at Penfield, Bowmans and other Australian hinterland terminals.

The next part of this report reviews these case studies.

Australia

The practices of co-location and value-adding terminals are evident in some instances of domestic intermodal–rail facilities, and in the international short-haul rail operations. There are some major co-located businesses in domestic intermodal operations. These operations include:

- the co-location of Foster's distribution centre at SCT Logistics' Penfield rail-served facility on the northern edge of Adelaide;
- the co-location of the Heinz-Watties national distribution centre adjacent to SCT Logistics' Altona rail-served facility on the western side of Melbourne; and
- the co-location of Linfox, K&S Freighters and Toll (and other logistics company) facilities at Pacific National's Perth Freight Terminal. The location is such that container movements between the Toll facility and the Terminal can be undertaken without using the public road system and conveyance is undertaken by Internal Transfer Vehicles (ITVs).

In these cases, the integration of the supply chain benefits shipper and logistics or rail operator, with substantial volumes of rail-linehaul freight. Clearly, the logistics operate like a hand in a glove, so drayage minimisation through the co-location becomes an obvious decision when producers and logistics companies are choosing sites.

There are four short-haul urban rail operations linking hinterland terminals with Australian ports, as discussed in the case studies:

- Yennora — Port Botany;
- Minto — Port Botany;
- Penfield — Outer Harbor (Port Adelaide); and
- Forrestfield — Fremantle North Quay (Inner Harbour).[32]

There are keystone customers in each case, with large regular volumes, featuring co-location and value-adding. Short-haul urban and regional services also benefit from the large regular volumes that arise from relocating empty containers to the terminals for shippers to pack. These movements provide revenue-earning backhauls.

Each of the short-haul urban shuttles has substantial anchor customers, all of whom have minimal drayage as their facilities adjoin the hinterland terminal or lie within the terminal precinct. Thus:

32 Enfield and Cooks River (MCS) rail shuttle operations do not fall into this categorisation. For the same reason, container movements between Kwinana (Fremantle Outer Harbour) and Fremantle (Inner Harbour) are excluded.

- Yennora serves the adjoining Woolworths facility and the Australian Wool Exchange;
- Minto serves the adjacent Joe White (Cargill) Maltings and the Kimberly-Clark paper plant for exports, and the Sunbeam distribution centre, for imports;[33]
- Penfield incorporates the Treasury Wine Estates plant, for exports; and
- Forrestfield serves the adjacent Metro Grain Centre (CBH Group) facility, for exports.

Each of these co-located facilities undertakes value-adding tasks. These tasks include consolidation, distribution, specialised packing, and cleaning (grain). Those activities are pivotal to the attractiveness of the urban short-haul. An exporter located away from the hinterland terminal will not divert to the rail facility unless such logistics attractions are present. As was found with a Fremantle Port users' survey, "where an exporter has to travel a considerable distance to the port, redirection to the rail terminal may add a costly additional leg to container transport without providing sufficient off-setting benefits". (Fremantle Ports 2012a, p. 4) Those off-setting benefits can include the value-adding tasks and, as discussed later, (p. 98) road congestion to, or around, the port.

The short-haul regional shuttles incorporate similar characteristics: co-located facilities and on-site value-adding. Illustrative examples include:

- Bowmans (Balco) terminal, for Port Adelaide exports, has within-site facilities for consolidation of agricultural products from around its region. Goods such as hay are then compressed and palletised and packed, along with wine and pulses;
- Deniliquin terminal, for Port of Melbourne exports, has within-site facilities for rice consolidation, milling and packing;
- Ettamogah Rail Hub, for Port of Melbourne exports and domestic intermodal, is co-located adjoining the Nexus industrial precinct outside of Albury. Major exporters such as Norske Skog, Overall Forge, and Peter Cremer Australia have facilities in or near the precinct and Rail Hub;
- Iron Horse Intermodal Rail Transport Hub at Merbein, for Port of Melbourne exports, includes a boxed-grain packing facility, fumigation, a cool room for citrus and grape treatment (for disinfestation of fruit fly), an empty container park, and has staff approved for government quarantine inspections for some imports and exports;[34] and
- Fletcher Dubbo terminal, for Port Botany exports, lies within the Fletcher International Exports processing facility. Lamb and sheep are processed on-site at the abattoir, sorted for the various cuts of meat and pet food and then packed in reefer containers. Wool bales are also boxed. The Grain Handling and Intermodal Freight Terminal also grades and containerises wheat and pulses, and cotton seed and baling of cotton. On-site government quarantine and Quality Assurance testing is also undertaken.

In the case of these regional facilities, the drayage to the hinterland terminals may be very extended. While this may appear to contradict the requirement for short drayage, the key factor that makes it viable is the value-added activities being undertaken at the facility. For

33 The terminal has major anchor customers but QR National expressed doubts about the terminal's wider hubbing, hence the company's support for a terminal at Moorebank: "Minto is located on the edge of south-western Sydney and is some distance from the main catchment zones and core centres of industrial/logistics activity. This means that there is little financial incentive for trucking operators to pick-up and back-haul empty containers to the terminal. More importantly, QR National does not believe that an expanded Minto terminal could serve as an adequate substitute for the development of a high capacity terminal at Moorebank." (QR National 2007, p. 16)

34 Department of Agriculture and Water Resources.

example, the Fletcher Dubbo facility undertakes key production and supply-chain activities, in processing, grading, packing and inspecting the goods for export. The relatively long drayage distances to the facility are part of the production and supply-chain, not part of the component of intermodal operation. Having undertaken those tasks, the goods will have then been consolidated and are therefore ideal for conveyance in one shift by train.

In summary, then, these short-haul urban and regional rail–intermodal flows eliminate the drayage. Arguably, this is the primary obstacle to running short-haul intermodal trains.

Overseas

There are a number of short-haul regional rail–intermodal shuttles in overseas countries. These operations also involve co-location and value-adding, such that hinterland drayage is eliminated in principle or in practice.

There are very few examples of short-haul urban rail–intermodal operations and those that exist involve very modest container throughput. However, it remains instructive to observe that the failure to establish sustainable operations arises from the inability of motivated agents — railway companies, port and shipping entities, and governments — to overcome the drayage issue.

Examples of urban rail–intermodal shuttle service include:

- Wiri Inland Port — Ports of Auckland; and
- Göteborg Norra — Port of Göteborg.

The Wiri Inland Port lies at the heart of one of Auckland's industrial and manufacturing areas. This strategic location results in drayage minimisation for intermodal operations. That is, shippers are essentially co-locating around Wiri. The terminal, and rail shuttle also have some degree of appeal because the productivity of the direct truck haulage alternative is undermined by the highly-congested road connection between the area and the port. Despite the low train frequency — a train each night during weekdays — the operation can appeal to shifting low-priority goods, storage of goods, and box consolidation and deconsolidation. Similarly, the Göteborg Norra terminal is served by a local rail service that is also used for low-priority goods, chiefly in their storage and unpacking.

The Transferium terminal and short-haul barge operation opened in mid-2015 and serves the Port of Rotterdam. The purpose of the facility is to divert long-distance trucks away from the port, to the Transferium. The benefit for exporters depositing their containers at that terminal is that it eliminates the low-productivity truck movements along a fifty kilometre congested road to the Port (and then out of the Port). The success of the Transferium depends on the appeal of the extended-gate value-added services, and on how much the exporters value the truck productivity improvements arising from paying to use the terminal. See the Port of Rotterdam case study in Appendix A,

The land-use pattern in the Inland Empire, in the hinterland of California's San Pedro Bay ports, illustrates an arguably-insurmountable drayage issue that prevents sustainable short-haul rail operation. There are large container flows between the San Pedro Bay Ports and the Inland Empire: the diversion of a small proportion of this would surely suffice for a short-haul operation. However, despite this, the Empire's existing warehousing and manufacturing facilities are very dispersed. This dispersion prevents the development of a centrally-located hinterland terminal with minimal drayage that could support co-located shippers. More to the point, the drayage distance between that Inland Empire terminal and the shipper might well rival the direct road haulage distance between the port and the Inland Empire. There is arguably little opportunity for short-haul operations given the existing mature, and dispersed, nature of the shipper patterns in the Inland Empire.

CHAPTER 5

Reducing the sweet spot distance: terminal handling costs

Key messages

- The advent of the container has brought down the double-handling costs of intermodal rail relative to previous non-unitised handling systems. Nonetheless, terminal costs are a barrier to rail's competitiveness, especially on shorter-distance movements.
- Terminal costs can be reduced by improving performance of the two key tasks: container handling and train activity levels.
- Investment in high productivity container handling systems is warranted only when there is high-volume throughput.
- In general, the optimisation of terminal operation is location-, market-, and train formation-specific.
- The use of unit—fixed-formation—trains minimises train actions, notably the costly practice of shunting wagons. However, use of unit trains is best when the freight flows are substantial, continuous and relatively balanced.
- Railed containers usually incur additional handling—moves, lifts and intermediate storage—relative to road, and this increases railed-container costs and time.
- Maritime terminal design and layout often compromises operational efficiency with land constraints. Terminal provision is also typically based on legacy decisions dating from before containerisation, before technological advances, and with much lower port throughputs.
- It is desirable to have on-dock rail terminals because they eliminate box shifts across congested public roads, do not require trucks for shifting boxes, reduce intra-port box-transfer distances and so reduce container handling costs. However, the terminals absorb vital port land, can result in multiple rail terminals (which may not be efficient for train operations) and terminal operations are more likely to be compromised by land constraints.
- The local factors at play with the provision of various maritime rail terminals mean that we cannot say whether on-dock is superior to near-dock. In that context, we also cannot say whether a single maritime rail terminal is superior to provision of terminals for each container terminal. However, legacy provision of rail infrastructure may not now be optimal.

In Chapter 3 we outlined the circumstances for intermodal–rail to be sustainable. We noted that the economics of intermodal–rail could be described through three intermodal parameters: drayage, terminal and linehaul tasks. Terminal transfer activities and their influence on intermodal viability are now considered.

Introduction

The terminal costs that we consider here are those associated with the tasks of container transfer between modes, and these costs include the necessary underlying rail-wagon handling costs. As discussed in Chapter 4, however, the terminal functions increasingly extend beyond the simple transport tasks, and those complementary functions have a major impact on the perception and scale of the drayage task. Terminal functions are therefore:

- At their simplest, a transfer point between road and rail, as undertaken at early intermodal terminals in the USA.[35]
- Beyond the terminal itself a range of value-added tasks is undertaken at adjoining or nearby distribution centres or warehouses. Stuffing and de-stuffing of containers are undertaken as part of a broader range of logistics tasks.
- Finally, the inland terminal can be used for a range of port-like activities—that is, activities that form part of the port task. These include customs and bio-security clearances, and the buffering of containers. Indeed, a role of the close dry port terminal is to buffer containers.[36] The closeness of the terminal to the port enables the timely drawing forward of containers for loading on vessels in a synchronised system. (See Bergqvist and Woxenius 2011, p. 163)

These wider functions influence the container-transfer and wagon-shunting tasks that are undertaken. What matters in the first instance, however, are the efficiencies of those box transfer train movements. These movements are the specific functions that are of relevance to short-haul efficiency.

We should note, at the outset, that we generally found notable inefficiencies in terminal operations that undermine short-haul rail, rather than factors that support it. This is in spite of the considerable attention that has been given to improving intermodal interfaces. This topic is discussed in more detail in Appendix B.

The analysis here considers the relative intermodal–rail performance in container handling and in train terminal movements, at hinterland and maritime terminals. Where appropriate, consideration is given to how railed containers are handled at terminals compared to trucked containers. We note, however, that door-to-maritime terminal movements naturally do not have hinterland terminal costs unless it forms part of a logistics movement.

As with Chapter 4, the review of systems is then used to provide insights into the viability of short-haul intermodal–rail in Australia and overseas as outlined in the case studies described in Appendix A.

35 The introduction and development of these early systems is discussed from p. 174.

36 As discussed by Cullinane, Bergqvist and Wilmsmeier (2012, p. 2), the current attributes of a dry port are "rather vague"; originally, however, the dry port was an inland terminal "to and from which shipping lines could issue their bills of lading". Rodrigue, Debrie, Fremont and Gouvernal (2010, p. 528) conclude that "the generic term inland port is more suitable to label such facilities as it considers the relationships between terminals, the associated logistic activities and their hinterland. They form a three tier system where functionally an inland port can act as a satellite terminal, a load center or a transmodal center and where several logistics activities, such as consolidation, transloading, postponement or light manufacturing can be performed".

Terminal tasks

Intermodal hinterland and maritime terminal costs arise from the following tasks:

- loading and unloading containers;
- sorting and storing of containers;
- shunting of railway wagons to facilitate container handling; and
- the assembly and splitting of trains for linehaul movement.

In essence, those terminal costs can be reduced by improving the productivity of the container transfer and sorting, and by reducing the level of train activities.

The single most important change to intermodal operations has arguably been the adoption of the container, although the pallets that sit within the container are equally indispensable. The container has transformed the economics of maritime movements by reducing the handling, or "bridging", costs at terminals.[37] Levinson notes the paucity of data on pre-containerisation costs at terminals but noted that maritime terminal costs dominate the overall port-to-port costs. He observed that two maritime terminal cargo transfers—dockside to ship and ship to dockside—incurred one-half of the total transport costs of moving a shipment 4 000 miles. (Levinson 2006, pp. 8–10)

Those handling benefits of shifting cargo in containers through maritime terminals apply also to hinterland terminals—that is, in shifting goods between rail and road. The container has greatly reduced the task and cost of shifting goods between road and rail. Indeed, arguably, by reducing time-consuming handling costs, the container has saved intermodal–rail freight.[38] [39]

The transfer tasks at terminals were seen as the primary impediment to intermodal.

> *Rail will only become competitive when the loading and unloading function at each end of a route becomes efficient. (Mayne Nickless Limited, quoted in Industry Commission 1991a, p. 312)*

Various forms of technology have been developed over the years to reduce those tasks; Flexi-Van and RoadRailer are two examples of technological applications—see further discussion in Box 2 and Appendix B.

These technological innovations were aimed at easing terminal transfers. The more promising systems have been implemented but they have not endured, as other superior systems have emerged. The RoadRailer, in particular, was seen as being a particularly useful intermodal development: it was argued that the RoadRailer offered "competitive potential in a short haul market once believed to be the exclusive domain of over-the-road trucks". (Tellier 1996, p. 57) While the RoadRailer and conventional piggyback (TOFC) systems were widely adopted in North America, they involved use of inflexible bespoke technology, or increasingly incurred payload penalties relative to emerging alternative intermodal systems — specifically, double-stacked containers — and the use of both systems has declined to relatively minor roles, supplanted by conventional crane lifts of containers onto various forms of rail wagons.

Box 2 sets out the principal intermodal systems and trends and it is explained how the system that prevails is ultimately a function of the dominant cost — the linehaul cost — rather than the cost that might be saved in handling costs within the terminal.

37 See footnote 6 for an outline of bridging costs.

38 Ironically, the container made the drayage plus sea transport intermodal traffic more competitive. As Rimmer noted, the container restored some competitiveness to non-bulk shipping and in 1964 the world's first purpose-built container ship, *MV Kooringa*, was introduced to the Western Australia – Eastern States route and additional vessels later, including on Brisbane–Sydney–Melbourne. (Rimmer 1970, pp. 16–17; McKillop 2013b, p. 10) Gauge-standardisation brought stronger rail competition and the shipping services ended in 1975. (McKillop 2013c, p. 3)

39 It is worth stressing, however, that containers are often used for the transport of bulk goods.

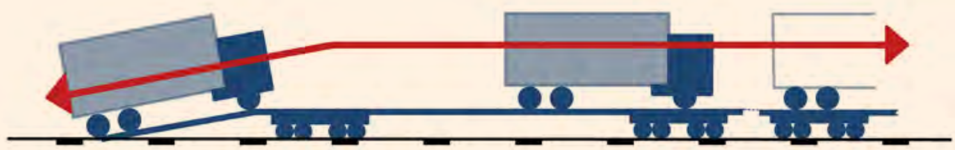
Box 2 Unitised intermodal transfer systems at terminals

Intermodal systems are based around unitisation of which there are three principal forms: pallets, piggyback and containers.

A. The pallet was used by the US Army in the 1940s and was adopted commercially in the early 1950s. (Levinson 2006, p. 177) The pallet is a unit of relatively modest size. It has been integrated within the container system but can be applied equally to use with road vehicles and rail vans.

B. There are several key piggyback rail systems operate.

1. **Rolling highways.** Where the rail wagon conveys the entire road vehicle inclusive of the prime mover, it is sometimes called a "rolling highway" and the driver is conveyed in a separate passenger carriage on the train. This approach is common in Europe's alps. It is also used by Canadian Pacific Railway, with its CP Rail Expressway, over the 528 kilometres between Montréal and Toronto. The rolling highway system is illustrated in the following figure, where loading is undertaken via a "circus" ramp at the end of a rake of wagons, with trucks driving along the length of wagons (see discussion of circus loading, p. 196); sometimes there are intermediate access points from the side of a wagon. See the figure below:



Source: This figure is based on Woxenius 1998a, p. 92.

2. **TOFC.** A related intermodal system involves railing the road trailer without the prime mover (that is, without the driving unit). A conventional road trailer is used. In North America these movements are known as TOFC: Trailer On Flat Car. (The flat "car" is a U.S. term for a flat wagon.) Side-loader cranes are used to side-load trailers onto rail wagons.
3. **RoadRailer Mark IV.** In this innovative technology, the bespoke road trailer converts to a rail wagon, with the trailer frame forming the wagon frame itself, and a second set of metal wheels on the trailer forming the wagon's single wheel set; the balancing wheel set is attached to the adjacent RoadRailer trailer. Trains are formed by joining adjacent RoadRailers.
4. **RoadRailer Mark V.** A further development of the RoadRailer involves using the bespoke road trailer but without rail wheels. Adapted conventional rail wheels are inserted under the trailer. This development is illustrated in Figure 19. Trains are formed by joining adjacent RoadRailers.
5. **Flexi-Van.** This system is a hybrid between a TOFC and a container system (COFC — Container On Flat Car). The enclosed goods-carrying frame of the bespoke road trailer (forming, essentially, a container) can be detached from the trailer. The unit is transferred manually from the road trailer onto a turntable that is mounted permanently within a bespoke rail wagon; once on the wagon the turntable is turned so that the goods container is aligned with the direction of the train. This approach obviates the need for terminal yard cranes. This system is illustrated in Figure 21.

C. Containerisation is based on a single international standard box, with limited length variations — principally 20 foot and 40 foot — plus a standard width and limited height options. Containers are shifted between modes using a range of side- and vertical-shifting equipment.

Trends

TOFC is a common, but declining, freight mode in North America, being replaced by COFC, notably double-stacked containers. TOFC generally involves less wagon handling and classification for linehaul than containerisation, but COFC offers superior payloads to TOFC. (Armstrong 1978, p. 180) Piggyback was once common on Australia's Commonwealth Railways to Western Australia and Alice Springs, ceasing in 1992–93, on the East–West Corridor when Australian National switched service provision to containers. (Australian National Railways Commission 1993, p. 18). Piggyback is now found only on Genesee & Wyoming's freight service to Darwin, where it is used for the conveyance of oil tankers. Australian National used the RoadRailer; this was later renamed "Trailerail" by National Rail when it took over its operation. RoadRailer is a TOFC system (p. 237) from the Wabash National Corporation (Australian National Railways Commission 1992, p. 21). Under the two entities it operated from 1992 until 2004, shortly after National Rail was taken over by Pacific National. The concept offered a simpler system of transferring the freight unit between road and rail, needing minimal terminal equipment.

Each intermodal system involves different terminal handling costs but the fate of the systems is often dictated by the dominant, linehaul, cost. Thus cost indices estimates from the USA for moving an 89 foot wagon are 0.55 with TOFC, 0.53 with COFC, 0.41 with a double-stacked container wagon, 0.57 with a RoadRailer and 1.00 with a truck. (Clarke, 2014, Slide 10)

Without the container the double-handling costs of much of the non-bulk goods that now move through the road–rail terminals would have been prohibitive. Indeed, the remarkable aspect of the container is that the overall logistics costs are competitive despite the intermodal double-handling that still occurs. By contrast with single-mode operations, intermodal provides two key benefits. Logistics managers in the USA say that intermodal's biggest benefit is its price and its flexibility — while accepting that the additional handling occurs, which brings a heightened risk of unreliability. (Levans 2008, p. n/a)

Intermodal–rail competitiveness faces additional risks to service quality due to the additional mode interfaces at the terminals. Each additional transfer increases the risk of delay. The way in which logistics chains are structured can both manage and mitigate those risks.[40] Chapter 7 discusses how the interface and motivations of logistics agents influences the outcome.

Thus rail-based intermodal competitiveness is undermined by relatively high drayage and terminal costs and the potentially-lower reliability.

> *One of the great labor and energy efficiency advantages of rail is that about 200 containers can be moved at a time in one unit train. Yet the requirement of assembling long intermodal trains presents an impediment to reliability that is not applicable to goods movement by truck. From a*

40 International Transport Forum (2010, p. 108) illustrates this point with a transcontinental farm-produce train in the USA. The intermodal terminals at the production end of the supply chain have been placed within one day's drive of the farms. The proponents of the service argued that such drayage had relatively fewer reliability issues than when drayage extended beyond a day's haulage.

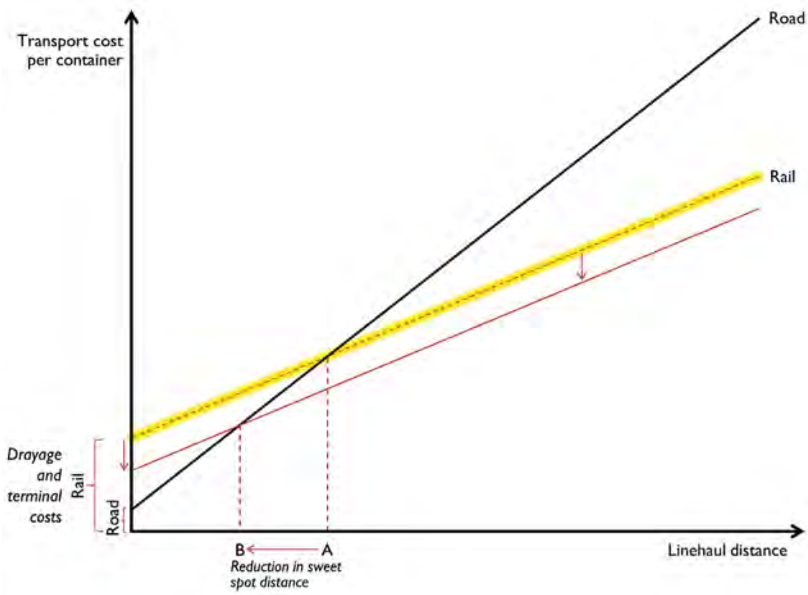
logistics perspective, the larger and more fragmented the freight, the more challenging the task of quickly assembling trains. (Zumerchik, Rodrigue and Lanigan (2009, p. 59)

However, even with longer trains, the traffic consolidation at larger terminals has brought train operating efficiencies. The time involved in the various tasks of handling multiple wagons does not rise commensurately with the number of those wagons.

However, consolidation of traffic at fewer terminals has an important downside. Other things being equal, fewer terminals means longer drayage distances between a central intermodal terminal and the shipper's facility. As was discussed in Chapter 4, longer drayage distances undermine intermodal economies. (TRB 2007, p. 14)

As outlined in Chapter 3, terminal costs are up-front — fixed — costs that are incurred irrespective of distance. This is illustrated in Figure 18, where the reduction in terminal costs brings about a reduction in the sweet spot position from A to B.

Figure 18 Impact of reducing terminal costs



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

In the following discussion we consider the principal factors in terminal systems that influence efficient handling of railed containers and efficient handling of the trains. As the discussion will illustrate, there is no single optimal terminal design. As has been described succinctly by Zimmer:

…the ideal terminal is not a certain physical configuration of pavement and tracks, but an organization of services integrated with a physical plant that meets the business needs of a specific marketplace. (Zimmer 1994, p. 99)

We address the four specific rail–intermodal tasks at the port that influence rail's competitiveness relative to road:

A. **hinterland terminal container handling and sorting.** Efficiency here depends on box transfer productivity between drayage vehicles and wagons. The three task elements here are those between dray and rail wagon, or between dray and on-site stack within the terminal, and transfer between stack and rail wagon.

B. **hinterland terminal train assembly tasks.** These are the train configuration tasks, involving wagon shunting, wagon coupling or uncoupling, and then safety and procedural preparations for linehaul.

C. **maritime terminal landside container-handling.** These tasks are performed by road and rail vehicles. Productivity across the modes varies between the road and rail operations due to different terminal locations and the relative efficiency of the different container handling systems.

D. **maritime terminal train handling tasks.** As with hinterland terminals, these are the train configuration tasks, involving wagon shunting, wagon coupling or uncoupling, and safety and procedural preparations for linehaul.

The report now discusses each of these aspects of rail–intermodal.

A. Hinterland terminal container handling

Terminal efficiency is a key factor in intermodal competitiveness. This is particularly the case when it is remembered—as illustrated in Figure 13—that door-to-door truck movements do not require terminals at all. Various efforts have been made to minimise those terminal costs.

Figure 19 Australian National's (Mark V) RoadRailer, 1990

Note: The service was operated subsequently by National Rail, under the "Trailerail" label.
Source: Australian National Railways Commission 1990, pp. 4–5.

Efforts to minimise terminal costs have previously included transferring different modules between road and rail, including:

- the rail wagon, such as on sea–rail operations, where the rail wagon is conveyed in the hold of the vessel, resting on rails laid into the vessel's decking;
- the road vehicle, such as on piggyback rail–road operations—where a road vehicle or trailer is driven onto a railway flat wagon; and

- the road trailer, which is converted into a rail wagon where the trailer incorporates rail wheels that replace tyred wheels, such as the *Mark IV RoadRailer*. A variation on this system is where rail bogie-wheel sets are added to the road trailer unit such as the Mark V RoadRailer, which is illustrated in Figure 19. The technology was introduced on dedicated trains by Australian National and re-branded by National Rail as the *Trailerail* service. That train was withdrawn by that company's successor, Pacific National, in 2004, and the wagons were withdrawn around five years later.

Ultimately, however, the container became part of the most cost-effective domestic and international intermodal system.

Container-transfer systems at intermodal terminals have developed into three broad categories of container transfer systems—with diverse specifications within those categories:

- Circus loading. Historically this approach has been common with piggyback operations for domestic freight. Loaded containers on road trailers, or road trailers—with or without their prime-mover—are placed on the deck of a rake of rail wagons via a ramp. Loading and unloading are relatively slow. This was a keystone of the Commonwealth Railways' intermodal operations to Kalgoorlie and Alice Springs—with K W Thomas Transport, and Territory Transport Organisation, respectively. (McKillop 2013b, p. 7)
- Side loading. Various forms of machinery can be involved. These range from forklifts to special mechanisms that slide the container between the road vehicle and sideways onto or off the wagon. (Armstrong 1978, p. 178) This is illustrated in Figure 20.
- Gantry loading. A travelling overhead crane straddles the road and track and lifts the container or trailer across between the road vehicle and vertically onto or off the rail wagon.[41] This is illustrated in Figure 23.

Figure 20 Unloading containers by reach stacker

Note: This image shows container unloading under way from a Qube Logistics rail wagon at the company's intermodal terminal at Harefield, near Wagga Wagga, NSW. The side-loading reach-stacker is on the hardstand adjacent to the railway tracks. The reach-stacker grips the container from above.

Source: Photograph courtesy of John Hoyle.

41 In 2015 Pacific National introduced a Rail Mounted Gantry Crane at its Sydney (Chullora) terminal. Compared to the previous equipment, the cranes move faster, shift containers faster and have larger capacity. One intended use of the cranes is to transfer containers between road and rail for the company's Chullora – Port Botany shuttle (which commenced operations in June 2015). http://asciano.com.au/news/articles/news/a/pacific-national-doubles-sydney-intermodal-terminal-capacity-with-new-rmg-cranes

This list is by no means exhaustive. For example, Figure 21 illustrates the New York Central Railroad system, adopted in Australia in the 1960s. This Flexi-Van system was based on investing in specialised wagons rather than in the terminal itself. The wagons had inbuilt turntables that were used to pivot containers between the wagon and the road vehicle. This, and other systems used in Australia, are discussed in detail in Appendix C. A deep and broad analysis of a range of intermodal transhipment systems is provided in Woxenius 1998 and Woxenius 1998a.

Figure 21 Flexi-Van intermodal system

Note: The photograph shows the Flexi-Van container in use in 1963. The van is shown being transferred between the road trailer and the rail wagon. The van is pivoted on the specialised rail wagon's inbuilt turntable.

Source: Photograph courtesy of National Archives of Australia. Reference: NAA A1200, L44101.

The higher cost involved in investing in high-productivity container transfer systems precludes their universal adoption. The ascendancy of the container over piggyback systems has led to investment in gantry cranes and, where lower volumes are involved, in side-loading systems. Inevitably, however, this area of terminal efficiency relies upon higher container throughput to warrant higher-productivity handling equipment.

B. Hinterland terminal train assembly tasks

The shift of handling systems from circus transfer of intermodal units—or trucks or truck-trailers—to a lift-on/lift-off system of containers was an important enhancement. Changing the system reduced the amount of wagon shunting required.[42] In addition, changing the handling systems removed the need for decks on the wagons, which thereby reduced the tare weight and increased the payload. (Muller 1999, p. 86)

The development of intermodal systems has led to terminal designs and train operating practices that minimise the need for shunting wagons and the uncoupling and recoupling of wagons. As illustrated with British Rail's 1960s Freightliner policy and investments, complementary wagon and terminal equipment was matched by streamlined operating practices, notably the operation of block trains of permanently-coupled wagons.[43] (British Rail 1965, p. 8) As has been noted:

42 "Shunting" is sometimes referred to as "switching".

43 Previous efforts to improve terminal efficiency — particularly with non-containerised non-bulk traffic — involved using a hump yard, where wagons were assigned to given trains by use of a centrally-controlled gravity system.

> *Shunting is a fairly time-consuming operation. In Europe, shunting operations may take 10-50% of train total transit time. Other disadvantages of shunting are their relatively high level of land use and shippers' fear of damaged freight. (Bontekoning and Priemus 2004, p. 339)*

Terminals require long sidings and hardstands for cranes and trucks to avoid shunting—with attendant coupling and uncoupling of wagons. If the terminal's operational length is below the optimal loading/unloading distance then the trains will need to be split. Note, however, that there may be merit in some splitting of the train at the terminal so as to optimise the distance between the container stack or park and the wagon. It may warrant shifting the rake of wagons periodically so as to reduce the movement of the side-loader or gantry crane—called reshuffling.

Steenken, et. al. note that optimisation of the tasks involves the balance between train shunting and crane reshuffling as well as the specific needs for placement of the container within the train consist:

> *The aim of the rail operator is to minimize shunting activities during train transport while the aim of the terminal operator is to minimize the number of yard reshuffles, to minimize the crane waiting times and the empty transport distances of cranes and transport vehicles… Transport and crane activities have to be synchronized to avoid unnecessary crane waiting times or movements. (Steenken, Voß and Stahlbock 2004, p. 31)*

Similarly, Meyrick notes:

> *The dilemma here is the advantages conferred by long terminals, for handling long trains without splitting and shunting, as against the long distances which container handling equipment then has to travel. (Meyrick, Arup 2006, p. 10)*

Hearsch (2008, p. 28) acknowledges the importance of extensive land holdings for modern terminals, while noting that the availability of such sites is limited, especially around ports and developed metropolitan areas.

The foregoing illustrates the general conclusion that terminal efficiency is influenced by equipment and terminal — buildings and layout — characteristics. This optimisation can be location-, market- and train-formation-specific.

Two responses to the train-shunting task are notable. The first is the unit train, which is a permanently-coupled rake of wagons that forms an entire train. Short-haul operations are typically operated as such unit trains that shuttle between terminals—hence the term shuttle trains. The objective of such trains is to reduce or eliminate the shunting costs — and the time — involved in attaching, detaching or repositioning wagons at terminals. Again, a price to pay for a long unit train is a need for extra wagon or crane reshuffling, and extra effort in sorting container placement on that train. A pioneer of unit intermodal trains was British Rail's Freightliner services, initiated in the 1960s. This is discussed in more detail in Appendix B.

The German Cargo Sprinter concept was the second solution to the excess train-shunting and reshuffling. The Cargo Sprinter operated in this country in 2003–07. This is discussed in detail in Appendix D. The Cargo Sprinter was a short train with wagon capacity totalling about 10 TEU. With propulsion rated in proportion to train weight, the Cargo Sprinter could travel at high, passenger-train, speeds between terminals. It operated in a fixed-formation — that is, permanently-coupled wagons — and had a driver's cab at each end. With such features, the train could be operated without the need to shunt locomotives or wagons. In the absence of that task, the train could deliver quick turnarounds at terminals. (European Commission 2012, p. 43) Further, the short train formation meant that box transfers could be undertaken in a very short time and with little reshuffling. The attributes and applications of the train were described thus:

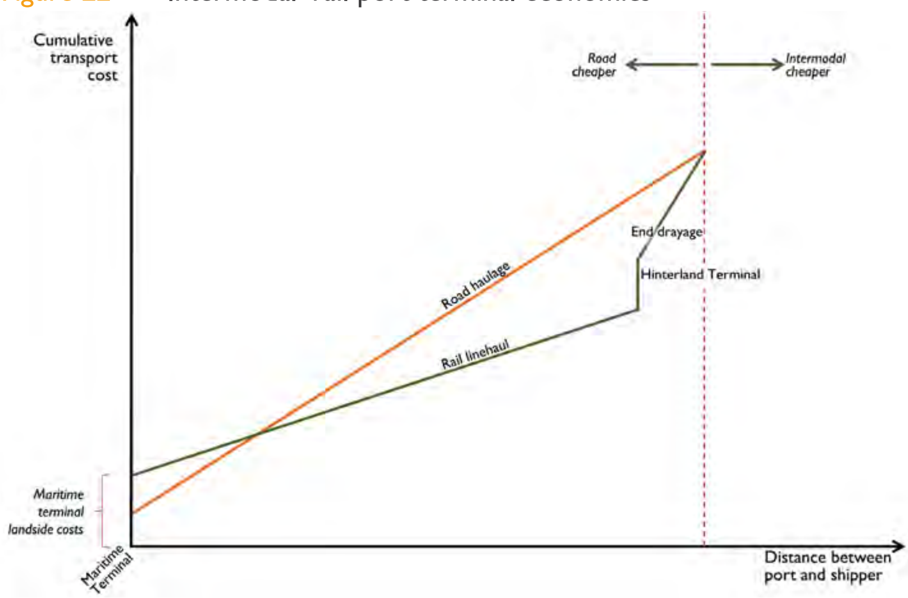
> *The major sources of benefits of introducing unit train operations in place of traditional goods trains are that shunting costs at the terminals and at the intermediate marshalling yards can be avoided and higher wagon and locomotive utilization rates achieved. The introduction of unit trains is most appropriate when freight flows between two points are substantial, fairly continuous and relatively balanced. (UNCTAD 1991, p. 8)*

Unproductive train movements at terminals can arise from a few key deficiencies. First, there is poor terminal equipment. Second, there can be poor terminal design, which may arise from inadequate space and from legacy infrastructure—that is, outdated, or superseded systems. Finally, unproductive train movements can arise from poor train operational systems, which may be incompatible with the utilised terminal capacity.

C. *Maritime terminal dockside container-handling productivity and tasks*

The sweet spot distance is affected by the relative efficiency of road and rail transhipment at maritime terminals. We noted that rail is less disadvantaged at the maritime terminal relative to the hinterland terminal because it usually does not have a port drayage task—except where the rail terminal is some distance away, that is, "off-dock". These characteristics are illustrated in Figure 22. Neither mode is shown as having drayage at the port, although both incur terminal costs, with rail's terminal costs being higher than the road costs.

Figure 22 Intermodal–rail port terminal economics



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Source: Adapted from chart in OECD/ITF 2011, p. 67 (and which was sourced from Netherlands Organisation for Applied Scientific Research).

The roles undertaken at the maritime terminal involve:

- short-term container storage;
- customs inspections; and
- quarantine inspections;

A crucial organisational role is also undertaken as the boxes are moved within the terminal. Boxes are sorted to ensure that box repositioning, which is called box shuffling, is optimised when loaded on the vessel or land mode. The objective is, as far as practicable, to ensure that when a box needs to be unloaded there should be minimal movement of boxes that have subsequent destinations.

The actions performed at the maritime rail terminal involve:

- lifting the boxes from a mode (vessel, rail or road) to the ground;
- lifting boxes to and from the ground and the stack (vertical storage area);
- box transfers between the landside exchange area (such as the rail sidings) and the stack; and
- box transfers between the stack and the dockside.

A key role that is implicit in actions (a) through (d) is the task of sorting the containers. That is, the containers are sorted as they are moved between the dockside and the stack and between the stack and the train.

Table 1 presents an overview of the core maritime terminal actions, with several of the different forms of equipment that can be used to perform the tasks. The tasks fall into the categories of horizontal and vertical container movements, moving through the stack for sorting and storage.

Table 1 Overview of maritime terminal actions

Area	Shift	Selective equipment options	Activity
Sea-side	Vessel–dockside	Quay crane	Berthing, loading, unloading
Dock	Dockside–stack	Straddle carriers, automated-guided vehicles*	Transfer
Sorting and storage	Stack	Straddle carrier, rubber tyred gantry, Automated Stacking Crane (ASC)	Storage and sorting
Landside loading/ unloading or intermediate stacking	Stack–road; stack–trackside	Straddle carrier, gantry crane; Internal Terminal Vehicle	Transfer/ loading, unloading
Railway	Trackside–train	Side loaders—forklift, reach stacker; gantry crane	Loading, unloading

Note: *A proprietary form of automated straddle carriers is the AutoStrad™. An alternative form of automation is the Automated Guided Vehicle.

A crucial differential between road-based container transfers and intermodal–rail transfers is that railed containers usually incur additional container transfers and additional lifts. This is one reason for the higher rail maritime terminal cost illustrated in Figure 22. This differential is widened when the rail facilities lie outside of the port perimeter—that is, at near-dock and off-dock terminals.

One reason for this handling differential arises from the practical considerations of terminal configuration in a constrained site. This leads to the necessary nature of placing rakes of wagons for loading and unloading relative to truck siting. The truck can be directed to the precise box loading/unloading point. To use the same approach with rail would involve shifting the rake of train wagons. Instead, the rail loading/unloading equipment moves along the rake of wagons. A gantry crane is illustrated in Figure 23.

Figure 23 **Gantry crane, Melbourne, 1983**

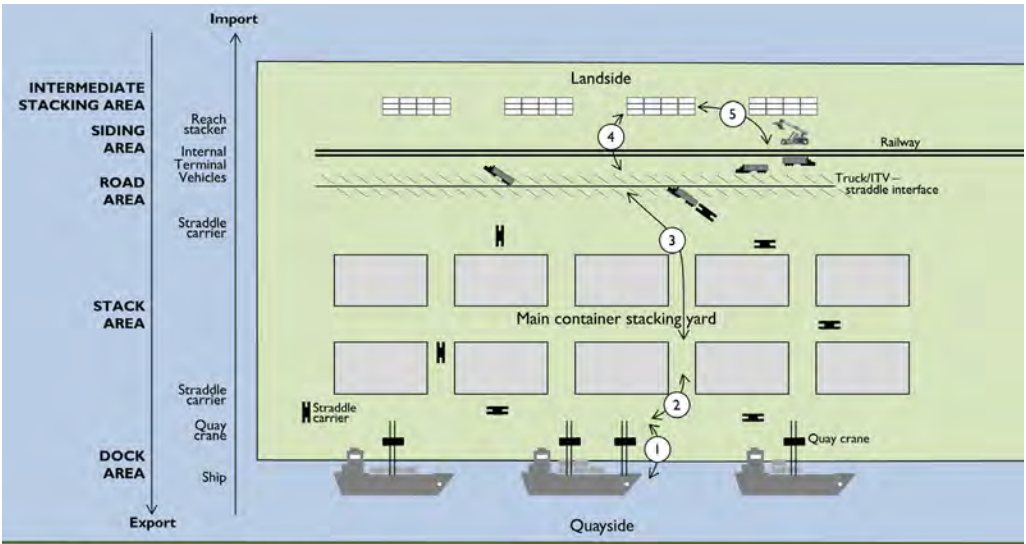
Note: The photograph shows a container being transferred between the road vehicle and a rail wagon.
Source: Photograph courtesy of National Archives of Australia. Reference: NAA A6135/17, K30/3/83/47.

There are methods for handling railed containers through the landside of the marine terminal that does not necessarily involve additional lifts and moves to trucked containers. As outlined in Box 3, however, this can be challenging, particularly with efforts to automate container handling systems.

Generally, railed containers at maritime terminals involve more box lifts and transfers than containers moved by road and this can be illustrated by the box moves at the Patrick terminal at Port Botany—see Figure 24. The box handling process is identical for the two modes from the vessel up to the interface point between the straddle carriers and the trucks, and the Internal Terminal Vehicles. (These are shown as container movements 1 through to 3 in the figure.)

However, whereas the truck can remove the box from the port at stage 3, for rail there are an additional two stages. The example described here relates to imports. First, boxes are positioned from the straddle carrier onto the Internal Terminal Vehicle (ITV). The ITV then moves the boxes to specified rail stacking areas. The segregation of stacking areas facilitates the sorting of inbound and outbound boxes and their subsequent destinations. Second, the boxes are then moved by reach stackers from the stacks, to wagons along the train.

Figure 24 Rail landside box movements at Patrick terminal, Port Botany



The numbers correspond to container movements:

1 The container is lifted by the quay crane between the vessel and the dock.

2 The lift and transfer of the container by straddle carrier — AutoStrad™ — between the dock and the container stacks.

3 The lift and transfer of the container by straddle carrier between the container stacks and transferred to or from the truck or Internal Terminal Vehicle (ITV).

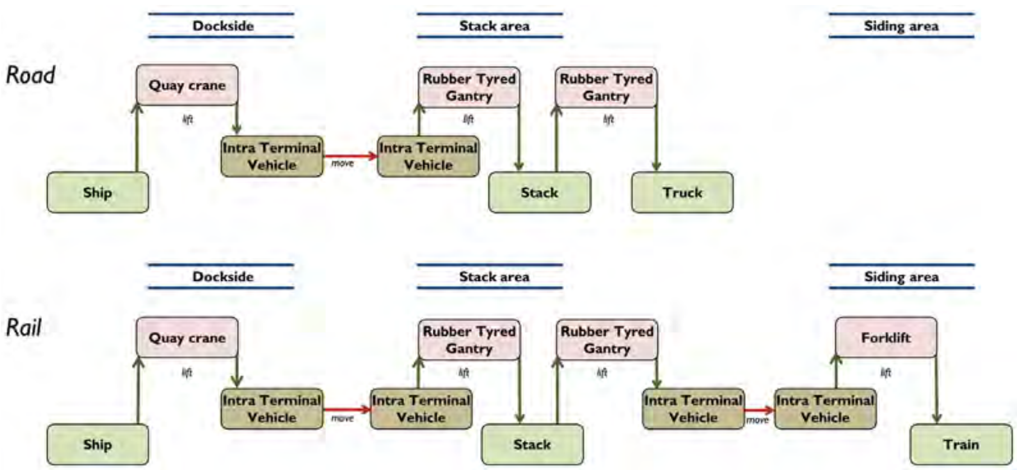
4 Container is moved by Internal Terminal Vehicle (ITV) between the road dock and the rail Intermediate Stacking Area.

5 The container is moved by Reach Stacker between the Intermediate Stacking Area and the rail siding, and lifted to or from the wagon by that stacker.

Notes: This diagram is derived from Froyland, et. al 2008, p. 55, which presented a simplified view of the Patrick Stevedore Terminal facility operations at Port Botany, as outlined in Box 3; see, also, the illustration in IPART 2007, p. 105. Those diagrams were based on the use of a rail mounted gantry to transfer boxes to or from rail or road, to an intermediate stacking area. That system was abandoned in 2010.

The DP World facility at Port Botany uses a different system to move and store containers. Again, however, the railed boxes incur more movements: one more lift and one more box move. This occurs because, at the gantry–truck interface, the box can be moved directly between the stack and the truck—there is no intermediate stacking. Figure 25 illustrates the terminal lifts and transfer movements for imported boxes at the DP World facility.

Figure 25 Imported box lifts and transfers at DP World terminal, Port Botany

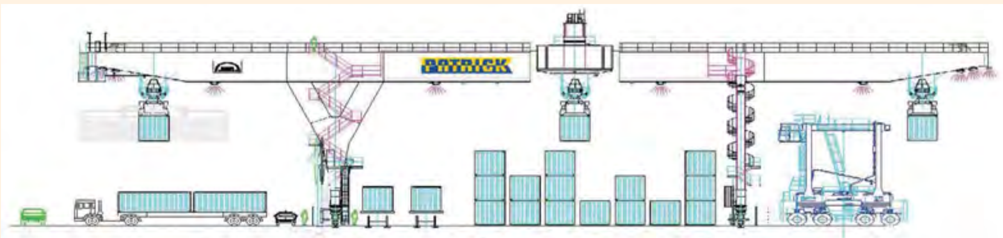


Source: Based on IPART 2008, p. 105.

Box 3 Box handling experiences at Port Botany

As illustrated in Figure 24 and Figure 25, the movement of railed containers through the Patrick and DP World terminals at Port Botany involve more lifts and moves than trucked containers. In the case of the Patrick operation, however, this was not always the case. In principle, the stevedore's use of rail mounted gantries could have placed road and rail on an equal footing with lifts and moves.

In 2003 Patrick ordered five rail mounted gantries. The gantry spanned roads under one cantilever, a central area with two rail tracks and an intermediate stacking area, and a second cantilever with an interchange zone with straddle carriers—see the illustration below. It was intended that the cranes would be semi-automated, and be controlled remotely using cameras. The first of the cranes was delivered in 2006. Subsequently, however, the cranes were "… plagued by commissioning difficulties including problems with the automated systems and wheel wear… Much of the delays were related to the development of the automated systems and Patrick's ambitious plan to automate rail car handling. Other terminals using automated stacking cranes in the yard have decided against this as the variation in rail car design makes it very difficult to achieve". (World Cargo News 2010, p. 6)



Source: Patrick Corporation Limited 2007, p. 17.

Thus, box handling between the rail head and the stack typically use more resources than the equivalent road–stack movement. This will almost certainly result in stevedores imposing a higher rail charge for the additional landside handling.

There are a few underlying differences in box-handling that result from the nature of road vehicles and rail wagons that explain why additional resources are used to move boxes between the wagon and the stack. In the following discussion we describe the problem by using box imports. First, a truck can be moved to the container but it is generally impractical to move a wagon, within a rake of wagons, to the container. Second, the container needs to be moved by gantry crane or side-loader to the wagon; while straddle carriers are adept at moving containers, they are far less adept at loading and unload boxes along a rake of wagons. Finally, even if the sidings are near to the stack, the transfer of the box along a long-distance rake of wagons (such as the 600 metre length rakes at the Patrick terminal at Port Botany) inevitably involves more time than a direct transfer across from the stack to the road collection point.

Three other aspects can hamper the landside rail task at the maritime terminal. First, effort is needed to assemble and sort the railed boxes for the relevant trains—hence the intermediate stacking areas. Truck containers are sorted as they are extracted from the stack as they are collected.

Second, the rail sidings themselves may be more distant from the stacks than the truck receival/delivery point—particularly with distant near-dock and off-dock sidings—resulting in higher costs for transferring the boxes to and from the wagons. In some circumstances, then, the processing of railed containers through the maritime terminal involves additional land, capital and labour resources than containers that are trucked in. These options are considered further in Box 4.

Box 4 Options for vessel–rail container handling systems

The discussion here illustrates that the efficiency of the handling of railed containers at maritime terminals is a function of the container transfer systems used. These systems should be seen as a series of trade-offs between a range of factors—including investment costs and land-opportunity costs—rather than converging to a single optimal arrangement.

The box transfers are a function of a range of factors, including:

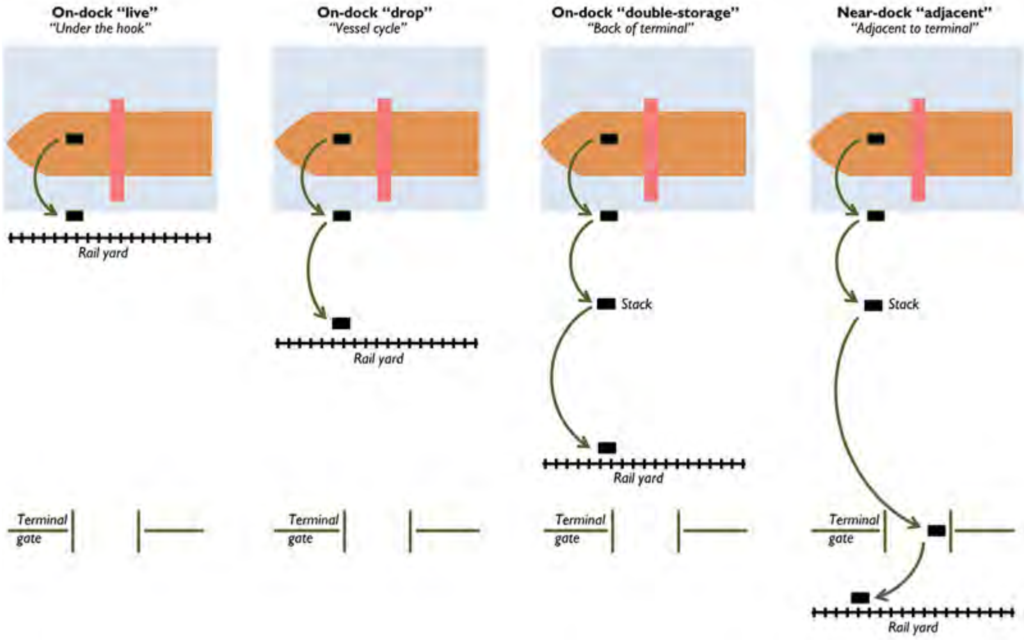
- location of the rail yard relative to the maritime terminal: on-dock—that is, within the port land; near-dock—a site just beyond the port boundary;, and off-dock—a site more than eight kilometres from the port;
- rail yard configuration;
- operating system for shifting boxes;
- the type of handling equipment (lifting and transferring);
- sources of labour and labour-productivity incentives; and
- the type of traffic served. (Ashar and Swigart 2007, p. 7)

Five broad transfer systems have been identified, and are described here for imports:

- On-dock live. Here the rail yard is an integral part of the container terminal, with boxes being moved directly between dockside and rail terminal without intermediate storage. Additional box lifts are avoided but boxes need to be pre-cleared by Customs, with boxes required to be pre-sorted on-vessel so that they conform to on-wagon placement. This system is illustrated in more detail in the discussion on the "Montréal Model" later in this chapter.
- On-dock drop. In this process the boxes are first stored at the container terminal and then transferred to the rail terminal by port equipment. The boxes travel longer distances between dockside and trackside and involve additional box lifts—through the container stack—but do not involve on-vessel box sorting.
- On-dock double-storage. This system is similar to the "drop" option but involves additional box placement at an Intermediate Stacking Area, as used at Patrick at Port Botany and illustrated in Figure 24.
- Near-dock adjacent rail terminal. This approach is similar to the double-storage situation except that boxes are conveyed outside of the port and customs facility. Where the facility is adjacent it may be possible for port labour to shift the boxes and to transfer them without having to use public roads.
- Near-dock non-adjacent rail terminal. In this case public roads are used to transfer boxes from the port, using conventional public drayage to do so.
- Off-dock rail terminal. In this system, the rail terminal is located more than eight kilometres from the port. Access is by road. This results in additional drayage time and cost. (Ashar and Swigart 2007, pp. 7–10 passim.)

The first four of these systems is illustrated in Figure 26. There is further discussion of terminal locations in Appendix B.

Figure 26 Classification of port rail–intermodal transfers



Note: Derived from Ashar 1988, p. 47.

Finally, the rail costs incurred with these more extensive tasks may also be inflated by the agents — that is, the stevedores — who undertake the work. Their cost mark-ups may be unreasonable and their monopoly service provision may mute the incentives to perform effectively. Prince (1998, n.p.) observes for the USA that:

> *In many cases, the on-dock operator has no incentive to control expenses so costs continue to increase. One East Coast on-dock operation has a contract that stipulates that the railroad must absorb all cost increases.*

Arguments put forward in Independent Railways (2007, passim.) illustrates similar issues about stevedores' handling of railed containers at Port Botany. In this context, Ashar (1997, passim) argues that productivity of activity at terminals should be monitored and that performance rates should be incorporated into contracts. These issues are discussed further in Chapter 7.

D. Maritime terminal landside tasks and productivity

A further important aspect of road and rail landside modes is their relative productivity at the port. In this context we mean the productivity of the vehicles themselves rather than the productivity of container handling.

Truck systems are impeded by bunching of deliveries and collection of containers to, and through, the terminal. This has an impact on both terminal operators and truck operators. Truck queuing reduces vehicle utilisation, thereby increasing truck-operating costs. This queuing can be reduced by scheduling truck deliveries and collections, through offering vehicle-booking systems.[44] Differential fees can also be used to encourage shifting of terminal use away from peak periods, and was implemented for truck usage at Port Botany as part of reforms to the Vehicle Booking System that were announced in 2008. The same reforms incorporated financial penalties for stevedores and truck operators not meeting performance standards.[45] The lower truck turn-around times at Port Botany is attributed to these pricing and performance reforms—formally known as the Port Botany Landside Improvement Strategy. The costs of running the system were recovered through increased wharfage and booking reservation fees. (Davies 2013, p. 2)

Rail's maritime landside tasks involve similar operating issues to rail activities at the hinterland terminal. For the maritime landside facilities, however, the rival uses for port land present a particular constraint on the dimensions of the rail yard. It can also leads to compromising the preferred location for the rail yard relative to the container stack. Arguably, these compromises are less evident at the hinterland terminal, especially where the container stack can be built on a relatively open, unconstrained, site—which is more likely if it is not a legacy facility. (See, also, Rickett 2013, p. 11)

The nature of the port can generate compromises in rail's performance that bring a range of less-than-desirable operating practices. These are now considered.

Multiple container terminals served: excessive shunting

Shunting is a time-consuming rail task that can also absorb track capacity and be a source of unreliability. The extent of the task is very specific to individual operations but it can dominate overall train costs. European shunting time has been estimated to take between 10 per cent and 50 per cent of total train transit time. (Bontekoning and Priemus 2004, p. 339). The need for rail to serve multiple container terminals may lead to a substantial shunting task in situations where each terminal has a rail yard and where the hinterland–port trains assemble traffic from or to each of those terminals. Larger ports have multiple container terminals, operated by stevedores or by shipping companies. Trucked containers will move directly to the required terminal to deliver the one- to three-container payload, but for a train the container wagons need to be split and shunted into multiple terminals.

Delivering and collecting containers from multiple terminals involves two principal sub-optimal activities. The containers may have to be railed to one terminal and then be trucked to another terminal, resulting in extra costs. Alternatively, the train may be formed or split by shunt wagons to and from railway yards at the relevant terminals.

Rail's productivity is hampered where trains have to be repeatedly split and re-joined (coupled) and shunted between different locations. Inevitably, a train destined for the port will need to have a consist ordered in a way that it can be split readily into rakes of wagons for each terminal. Additional labour and time resources are incurred, reducing rolling stock utilisation. Inevitably, operating costs are higher.

44 A major pioneering road container-collection system is PierPass, which is used at the Ports of Los Angeles and Long Beach. In August 2015 ten of the participating container terminals within the system agreed that during 2016 a mandatory booking system would be required for scheduling truck collections of imported containers. See http://www.pierpass.org/uncategorized/pierpass-terminals-embrace-appointment-systems-at-ports-of-los-angeles-and-long-beach-to-control-congestion/

45 See the Sydney Ports 2008 summary of the reforms, at http://www.sydneyports.com.au/__data/assets/pdf_file/0013/5404/PBreform.pdf

Splitting and assembling rakes of wagons between a train and multiple terminals requires coordination of container processing at the terminals' respective railway yards. Failure to coordinate impedes shunting productivity.

Shunting can be reduced is where the port has a central railway yard, with containers shifted between that facility and the individual terminals by non-rail transfer systems (Intra Terminal Vehicles, or by truck). This approach saves shunting time and costs but the non-rail transfer brings its own costs.

Constrained rail landside terminal space: excessive shunting

Portside land is inevitably sought for a range of cargo-handling and processing activities, ancillary tasks (such as empty container placement) and logistics tasks. Thus, the land available for railway terminal facilities is therefore inevitably a compromised scale.

Land constraints can also lead to excessive shunting when the terminal sidings are shorter than the train, requiring splitting the train. For example, the West Swanson Intermodal Terminal at the Port of Melbourne has a single storage siding length of 565 metres while linehaul train lengths of up to 1 800 metres are permitted. When trains exceed the siding length, the extra wagons have to be placed beyond the terminal gates (Meyrick 2006, p. 35). Again, that mismatch of long trains and short sidings typically arises when the rail facilities are located at on-dock sites, where land—and especially long, narrow areas of land—is scarce and facing a range of multiple alternative uses.

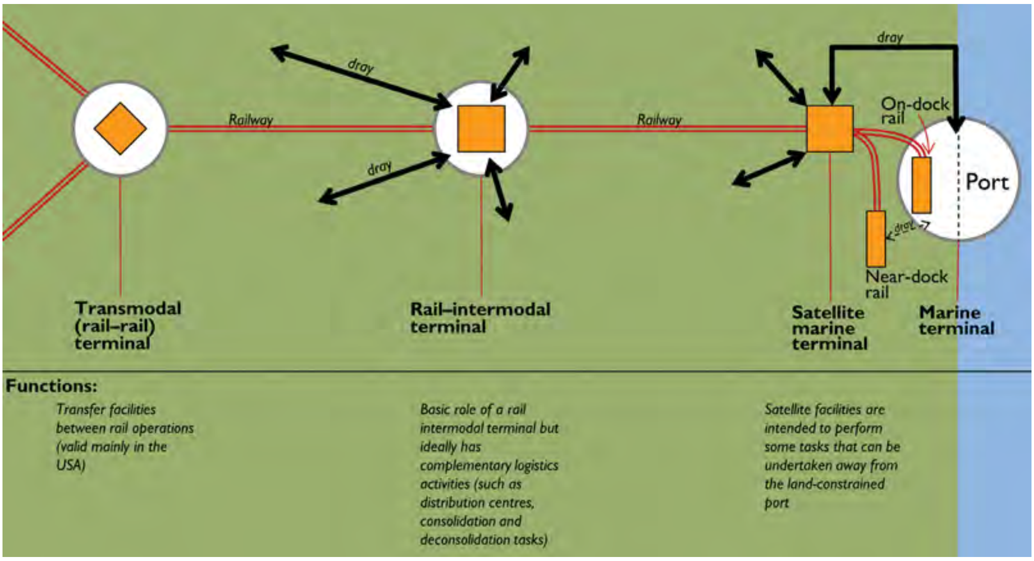
Trade-offs in rail yard performance with rail terminal siting

A core operational parameter in box handling at the maritime terminal is whether the rail facilities are located on-dock or near-dock; these are illustrated in Figure 27. The on-dock facility lies within the port boundary while the near-dock facility lies near, but beyond, the port boundary. The port boundary is being used as a proxy for the distance between the railway terminal and the container stack, with the presumption being that a shorter distance is preferable.

There is no precision about what "near" means but in North America a maritime rail terminal is classed as near-dock when it lies beyond the port boundary but no more than eight kilometres from the port. It follows that an off-dock facility is located at least eight kilometres from the port. (There is further discussion of the terminology of maritime rail terminal locations in Box 20.)

The port boundary may not always be a good proxy for the proximity of the rail terminal to the stack. In particular, the rail facility may lie beyond, but abut, the port boundary, with no practical consequence of the operational siting. For example, Fremantle's North Quay Rail Terminal lies beyond, but abuts, the port boundary. Containers are transferred "through the back fence" between the rail terminal and the two container terminals, and two of the empty container parks. That is, in this case the near-dock rail facility has all the locational attributes of an on-dock facility. Further, an important attribute of the arrangement is that on-road movements are eliminated. This cautionary note should be borne in mind in the forthcoming discussion.

Figure 27 Principal marine-rail terminals



Source: Derived from Notteboom and Rodrigue 2009, p. 6.

An important economic, rather than financial, consideration in encouraging on-dock terminals is that do reduce usage of the road system. On-dock operation is encouraged at the San Pedro Bay (Los Angeles, Long Beach) ports:

> *The Ports have developed and are continuing to pursue development of on-dock rail yards so that cargo can be loaded onto trains at the marine terminals without generating truck trips on the local roadways and freeways. (Leue, et. al., 2012, p. 3)*

Options for rail container handling systems are discussed in Box 4. That discussion notes the trade-offs involved in the different systems.

In general, we should note that on-dock systems have fewer container-handling costs — lower box transfer distances (including any drayage) and fewer box lifts — but additional train-handling costs. Because the on-dock rail facilities are more likely to be confined to smaller land areas it means that more wagon shunting and train-splitting are likely. The on-dock facilities may even result in shorter trains being operated, thereby undermining linehaul economies of density. These economies are discussed in more detail in Chapter 6.

As noted by Hansen, the on-dock rail facility absorbs valuable land, so high-volume throughput is necessary to justify it:

> *Consuming high-value dock space by a number of loading/unloading tracks can be justified economically only if the rail terminal realizes a very high daily throughput. (Hansen 2010, p. 389)*

Logistically the near-dock operations—container handling, container sorting and rail wagon shunting— for railed boxes at multiple container terminals may well be superior to on-dock operations:

> *While on-dock rail yards are dedicated to a single marine terminal, near-dock rail yards have logistical advantages due to their ability to serve numerous marine terminals. (Leue, et. al., 2012, p. 3)*

However, it is important to note that there is no consensus on whether one rail-terminal location is clearly superior to another; in practice, this will depend on port-specific circumstances. Ashar (2009, p. 4) notes that while near-dock requires moving boxes longer distances between the rail terminal and the stack than on-dock, those costs may be relatively low. The extra container-transfer costs may be more than offset by the benefits arising from being able to have larger near-dock rail facilities:

> *[The near-dock drayage] is less costly than switching long trains to smaller on-dock yards, requiring breaking trains into short strings, pushing them in/out the on-dock yards, assembling these strings to trains and then switching them back, blocking the traffic to/from the marine terminals and around them. (Ashar 2009, p. 3)*

Constrained on-dock facilities impede the process of sorting containers, and this is of concern when the increasingly-large vessels lead to more complex container-sorting processes. The rail facilities at the maritime terminals consist of both rail terminal sidings and access tracks connecting those facilities to the rail network, but sites are generally constrained. This is an important consideration for sorting containers to/from trains and vessels, for ultimate destinations; it is also important for sorting rail wagons—that is, for shunting and train assembly. Tiogra Group assessed rail operations in the two ports in California's San Pedro Bay. They concluded that there was insufficient yard capacity, inefficient historical — that is, "legacy" — infrastructure and outdated design:

> *… the legacy port rail network was not designed to assemble intermodal trains from multiple terminals and does not work well for that purpose…Cost aside, it appears unlikely that the port-area rail network will ever [have the capacity to] be able to support assembly and breakup of multi-terminal rail shuttles without disruption to higher-priority movements. (Tiogra Group, et. al. 2008, pp. 116–18)*

Constrained on-dock facilities can impede assembly of optimal train volumes that facilitate economies of density; near-dock rail yards are indispensable for assembling those volumes. A study commissioned by the San Pedro Bay Ports noted that shipping line volumes through their individual on-dock facilities at Los Angeles/Long Beach were unlikely to be sufficient to be able to build a full-capacity transcontinental train for imported boxes. By contrast, the near-dock facilities (notably, Union Pacific's ICTF, shown in Figure 49, p. 149) are in a position to assemble trains from multiple container terminals. (San Pedro Bay Ports 2006, p. 18)

Newer and developing ports are often less land-constrained and can introduce operations with new rather than legacy equipment. For example, in 2014, the Port of Miami and Florida East Coast Railway opened the port's on-dock facilities, with a simple parallel-track layout with side-loading access; this is shown in Figure 57, p. 163. Final train assembly for imports is undertaken at the railway's nearby Hialeah Yard, drawing in the domestic traffic that provides the linehaul volumes that improve viability.

Florida East Coast Railway's near-dock facilities at Port Everglades were also opened in 2014, and the facility benefits from an absence of legacy equipment, from relatively unconstrained land use and from newer logistics consolidation of domestic and international freight flows. The "state-of-the-art" facility reflects the new logistics needs and is co-located with Crowley Marine, a logistics provider, for whom the railway shifts international and domestic intermodal freight. The intermodal facility is shown in Figure 28. Co-location of international and domestic movements enables the ready transfer of imports from smaller ISO containers into larger domestic containers (that is, "trans-loading), because the domestic facility is a receival point for emptied domestic 53 foot (16.2 metre) containers. The railway linehaul thus benefits from the consolidated volumes arising from shifting both domestic and international intermodal units from the one terminal. Total international and domestic traffic through Port Everglades rose by 26 per cent in the terminal's first year of operation.

Figure 28 **Near-dock rail terminal, Port Everglades, Florida**

Source: Photograph courtesy of Florida East Coast Railway

Multiple rail terminals: coordination issues

The efficiency of railway operations at ports can be undermined by the need for the various parties to act in concert. The incentives for the different freight agents to optimise the supply chain are discussed further in Chapter 7. Container terminals' rail operations are affected by other terminals and by mainline operations. The inefficiencies of activities at one terminal are likely to affect another terminal—particularly when trains arriving at, or leaving, the port are formed from wagons destined for, or assembled from, multiple container terminals. Services can be impeded if there are train operators from multiple train operating companies.

At the heart of these potential clashes of activity is the issue of coordination. Where there are multiple parties operating then such clashes are inevitable. Clearly, the coordination of activities is crucial. One approach to improving the operational interfaces is to have a coordination committee that seeks to work together to solve potential clashes before they happen.

The other solution is to place one entity in charge of given tasks and permit that entity to use its own communication systems to resolve any conflicts. An example of this system is at the San Pedro Bay ports, where the company Pacific Harbor Line operates all the trains within the port precinct. The company assembles trains from multiple terminals and delivers rakes of wagons to those same terminals. Another examples is the New Orleans Public Belt Railroad (providing the rail services for major railroads within the port of New Orleans). A related approach has been adopted at California's Port of Stockton, where the Stockton Public Belt Railway provides port-shunting services. That railway is a joint-stock entity, being owned by the two companies it provides services for, namely Union Pacific, and BNSF Railway. Independent and coordinated rail movements can then be planned from within the single entity.[46]

This coordination issue can be heightened when the maritime rail terminals are served by multiple train operators. This is particularly evident at Australia's ports, which are served by multiple train operating companies, reflecting the regulations on open-access and third-party access to railway infrastructure. Port Botany, especially, is served by a number of train operators. These operators include Pacific National, Qube, Sydney Rail Services, Freightliner, Maritime Container Services and Southern Shorthaul Railroad.

There is no evidence about the efficacy of port coordination committees or operating agencies in resolving coordination problems in container movements.

Container sorting

Maritime terminals have a yard stack that is used for container storage as well as their sorting for subsequent vessel-loading or hinterland dispersal. This task is often more challenging for containers that are railed. While exported boxes are already assembled — or grouped — for ultimate overseas ports, the imported boxes destined for a given destination may need to be assembled if their location on the ship is not systematic. This is less of an issue for roaded imports as the boxes are sent individually, or in pairs, on a given road vehicle.

Thus, while rail has a comparative advantage with shifting large import consignments, the economics can be undermined by the trainload consolidation task performed at the port. As noted in Chapter 2 (p. 24), increases in vessel size have led to less systematic box placement on vessels, and this has increased the landside task for consolidating trainloads for movement inland. This tendency will intensify as vessels increase in size and the complementary alliancing rises. As has been noted, then,

> *Unless ports, shipping lines, terminal operators, truckers and cargo interest break out of their current siloed approach to cargo retrieval, congestion problems will intensify. (Mongelluzzo 2015, n.p.)*

The ports of Los Angeles and Long Beach face congestion problems irrespective of the hinterland mode that is used to shift the containers from the ports. One option they are exploring is to use the railway to shift containers to an inland location, to sort and to make the containers available for distribution from that site. In those circumstances rail would be favoured to the extent that boxes would already be on rail wagons, but the boxes would still require sorting at that inland facility.

Evidence from the case studies

This section considers evidence about the performance of hinterland and maritime terminals in Australia, and overseas. The evidence is drawn principally from the case studies, discussed in Appendix A; from Australian inquiries into the port landside task discussed in Appendix D; and in maps showing regional and urban port–rail intermodal services (Appendix E).

46 This approach was also discussed in BTRE 2003, p. 120.

The foregoing discussion in this chapter demonstrates that rail terminal efficiency is strongly influenced by container-handling systems and rail-wagon systems. There is no clear-cut conclusion, however, as to whether on-dock rail is superior to near-dock rail. Similarly, it is inconclusive as to whether a single central rail terminal for the port is superior to providing a rail terminal for each container terminal. Perhaps the clearest conclusion, then, is that the merit of each form of facility is location-specific—due to factors such as land availability, legacy rail infrastructure and the motivations of freight agents.

These factors are borne out by the conflicting practices evident in the case studies. Indeed, in the context of our examination of why short-haul rail operations succeed, there is less evidence illustrating why those services are sustained than there is evidence illustrating the impediments to their operation.

Australia

In the following discussion we outline notable deficiencies in short-haul terminal operations, while noting that short-haul services are functioning despite these impediments.

Hinterland container handling

Australia's short-haul urban hinterland terminals are at Yennora and Minto in Sydney; Forrestfield in Perth; and Penfield in Adelaide. The Yennora terminal essentially grew from existing rail land based around the extensive Yennora Distribution Centre. However, the other sites have benefitted from development within a broader greenfield logistics centre expansion. Co-location of shippers and terminals—which minimises drayage and terminal handling tasks—is more likely when operations can be initiated with greenfield siting. By way of illustration, distribution centres and production facilities have developed around Minto and container handling has been simplified. For example, containers are transferred by private road between the Minto terminal and the Breville facility. Thus the co-location streamlines container handling.

Hinterland regional terminals can be tailored to meet the circumstances and can involve relatively modest terminal handling systems where land and rail-capacity permit. The "terminal" may consist of just a hardstand (sealed based) abutting the mainline railway. That is, where mainline capacity permits, terminal sidings are not required. Loading and unloading of the train can be conducted given that few trains use the line. This is illustrated in Figure 29. The simplified operation for containerised goods is conducted at Agrigrain's terminals at Coonamble and Narromine. (See Hoyle 2015 for further information.)

The importance of streamlining the container-handling processes at intermodal terminals was recognised from the early days of modern intermodal systems. For example, the importance of the Flexi-Van system, as illustrated in Figure 21, was that at the time it provided a cost-effective way of expediting the intermodal transfer of containers.

Figure 29 Simplified regional intermodal terminal facilities, Coonamble, NSW

Notes: There are no sidings at Agrigrain's Coonamble terminal. Containers are loaded and unloaded directly from the train, which remains on the main line. In this April 2015 photo the Qube Logistics train has arrived at the facility. The Hyster container handlers are used to unload empty containers and to load containers filled with grain and cotton seed.

Source: Photograph courtesy of John Hoyle.

Assembling trains at hinterland terminals

Hinterland terminal efficiency has generally been a function of the land dimensions and the related legacy of earlier railway facilities.

The Yennora terminal illustrates those inherited land constraints. A RailCorp representative argued that Yennora was "… generally not configured for efficient train operation". (RailCorp 2007, p. 19) Sometimes a terminal may be sited where its activities create disturbances for local communities. This was one reason for the shift of the Horsham regional intermodal terminal to nearby Dooen.

As traffic grew, the Minto operation was increasingly impeded by short terminal sidings. The consequence of this was that shuttle trains were shorter than desired. The desired train length was 600 metres but terminal sidings were less than 400 metres in length. (ARTC 2007, p. 13) There was also insufficient land to provide an extra track that would enable the locomotive to be shifted from one end of the train to the other end. To overcome this it was necessary to attach a locomotive at each end of the train. In 2010 the siding was lengthened to enable the locomotive to shift from one end of the train to the other, and so removing the need to have a locomotive at each end of the train. The lengthening was made possible when the terminal operator was able to purchase the relevant land parcel.

Maritime terminal dockside container-handling productivity and tasks

Australian inquiries that have examined landside maritime container movements in the last decade have indicated that some railed containers face additional container lifts and moves at the dockside. This is particularly the case with Port Botany and the Port of Melbourne.

Railed containers sometimes involve additional shifts relative to trucked containers. The Patrick operation at Port Botany, illustrated in Figure 24, involves the same number of container lifts and moves for trucked and railed containers. The DP World facility at that port, illustrated in Figure 25, involves one extra lift and one extra move. Investing in different container handling systems is a commercial decision, however, but the extra lifts must leave DP World's rail operation at a disadvantage relative to the Patrick operation.[47]

The consequence of these systems, however, is to reduce container-handling productivity, which will "… lead directly to longer cycle times for train sets and crew". (IPART 2008, p. 99) Hearsch noted that:

> … *terminal operations are critical to the overall logistics chain and can often be the link that has a significant impact on productivity of the overall system. There ia an obvious disconnect in some instances between the interests of terminal operators (and particularly stevedores in capital city ports) and those of rail operators, which reflects in interacting delays and extended cycle times for rail services. (Hearsch 2008, p. 27)*

The West Swanson Intermodal Terminal at the Port of Melbourne also faces extra handling costs for railed containers. The terminal is located a short distance from the container stacks. However, to transfer boxes between the terminal and the stacks involves crossing a public road, Coode Road West. This leads to the relatively inefficient use of trucks rather than intra-terminal off-road vehicles. This increases the costs of operation and the transit across the road is necessarily a slower, more considered movement—against other traffic—than a largely unimpeded move within a yard. This is discussed in more detail in the Port of Melbourne case study in Appendix A.

The West and East Swanson rail terminals—for DP World and Patrick respectively—operate independently. West Swanson railed containers that are exported through the Patrick container terminal are shifted between the facilities by road (and conversely for Patrick railed containers moving through the West Swanson container terminal). This is arguably more efficient than shunting the containers between the terminals.

In general, the various inquiries have highlighted the inefficiencies of the different railed container-handling systems—notably at Port Botany. These add costs to the operation, undermining the economics of short-haul urban and regional containers.[48] Whether it is cost-effective (in commercial and economic terms) to resolve those impediments is a matter for those who would need to fund any changes. However, the rail service operations are sustained in spite of these operational inefficiencies.

Maritime terminal landside tasks and productivity

Reports and public inquiries into Australia's landside port operations have highlighted the constrained rail terminal sites and capacity—with the impact on track layout and operations); and identified the diverse productivity of different rail terminal siting. In general, terminal

47 IPART commented in 2008 that "Patrick has invested over $200 million since 2005 in new equipment, including five RMGs. Patrick believes that this investment, together with other investments, will enable it to meet its share of the 40 per cent rail target. It is important to note that Patrick has made this investment on a strictly commercial basis, without the need for government intervention. While DP World has not adopted the same future operating philosophy, it is consistent with workable competition for competitors to follow different investment strategies."

48 By way of example, Wakefield Transport with Seaway Logistics has contracted to move around 100 TEU of containers from Merbein (near Mildura) to the Port of Melbourne, a distance of 616 kilometres. The company has advised a Parliamentary inquiry that the costs of shifting the containers a distance of 100 metres from the train to the waterfront amount to about ten percent of the linehaul costs from Merbein. Wakefield Transport has found that despite this the relatively high volumes make rail preferable to road. (Parliament of Victoria, Rural and Regional Committee, 2014, p. 131)

configurations may have developed from legacy — that is, prior-use — decisions. The configurations may now be inconsistent with increased traffic throughput and with better practices and technology that have subsequently emerged.

Rail maritime facilities have been developed with, but sometimes trailing, the strong growth of containerisation. Diverse rail facilities and capacities have resulted. Against this background of growing port throughput—and lengthening linehaul trains—the scale of some rail terminal capacity has increasingly been inadequate and triggered new investments. Examples include:

- Expansion work that was completed in 2014 at Fremantle's North Quay Rail Terminal. This resolved the deficient siding lengths and improved operational efficiency with provision of locomotive run-around capabilities. The Terminal now enables direct transfer of containers between the rail facility and adjoining container terminals and two empty container park sites (Qube, Australian Container Freight Services).
- "Optimisation" work at the Port of Burnie in 2015 involved removing the dockside rail sidings. Container handling has been shifted to a less-constrained rail terminal further from the dock (House of Assembly [Tasmania] 2014, p. n.a.). This is discussed in more detail in Appendix B.

Work at the DP World Port Botany rail terminal in 2010–12 removed conflicting road movements across the rail site, added reach stacker equipment, and enhanced the rail yard layout.

- Figure 31 illustrates the new rail layout at Port Botany.

Despite that Port Botany work, the siding lengths at the DP World facility are still shorter than the standard 600 metre train formations operating to the port. The DP World yard has three sidings of 340 metres each.. An insight into the wider effect of the constrained rail facilities is illustrated here. This quote dates from before the 2010–12 work:

> *Rail operators bear the major costs of waiting, excessive shunting, and insufficient loading time that arise from the inefficient track configuration at DP World. Patrick is affected in two ways. First, as most export trains are split between Patrick and DP World, the train cannot be rejoined until both stevedores have finished unloading, so the Patrick half of the train must wait for the DP World half to be finished. Second, longer trains sometimes stick out beyond the end of the short DP World and POTA sidings, blocking the mainline access to Patrick's sidings. (IPART 2008, p. 97)*

Similar "growing pains" have been evident with the approach rail path through Cooks River, into Port Botany. Figure 63, in Appendix D, depicts Sydney's metropolitan rail freight network. Meyrick observed in 2006 that:

> *The main external hindrance to the efficiency of the terminal is that there is only one rail line in and out from Cook's River to Port Botany. This subsequently causes excessive shunting delays by the rail provider and in turn reduces the efficiency of the facility. (Meyrick 2006, p. 31)*

In response to these issues, in 2013 Australian Rail Track Corporation (ARTC), the rail infrastructure manager for Sydney's Metropolitan Freight Network, opened the Enfield Staging Facility. The facility enables the holding or re-sequencing the trains heading for the port or the Botany Yard, relieving congestion on the port-approach tracks.[49]

49 The project formed part of the upgrade programme (track capacity, track specifications, track layout and signalling) to the Metropolitan Freight Network to Port Botany, which is being undertaken in three stages. Stage One was completed in 2010 and Stage Two was completed in 2015. The contract for Stage Three was awarded in 2015.

The diverse systems of rail operations at the container ports affect the efficiency of shifting railed containers. The operations fall into the following three main categories of provision:

- on-dock rail—single central terminal: Fisherman Islands; Outer Harbor (Adelaide); Fremantle Inner Harbour;
- on-dock rail—multi-terminals: Port Botany; East Swanson Dock (Melbourne); and
- near-dock rail—the West Swanson Dock and Dynon terminals (Melbourne).

The two rail operating productivity aspects here are the merits of central terminals versus multi-terminals and the advantages of on-dock rail over near-dock rail. The choice between operating a single central rail terminal, and operating multiple rail terminals, is both location-specific and scale-specific.

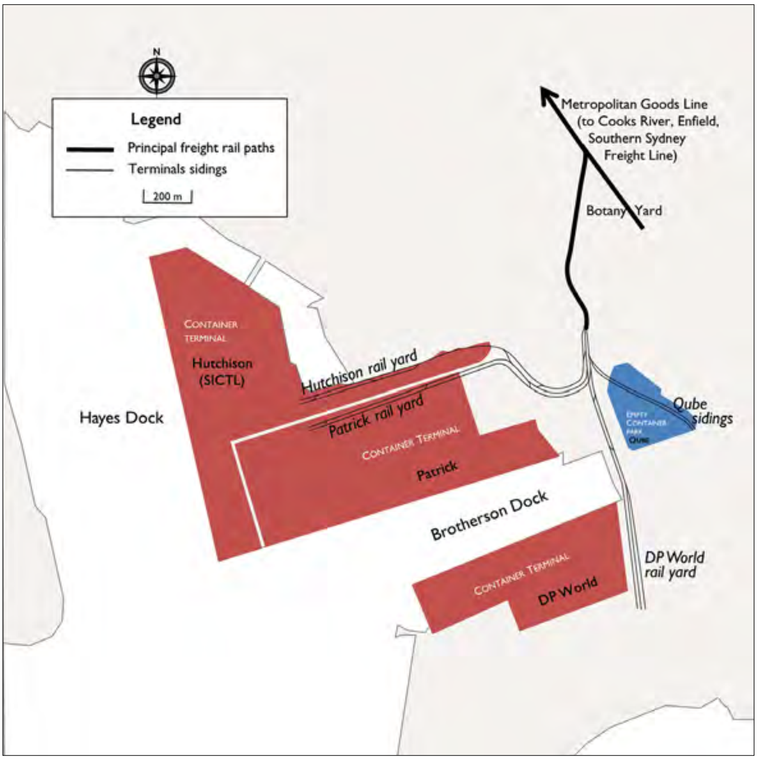
For example, there are contrasting layouts and operating systems used at Port Botany and at Fremantle Ports

Figure 30 and Figure 31 illustrate the respective rail yards. At Fremantle, the single North Quay Rail Terminal serves the adjacent DP World and Patrick container terminals and the Qube empty container park. By contrast, Port Botany's rail facilities are split into four near-dockside operational areas: a rail terminal for each container terminal—DP World, Patrick, Hutchison—and rail sidings for Qube's empty container park.

Figure 30 Rail facilities at the Port of Fremantle (Inner Harbour)

Thus, it is notable that Fremantle's rail terminal does not require complex shunting, with the box transfers between dockside and rail terminal being undertaken without shunting. Containers are shifted directly by inter-terminal vehicles between the "back fence" of the Rail Terminal and the container terminals. We should note that this arrangement has merit for public policy in that, despite being a centralised rail facility, the boxes can be shifted between rail and maritime terminals without resorting to movement along public roads.

Figure 31 Rail facilities at Port Botany



It might be argued that the operations involved at a large, sprawling, port site, such as that at Port Botany, might lend itself to multiple rail terminals. Indeed, the port's relatively large container volumes would also support the such a provision. However, conversely, those same larger volumes might then increase the shunting task and complexity. This is because, apart from the inefficiencies involved in train shunting and train splitting and formation, the operations increase the challenge of coordinating container flows between relevant agents (such as shipping lines, stevedores, train operating companies and rail infrastructure managers).

Interested parties offered views to inquiries about the landside task at Port Botany suggesting that rail's efficiency is being undermined by the complex shunting operations required to shift boxes between a train and each of the port's four rail facilities. Consistent with this, a port rail strategy study concluded that Port Botany would be better served with a single, central, rail terminal. (AECOM 2012, cited in Guimarans et al 2015, p. 2)

A NICTA-sponsored study that conducted simulations of the rates of handling at existing Port Botany rail terminals, and at a centralised rail terminal, concluded that, over the medium term, the central facility offered only marginal gains and that these were manifested only at periods of peak-throughput.[50] Such gains emerged through faster shunting, and reduced need for shunting at the single terminal. Further to these marginal gains, the study's authors noted two disadvantages. First, converting to a centralised terminal would require substantial investment in new infrastructure. Second, additional resources may be required to convey boxes between the rail facility and the container stacks. (Guimarans, et. al. 2015, p. 14)

While inquiries have questioned Port Botany's infrastructure form, changes in operations have been seen as solutions. For example, inquiry recommendations have focused on better coordination of the activities of the individual parties. A Port Botany Rail Team has been established to facilitate coordination of train, track and stevedore rail activities.[51] Similarly, the NICTA study concluded that changes in operational procedures for serving the multiple terminals could enhance productivity. Such changes included serving each terminal with a dedicated train. (Guimarans, et. al. 2015, p. 15)

The following views illustrate how the merits of centralised and multiple rail terminals can be location-specific and scale-specific. In a 2014 inquiry, one shipper association noted the virtues of the Port of Brisbane's central rail facility, the Brisbane Multimodal Terminal, which is similar to Fremantle's North Quay Rail Terminal:

> *In Brisbane we have the multimodal terminal. It is there, it is underutilised but it is a fantastic facility. We can put a train in there, get it stripped and reloaded and out within three hours. You cannot do that in Sydney. You have to go into each individual terminal. (Queensland Parliament 2014, p. 95)*

The inquiry concluded from the evidence that the "Brisbane multimodal terminal can load and unload with extreme efficiency…".[52] (Queensland Parliament 2014, p. 95). Subcontractors of the Port of Brisbane Corporation then transfer the containers by road between the rail facility and each container terminal. QR National believed that the Brisbane rail operations would "work more efficiently under the model". (QR National 2007, p. 11)

An additional suggested virtue of the central rail terminal is its isolation from the container terminal. This isolation insulates the terminal from the possibly adverse priorities of the stevedores:

> *Management of the North Quay rail terminal is similar to that of the Port of Brisbane Multimodal Terminal at Fisherman Islands, which is undertaken by the Brisbane Port Corporation and allows trains to arrive/depart without being impeded by stevedore terminal operating priorities. (Department of Transport [Victoria] 2010, p. 38)*

As identified elsewhere, however, there are conflicting views on the merits of on-dock and near-dock and terminal-specific rail terminals versus central facilities. An example of this is the case study on the San Pedro Bay ports discussed in Appendix A. Thus, a representative from Sydney Ports Corporation argued that:

> *… what we've got in Sydney is actually a fairly progressive rail access to the port. It is certainly the envy of both Melbourne and Brisbane to the extent that we have rail sidings going to each*

50 NICTA was an Australian technology-based research centre. The centre's title was derived from its previous terminology as the (National) Information and Communications Technology (of) Australia.

51 The NSW Cargo Movement Coordination Centre aims to improve coordination of the different entities in the supply chain. See http://freight.transport.nsw.gov.au/network/cmcc/

52 The establishment of the central facility was not without problems, however. The Port of Brisbane Corporation noted that communication of, and scheduling, container movements through the facility needed to be good, with contact made with all participating parties reinforced with electronic information links. (UNESCAP 2006, p. 33)

stevedore, whereas Brisbane has a consolidated terminal, which means that you've got to shunt containers to and from it, and in the case of Melbourne, a bit of a hybrid between the two. (IPART 2007a, p. 7)

In their report for the Sea Freight Council of NSW, Sd+D summarised the net attributes of the Brisbane terminal relative to those at Port Botany, which are paraphrased here as:

- **Train marshalling and configuration.** In Brisbane there is a single unload point for exports, plus a balloon rail loop to expedite train turnaround. At Port Botany the trains have to be dissembled and shunted into multiple, dead-end sidings with extra time required and triggering additional safety inspection procedures.
- **Connection to container terminal.** In Brisbane the export containers need to be conveyed onwards across public roads to each container terminal. At Port Botany the containers are delivered directly to each container terminal without using public roads.
- **Operating interface.** In Brisbane the rail operations are separated from the stevedore operations and performance; at Port Botany the rail service performance is highly dependent on how well the stevedore performs. This has implications for trains meeting booked train paths on the railway network. (Sd+D 2005, p. 73)

It should be noted that Brisbane's central rail terminal replaced a system similar to Port Botany's, where rail spur lines entered each container terminal yard. The shift to the central facility occurred in 1994. A similar plan has been mooted for the Port of Melbourne, with its central near-dock Melbourne International Freight Terminal in the Dynon precinct.[53] The Colin Rees Group has argued that the port's rail terminal provision impedes container movement along the "last mile" to the container terminal; this, the Group argues, would be resolved with a central common-user port facility:

An independent, low-cost common user, on-port terminal would allow direct on-dock delivery of rail containers, thereby removing cost from the "last mile" of the journey for Victorian exporters. (Colin Rees Group 2015, p. 2)

For more information, see the discussion on the CRT rail shuttle in Appendix D.

Concerns for Melbourne's existing rail facility and charges have been raised by other port users, with Wakefield Transport indicating that it is charged $200 to shift a one TEU container between the Patrick terminal in Coode Road and the East Swanson Dock, while a trucked container incurs just $7 for a timeslot. The company believes that the port needs to be efficient, with on-dock rail deliveries being one approach to achieve this. (Parliament of Victoria 2015c, p. 36)

Australian evidence provides no consensus or consistent experience on some issues such as the appropriate form of maritime terminal provision. This arises in part from location-specific and market-specific circumstances. Nonetheless, as the CRT company's experience demonstrates, resolution of maritime terminal issues can be a crucial factor in bringing about greater uptake of short-haul rail.

53 For information about the mooted *Port Rail Shuttle Project* see Austrak 2015 (passim); also City of Melbourne 2012, p. 105.

Overseas

Container-handling and train-handling systems at rail terminals have evolved in response to the growth in maritime throughput. The shift in the role of hinterland terminals and the growth in throughput have led to enhancements in handling systems, notably with more efficient cranes for transferring boxes. While the initial intermodal developments tended to be based on re-using existing rail yards, the new terminals are sited on greenfield locations. For example, the Front Royal terminal (Virginia Inland Port) and the coastal port facilities have justified additional investments that enhance terminal productivity. This has evolved as confidence has grown in the operations, with growing throughputs. For example, for the Virginia operations:

> *VPA completed construction of a new high-capacity rail yard at its Norfolk International Terminal (NIT) in 2011, and acquired a new on-dock rail yard when it began leasing the private APMT facility at Portsmouth in 2010. These actions reduced the need to truck containers between VPA's terminals and off-property rail yards and increased its capacity for handling rail cargo by an estimated 250,000 TEUs per year. (JLARC 2013, p. 24)*

The limited scale of the operations tend to limit the investments in equipment and the land footprint for both dockside and hinterland terminals. Such investments are arguably fit for purpose while increased throughput justifies enhancements—such as those undertaken in the case of the Göteborg short-haul shuttle. Only occasionally has a revolutionary—rather than evolutionary—approach been taken to acquire land, and bespoke terminal and train equipment—as with British Rail's Freightliner operations. There is more discussion about British Rail's operations in Appendix B and in Appendix C.

Trends of rising port throughput have led to attention to the soft side of terminal operations—specifically the efficiencies of interfaces between the various rail operations at the ports. Systems for coordinating the activities can facilitate communication between the various players in container movements between hinterland and port rail facilities—and within the port precinct. As we noted above, the Port Botany Rail Team is a coordinating entity consisting of the various logistics participants. A different approach has been taken at the San Pedro ports, Los Angeles and Long Beach. There, the Pacific Harbor Line railway operates on-dock train services for the ports, on behalf of national railway companies. It serves multiple container terminals in lieu of individual railways vying to undertake those services individually. Each of the mainline railways—Union Pacific Railroad (UP), BNSF Railway—then interfaces only with Pacific Harbor Line. As illustrated in Table 2, it is common for ports to use third-party train operators to shift container wagons within the port.

Despite the Ports' large volumes, the Pacific Harbor Line operation still needs to assemble trains—for long-haul rather than short- or regional-haulage—from multiple terminals. Individual on-dock terminals generate insufficient volumes for the UP and BNSF to warrant operating terminal-specific trains.[54] Mainline trains in North America shift very large volumes due to double-stacking and substantial train lengths—up to 3.6 kilometres.

54 The railways' linehaul container trains are between 2.1 kilometres and 2.4 kilometres long and dominated by double-stacked wagons.

Table 2 Organisations undertaking rail activities at selected ports

Port	Maritime facility	Port railway operator	Connecting railways	Container terminals	Port rail facilities ownership
On-dock operations, USA					
Ports of Los Angeles and Long Beach	Ports	Pacific Harbor Line	BNSF; Union Pacific	15	Ports of Los Angeles and Long Beach
Port of Stockton	Port	Central California Traction Co. (operating the Stockton Public Belt Railway)	BNSF; Union Pacific	Satellite Container Terminal	BNSF; Union Pacific
New Orleans	Port	New Orleans Public Belt Railroad	BNSF, CSX, Canadian National, Kansas City Southern, NS, Union Pacific	Napolean Avenue Container Cargo Terminal	City of New Orleans
Port of New York and New Jersey	Terminal	Staten Island Railroad	CSX; Norfolk Southern via Conrail Shared Assets Operations	Howland Hook Marine Terminal	Metropolitan Transportation Authority (State of New York)
Port of Virginia	Selected port terminals	Norfolk & Portsmouth Belt Line Railroad	CSX, Norfolk Southern, Chesapeake and Albemarle Railroad	Portsmouth Marine Terminals	Jointly owned by CSX and Norfolk Southern Railway
Port of Virginia	Terminal	Commonwealth Railway	Norfolk Southern Railway	Portsmouth (APM) Container Terminal	Commonwealth Railway — part of Genesee & Wyoming
Houston	Terminal	Port Terminal Railroad	BNSF, Union Pacific	Barbours Cut Container Terminal	Jointly owned by Port of Houston Authority of Harris County; Houston Belt & Terminal Railway Co.; Union Pacific Railroad, BNSF Railway; Kansas City Southern Railway Company.
Near-dock operations, USA					
Port of Savannah	Terminal	CSX Norfolk Southern	Chatham Yard ICTF (CSX); Mason Intermodal Container Transfer Facility (Norfolk Southern)	Single terminal: Garden City Terminal	Georgia Ports Authority
On-dock operations, UK					
Felixstowe	Port	Network Rail (below-rail infrastructure)	Train operators	Container terminals	Port of Felixstowe (Hutchison Ports)
Southampton	Port	Network Rail (below-rail infrastructure)	Train operator: Freightliner; also 3rd party access train operators	Southampton Maritime (DP World Container Terminal)	Freightliner (Genesee & Wyoming)
London Thamesport	Port	Network Rail (below-rail infrastructure)	Train operators	Container terminal	London Thamesport (Hutchison Ports)

There is no evidence that on-dock is consistently preferred to near-dock. Operators value both on-dock and near-dock operations. At the San Pedro Bay ports there has been strong growth in on-dock operation, with a strong shift from near-dock to on-dock. The container transfer is straightforward. Containers are generally offloaded from vessels onto rubber-tyred equipment and then conveyed directly to a rail wagon, or to a trackside container staging area. Major expansions project at Long Beach incorporate new and expanded on-dock facilities. The two mainline railways have also encouraged on-dock operation as from 2004 they levied container dwell-time fees and volume quotas for customers using their off-dock terminals. (Smith-Peterson 2006, p. 39) Meanwhile, strong traffic growth has led to the plan, approved in 2015, to construct a second (BNSF) near-dock rail terminal adjacent to the original Union Pacific facility. One use of such near-dock terminals arises when the shipper seeks an earlier train departing from Los Angeles than the scheduled trains departing from the on-dock facility. (Smith-Peterson 2006, p. 36) The near-dock facility can appeal to shippers transferring boxes between port and off-dock terminals—for rail long-haul movement. Because the near-dock terminal is just eight kilometres from the port, shippers avoid a 32 kilometre drayage between the port and the off-dock facility.[55]

The Port of Montréal has a unique on-dock rail interface—part of an container-handling organisational system that the port refers to as the Montréal Model. More than one-half of the container traffic moves to and from the port by rail. The port has adopted a genuine on-dock rail transfer—containers are shifted directly between vessel and rail wagon. Sorting of containers—for transfer to vessels, or to different hinterland destinations—occurs in nearby Canadian National and Canadian Pacific rail yards. This model is made possible by the long, narrow layout of the port, which allows containers to sit on wagons adjacent to the dock rather than be transferred through an intermediate stack. This means that the model may not be readily transferable to other ports.

Concluding comments

The foregoing material points to the importance of hinterland and maritime terminal efficiency—equipment used, organisational interfaces and location in container handling and in train operating efficiency.

There are, however, no clear-cut lessons from those overseas operations. Indeed, a number of the short-haul/terminal operations—MetroPort Auckland/Tauranga, Göteborg Norra/Göteborg—will arguably have throughput that is too modest to conclude other than that the equipment and nature of the terminals and rail operating systems matches the modest throughputs.

There is no clear-cut conclusion, either, about on-dock versus near-dock maritime rail facilities or central maritime rail terminals versus container terminal-specific rail facilities. Some ports have adopted both on-dock and near-dock. Optimal terminal siting is specific to locational characteristics and to markets served.

However, evidence from case studies point to inefficiencies in maritime terminal infrastructure, organisational-interface and operating systems. While this study seeks to understand why short-haul rail operations succeed, against the odds, it is important to stress that the case studies indicate inefficiencies that undermine efforts for greater uptake of short-haul.

55 https://www.port-montreal.com/files/PDF/publications/2015-05_brochure-general-EN.pdf

The case studies do point to the importance of organisational interfaces—notably the ideally-seamless coordination between the various freight agents. That coordination and communication is important in terminal efficiency, notably in handling and processing containers. As is discussed in Chapter 7, the quality of that liaison derives from the motivations of the freight agents to work on different, but mutually-beneficial, aspects of the supply chain.

CHAPTER 6

Reducing the sweet spot distance: linehaul costs

Key messages

- Rail's relatively low energy consumption and low labour requirements provide inherent linehaul operating cost advantages over road.
- These linehaul operating cost advantages rely on train economies of density: high train and wagon payloads.
- Hinterland terminals for international traffic provide key attractors for activity that brings about the necessary linehaul traffic consolidation and the necessary attractive end-node for traffic deconsolidation.
- Hinterland terminals create opportunities for capturing linehaul economies through consolidation and deconsolidation, but terminal–rail operations need to address slow traffic build-up when terminals open, they need to address any traffic imbalances (traffic backhaul issues) and they need to address seasonal traffic flows.
- Track economies of density also exist: high traffic levels are required to recover the infrastructure capital costs. Outside of North America, the access charges for using the tracks rarely do recover those costs.
- Spreading the high train (locomotive and rolling stock) capital costs across the linehaul operations requires high asset utilisation. That is, equipment should not stand idle.
- There is a balance between operating longer trains (capturing train economies of density) and the need to serve the market with sufficiently frequent trains. Large train volumes with relatively low service frequency may be possible when the hinterland terminal serves a high-volume single shipper and connecting single vessel.
- Higher train frequency may be required when moving boxes from smaller, multiple, shippers, to connect with the range of international vessel movements. This may mean running trains of less-than-optimal length.
- Increasing the wagon payload area (notably, by double-stacking) can improve train payloads but only if the payload is then not constrained by track axle load limits.
- Linehaul economics are influenced by traffic balance, and empty backhauls can skew intermodal and truck viability. Rail can be relatively less impacted by backhaulage issues.

- Rail sweet spot distance is reduced when truck productivity is undermined by road and maritime terminal congestion. A particular discontinuity arises when the truck driver cannot make a day-return region–port return journey.
- Rail may not have linehaul cost advantages when new facilities open without major anchor shippers. Initial operations are more sustainable when the hinterland terminal is based around existing shippers.

In Chapter 3 we noted that rail–intermodal sustainability depends on three intermodal parameters: drayage, terminal and linehaul tasks. As a rule, much of rail–intermodal's drayage and terminal tasks are activities that are not undertaken by direct road movements.

For intermodal to be competitive with road, therefore, rail must have lower linehaul costs that will fully compensate for the drayage and terminal costs.

In this chapter we consider how linehaul costs influence the intermodal viability and, thus, the sweet spot distance. The analysis here considers the intermodal–rail linehaul performance relative to road. As before the review is then used to provide insights into the viability of short-haul intermodal–rail in Australia and overseas.

The linehaul task in intermodal–rail operations

In Chapter 3 we asserted that the railway linehaul component of the intermodal–rail task drives the competitiveness of intermodal operations, offset by the drayage and terminal tasks to varying degrees, but particularly over shorter distances. Short-haul rail competitiveness relies on the linehaul efficiency.

Thus, the contention is that railways can offer cost-competitive freight services relative to road and maritime modes over longer distances. Once the freight has been delivered to the terminal and placed on wagons, and once the trains have been assembled, then railways' enormous economies of density can begin to be captured.[56] For instance, with the train in motion a single driver of a double-stacked train in the USA can perform the task of 300 trucks while moving the equivalent of one tonne of freight 183 kilometres while consuming just one litre of fuel.[57] Double-stacked rail in the USA has been estimated to be three- to five-times more energy efficient than freight movements by truck. (Zumerchik, et. al. 2009, p. 61)

In the following sections we examine the linehaul attributes that bring about this efficiency, and whether short-haul rail's operational and marketing attributes are favourable to capturing these efficiencies.

Inherent attributes that can make linehaul railways competitive

Railways have two key operating attributes that contribute towards competitive linehaul services: relatively low energy consumption and low labour requirements. Other operating overhead costs include head-office staff. Conversely, the "high" upfront infrastructure capital costs undermine that railway competitiveness.

56 "Economies of scale" is a generic term that is often used by laymen to describe these economies of density. However, when attempting to describe different efficiency aspects of a business, interchangeability of terms—such as scale, scope and density does not help to understand the different cost-driving parameters of the firm. This report therefore uses the precise terminology. With economies of density, incremental costs decline as usage increases. In essence, adding payload, meaning more wagons or heavier wagons, to the train can be undertaken with less-than-commensurate increases in manpower. For example, a train operator must use a single driver whether the train consists of one wagon or 100 wagons. It is also likely that a very short train will have a locomotive that is overpowered relative to the tonnage hauled. Further, longer trains incur relatively lower infrastructure charges than shorter trains. This is because infrastructure charges are generally structured to not rise as fast as train length rises, reflecting the fixed overhead costs—such as for signalling and administration—that are invariant (or mostly invariant) with rising tonnage.

57 Union Pacific Railroad web site, with conversions from Imperial units to metric: http://www.uprr.com/newsinfo/releases/environment/2013/0903_arrowedge.shtml

The reasons for rail's relatively superior linehaul attributes are:

- low energy consumption because there is relatively little rolling resistance between the wheels and the rails;
- low energy consumption due to low wind resistance, when trains and wagons are, or can be, configured to reduce the drag;
- low energy consumption due to railway alignments involving flatter routes than road;
- low traction inputs, with as little as one powerful locomotive using the low rolling resistance to haul far more freight than the equivalent road haulage traction horsepower; and
- low labour inputs, such that only one train driver may be required to haul the equivalent of 300 truck-payloads.

There are important caveats to these observations:

- train energy consumption (and rail maintenance/renewal costs) is higher when rail tracks are curved because rolling resistance between wheel and rail is higher.
- Train energy consumption tends to be higher for intermodal trains than bulk freight trains because the intermodal trains operate at higher speeds and container payloads may preclude aerodynamic drag reduction. (Rickett 2013, pp. 5–6)
- train energy consumption on flat routes can be undermined when the rail route length is longer than the road length—for instance, in the case of the Virginia Inland Port route to the maritime port, the rail length is around 50 per cent longer than the road route (See the case study on the Port of Virginia in Appendix A.
- labour input costs are higher if trains are short, that is, the driver is less productive.

This latter caveat is intended to illustrate railways' two economies of density. In this case, the economies of train density can be captured when a single driver is more productive by, for example, moving 200 wagons than moving 20 wagons. The other "economies of density" are achieved with infrastructure usage—and here we can include train equipment. If we can we can spread those costs across higher traffic volumes then we can reduce the capital cost of fixed infrastructure and equipment. It is true that there are extra costs arising from increased track and equipment usage, but those incremental costs are low relative to the upfront capital costs. The notional or real rail infrastructure, or track access, charges paid by train operators usually embody at least some element of track operating costs and, ideally, some element of track capital costs.[58]

The conclusion from the foregoing discussion is that the competitiveness of linehaul rail operations is achieved through relatively low energy and labour costs, and when per-tonne track and equipment capital costs can be reduced with high track and equipment utilisation, that is, large traffic volumes.

Two other aspects of linehaul efficiency should be noted:

- Rail's door-to-door transit time is almost invariably greater than for road. This also affects rail costs, by increasing labour costs and reducing train equipment utilisation.

58 Integrated railways may not have explicit access charges, particularly when they do not have third-party track users—hence the concept of a notional infrastructure charge. See BTRE 2003, passim, for further discussion of access charges.

- Rail linehaul competitiveness is often reduced because rail's routes are usually longer than road for any given freight market. Often roads have been updated to modern standards whereas rail routes follow legacy alignments.

The foregoing highlights the importance of traffic volumes, so short-haul viability relies on having sufficient containers to capture economies of density.

Figure 32 **Short-haul regional operation, Cullerin Range NSW**

Source: Photograph courtesy of Brad Hinton.

Rail's per-unit linehaul costs

Efforts to reduce linehaul costs usually focus on improving the train payload. That is, for each train operated it means getting more tonnes, or containers, moved. This will be cost-effective, assuming that increasing the payload does not result in commensurately more energy, labour and capital being consumed.

Reducing these linehaul costs will consequently lead to a reduction in rail's sweet spot distance. Two important ways to lower the sweet spot distance arise through increasing the train and wagon payloads. Both these examples illustrate forms of economies of density in train operation. To the extent that they generate additional railway traffic they also improve the economies of density in capital provision—that is, track and equipment.

Train payload

Attracting sufficient train volumes is essential for competitive linehaul. Increased train payloads capture the energy, labour and traction factors that bring about economies of density in train operation. The practical effect is that the largely-fixed train operating costs are spread over more wagons. Achieving higher throughput on the track also captures economies of density in infrastructure provision and this reduces the notional — or real — railway infrastructure charges.

Increasing train payloads depend on two market considerations and two supply-side issues:

- the density of the catchment area around the hinterland terminal;

- rail service quality—trading off train length and service frequency;
- physical constraints on operating longer trains; and
- the financial case for relieving those constraints.

The development of large hinterland terminals—and clusters of shipper and logistics activities around those terminals—has generated sources of rail traffic that rely upon such large, consolidated freight flows. Sheffi (2012, p. 7) notes that the logistics-intensive cluster of activities that are built around an inland terminal enables clustering firms to capture economies of scope. Firms can be attracted to clustering around inland terminals, particularly where they offer a broad range of services and labour skills. Those firms can also capture the economies of density that are achieved through the consolidation of the transport task between the terminal and the port. That is, the clustering builds its own critical mass of goods to be conveyed between the inland and maritime terminals—enhancing the conditions to support regular rail shuttle operations.

However, such hubs cannot rely upon a large logistics catchment area. Drayage lengths rise to draw in the requisite traffic volumes (Muller 1999, p. 90). As we noted in Chapter 4, however, hubs cannot rely upon long drays, except where value-adding is undertaken.

Train lengths are also constrained by the need to offer the market a sufficient rail service frequency, to reflect the road competition with its immediate, unconstrained service schedules. Conversely, to capture the train economics, the rail operators are likely to prefer to offer fewer, longer trains.

It should be noted that these market factors are relevant particularly for short-haul operations, which tend to have less opportunity to capture train economies of density.[59] It has been noted that "Rail is at a natural disadvantage in short-haul markets because of its lesser service frequency and need to aggregate multiple shipments into trains". (Railroad–Shipper Transportation Advisory Council 2011, p. 2) Nonetheless, short-haul tends to involve smaller train sizes (losing economies of density) and involve extra shunting and handling relative to longer hauls. (Ibid, p. 5)

In this sense, increasing train payloads is a market — demand — issue. For rail–intermodal operations between the hinterland and the port to work, it requires "large" volumes being moved on each train. Low frequency may be acceptable when large consignments are dispatched from single shippers, to single vessels.

More generally, however, when operating freight services, it is necessary to trade off service frequency and train length. Given the market's need for timely delivery of containers to or from the port, it means that the "long" trains should be sufficiently regular so as to meet shipping departures and arrivals without attracting stevedore storage charges. This is an important balancing act.

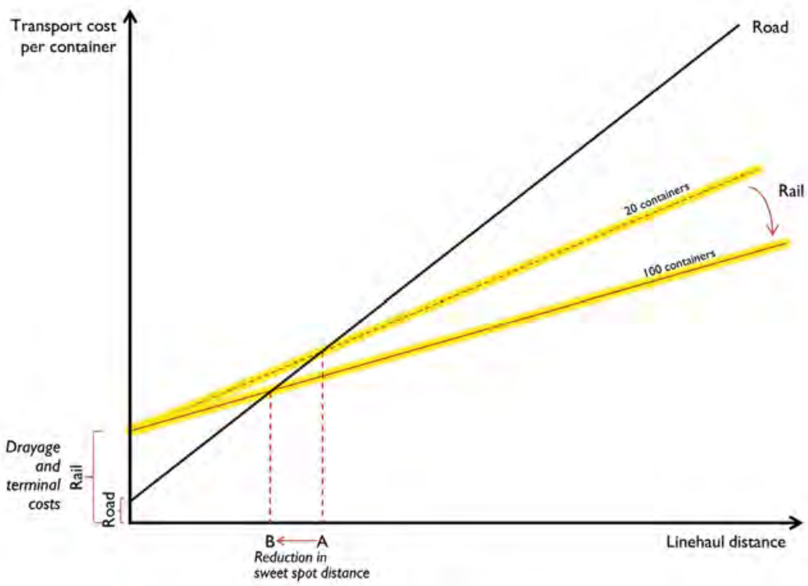
59 An example of this issue has been illustrated by Australian Paper in their evidence to the inquiry into the proposed lease of the Port of Melbourne. The company contracts for the transfer of containerised paper products from Maryvale, in the Victorian Gippsland, to an export storage facility at Victoria Dock in Melbourne; domestic stock is stored at a Dynon Road facility. Containers are exported through DP World's West Swanson Dock. The company has noted that the hoped-for freight volumes from other entities has yet to materialise, reducing the savings from using the rail service. (Parliament of Victoria 2015, p. 7) A train operates from Melbourne six days a week, each hauling around 43 forty-foot containers. (Parliament of Victoria. Rural and Regional Committee 2014b, p. 6)

Train length issues may also be practical — supply — issues. Train lengths may be capped by the length of track passing loops (when the railway is single-track) or by signalling specifications. The nature of the terrain (gradients) and wagon specifications may also constrain train lengths.

Finally, we note that these physical constraints can usually be relieved through investment. However, such expenditure may not be financially justified, if the outcome is modest and/or uncertain.

We can use the principles underlying the earlier chart of rail's sweet spot distance—see Figure 13—to demonstrate the impact of increased train payload. In Figure 33 we show that the effective transport cost per container is reduced when the train payload is increased. This results in the sweet spot distance being reduced—from point A to point B.

Figure 33 Reducing the rail "sweet spot" distance with increased train payload



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

An important aspect of linehaul cost recovery is the variability of train payloads. In particular, payloads can be suppressed when rail services are introduced, and if there is seasonal fluctuations in the commodity shipments. Thus, while a given short-haul operation may be perceived to be viable in the longer term, the short-term volumes may result in high per-unit linehaul costs—in Figure 33 this is akin to the train operating with 20 containers rather than 100 containers. That is, the operation may be loss-making. Seasonal fluctuations in volumes influence viability in a similar way.

Wagon payloads

We have noted that reducing linehaul costs usually focuses on improving train payloads. As noted, balancing market demands for frequent services with less frequent but longer trains is one approach; removing technical obstacles for longer trains may also be required.

A financial case may not exist for investing to increase payloads by operating longer trains. There are options, however, for increasing wagon payload and these may be more cost-effective than train lengthening if they can avoid heavy capital expenditure.

Depending on the circumstances, once the train is at the maximum length, a train's payloads can also be enhanced by increasing the payload that is carried within each wagon. For example, in the double-stacking discussion in this section, ten 40-foot containers could be shifted in an 87 metre double-stack wagon rake, whereas a single-deck wagon rake would be 150 metres long.[60] Increased wagon payload has train-operating benefits when track capacity is constrained—more cargo can be shifted for a given level of capital—and because additional payload can be added with relatively little or no additional, non-revenue-earning, tare weight.

Increasing wagon payload can be achieved in three ways:

- increasing the axle load permitted for the railway;
- reducing the tare, that is, the empty wagon, weight without reducing the permitted payload. This increases the freight allowed within a permitted axle load; and
- increasing the dimensions of the wagon's payload area—or volume—so that the wagon's actual payload is closer to the maximum payload that is permitted by the axle load limit. It may be that the container(s) on a wagon are full but the loaded wagon weight's axle load is less than the maximum-permitted axle load.[61] In an ideal situation, the maximum allowed weight would be reached as the maximum payload volume is reached.

In the first instance, increasing the permitted axle load is a function of infrastructure standards—track bed, rail weight and welding, ballast, sleeper and bridge strengths, and the condition of those parameters. Permitted axle load is also a function of other factors such as wagon design — particularly where there are "track-friendly" wagon suspensions that cushion the impact of the wagon on the track, and train speed—with the impact of wagon on the track rising as speeds rise. Improving those standards involves substantial capital investment.

In the second instance, there is potential for reducing wagon tare weights, thus enabling higher wagon payloads for a given axle-load. Examples of tare-reducing strategies include lighter wheel sets, or bogies, and lighter wagon frames. An alternative tare-reducing strategy is to operate five-pack wagons, although this does not usually result in enhanced wagon payloads. With the five-pack, there are five permanently-coupled wagons that share the bogies that straddle adjoining wagons. This reduces the number of bogies from ten, to six. With lower tare weight there are track access cost savings as track fees are usually based on the overall train weight. However, the overall payload is not necessarily higher because the payload is shared amongst fewer axles—12 instead of 20. This reduces the permitted payload. The five-pack may be a cost-effective strategy if the wagons do not exceed the axle-load limit when the containers are full. In those circumstances it can also enhance the train payload where the train is otherwise length-constrained.

Another potentially cost-effective strategy and key method of increasing the wagon's payload area involves increasing the height—that is, the payload area—of the wagon or by stacking one container on top of the other. Research on the introduction of double-stacking containers in the USA concluded that linehaul costs were reduced "dramatically", bringing the sweet-spot distance down from 750 miles to 500 miles. (Resor and Blaze 2004, p. 1) The improved

60 Based on calculations in Resor and Blaze 2004, p. 3.

61 In this case, the payload has "volumed out" before it has "massed [weighed] out" of its maximum permitted axle load.

payloads formed a key reason for intermodal shippers' decision to shift from piggyback—road trailers on flat wagons—to double-stacked containers. Such a train is illustrated in Figure 34.

Figure 34 Double-stacked short-haul operation on Florida East Coast Railway

Source: Photograph courtesy of Florida East Coast Railway.

The financial gain from such double-stacking of containers is somewhat qualified, however, by infrastructure- and market-specific factors:

- The railway's prevailing loading gauge—the railway's maximum permitted height and width clearance—may be insufficient to double-stack the containers. Considerable investment may be required to enlarge the loading gauge due especially to constrained existing tunnel diameters, low clearances below overhead bridges and clearances under overhead electrical catenary, that is, the wires.[62]
- If the permitted axle load is low then there may little incremental payload that can be added to the wagon. Again, this reduces the linehaul benefit of double-stacking. However, ultimately, the linehaul benefits of double-stacking will depend on the freight market. There would be more opportunities for double-stacking where typical freight was low in mass but high in volume.
- Double-stacking involves higher terminal costs than single-stack operation: double-stacking involves more planning and activity when placing containers on the wagons.[63] There are a few constraints here. Light containers need to be placed above heavy containers. Twenty-foot containers are not permitted on the upper level. However, longer—40, 45, 48 and 53 foot containers are permitted, with anchoring of upper containers occurring at the top edge of the lower, 40 foot, container.[64] Finally, container weights need close monitoring to ensure that axle loads do not exceed the prescribed limit.

In some circumstances, then, the practice of double-stacking may not be cost-effective, particularly where there is a combination of limited gains in linehaul efficiency, with higher terminal operating costs, and with costly investments to raise lineside clearances.

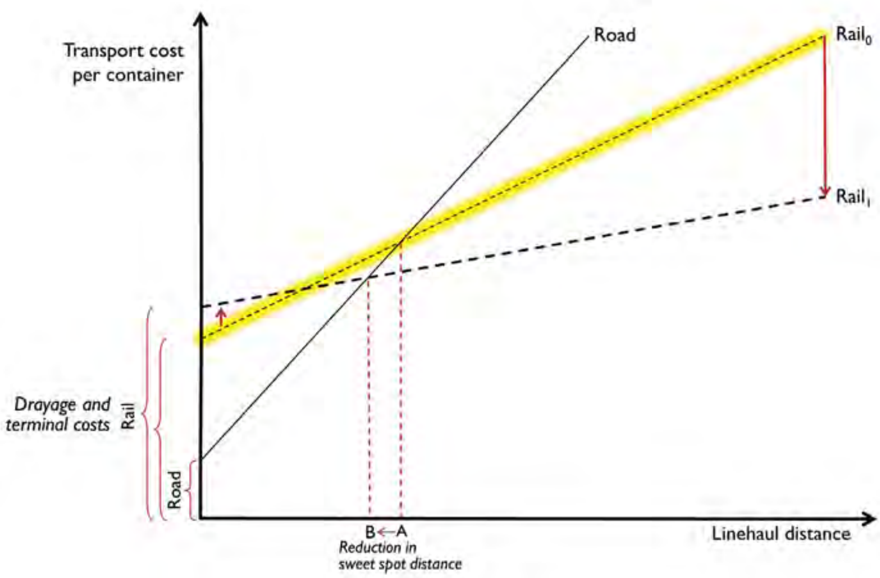
62 Reducing the wagon wheel diameters may also increase the payload height above the rail but a lower permitted axle load is typically the price of such small-diameter wheels.
63 Resor and Blaze note, however, that double-stacking may reduce the required terminal length as "more containers per foot of train can be loaded" (Resor and Blaze 2004, p. 4)
64 Resor and Blaze 2004, p. 7. The 53 foot container mentioned here is a USA-domestic container, not an ISO container.

An Australian report concluded that "…it is not economic to undertake a proactive upgrading programme to provide double stack clearances on the routes investigated in the short to medium term". (Geldermalsen and Leviny 2005, p. 16; Maunsell 2003, passim.) In this context, it is notable that double-stacking is undertaken on long-haul operations in the USA. Compared with Australia, its railroads shift greater traffic volumes, which are more likely to justify enlarging clearances, and where legacy track axle loads are typically substantially more than those prevailing on Australian lines where intermodal freight predominates—33 tonnes versus 21 tonnes.[65]

When linehaul distances are short, the benefits accruing from increased wagon payloads are less likely to exceed the additional terminal costs arising from the double-stacking. Thus double-stacked container operation over short distances is therefore unlikely in general and, in particular in Australia because of the low incremental payload that can be added. Again, there are qualifications, and the case study on the Port of Miami and Port Everglades discusses circumstances that are conducive to profitable short-haul double-stacked operations (from p. 160).

The foregoing discussion on wagon payloads — notably that of double-stacking — is illustrated in Figure 35 and in Figure 36. In the first diagram the introduction of double-stacking increases the terminal costs due to the longer process of correct placement and handling of containers. Notionally, over ***longer*** distances this additional terminal cost is more than offset by lower linehaul costs—assuming that there is considerably more payload per standard train length. In this case, however, the additional payload is sufficient to bring about a reduction in the sweet-spot distance, shown as the shift from position A to position B.

Figure 35 Reducing the rail "sweet spot" distance with increased wagon payload from double-stacking

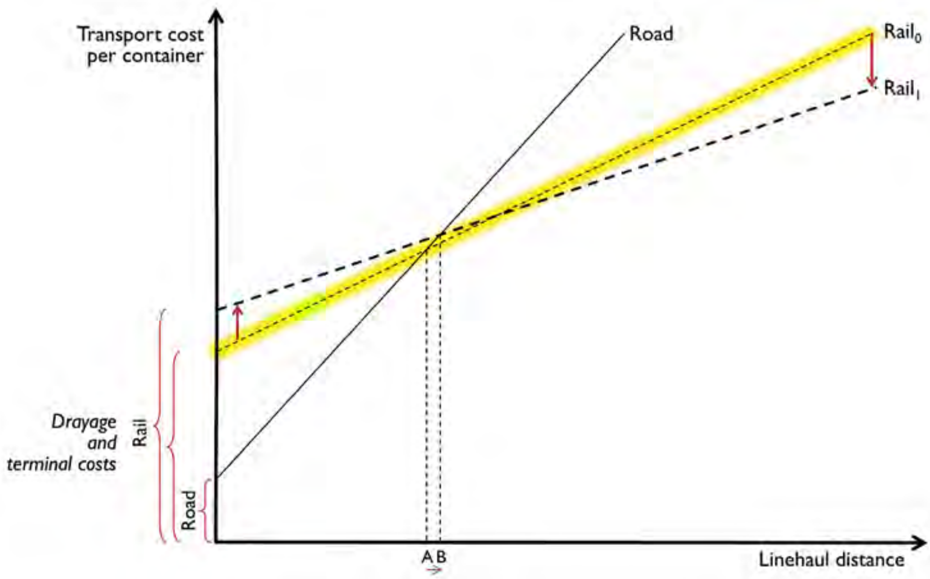


Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

65 Chapter 3 of BTRE 2006 discusses a range of the technical parameters of Australia's railways.

In Figure 36 the terminal costs rise if double-stacking is adopted where there is only a modest increase in payload due to the axle-load restrictions. The consequence is that the sweet spot distance, position B, if using double-stacking, would be greater than without, position A. Gains would be achieved from double-stacking but they would not be as great as those achieved where larger axle loads are permitted. The angle or slope of the rail line in the two diagrams illustrates the relative linehaul productivity.

Figure 36 Impact on the rail "sweet spot" distance of a modest increase in wagon payload from double-stacking



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Infrastructure charges

Infrastructure charges are a key element that influences linehaul competitiveness. Data that split rail costs into train and track are unavailable. However, the rail infrastructure charges that prevail are not relevant for the contribution to total rail costs that they make but, rather, the reverse. Rail infrastructure charges generally recover a minimal proportion of long-run costs. The underlying cost profile is one of high levels of upfront infrastructure, that is, capital, costs but very low marginal, that is, operational, usage costs.

Both rail and road cost-recovery infrastructure charging levels and infrastructure charging structures influence the sweet spot distance.

- The rail infrastructure charging structure is applied directly in response to usage of a specific railway line. By contrast, the application of road user charging uses average road network cost recovery, with prices not applied to usage of a given road—toll roads excepted.[66]

66 OECD/ITF notes "In most countries road user charges are not closely related to road use and the associated infrastructure or social costs. The main charging instruments are some form of fixed periodic charge (e.g. vignette or registration charge) and a fuel tax. Revenue from these charges generally accrue to central government funds, although in some countries they are paid into dedicated road or transport funds. In most countries, local government, although responsible for a substantial proportion of road expenditure, receives no revenue directly from charges." (OECD/ITF 2011, p. 56)

- *In principle* the level of rail charges is a function of track utilisation when charges are set to achieve cost recovery: greater rail volumes on a given track reduce the track access charges.[67] These reductions reflect track economies of density. To the extent that infrastructure charges are reflective of the prevailing level of rail traffic then traffic levels influence linehaul competitiveness. That is, when a railway is well-used then rail costs will be spread across a larger pool of traffic and this should result in lower rail infrastructure charges.

However, outside of North America, railways rarely recover their long-run costs. The principal exception to this is some large-volume bulk-cargo railways. We note, then, that the low rail access charges improve the competitive position of intermodal rail. We also note that similarly in some countries road-user cost recovery levels may also not reflect long-run costs.

It is worth stressing that when the rail charges do not fully recover infrastructure costs then the sweet spot distance for competitive intermodal-rail will be lower than when full cost recovery is sought.

Competitiveness of short-haul rail services is therefore facilitated when rail infrastructure charges are set below long-run cost recovery levels. In such circumstances taxpayer support is required if such services are to be sustained over the long-term—when infrastructure renewal is required.

Another mechanism for providing support for short-haul rail is to apply differential infrastructure charges for short-haul rail services. That is, access charges would be set so as to favour specific trains, namely those:

- going short distances;
- for intermodal services;
- for short trains; or
- where the short-haul service is operating in a start-up phase—that is, building volumes.[68]

Train capital charges

Irrespective of the market distance, the train—locomotive and rolling stock—capital needs to be used intensively. It is important to spread those high, upfront fixed costs across as much payload as possible, in order to reduce the per-unit costs. That is, train equipment productivity (and, by implication, labour productivity) can draw down the per-unit rail linehaul costs. This equipment productivity is also impeded by low productivity at terminals, which some observers attribute to conflicting incentives of rail terminal operators and rail operators—see, for instance, Hearsch 2008, p. 27.

Road's per-unit linehaul costs

Road vehicle costs affect rail's sweet spot distance. Road's linehaul costs are determined principally by the vehicle operating costs and road usage charges. As with rail, those operating costs are influenced strongly by vehicle productivity.

67 This type of pricing is known as combinatorial pricing—see BTRE 2003, *passim*. The combinatorial aspect of the pricing sets the floor or ceiling revenue to be the combined floor or ceiling revenue of all the operators on a given line segment, for which a specific access charge is being allocated.

68 An example of this is ARTC's "Road to Rail Rebate" on its track access charges.

Road user charges impact on road freight operators in two ways: charging levels and charging structures. In terms of the charging level, in 2006 the Productivity Commission's freight infrastructure pricing report found that the available evidence did "…not support the contention that road freight [in Australia] is subsidised relative to rail on either the inter-capital corridors or in regional areas". (Productivity Commission 2006, pp. LIII–LIV; emphasis added)

Australian and overseas road charging pricing structures are mostly insensitive to road usage and this can work against rail's sweet spot. The Australian Competition & Consumer Commission, ACCC, has observed that the country's road users face charges that are generally unchanging, regardless of the roads used, the costs of those road, and when those roads were used. The Productivity Commission, concluded that this charging system led to some individual trucks on inter-capital corridors not covering their costs of infrastructure use while other trucks would pay more than the cost that they impose on the road network.

The consequence of this charging structure, the ACCC concludes, is "…that investment decisions in, and the use of, infrastructure for alternative modes of transport, such as rail, will be less than optimal". In this context, the ACCC noted that governments provide financial support to intermodal activity—infrastructure charges, movements, connections, and capital expenditure—but that this support is undermined by the structure of road usage charges and by major road investments. (ACCC 2015, p. 25)

As with rail, the principal linehaul costs are overheads, capital equipment and labour. The unit costs of that operation are then determined by operating productivity. Four key factors determine road vehicle productivity:

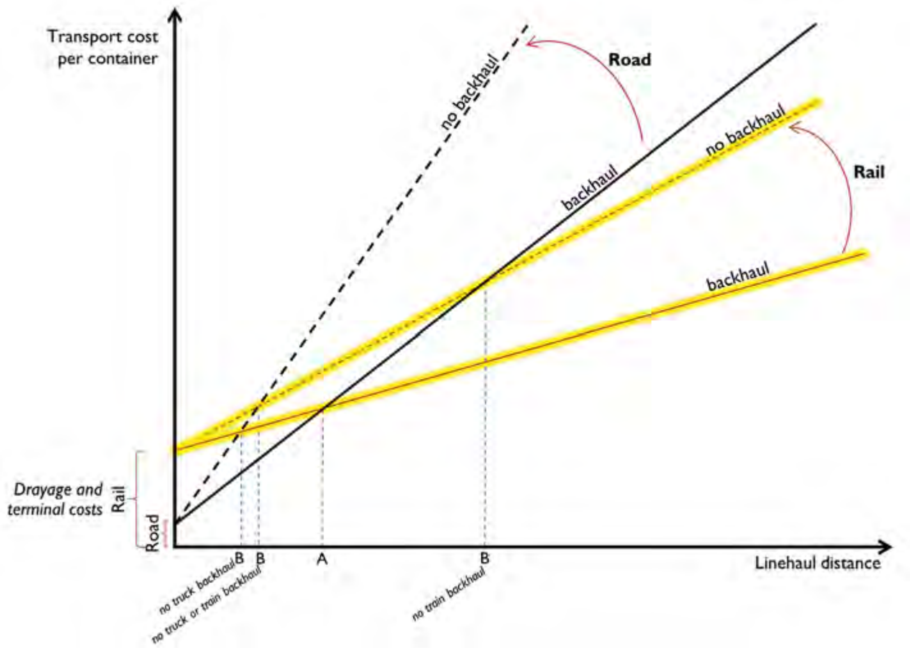
- **truck transit speeds**—including turnaround times at the port terminal; these determine vehicle and driver utilisation;
- **length of haul** between factory/warehouse door and port;
- container **backhauls**; and
- permitted **truck capacity** (volume and weight).

Clearly, road vehicle productivity will be relatively high when the transit and terminal unloading/unloading time is short and when full loads are carried in both directions and when multiple containers are permitted. Conversely, road productivity will be very low from combination of empty trucks in one direction (an empty "backhaul" in essence) and low driver/vehicle utilisation (long distances and slow road speeds).

In essence, when an outward or return leg of a journey is devoid of a payload then the effective cost involved in shifting the cargo can almost double. The reason that the costs are not quite double arises because on the empty leg the lower — tare — weight means that fuel consumption and wear-and-tear on the vehicle are less. In the case of rail freight the fuel consumption would be less and rail infrastructure charges would be less—if the charges were based on tonne–kilometres. This is illustrated in Figure 37. What should be noted is that doubling effective rail linehaul costs per container has relatively less effect than doubling road linehaul costs, which are already high. Beyond a relatively low distance the road haulage option would be prohibitively expensive.[69]

69 The Port of Miami and Port Everglades case study, p. 114, discusses some consequences of back-haulage problems in the State of Florida.

Figure 37 Impact of empty backloads (backhaulage) on the "sweet spot"



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

Figure 37 can also be used to interpret the impact of linehaul transit time: replacing the x-axis label distance with time represents how road and rail costs rise over time. If transit time rises then the road and rail unit-cost lines swivel upwards. Thus, if road congestion rises then truck transit time rises and the underlying sweet spot distance will fall.

Road congestion has a particularly marked effect when long lengths of congested road are involved. Truck and driver utilisation is reduced, with a general depressing effect on road productivity. As is discussed later, in Appendix A, this depressed truck utilisation is an important factor that reduces rail's sweet spot distance in Sydney.

Adding a complication reinforces this conclusion: cost discontinuities arise due to drivers' hours-of-work considerations. Figure 38 illustrates the impact of road deliveries that exceed a one-day return journey. The freight forwarder incurs additional costs for driver accommodation and an inability to utilise the vehicle during the rest period. This has been suggested to be a reason for a marked decline in rail–intermodal traffic between Shepparton and the Port of Melbourne. Road upgrades have improved truck/driver productivity, now enabling day-return trips to the port.[70] (Victoria University 2012, p. 77) This would probably be exacerbated by the modest flows involved. This means that in shifting to road there would be little logistics benefit lost in not consolidating traffic. Therefore, transport costs per container moved by road ramp upwards and this reduces the sweet spot for rail competitiveness.

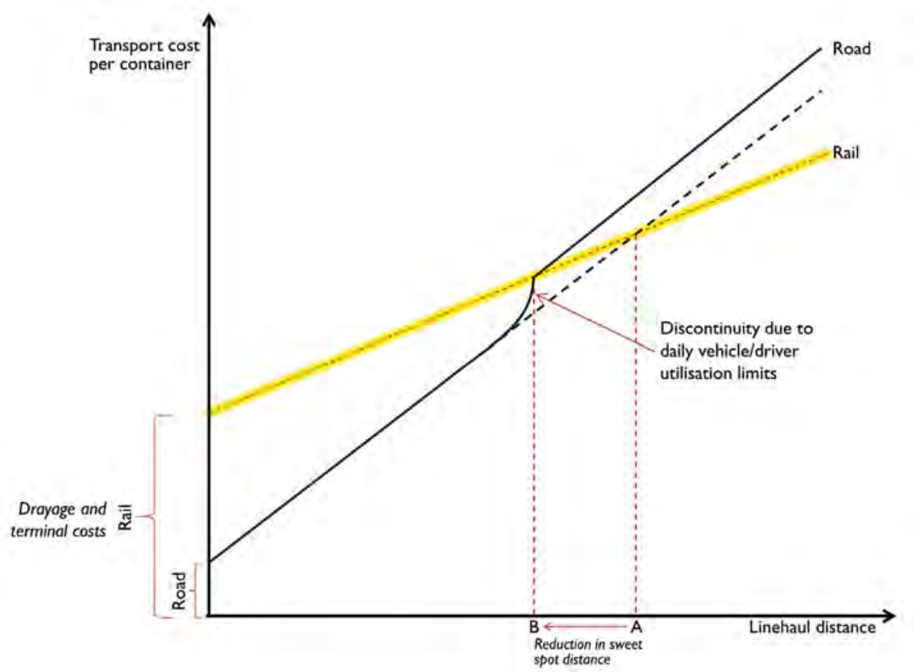
70 The operation once had 10 rail services per week, was then cut back to 6 services and then ceased operation in 2012. Most of the business has moved to two road transport companies, offering three deliveries per day (compared with three services per week by rail) and transit time to the terminal of 2.5 hours. (Parliament of Victoria 2014a, p. 4) Rail services resumed in October 2015 with a new UHT/powdered milk export shipper, using 2 services per week. (Parliament of Victoria 2015b, p. 6)

A similar cost discontinuity can arise when container payloads are sufficiently heavy so as to exceed the maximum road vehicle payload. In such a situation the truck operator has no alternative than to reduce the payload; this affects the road economics. This issue is illustrated by considerations by KB Logistics, who have commented that:

> *We are currently seriously looking at a future intermodal solution for this area. We need to get in front of the game. At the moment all of our clients want to pack as much as they possibly can into their containers. Conversely they want to try to get as much as they can into their containers while they are coming back this way. It is heavy boxes; it is 40-foot boxes, and if that is the case and it is too heavy for a B-double combination it means a truck on the road for every container. (Parliament of Victoria 2015b, p. 4)*

More generally, while the principles of the traditional distance-based road– versus–intermodal competitiveness chart remains valid, there is a a more informative approach to using the model. In this alternative approach, the relative costs of each mode are adjusted to account for changes in their productivities.

Figure 38 Impact of introducing road congestion—impact on sweet spot



Note: The representation of costs presented here is stylised and represents each mode's broad relationship between cost and distance.

The degree of competition between road hauliers is a further factor in considering rail–intermodal competitiveness. Where that haulier competition is strong then rail's competitiveness around the sweet spot, point A, is still likely to be very strained, with a competitiveness band rather than a point being more appropriate.[71] The importance of this competitiveness band is relevant in the following commentary on intermodal-rail competitiveness:

71 In this context, Tioga (2003, p. 212) modifies the chart, using a breakeven zone rather than a point.

> *...the preponderance of North American freight moves less than 750 miles, and right now [2003] railroads are practically invisible in that market. In other words, it's the biggest potential market that railroads have, but it's a* ***potential*** *market instead of an* ***actual*** *market for good reason: profits are razor-thin and truckers aren't exactly asleep at the wheel. (Stephens 2003, p. 38)*

Road competition can be particularly strong over shorter distances. For many road operators the local movements are preferred to long-haul:

> *Truckers feel more confident about their economics, are in greater control of their assets, and can better recruit drivers for short-haul moves, especially repetitive ones. (Railroad–Shipper Transportation Advisory Council 2011, p. 5)*

Evidence from the case studies

This section considers evidence about the performance of linehaul operations that is drawn principally from the case studies, in Appendix A; from Australian inquiries into the port landside task, outlined in Appendix D; and in maps showing regional and urban port–rail intermodal services, presented in Appendix E.

The case studies provide strong evidence of how linehaul issues facilitate sustainable short-haul services.

Australia

The Australian experiences highlights key factors at play that facilitate relatively good rail linehaul economics:

- linehaul infrastructure is typically able to accommodate long trains, while noting that ongoing work is progressing in Sydney to improve train handling—signalling, track layout and axle-loading—on the Metropolitan Freight Network, Port Botany;
- dominant customers and distribution centres provide volumes to enable regular long trains to operate, thereby securing some degree of train economies of density—in all cases these are dominant-product export flows—for example the Bowmans (Balco) – Adelaide Outer Harbor shuttle, with multiple shippers developed at the Bowmans terminal and with supplementary traffic from Port Pirie;
- the train service does not need to be as fast or as frequent as a truck because services are tailored to specific shippers and the usually export commodities. The service just needs to meet the shipping service, even if the journey is somewhat protracted;
- most train services involve a degree of back haul, albeit that an empty container that is repositioned to the hinterland terminal is revenue traffic, albeit the low tonnage and low revenue;
- in most cases the infrastructure charges are set well below long-run cost recovery levels. This facilitates rail's competitiveness with road services—while noting deficiencies in the allocation of cost recovery for road usage;

- where road linehaul operations are impacted by long, protracted journeys, it impacts on driver and vehicle utilisation — and can ultimately result in the need for two-day operations. This works strongly to facilitate rail competitiveness and is particularly relevant for Sydney urban short-haul operations.

The standard feature of the regional and urban trains is the large scale of the dominant customers using the hinterland terminal and complementary rail service. In particular, these are almost entirely export-based customers, such as malt from Minto and wool from Yennora; Breville and Sunbeam importing at Minto and Yennora are notable exceptions. In this way, while the operations consolidate container flows, those flows are emanating from one customer, or at most a few, customer. The frequency of the linehaul operation can then match the shipping schedule while still bringing sufficient linehaul volumes for rail to capture the economies of density. These flows lend themselves to single, *en masse* flows, which is ideal for capturing the rail economies. The regional container flows, mostly exports, involve such flows—often with large single-customer flows of boxed agricultural products—for example, hay, grains, wood and paper products.

A further approach to capturing linehaul economics is to append the freight to an existing service. This is undertaken with freight through Ettamogah Rail Hub. Exports from Ettamogah are shifted through the Port of Melbourne. The boxes are then attached to an existing Griffith – Port of Melbourne export-bound container train. In this case the incremental containers from the Hub improve the Griffith container economics and incur only relatively-modest incremental costs—extra train weight rather than the full crew and train path costs.[72]

The Penfield – Outer Harbor containerised wine flows also illustrates consolidated flows. In the Bowmans (Balco) flow there is incremental container traffic from Port Pirie that is added to the train on two trains per week.

A further benefit of the Penfield shuttle train operation is that the linehaul operation avoids issues with road-fleet asset utilisation through consolidated flows. Goods are bundled into single railed batches, capturing economies of density, rather than requiring a convoy of trucks. This process also facilitates the synchronisation of movements and the loading of individual vessels at the port. Similarly, the Canberra scrap metal train to Port Botany is a large, single-commodity flow that is assembled at the hinterland terminal and then sent as one consignment for shipment.

A general observation is that each regional and urban shuttle operation has volumes that are anchored on dominant customer. It does not preclude the possibility that small consignees may also operate through hinterland terminals.

Operations based around existing shipper export flows have a stronger traffic base than those based around (slower) organic growth of terminal activity. In this context, a Victorian review of the performance of intermodal projects that received public funding concluded that "the most successful in cost benefit terms were those [projects] that supported the development of existing, commercial enterprises". (Department of State Development, Business and Innovation, Victoria 2013, p. 37)

72 Domestic cargo flows are shifted through the Hub in a similar way, notably with Brisbane-bound wagons being attached to the Melbourne-to-Brisbane train. This practice is more cost-effective for the Hub than attempting to run a train (which would inevitably be short as there would be insufficient cargo from the terminal itself); and capturing greater economies of density for the Melbourne–Brisbane service.

A further general conclusion from the case studies is that intermodal–rail viability depends on relatively weak road linehaul performance. Even with the very short, 30 kilometre, rail operation between Penfield and Adelaide Outer Harbor involves logistics that prefers large consolidated bundles of goods being handled. If this was managed by road it could involve relatively poor truck utilisation. Indeed, road haulage is more suited to the scattered individual flows rather than the large, consolidated flows. Driver and vehicle utilisation are undermined and more resources are required at any one time for fleets of trucks delivering single-commodity exports and queuing at port gates. Further, vehicle and driver utilisation is undermined when protracted transit to and from the port is involved—such as arises with Port Botany flows. Thus, where there are large individual consignments the low truck and driver utilisation can be overcome by using rail. Similarly, a 2005 study found that rail was preferred for moving containerised wool from Yennora to Port Botany because "road cannot handle heavier forty-foot containers". (Rural Industries Research and Development Corporation 2005, p. 80)

It is instructive to consider the failure to sustain Port of Melbourne shuttles, particularly from the rail-based Somerton distribution centre. The distances are shorter than Minto – Port Botany, for instance, and the road is less congested. This results in superior truck and driver productivity. This contrast was noted by the Secretary to a Victorian Government department, observing that "We have a relatively congestion-free network and direct road links, which contrast strongly with, for example and in particular, the Port of Botany". (Parliament of Victoria. Port of Melbourne Select Committee 2015d, p. 21) Further, the Somerton flows are import-based operations feeding the distribution centres, rather than the large, single-commodity consolidated export flows from logistics centres that complement short-haul rail economics.

Overseas

In the case studies considered the rail linehaul economics have generally been favourable to sustaining the short-haul operations. In two North American examples the freight rates have favoured the short-haul operations, while implicitly recovering operating costs:[73]

- we interpret the freight rates as being those that at least cover the incremental costs of the operation for the rail operation between Portland and the ports at Tacoma and Seattle. Double-stacked wagons operating between the terminal and the port are conveyed on trains operating to or from other, further, destinations with domestic freight. The wagons add incremental cost to an existing service and the revenue will more than cover those costs as well as contribute to below-rail infrastructure cost recovery. This operation has similarities to the Ettamogah Rail Hub example cited above.
- international containers operating in double-stacked formation from the Port of Miami benefit from sharing loads—that is, economies of density—with containers from Port Everglades and northbound domestic movements. With most of the freight flow heading south into Florida, the northbound freight rates can be set at competitive lower, backhaul, rates. Similar two-way flows for BMW between Greer and the Port of Charleston also capture linehaul economies.
- short-haul viability also benefits from operating with further-distance transmodal traffic, where short-haul and long-haul freight operates between hinterland and ports. For

73 We refer to freight rates here, rather than rail infrastructure charges, because the North American railways are vertically-integrated. The freight rate represents the integrated railway rather than the below-rail operation.

example, on-dock railed containers between Rotterdam and Venlo – Duisburg is shifted with long-distance railed international containers. Economies of density are captured with the longer trains, which ensure that train path capacity is used effectively.

The double-stacking practice is not a prerequisite for commercial short-haul operations. That said, the high axle-loads that prevail in much of North America do make double-stacking more cost-effective than in Australia. Limited track and train capacity on that continent may in fact preclude adopting flat, that is, single-stacked, operation, while adding justification for practising double-stacking.

As long-running commercial operations, these North American operations are presumed to recover their costs. The Port of Virginia subsidises the transport costs between its Virginia Inland Port at Front Royal and the maritime port. Despite that subsidy, Norfolk Southern—the railway operator for Front Royal—is still levying concessional freight rates. This concession offers some payback to the railroad in that it contributes to the firm's economies of density in track operation, and economies of density in train operation when the container wagons are appended to other existing freight trains.

Experiences with Virginia's Front Royal facility also provides a key lesson. The traffic levels that have made a rail service viable are often not present from the outset. The rail services for the Greer inland port (South Carolina Inland Port) were built on the strong traffic base of existing BMW car-parts flows from the factory, which were shifted to the inland port when that facility opened in 2013. However, there was no equivalent anchor customer for the Front Royal facility, when it opened in 1989. Front Royal is the earliest of the USA's current inland ports and the rail service is still subsidised by the port and the railway company, even though traffic levels doubled between 2003 and 2012. That is, the facility and complementary rail service were much further from a sustainable position until a major anchor customer was secured in 2003. Short-haul rail services may therefore have to withstand a prolonged period of losses before the operation can be considered to be "sustainable". There can be similar concerns when traffic volumes are seasonal. These build-up and seasonality issues are considered further in Box 5.

Outside of North America, train operators pay rail infrastructure charges that do not recover long-run costs. That is, the linehaul element of short-haul operations needs to be sustained, in part, by periodic public funding.

Poor truck productivity is a common linehaul feature that drives sustainable intermodal operation. Improved driver and vehicle utilisation, by channelling containers through intermodal operations for part of the journey, has been cited as underpinning rail services from the ports of Tauranga, Göteborg, Miami/Everglades and the Dutch Transferium facility for the Port of Rotterdam.

Discontinuities in road vehicle operations can also be a factor that sustains rail–intermodal operation. For instance, it has been suggested that the modest improvement in road transit times between Shepparton and the Port of Melbourne enabled truck drivers to undertake a return journey between the regional centre and the port without exceeding maximum hours of driving. Those considerations underpin the hubbing through the Florida East Coast Railway's Jacksonville terminal, ensuring that truck drivers remain within hours-of-work caps. Similarly, the Greer inland port in South Carolina won traffic from the Eastman Chemical company after changes to the Federal hours-of-service rule made it impossible for drivers to complete a day-return trip.

Box 5 Traffic build-up, backhaulage and seasonality

The success of the hinterland terminal in attracting traffic underpins the rail volumes. When the terminal/rail operation commences operation there will be a traffic build-up period. This means that sub-optimal—loss-making—volumes and financial losses may have to be endured over a protracted period.

There is limited leeway in reducing exposure to these losses during the traffic build-up phase. A good—and risk-management—strategy is to build the terminal in stages, expanding the facility as traffic volumes rise. This reduces the call on the upfront investment finance, which then reduces the cashflow requirements for servicing debt.

In this context, as the North American case studies illustrate, one strategy for achieving low train operating is to attach wagons to existing trains rather than running dedicated trains. This approach was undertaken initially for trains serving Front Royal and is used with current Portland–Tacoma/Seattle trains. A variant of this approach has been adopted with Bowmans Balco trains, where the service is extended to serve Nyrstar at Port Pirie.

Rail service frequency can be relatively low, although if frequency is too low then it will discourage the shippers requiring frequent dispatching and delivering. This is less likely to be an issue when it is the shipper who is initiating the terminal/rail service. In this case, the shipper ensures that it has sufficient volumes to sustain the terminal/rail operation.

The pace of traffic build-up is, in part, a function of the hinterland terminal site, and also of the nature of terminal cargo consolidation and deconsolidation of exports and imports, respectively. This is a determinant of the maturity of the existing flows between the site and the port. Existing port volumes between port and hinterland may be sufficiently mature to enable a shift of goods across to rail. By contrast, protracted build-up is more likely where the terminal is built in an area where initial port flows are relatively low. As explained by South Carolina Port Authority, its Greer inland port was built in the backyard of BMW and Michelin: "We started with a significant cargo base. It wasn't a build it and they will come strategy." (Hutchins 2015, n.p.)

The Greer facility opened in 2013 and its container throughput in 2014–15 was 58 407 boxes, built on a key existing anchor rail customer, BMW. Prior to the inland port being built, the company had been using intermodal but lacked the land to accommodate an intermodal terminal. Establishing the inland port provided the system for efficient container handling. The car parts flows are both imports and exports, with imports from Europe and exports to India and Russia. The BMW, and other shippers', two-way flows through the terminal reduce the incidence of empty, that is, backhaul, movements. The terminal's railway service provider is Norfolk Southern, who conceded that they probably would not have invested in the terminal in the absence of the BMW traffic. (Stagl 2014, n.p.)

By contrast with Greer, the Cordele facility in Georgia (USA) opened at the end of 2011 and its 2012 throughput was a relatively modest 1 400 boxes. In 2015 the terminal expected to shift up to 10 000 boxes. The facility serves agricultural exporters, with a greater propensity for seasonal variations and with empty container backhaul flows from the port, albeit that empty containers remain a valuable movement as the boxes are required for packing exports. As with other such facilities, the Cordele operation also offers value-adding container repair and container cleaning activities. In 2013, the private company that built the facility signed an accord with the Georgia Port Authority to share processes to operate Cordele as a formal inland port for the Port of Savannah. The expansion of Cordele's throughput triggered the expansion of the initial twice-weekly port rail service, to thrice-weekly. Similarly, the increased traffic has triggered additional terminal employment and terminal railway facilities.

As the Greer facility illustrates, the balancing of container flows affects linehaul economics and the underlying export–import viability. Export containers need to be shifted to the shipper in the hinterland for loading; import containers need to be returned to the port. The economics of the operation are enhanced when balancing freight flows can be found. For example, hay exports from South Australia use empty 40-foot containers that are used to import components into the State for the GMH car manufacturer. The closure of that car operation will lead to changes in the freight flows. (Parliament of Victoria. Port of Melbourne Select Committee 2015e, p. 25)

The Port of Tauranga's hinterland terminal has managed to establish a counter-flow for its traditional imports. The MetroPort terminal provides de-hired emptied import containers, for exporters and the remaining empty containers are railed to Te Rapa terminal—which is on the route to Tauranga—for supply to a major dairy-produce exporter. The resulting two-way traffic facilitates the viability of the terminal and rail operation.

Finally, as is discussed with the Port of Rotterdam case study, in Appendix A, the two Dutch intermodal barge shuttles illustrate contrasting operations. The Alpherium shuttle is based around consistent-volume, dominant-shipper (Heineken) exports from service commencement in 2010. By contrast, the Transferium shuttle, which opened in 2015, aspires to carve a niche from unidentified individual truck shipper movements for exports and a hope that traffic-inducing value-adding logistics operations will develop around the terminal site. We conclude, then, that unless the shuttle's perceived benefits are apparent at the outset, then there could be a considerable elapsed time before the terminal–shuttle operation reaches sustainable levels. Both operations suffer from backhaul problems—an absence of imports.

A prevalence of empty back-hauls can be a strong factor that undermines road linehaul competitiveness. In securing large volumes of northbound, import, flows from the Port of Miami, the railway operation can offer competitive intermodal.

In conclusion it is evident that while intermodal–rail linehaul competitiveness can be driven by rail efficiencies, it is also evident that road linehaul competitiveness is equally relevant to short-haul sustainability.

CHAPTER 7

Promoting hinterland intermodal logistics

Key messages

- Logistics involves multiple supply-chain interfaces that can undermine hinterland–port efficiencies; aligned self-interest motivations between agents are important for supply-chain coordination.
- Hinterland terminal – rail – port supply chain logistics require good coordination, which works best when there is an alignment of common incentives for the logistics to work.
- Intermodal is particular prone to coordination issues and diverse motivations. However, there is increased pressure to improve the supply chain when faced by inter-port, inter-stevedore and inter-shipping competition.
- Rail service viability is a derivative of the vibrant hinterland terminal. Terminal viability is driven by terminal entities wanting to increase throughput, by shippers wanting good links to the port, and by government entities seeking to boost regional economies and to divert freight from congested roads.
- Evidence from the case studies shows that where ports actively compete with each other, the hinterland terminal may be used to make incursions into competing port catchments, or as a mechanism to protect the catchment. In this way the port can take an active role in supporting hinterland links.
- There are a range of formal structures of co-operation between supply chain agents, such as vertical integration within the supply chain, joint ventures and joint ownership. Such structures can align incentives for operating as well as mechanisms for sharing capital investment expenditure and risk.
- Regional and urban short-haul is fostered by a range of agents who share a common interest in viable hinterland–port operations.

This chapter outlines why and how different freight agents promote hinterland intermodal logistics, drawing in, that is, reducing, the hinterland drayage distance and reducing interface costs between the agents. Where the agents make the hinterland terminal a magnet for freight activity—by reducing drayage—it provides a ready freight market. The resulting consolidation of volumes facilitates sustainable short-haul rail.

In Chapter 2 we outlined the trends in international container movements and in intermodal freight. We noted the policy and commercial objectives in establishing hinterland terminals with intermodal linkages to the port. This chapter reviews the motivations behind the landside systems.

These motivations provide important reasons for the provision of short-haul intermodal–rail services. Where agents are motivated to see the intermodal operation succeed, it:

- improves incentives for those agents to perform efficiently;
- encourages active co-operation with other agents in the supply chain; and
- encourages the agent to view the economics of the overall integrated business rather than to see each activity as an independent profit-centre activity.

We recognise that a broad coalition of agents is motivated to foster hinterland–port logistics. However, we also note that poorly-motivated or disinterested agents do exist, and this is important for hinterland logistics because good coordination is essential for the modern supply chain.

Supply chain incentives

With additional supply chain stages, the coordination of the supply chain is especially important for short-haul intermodal supply chains than direct road supply chains. Poor coordination impacts disproportionately on intermodal operations.

That coordination has become more important as logistics systems have become more complex and contributes to the competitiveness of the actors in that chain. (de Langen 2008, p. 8) Asymmetry in costs and benefits within the chain can lead actors to deviate from desirable levels of coordination. Thus, sustainable hinterland terminal – short-haul rail systems can be underpinned by the alignment of incentives by participating agents.

de Langen identifies five general aspects of transport chains that create supply chain asymmetries. It can arise when one party receives a disproportionate level of the benefits or costs or exposure to risks. The thrust for coordination is likely to be muted when there is an absence of a dominant firm. Some firms may be reluctant to cooperate if they perceive that competitors would also benefit. Asymmetries may also arise where players in the chain are relatively small—firms that would lack resources to be involved in coordination—and where if firms are reluctant to allocate resources when they have a short-term focus. (de Langen 2008, pp. 8–9)

These asymmetries can be manifested in a range of outcomes. Thus, short-haul rail is undermined where an agent sees the operation as a discrete activity and behaves accordingly:

Unfortunately, some port operators view their rail intermodal terminals as profit centers. This results in relatively high prices for container movement, and of course works against the competitiveness of rail. (Resor and Blaze 2004, p. 11)

This observation is part of the wider issue of misalignment of incentives that can arise between the agents in the supply chain. For example, when the Australian Competition and Consumer Commission, ACCC, examined the role of stevedores, the Commission concluded that stevedores' commercial interests may not always align with the needs of the supply chain:

Because stevedores derive most of their revenue from servicing shipping lines, and land transport operators do not choose between terminals, this may affect a stevedore's incentive to provide landside services that best meet the needs of road and rail operators and the wider supply chain. It is likely that the stevedores' motivation in servicing the landside will generally be for operational reasons and to minimise costs, as road and rail transporters do not have a role in generating demand for a stevedore's business. (ACCC 2015, p. 23)

The disconnection between the motivations of various freight agents can work in various ways, for example in the following situation where the port operator attributed the failure of the intermodal–rail operation to the performance and insular perspective of the train operator:

One of the key factors influencing the success of any multimodal terminal is the quality and accuracy of information about the containers moving through the terminal. When BPC [Brisbane Ports Corporation] took over the management of the Brisbane Multimodal Terminal the transmission of export receival advice from the cargo owner to the rail operator was late, inaccurate or incomplete, thus making it difficult for stevedores to effectively and efficiently transfer containers to intended ships.

Inaccuracies in export receival advice regarding when containers would reach the port, their content and weight, or the ship on which they were supposed to be loaded, resulted in container congestion, damage to perishable contents, containers being wrongly despatched or containers having to be double handled. Doubling handling in particular had a direct impact on the BMT's costs because the Port Corporation was only paid for one lift per container.

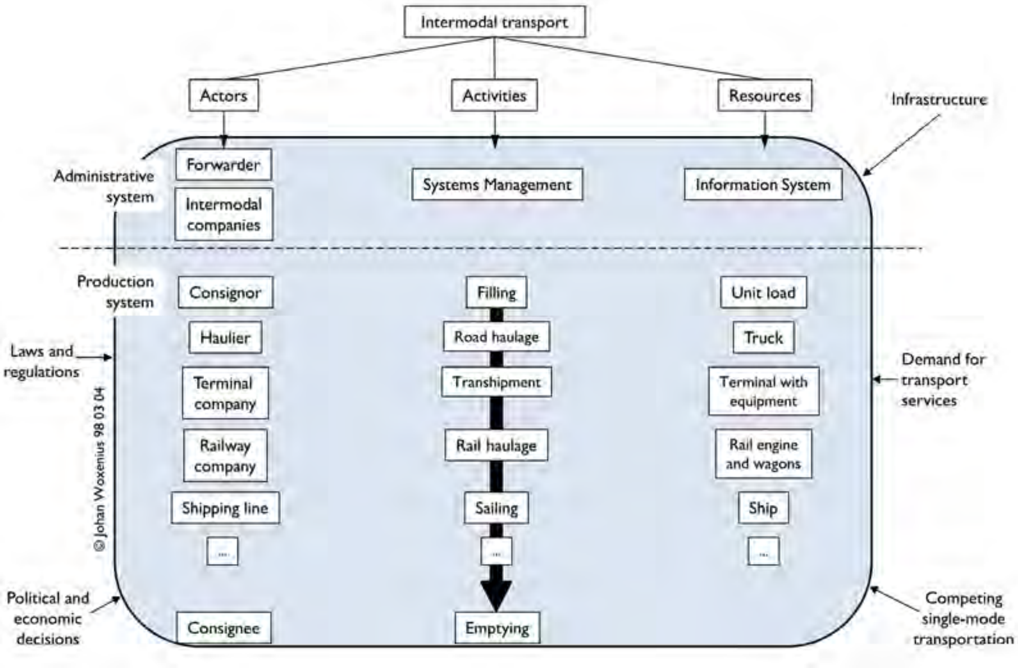
One of the suggested explanations for these deficiencies was that although Brisbane Port Corporation's vision was to provide a seamless door-to-dock service, Queensland Rail was still treating the new multimodal terminal as just another of its rail sidings rather than as a new business opportunity. (ESCAP 2006, pp. 32–3)

Appendix D provides an overview of a number of inquiries that directly or indirectly considered port–hinterland intermodal performance. A common theme of the report evidence presented was the twin topics of stevedore handling of railed containers, and the related issue of coordination of container and train movements to, and through, the port. Formal supply-chain coordinating bodies were seen as a remedy, although misalignment of incentives would remain.

In Chapter 2 we noted that the container has played a pivotal role in triggering a logistics system of production and distribution, where intermodal transport takes centre stage—at least in international water-borne trade. Extending that role on the port's hinterland task to a ship–rail–road operation rather than a ship–road operation relies crucially on the interfaces between the various agents—that is, interest groups. Irrespective of the favourable economics, intermodal will not prosper where there is misalignment of incentives across players.

We reproduce Figure 12 here (as Figure 39) to remind the reader of the importance of those inter-linkages—hence the term "supply chain"—and the larger number of interfaces relative to ship–road movements. Those linkages require good coordination and arguably perform best where there is self-interest to motivate coordination and co-operation. As is evident, there are many interfaces involved in intermodal transport—one Australian railway operator argues "too many interfaces".[74]

Figure 39 Schematic diagram of intermodal transport



Source: From Woxenius (with slight re-wording) 1998, p. 96.

We should therefore note the importance of the attitudes of different agents in the supply chain and the interfaces between them.

Interest groups promoting short-haul

In most cases, the demand for short-haul services is a derived demand, as discussed in Chapter 2, rather than a transport service that is required in its own right. Put another way, the short-haul service is generally a response to the functions of the hinterland terminal. In essence, the value-added activities at the hinterland terminal lead to clustering of shippers around the facility.

Two principal categories of interest groups promoting short-haul include:

- those who focus on the viability of the short-haul, particularly railway companies and governments; and

74 Colin Rees, from Colin Rees Group, cited in Parliament of Victoria 2015a, p. 7.

- those who have commercial interests in vibrant hinterland terminals, notably the import and export shippers—with distribution centres and logistics centres—and transport entities—freight forwarders, logistics companies, shipping lines, port owners and stevedores.

Various forms of collaboration or alliance emerge where there is a strong shared interest between these groups. These include:

- vertical integration of linkages in the logistics chain;
- joint ventures of parts of the supply chain; and
- joint ownership or operation of infrastructure.

In this context, Hearsch (2008, p. 28) argues that sub-optimal productivity at terminals arises because of the absence of such partnerships—that rail has a culture of being "a stand alone entity"—and thus that productivity can be enhanced by "developing partnering relationships".

The collaborative approach is important where the logistics chain involve complex inter-linkages. As discussed in Chapter 1, the growth in container volumes and especially, in vessel size, increases the importance of hinterland logistics and this involves a number of interest groups. As noted by Hansen, ultimately:

> *Integrated logistics of sea and rail carriers can be easily realized by promoting carrier haulage and business alliances between sea carriers and land shippers/operators or setting up of dedicated maritime terminals and/or rail services by shipping firms. (Hansen 2010, p. 390)*

The efficacy of the institutional and organisational aspects of the landside logistics chain is arguably more important in achieving efficient landside operations than technical innovation:

> *…new innovative technologies can only make a very modest contribution to improvement of the intermodal system; the institutional and organizational aspects offer more potential for higher productivity and quality of the intermodal transport chains. (Hsamboulas, cited in Hansen 2010, p. 387)*

Landside efficiency is one attribute of overall port performance, as discussed in Chapter 2. It follows, then, that the quality of hinterland links can provide a service advantage of one port or stevedore relative to another nearby port or stevedore. Hinterland corridors can be used by one port to compete in another port's catchment area. The port can make an incursion into the competing port's catchment area by offering hinterland terminal and complementary rail services. This is illustrated by strategies adopted at the Port of Virginia and at the Port of Tauranga. In that context, then, where port catchments do, or potentially do, overlap then the port agents—namely port entities, stevedores, shipping lines—can have incentives to work actively with shippers, terminal owners and railway companies to promote the functioning of hinterland terminals. That is, inter-port competition can encourage ports to promote and support hinterland terminals, with their complementary short-haul rail services. However, there is a weaker incentive in Australia to adopt this strategy because there is relatively little catchment overlap between Australia's ports, that is, weaker competition..[75]

75 In their evidence to the Committee examining the proposed lease of the Port of Melbourne, Shipping Australia noted that in New Zealand there was "proper, open competition between ports that are relatively closely spaced; for example, Auckland and Tauranga, and Lyttelton and Timaru on the South Island. I think this is the key to ensuring efficiency in port operations. We do not have that in Australia." (Parliament of Victoria. Port of Melbourne Select Committee 2015d, p. 78)

Thus multiple agents can contribute to the efficacy of the short-haul operation, with multiple agents having an interest in seeing the short-haul succeed.[76] The motivations of these agents are summarised in Table 3 and assessed further in the various case studies in Appendix A.

Table 3 Agents promoting the functioning of inland terminals

Agent	Motivations	Example
Railway co./train operating co./track infrastructure co.	Capture train haulage business; track usage revenue; facilitate jointly-owned inland terminal facilities	Qube – Yennora; Qube – Minto
Stevedore (port container terminal operator)	Competitive edge over other stevedores	Venlo (Hutchison)
Port	Competition with other ports; expand catchment area	Port of Tauranga; Ports of Auckland; Port of Virginia; Port of Miami and Port Everglades
Shipper (importer/exporter)	Efficient logistics through consolidation and packaging and other broader inland terminal activities	Balco (Bowmans)
Inland terminal operator	Core business	Venlo (Hutchison); Ditton, Merseyside (Eddie Stobart); Cordele Intermodal Services [Georgia]; Iron Horse Intermodal (Merbein)
Distribution centre parties	Co-located shippers/logistics operators at inland terminals secure a logistics centre, with a railway corridor to the port	Port of Virginia (Front Royal)
Shipping lines	Provide competitive edge over other shipping lines, through convenient inland access/egress points and value-added services	Venlo, Duisburg
Local councils	Facilitate attracting business/ employment via intermodal terminal activity and the business that co-locate	SCT – Penfield; Port of Ningbo
State governments/councils	Viable inland terminals to divert traffic from port/to inland terminal, to reduce road congestion, lower pollution (air, noise) and fewer accidents	NSW Portlink initiative; WA Kewdale Intermodal Rail Supply Chain

Lessons from the case studies

In this section we consider the motives for various agents for using intermodal–rail services.

Shippers and logistics companies

It is worth restating that the demand for short-haul rail is typically a demand that is derived from the functioning of the hinterland terminal. The short-haul rail operation is therefore more

76 Similar conclusions can be found in a study of the factors that contribute to the success of roll-on – roll-off ("Ro-Ro") short-sea shipping. López-Navarro found that successful operations arose when road transport firms and shipping companies shared their planning of these intermodal operations. "Shared planning helps to find multually satisfactory solutions, and achieves greater integration of both agents in the intermodal transport chain, which unquestionably contributes to value generation and improved performance". (López-Navarro 2013, p. 49)

likely to succeed when the allure of the hinterland terminal draws in clusters of shippers. These are principally agents with import-based distribution centres, or agents who are exporting their produce.

The following are illustrations of the complementary nature of logistics operations, with activities at hinterland terminals, linehaul and maritime terminals.

- In England logistics companies' terminals, or large distribution centres adjoining hinterland terminals, provide sufficient traffic volumes to sustain regular rail shuttle services linking with ports.
- As a 3PL logistics company Qube operates its own urban shuttle trains between Yennora and Port Botany and Minto and Port Botany, complementing its other logistics activities.
- Regional short-haul operations in Australia are typified by dominant export-based agricultural shippers. Such large operations provide anchor traffic to sustain regular shipments. Clearly those shippers have strong interests in sustained short-haul operation. The Merbein–Melbourne export operation reflects strong mutual gains from collaborations between growers, processors/exporters, terminal operators and train operators. (p. 131)

The short-haul economics can be transformed once large shippers make a financial commitment to a site. Dominant shippers ensure that regular trains can be operated. The earliest inland port in the USA, at Charlotte Intermodal Terminal (footnote 121) could only muster enough port traffic for one train per week, and other interest groups could not be attracted leading eventually to the withdrawal of the service. By contrast, the economics of Virginia's Front Royal rail shuttle were eventually transformed when a distribution centre for imported goods opened at the site and doubled the rail traffic (p. 155). In enhancing the rail operation, the new traffic has attracted additional distribution centres to the Front Royal site.

Maritime agents

Maritime agents—port owners, shipping lines and stevedores—can have an interest in viable hinterland transport and in hinterland terminals. The quality of that transport and those terminals is important where competition between ports is strong. The good transport links with hinterland terminals are an important adjunct to the attractiveness of the hinterland terminal.

We note, therefore, that there is greater incentive to develop hinterland terminals where the inter-port or inter-stevedore or inter-shipping line competition is strong. We noted that competition through extending catchment areas or offering superior hinterland terminal services is integral to the operations at Tauranga, Auckland, Virginia, Miami/Everglades, Rotterdam and the English ports. Inevitably the quality of the hinterland services includes the provision of regular rail–intermodal services.

In addition to hinterland terminal provision, port competitiveness (and expansion plans) can rely on efficient "green" maritime rail terminal operations and can foster strong port interest in sustainable rail options, including on-dock rail provision, and in efficient services. The adjacent, competing, ports of Los Angeles and Long Beach sought to provide efficient, neutral, railway activity within their port area and in 1998 they jointly purchased the tracks within those boundaries. A neutral train operator, Pacific Harbor Line, is contracted to assemble and distribute wagons from the two mainline railways serving the port. With control taken from the mainline railways, the ports are investing heavily in track infrastructure enhancements. Thus, notwithstanding the railroads' interest in the rail traffic, these ports themselves are heavily motivated by competition from other west coast U.S. and Canadian ports and also east-coast ports, to ensure good rail operations.

The Toll (logistics) – DP World (stevedore) joint venture at Villawood (Sydney), established in 2015, is a further illustration of the shared interest in hinterland transport. The Villawood facility will be used as a rail container staging zone for containers moved through the DP World stevedore's Port Botany rail terminal.[77] Similarly, DP World has worked with SCT Logistics to restore rail services to the West Swanson Intermodal Terminal at the Port of Melbourne, for export-based container movements from Dooen. (See map, Figure 67).

Train and railway operators

Train operators are naturally motivated to promote rail services. The North American case studies are particularly instructive. In the case of the Front Royal rail service, the freight tariffs levied by Norfolk Southern Railway are adjusted to reflect the considerable distance disadvantage of the rail routes to Front Royal relative to the road route; the port also subsidises the operation. The economics of the hinterland terminal, and thus the rail shuttle, would have been undermined by levying a standard tariff. As it is, the railway company has secured incremental traffic that enhances the economics of its other (Heartland, and Crescent) major intermodal corridors.

In a similar way, Florida East Coast Railway offers lower tariffs for its northbound Port of Miami/ Port Everglades to Jacksonville traffic, facilitated by backhaul capacity.

Governments

As discussed earlier (p. 33), governments have a range of policy objectives—reducing negative externalities, improving supply chain efficiencies, and expanding hinterland economic activity. The dominance of some ports means that governments have an interest in the economic activity generated by those ports. In that sense government and port interests can converge. In this way governments seek to enhance port throughput while minimising the negative effects of the commerce through the ports.

The Göteborg shuttle and the Fremantle shuttle are examples of where coalitions of port and government entities are funding the rail service. The rail shuttles serving the Port of Ningbo are similarly supported, with an eye to facilitating hinterland economic activity.

Concluding comments

The international container supply chain has various agents with different incentives to support rail–intermodal. Interfaces must be aligned and coordinated and these factors become more important as volumes and congestion rise:

- **Incentives.** Just as physical equipment need to complement, so too do agents need to have aligned incentives. The consequences of mis-alignment are apparent at operational

77 http://www.tollgroup.com/media-release/toll-group-and-dp-world-australia-in-talks-to-set-up-new-joint-venture

interfaces, for instance if the commodity shipper seeks to use rail but the stevedore finds it easier to handle trucked containers.[78]

- **Coordination.** Railed containers involve more interfaces than trucked containers, so success of the intermodal system relies on good coordination. This facet of intermodalism has sometimes led to the establishment of formal logistics-chain coordination entities.

The developing role of the various players in the landside logistics is directly linked to that coordination role: to what extent does each player have incentives to ensure the optimisation of the supply chain? Booz & Co's paper for the National Transport Commission (NTC) argues that shipping lines are the lead participant in the supply chain but that stevedore operations "are potentially the highest value capture component". (Booz & Co 2008, p. 35). It is concluded that individual ports may have mechanisms "to incentivise the stevedores' landside operations", such as performance deeds at the Port of Brisbane and (the-then) proposed changes to container terminal leasing structures at Port Botany. It is concluded, however, that "from a whole of chain perspective, there still exist a significant barrier to supply chain performance between the stevedore's land-side operations and the road/rail component of the chain". (Booz & Co 2008, p. 36)

These observations are location-specific. Nonetheless, the observations demonstrate the importance of the alignment of incentives between agents. Intermodal operations involve a high degree of coordination in activities and in different agents providing diverse services. The sustainability of rail–intermodal operations can be undermined by passive or disinterested interest by individual players. Arguably, joint ventures and provision of services by contracted neutral agents (such as rail operations at Los Angeles and Long Beach) improve performance as incentives are aligned and coordination is enhanced.

78 In this context, note the views of Prince (1998) on adverse stevedore incentives, as discussed on p. 75.

CHAPTER 8

Why short-haul intermodal rail services succeed

Key messages

- Rail–intermodal's Sweet Spot distance should preclude all short-haul rail movements.
- Rail's strength lies in its linehaul operation. Intermodal's strength lies in attractive hinterland terminals.
- Attractive hinterland terminals weaken or eliminate intermodal's drayage and terminal-handling disadvantages while the resulting freight consolidation at the terminal strengthens rail's linehaul cost advantages.
- Thus short-haul rail works because business is attracted to hinterland terminals, where a range of value-adding activities are undertaken.
- Short-haul rail also benefits from congested roads and maritime terminals, which make road haulage relatively unproductive.
- A number of agents in the supply chain benefit from vibrant hinterland terminals and the resulting container volumes are conducive to sustainable rail services.
- The intermodal supply chain involves more linkages than direct shipper–port movements, so the alignment of incentives or common interests between agents along the supply chain is a key factor that is conducive to rail-based systems. When agents' strategic interests in intermodal are in alignment then rail services become an integral part of the logistics chain.

Rail–intermodal economics should preclude viable short-haul urban and regional operations. In this study we have investigated the reasons why short-haul maritime rail container services are sustained. Short-haul rail works because business is funnelled to, or through, the hinterland terminal; and where linehaul road operations are relatively unproductive.

Linehaul competitiveness

Rail's linehaul costs are usually lower per container than road, particularly when a given train's volume is "high", thereby capturing train economies of density. However, intermodal–rail incurs substantially higher drayage and terminal costs. The Sweet Spot distance where those higher costs can be defrayed by rail's lower linehaul costs may exceed one thousand kilometres.

Short-haul rail's linehaul costs become relatively lower when truck linehaul operations are unproductive. This can arise if the arteries between the port hinterland and the maritime terminals are congested over an extended distance. The congestion reduces driver and vehicle utilisation. Road costs are therefore higher, while unpredictable congestion reduces service reliability. Truck operations are also unproductive when there are empty container back hauls; due its higher linehaul costs, this is a greater issue for truck than for train.

Drayage

Short-haul works when the hinterland terminal functions as a value-adding centre, and is not simply a ramp or transfer point between road and rail. In the first instance, the hinterland terminal is made attractive, becoming a magnet for businesses to co-locate. It is a logistics centre for exports or a distribution centre for imports. Operations are sustained when such traffic involves a dominant customer, rather than fragmented customer base. The co-location of businesses with the terminal drives down the drayage.

Short-haul rail operations are used as an adjunct service to hinterland terminal activity. In effect, drawing logistics activity into the inland terminal removes the drayage task—and cost—between the shipper's facility and the inland terminal. Logistics activities that are clustered around inland terminals capture economies of scope in their activities; the concentration/consolidation around that terminal then provide traffic volumes to/from the port that permit train operations to capture economies of density. As the logistics tasks—value-adding, consolidation and deconsolidating, stuffing and destuffing, storage—are performed, the inland terminal operates to accumulate freight (to or from the port). With goods being consolidated through the inland terminal, it provides a high-volume conduit between that terminal and the port; this facilitates rail's need to capture economies of density.

Short-haul may also be sustained when the hinterland terminal has value-added activities that attract road traffic. Ports, stevedores and shipping lines can be motivated to support the hinterland terminal with port-based services. In some cases ports use the hinterland terminal, with rail links to the port, to broaden the port's catchment area. In this case the hinterland terminal offers port services, the terminal becoming an extended gateway to the port.

For these hinterland functions short-haul rail plays an essential complementary role, as part of a wider strategy by freight agents. For that reason we have noted that some freight agents assess the value of short-haul rail as being a constituent part of the overarching business rather than as a discrete cost centre. The rail service is less likely to be sustained when low volumes are evaluated within a free-standing operation than when evaluated within a broader business strategy.

Terminal

Our focus has been on factors leading to short-haul operation, against the odds. While short-haul rail services operate, against the odds, the provision of *further* services is hampered by inefficiencies, particularly at maritime rail terminals. Australian public inquiries into port–hinterland links are notable for flagging inefficiencies in maritime rail terminals, making the rail services less efficient, competitive and commercially sustainable. Factors in debate include the alignment of incentives between the supply chain agents, and the impact of legacy rail infrastructure layouts on container-handling and wagon-handling. Vital factors are the rail terminal placement—on-dock versus near-dock—and provision—a central rail terminal versus a terminal for each stevedore. The appropriate placement and provision are location-specific and market-specific, however.

There are a number of pivotal factors that are conducive to short-haul rail, notwithstanding the value of direct rail subsidies (or taxes on containers moved by road). These are presented in Table 4.

Table 4 Key elements that support short-haul rail viability

Factor	Elements
Drayage	• Maritime flows do not have drayage at the port end; domestic intermodal-rail has drayage at both ends of the journey • Tight shipper catchment area around the inland terminal reduces drayage • When long drayage to the terminal is involved, ensure that the terminal involves a large amount of value-adding/logistics
Terminal costs	• Efficient maritime and inland terminal layouts • Location-specific/traffic-specific maritime terminal siting—this may be on-dock or near-dock; a single central terminal or a terminal for each container terminal • Optimal investments in equipment that facilitate efficient box transfers and reduce the number of box lifts required
Linehaul costs	• Dominant (anchor) customers are necessary for unit linehaul costs to capture train (and track) economies of density, and making the necessary terminal consolidation volumes easier to attain • Trends towards bulk commodities in containers (such as grain) facilitates provide high-volume anchor customers that capture economies of density and support frequent shuttles, enhancing the service on offer • Track access fees that are set at less-than-full long-run cost recovery. • Low truck/driver productivity — notably through road and port congestion, and backhaul problems — makes rail more competitive
Motivations of various interest groups (Figure 12)	• Government seeks shuttle use, to reduce road congestion and environmental impact around the port • Maritime container terminal operators (stevedores, shipping lines, terminal owners or import/export shippers) seek to funnel extra business through their inland terminals, with shuttles offered to complement those terminals. High throughputs make shuttles sustainable • Ports offer inland terminals, and complementary shuttles, as a commercial strategy to expand their catchment areas • Train/railway operators offer shuttles to capture business • Shippers establish shuttle/terminal operations as an operationally effective part of their logistics.

Many factors can undermine the short-haul rail operation.[79] However, when entities develop hinterland terminals for their own strategic reasons, the rail services become an integral part of the logistics chain. Like most freight operations outside of North America, these rail services do not pay access charges that cover long-run track costs. Within that financial envelope, however, short-haul rail can be part of the logistics and port operating solutions.

Start-up of short-haul operations requires initiation of activity around the hinterland terminal—processing, consolidation and distribution—or by diversion of containers from road to rail. The pace of traffic build-up on the rail operation is influenced by which of these factors that are in play. If a core traffic level is not developed at an early stage then unless the interest groups have long-term aspirations that override the initial financial losses then the operation will not be sustained.

79 Those factors discussed in this report include (a) rail access charges/access charging structure for port (stevedore) access charges/level and structure (b) where rail efficiency at the terminal is beholden to the efficiency of the stevedore (c) road access charging structure (d) ownership/adverse responses to obtaining access (e) poor rail/rail-terminal infrastructure (f) multiple box lifts (that is, more rail lifts than road lifts) (g) rail route capacity limitations (h) inland terminal deficiencies (location, capacity, access) (i) timing of services (poor frequency/ability to match with vessel times/ incurring box storage fees).

APPENDIX A
Port–hinterland terminal rail operations

This appendix reviews a range of existing and proposed port–hinterland terminal rail operations. Short-haul rail services exist and form a service that is a derived demand arising from vibrant hinterland terminal operations.

The role of the agents should be noted in considering these case studies. The underlying objective of the facilitating agents can be placed into three broad categories:

- train operators and governments: concerned to maximise rail throughput, for business and externality objectives, respectively;
- hinterland terminal operators and hinterland businesses and councils, seeking to drive business to the port; and
- maritime terminal and port operators, seeking to shift port activities inland and to expand port/terminal catchments.

In the following sections we provide case studies of rail shuttle experiences in Australia and overseas.

Port–hinterland terminal rail experiences in Australia

There are a number of short-haul regional intermodal port links in south-eastern Australia. As the discussion in the body of the report has outlined, longer-haul operations are relatively viable. The consultancy, pwc, indicate that Riverina shippers are generally in excess of 450 kilometres from Melbourne and 500 kilometres from Botany. pwc found that "railing TEU can be up to 20% cheaper per container than using a road option". (pwc 2014, p. 27) The consultancy concluded that:

> *Generally, regional intermodal terminals have a service catchment of approximately 100 km [drayage]. When a shipper has to move their goods via road for more than 100 km the cost effectiveness of rail is eroded and it is most probably that the shipper will continue to use road based transport to the destination. (PWC 2014, p. 29)*

The conclusions of this study, however, are that intermodal operation can tolerate long drayage when the hinterland terminal incorporates consolidation and value-adding roles.

An important aspect of the sustainability of those intermodal flows is the underlying rail infrastructure charge. Those charges typically do not recover their long-run costs. That is, rail services may not appear to be directly subsidised, such as by a reimbursement per container shifted, or implicitly subsidised, as with a tax on trucked containers.

Some landmark intermodal-rail port developments are presented in Table 5. It should be noted that services have also benefited from cumulative improvements—not listed in the table—such as track enhancements at Minto, at the Fremantle North Quay Rail Terminal and at the DP World facility at Port Botany.

Table 5 Landmark short-haul port-rail developments

Date	Location	Service	Haulage distance to port	Notes
1997	Regional NSW/Sydney	FreightCorp Portlink	-	Implementation of PortLink policy, with upgraded regional freight yards or new intermodal terminals and, later, development of a new urban terminal at Minto
1998	North Quay Rail Terminal, Fremantle	On-dock rail	41	Opening of rail link to Fremantle Inner Harbour, for container traffic
2000	Minto, NSW	Intermodal terminal	57	Opening of terminal as part of PortLink policy; shuttles to Port Botany
2003	West Swanson Intermodal Terminal, Melbourne	On-dock rail	-	Opening of terminal
2003	Balco, Bowmans, SA	Inland port	96	Balco opened inland port at Bowmans, north of Port Adelaide. Operates intermodal (to Port Adelaide) and transmodal (to Melbourne) traffic
2003–2007	Altona North, Victoria	Port shuttle	22	Operation of Cargo Sprinter and other shuttle trains by CRT between Altona North and the Port of Melbourne
2007	Victoria Dock, Melbourne	On-dock rail	-	Opening of dual-gauge rail sidings at Victoria Docks (Westgate)
2008	Yennora, NSW	Port shuttle	37	Opening of intermodal terminal at Yennora, by P&O Trans Australia [DP World/Kaplan Logistics joint venture]
2009	Ettamogah	Intermodal service	316	Commencement of intermodal service from new intermodal terminal, to Melbourne
2014	Penfield	Port shuttle	30	Commencement of port shuttle, by SCT Logistics, for Treasury Wines
2015	Dubbo	Intermodal service	468	Fletcher International commenced its own intermodal train, Dubbo–Port Botany

Port Botany

Box 6 **Port Botany rail service profile**

Hinterland terminals	Metropolitan: Yennora (41 km), Minto(57 km), plus Cooks River shuttles (9 km). Regional: A range of regional export flows, including Wee Waa (598 km from Botany), Narrabri (572 km), Warren (572 km), Manildra (384 km), Forbes (473 km), Bomaderry (171 km), Bathurst (250 km) Newcastle [Sandgate] (170 km), Dubbo (468 km), Canberra(327 km)
Service map	See Figure 40
Services	Intermodal
Port rail terminals	On-dock rail terminals at DP World, Patrick and Hutchison, plus sidings for the Qube empty container park. Port terminal maps with updated rail service provision are presented in an Appendix to BITRE's Waterline series; that publication also presents railed and trucked container data.[80]
Mode share	14 per cent (2013–14); target mode share of 28 per cent.
Background	Port Botany is Australia's second largest container port by volume, handling 2.2 million TEUs in 2013–14. It is managed by NSW Ports Consortium, which has a 99 year lease of the port's state-owned assets. There are three container terminals at the port, served by the stevedores Patrick, DP World and Hutchison. Additionally, Qube Holdings provides landside logistics through its Port Botany freight terminal and empty container park. The port is located next to Kingsford Smith airport, on the north-eastern side of Botany Bay. Port Botany is connected to Sydney's arterial road network by Foreshore Road. The rail network is a dedicated freight line that runs 8 kilometres between Botany Yard and Marrickville Junction. At Marrickville, the line joins Sydney's metropolitan goods line. In addition to the dedicated freight rail network, track is shared with passenger trains. Freight train access to the passenger network is subject to a peak-period curfew. Figure 63 shows Sydney's rail freight corridors and facilities.

Port rail operations

Table 5 lists principal scheduled medium and short haul container services to and from Port Botany.[81] Levels of railed containers through the port are presented in Figure 41. We focus specifically on the Minto shuttle service.

There is a range of agents at play in these examples. Train operators and logistics companies—Aurizon and Qube—are the lead agents in providing the urban services. Fletcher provides the regional service primarily for moving their rural produce between Dubbo and the port. In a similar way, Crawfords Freightlines provides a logistics service between the Hunter Valley and Port Botany. Cotton shippers provide a large and readily-classifiable commodity, and the cotton forms the largest export commodity through Port Botany. (Booz & Co. 2008, p. 14)

80 http://www.bitre.gov.au/publications/publications.aspx?query=s:"waterline"&link-search=true

81 Frequent rail services operate within the Manildra flour product logistics chain (Manildra/Bomaderry), including boxed processed grain products; these are not presented in published railway Working Timetables.

Figure 40 Sydney freight terminals

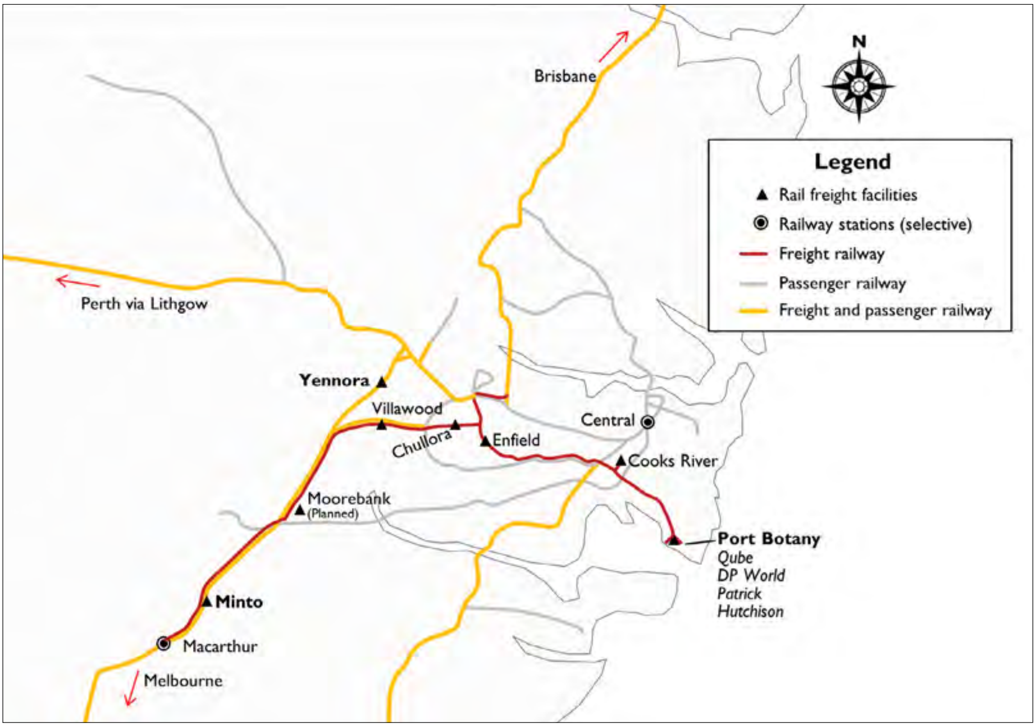


Table 6 Short-haul railed containers through Port Botany

Terminal	Terminal operator	Rail service provider	Rail distance to Port Botany (km)	Principal boxed products	Departures to Port Botany per week
Regional					
Bathurst	C3 (Asciano)	Pacific National	250	Logs	3
Bombaderry	Manildra Flour	Pacific National	170	Processed grain products	n.a.
Canberra	Espee Railroad Services	Espee Railroad Services †	327	Processed scrap metal	1
Coonamble	Agrigrain	Qube	621	Grain	n.a.
Dubbo	Fletcher	Southern Shorthaul	468	Refrigerated meat	3
Forbes	Mountain Industries	Sydney Rail Services	608	Agricultural products	n.a.
Goulburn ∞	International Primary Projects	Qube	228	Logs	1
Harefield (Junee)	Qube	Qube	508	Paper	5
Kelso	Grainforce Commodities	Southern Shorthaul Railroad	250	Logs	3
Manildra	Manildra Flour Mills	Pacific National	395	Processed grain products	2
Narrabri	Viterra Packing & Processing	Qube	567	Cotton, grain, chick peas	6
Narromine	Agrigrain	Qube	570	Grain	3
Nevertire	Auscott	Qube	559	Cotton	
Newcastle (Bullock Island)	na	Qube	178	Aluminium ingots	3
Newcastle (Sandgate)	Crawfords Freightlines	Sydney Rail Services *	178	Sawn timber, aluminium ingots	5
Newcastle (Walsh point)	Tomago Aluminium/ Mountain Industries	Qube	178	Aluminium ingots	2
Trangie	Namoi Cotton	Freightliner	603	Cotton	3
Warren	Namoi Cotton	Freightliner	579	Cotton	1
Warren (Auscott siding)	Auscott	Qube	572	Cotton	3
Wee Waa	Namoi Cotton	Freightliner	598	Cotton	3
Urban ⌀					
Minto §	Qube	Qube	57	Grain, maltings, paper; (imported) electrical appliances	23
Yennora§	Qube	Qube	41	Mixed exports, including wool	21

Notes: * Sydney Rail Services operates the service on behalf of Crawfords Freightlines.
∞ Service commencing in 2016.
† Espee Railroad Services operates the service in conjunction with Access Recycling Services.
§ The road distance between Minto and Port Botany Road is 52 kilometres; while Yennora – Port Botany Road is 37 kilometres.
⌀ Other short-haul operations include a service between Cooks River and Port Botany (about 10 kilometres—see Figure 63) operated by MCS Transport—the containers shifted by the company are predominantly empty (Meyrick 2006, p. 29); and a Pacific National shuttle, which commenced in June 2015, between the company's Chullora yard and the Port.
n.a. not available.

Sources: Victoria University Institute of Supply Chain Logistics (unpublished, 2012); ARTC and John Holland Country Regional Network online Working Timetables; O'Neil 2014; Railway Digest 2015, p. 9.

The Minto shuttle train

Qube's shuttle train operates approximately thrice-daily over the 57 kilometres between Port Botany and its Macarthur Intermodal Shipping Terminal (MIST) at Minto in south-western Sydney. As noted in Table 5, the MIST facility and the rail shuttle have their origins in the NSW Government's late-1990s PortLink policy, with a MIST–FreightCorp joint venture established in 2001 (Independent Rail 2007, p. 2) and intermodal operation commencing in 2002 (Roso 2008, p. 790); this policy is discussed further in Chapter 2 and Appendix D. In early 2015 were 23 scheduled train departures per week from Port Botany to Minto.

Public inquiries have identified a range of factors that undermine the rail service, such as track capacity limitations and port-terminal track configurations—see the discussion on these inquiries in Appendix D. However, by any reasonable assumptions, those 57 kilometres between terminal and port are far too short to sustain commercial shuttles… and yet they exist without direct subsidy.

The key factors that contribute to the viability of the shuttle train include:

- **Rail traffic volume.** The demand for the shuttle service is sustained by the presence around the Minto terminal of a few high-volume "anchor" export-based companies. The terminal is located in an industrial precinct and easily accessible by truck. One key shipper using the shuttle train is Cargill. The company has a malt processing plant adjoining the Minto site, which also receives railed containerised barley from regional NSW. Empty containers are also sent from the port to Minto, where there is a facility for filling boxes with grains that are railed back to the port for export. (Roso 2008, p. 790) Paper products are also railed for export from Kimberly-Clark's plant, which is located near the Minto terminal.[82] Breville has established a national distribution centre adjacent to the terminal, in this case for imported goods. Shuttles serve the three on-dock facilities and the empty container park; this is operationally inefficient but it bolsters train utilisation.
- **Low drayage distances to the terminal.** Low drayage distances are the corollary to the cluster of companies adjoining the Minto terminal. That is, the Minto terminal has appeal for intermodal operation because of the low drayage distance between the shippers and the terminal.
- **Value-adding at the hinterland terminal.** In addition to the basic transport task, the Minto terminal is used to supply an entire "wharf to gate" and "gate to wharf" service. The terminal provides a range of ancillary services including storage, warehousing, packing and unpacking, locomotive and container repair and offers Department of Agriculture and Water Resources quarantine services. (Roso, 2008, p. 790; Qube Holdings, 2014) To the extent that customs and quarantine services are undertaken at the terminal, it eliminates the task of transferring boxes at the port to third-party facilities for inspection and treatment.
- **Poor truck productivity/asset and labour utilisation.** By all accounts, the rail service should not be competitive over such a short distance. However, the road competitiveness is undermined by the road congestion on the arterial road network between the industrial area around Minto and the port. The M5 motorway, specifically, is the main road freight and commuter corridor between the port, Sydney airport and South West Sydney. The road is at or near capacity during peak periods. As discussed earlier, and as illustrated in Figure 38, congested roads reduce truck vehicle–driver utilisation as well as affecting reliability. Drivers

82 In 2007 the Kimberly-Clark paper-export traffic was one-third of the Minto terminal's throughput. (Roso 2008, p. 790)

> can be safely scheduled for fewer return trips within their shift or maximum-permitted hours of work, than would be possible with relatively uncongested roads. Where dray distances are low it can therefore be cost-effective to shift containers by rail–intermodal through Minto.[83]

These factors underpinned the decision by Breville to move its national distribution centre from Botany to Minto, opening in 2014. Goods are manufactured overseas and imported through Port Botany. It was reported that:

> *A key attraction of the Minto site was its close proximity to an intermodal rail container terminal, enabling improved shipping container handling efficiencies, a supply chain driver in Breville's high volume international product sourcing operations.*
>
> *[Breville's logistics manager stated] Being able to transport containers from Port Botany direct to the new Minto DC [Distribution Centre] by rail eliminates a lot of the time and unnecessary handling and transport costs associated with receiving containers by road transport… We have a private link road to the intermodal terminal, so our trucks don't even have to go out onto the main road anymore, with travel time between the sites typically less than five minutes. This means we have quicker access to stock, and have been able to significantly cut back on road transport… (Game-Lopata 2015, p. 63)*

We note that government policy, endowed in FreightCorp PortLink, promoted the terminal, encouraging private investment in the Minto terminal and the train company to establish the rail operation. As we discussed in Chapter 2, in 2012 government policy capped and set performance standards on stevedores' rail pricing and productivity, respectively.

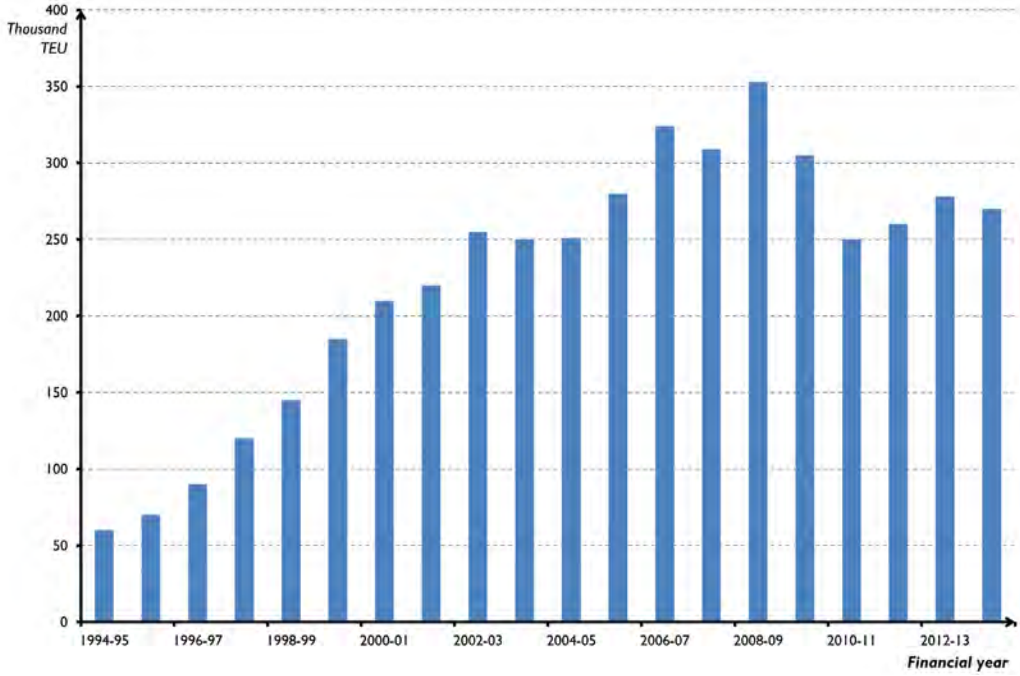
Restricted access to the Minto terminal impedes efficiency. Access is gained only from the northern end of the site—albeit that this is the direction that trains travel to and from the port. More importantly, while the terminal is on the eastern side of the suburban railway to Macarthur, the Southern Sydney Freight Line is on the western side of that railway. There is no at-grade or grade-separated link from the terminal across that busy commuter railway to the Freight Line.

The 2008 IPART report is notable in highlighting the challenge for short-haul rail operations at the terminal, with issues related to rail operations serving multiple stevedore facilities, and an empty container park, at Port Botany. Australian Rail Track Corporation raised similar issues about the operational challenges of serving multiple facilities. (ARTC 2015, pp. 24, 27) The short-haul services operate in spite of the range of deficiencies. The inquiry is discussed further in Appendix D.

Finally, as noted elsewhere, we note that the prevailing rail infrastructure charges are not set at levels that recover long-run costs; this is an indirect subsidy.

83 Victoria University illustrates this relatively unproductive road haulage with the Yennora terminal: with Qube's Yennora operation "the total fleet requirement [has been reduced] by an estimated 30 vehicles, allowing vehicles to perform 3–3.5 trips per day to the 1–1.5 trips per day achievable operating directly from Port Botany". (Victoria University 2012, p. 49)

Figure 41 Railed containers between Port Botany and the hinterland



Sources: Sd+D consult 2009, Shipping Australia 2011, Sydney Ports Corporation 2013.

Conclusions

There are numerous impediments to commercial operation of short-haul urban and regional rail at Port Botany. The port/rail interface, shared passenger and freight tracks and extra maritime terminal handling detract from rail's competitiveness. These factors have been extensively considered in earlier public inquiries.

Despite these impediments and detractions, but consistent with railway economics, the regional, containerised rail movements are sustained. These boxed exports are sustained by longer distances from the port (reducing truck utilisation), from low drayage issues and from regular high-volume flows of regional exports.

The short-haul urban services are notable, however, operating in spite of the maritime rail terminal impediments and detractions ***and in spite of*** the apparently-poor railway economics over very short distances.

Qube's Minto port shuttle is an instructive case-study when considering factors that contribute to competitive short-haul rail. Rail becomes more competitive because of poor road freight productivity; access between the Port and south west Sydney is heavily congested. However, the rail service is not simply a default option due to poor road reliability. The Minto terminal operates as an inland port because it is readily accessible to customers—drayage distances are low. The terminal is in an industrial area with easy access for trucks. Furthermore, the transport facilities are co-located with numerous ancillary services and with major shippers—a malt processing plant, a paper manufacturer—both of whom export large volumes of containers—and a customer with an import distribution centre. Demand for transport, therefore, has been sufficient at Minto for a regular rail service to be viable.

Port of Melbourne

Box 7 Port of Melbourne rail service profile

Hinterland terminals	Metropolitan: None. Regional: A range of railway corridors, with broad-gauge services from Maryvale (149 km), Warrnambool (265 km), Mildura (616 km), Tocumwal (247 km) and Deniliquin (320 km); and standard gauge services from Dooen (320 km), Ettamogah (318 km) and Griffith (639 km) and some land-bridge freight from Adelaide (832 km).[84]
Map	Figure 67
Services	Intermodal
Port rail terminals	On-dock rail terminals at DP World (West Swanson Intermodal Terminal), Patrick (Appleton Dock terminal), Qube (Victoria Dock rail yards). When boxes are delivered to one stevedore but moved inland or offshore through another stevedore then the boxes are transferred by road between the facilities. Port terminal maps with updated rail service provision are presented in an Appendix to BITRE's Waterline series.[85]
Rail proportion	Railed containers form approximately 11 per cent of landside-handled containers
Background	The Port of Melbourne is Australia's largest container port, by volume, with throughput of 2.5 million TEUs in 2013–14 (BITRE 2015, p. 14). The Port of Melbourne Corporation, a public entity, manages the city's port. The port is split into two precincts, Swanson Dock and Webb Dock. The former handles the majority of container traffic. There are two stevedores—DP World operates the West Swanson Dock terminal (with four berths) and Patrick operates East Swanson Dock (with four berths). Qube Logistics operates a container and general cargo terminal at Victoria Dock (within the Swanson Dock Precinct), with one berth. At Webb Dock East, Patrick handles some containers and general freight. The Swanson Dock Precinct is 2 kilometres from Melbourne's city centre; the precinct has easy access to the metropolitan freeway network, which radiates from central Melbourne. The port is also located alongside Melbourne Freight Terminals and Dynon Terminal, servicing interstate and intrastate trains. Dual broad and standard gauge rail sidings serve the three container facilities.[86] Containers can also be railed into the Dynon terminals and then transported by road to on-dock container stacks.

84 Tasmanian containerised freight passes through the port, of which an unknown proportion are conveyed by rail on the mainland.

85 http://www.bitre.gov.au/publications/publications.aspx?query=s:"waterline"&link-search=true

86 There is a single dual-gauge siding of 510 metres at DP World's West Swanson Intermodal terminal, serving the West Swanson Dock. Patricks' Appleton Dock facility, serving East Swanson Dock, has two dual gauge tracks of 640 metres while Qube's Victoria Dock rail facilities consist of two dual gauge tracks of 630 metres (BITRE 2015, p. 79).

Port rail operations

Table 7 lists regional and land-bridge rail services between inland terminals and the Port of Melbourne. There are no metropolitan short haul rail flows to the Port of Melbourne.

Table 7 Railed container flows to and from the Port of Melbourne

Terminals	Rail service provider	Rail distance to port (km)	Principal boxed products
Adelaide: Port Flat and Islington terminals. (Land-bridge)	Pacific National	790 (approx.)	Not known
Maryvale §	Qube	149	Paper
Deniliquin, NSW) §	Qube	320	Rice
Mooroopna (Shepparton) §	Qube	177	Milk products
Warrnambool (Dennington) §	Pacific National	265	Agricultural and mixed exports
Tocumwal, NSW §	Pacific National	247	Grain
Merbein/Mildura (Iron Horse Intermodal Freight Terminal) §	Pacific National	616	Grapes and citrus fruit (both cold storage), almonds, grain, cotton, wine, mineral sands
Donald	Pacific National	338	Faba beans, chick peas and other pulses
Griffith, Leeton, Bomen and Ettamogah, NSW	Pacific National	639 (from Griffith)	Wine, rice, paper, mixed export goods (plastic, pet food)
Dooen (Wimmera Intermodal Freight Terminal)	SCT Logistics	320 (approx.)	Grain and hay

Note: § broad-gauge flows, with the other flows being standard-gauge movements.

Sources: Victoria University, 2012; BITRE 2015, pp. 79–80; PWC 2014, pp. 16–17.

Services can be categorised broadly into land-bridge and south-eastern Australia regional flows:

- Land-bridge. Containers are transported between Adelaide and Melbourne, a distance of around 820 kilometres. Movements are predominantly exports. Some of those trains terminate on-dock at Appleton Dock. Other trains terminate at near-dock facilities at South Dynon rail terminal, with containers then being moved by road to container stacks within the port. In recent years this land-bridging task has declined as containers have increasingly been exported directly through Adelaide and then transloaded at major overseas port-hubs (notably, Singapore) to vessels destined for the final port.
- South-eastern Australia flows. These include a range of exported agricultural products (grains from Tocumwal, Deniliquin, Warrnambool, Dooen and Merbein (Mildura)), processed paper products (Maryvale), processed foods (Ettamogah and Warrnambool) and wine and beer (Griffith and Leeton).

As noted in Appendix C, the Victorian government subsidises a number of the regional container flows, as part of its Metropolitan Intermodal System programme.

The relative positions and rail–road interfaces in the Dynon – Port of Melbourne precincts influence the container handling logistics. Domestic containers railed to the port terminate at Dynon terminals beyond the Port, or are conveyed directly to one of the Port's rail terminals at West Swanson (DP World), Appleton (Patrick) or Victoria Dock (Qube). The subsequent dispersal of containers between the stevedores is undertaken by road vehicles; this contrasts with Port Botany, where trains are split in Botany yard and containers are then forwarded by rail to the respective terminals. Note, however, that it is common for public roads to be used to shift containers from the intermodal terminal to the stevedore stacks even when containers arrive at the appropriate intermodal terminal. For example, the West Swanson Intermodal Terminal is located on the north side of the public road, Coode Road West. Road trucks, rather than Port Precinct Vehicles (PPVs) such as straddle carriers, are used to convey containers across the public road to access the DP World container stacks to the south of the intermodal terminal. (Victoria University 2012, pp. 69–70).

Short haul urban shuttles

This report has outlined how the economics are weighed heavily against short-haul freight rail services. Our approach has been to invert the question and ask why specific short-haul services do operate. We consider the Altona shuttle that operated between 2003 and 2007, and the Somerton shuttle that for practical purposes has never operated.

Cargo Sprinter

One key underlying factor that undermined the Altona shuttle was inadequate volumes. The Port of Melbourne had short-haul services over an extended period, with CRT making concerted efforts and investment in a port shuttle between Altona and the port in periods between 2003 and 2007. The service initially used the Cargo Sprinter technology, based on short, fixed-formation trains; later, conventional train formations were used. A range of operational and organisational–interface factors were identified that impeded the service's efficiency and reliability and, thus, overall cost-competitiveness—see the discussion on the Inquiry into managing transport congestion, in Appendix D, for further discussion and cost breakdowns. Such uncompetitive charges inevitably meant that CRT would have to levy container-handling charges that were uncompetitive, or were competitive with road but loss-making. Either way, the outcome was that the service attracted insufficient traffic for the service to break even; economies of density could not be realised.

As noted by Asciano:

> *The more fundamental issue is the economics of running short shuttle trains through a shared network. … Typically, for a train movement to be competitive against alternative modes and commercially viable, they must have either "density or distance". Short distance shuttles of short trains clearly have neither." (Asciano, quoted in Essential Services Commission 2007, p. 235)*

Box 8 Somerton as an intermodal terminal

Somerton is a terminal located approximately 20 kilometres north of Melbourne. Private-sector development of the terminal and "freight village" commenced in 1998. Major companies (including the-then Coles Myer, Visy, Mars, Linfox, Kraft and Barret Burston Malting) located their distribution centres at Somerton (Department of Transport [Victoria] 2010, p. 34). The facility and complementary distribution centres that are clustered around have generated large volumes of TEU imports and more modest export volumes. (Port of Melbourne Corporation 2010,pp. 91, 95)

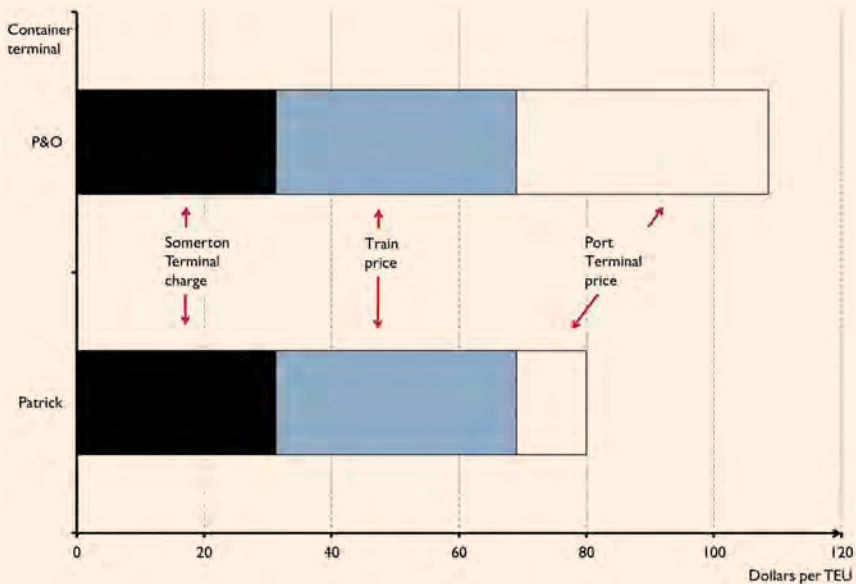
It was envisaged that intermodal shuttles would operate between the Somerton terminal and the Port of Melbourne. The railed boxes would move between the port and the distribution centres, as well as regional boxes (which would be shifted by road beyond the terminal). Despite a terminal site lessee perceiving that the rail operation was "guaranteed to succeed", several attempts during the mid-2000s have not succeeded in maintaining a shuttle service. (House of Representatives 2005, pp. 32, 38)

The uncompetitiveness of the shuttle seems to be borne out by subsequent analysis. Modelling work on rail shuttles that was undertaken in 2007 by the Victorian Freight and Logistics Council (VFLC) indicated that higher costs would be incurred with Somerton and Altona shuttles using the West Swanson (then-P&O, now DP World) rail facility than at the East Swanson (Patrick) rail facility. The modelled West Swanson costs were more than one-third higher than the East Swanson costs—see Figure 42. At 80 per cent utilisation, railed containers to the Eastern facility were competitive with road but to the Western facility the rail cost was one-third more than road. The insight into the differential was that "At present, Patrick has an optional pricing tariff which offers parity with road pricing". (VFLC 2007, p. 12) The analysis noted that rail incurred a port terminal handling charge that did not apply to road. (VFLC 2007, p. 58) Other factors that impeded service efficiency included indirect track alignment at Somerton: shuttles leaving Somerton had to travel north before reversing in order to reach the port. (Department of Transport [Victoria] 2010, p. 34)

More generally, the-then Department of Infrastructure [Victoria] noted that the environment in Sydney was more conducive for short-haul rail shuttles than in Melbourne. It noted that "congestion is less than in Sydney and trucking efficiency remains relatively high, reducing the viability of rail shuttles in Melbourne" (Department of Infrastructure [Victoria] 2007, p. 61)

The truck productivity is also relatively higher in Melbourne than in Sydney due to the location of Melbourne's empty container parks making the road fleet more productive. Melbourne's empty container parks are largely clustered in the Tottenham/Brooklyn area, approximately 6–7 kilometres from the port; unlike Sydney, the parks are not connected to rail. The parks are situated between the port and locations of full container demand—largely in western and northern Melbourne. These locations, combined with relatively low-congestion roads, have allowed road operators to establish highly efficient operations that do not require all vehicles to return to the port. (Victoria University 2012, pp. 69–70) Thus, while road fleet utilisation in Sydney is enhanced by using road/rail inland terminals, those benefits are absent in Melbourne. (See also Austrak 2015, passim, for insights into Somerton.)

Figure 42 **Modelled Somerton port shuttle costs, P&O (West) and Patrick (East) port terminals**



Source: Data are from VFLC 2007, p. 12, assuming the use of 40 foot containers.

Somerton

Based on railway-economic principles constructed through this report, Somerton ostensibly presents an ideal situation where short-haul should work. The leaseholders of the Somerton rail facilities noted that the site had a strong natural catchment area of large shippers, closely located around the terminal, with a range of value-adding logistics tasks. At first look, therefore, it would seem that (as the terminal operators put it) the operation was (as the leaseholders suggested) "guaranteed to succeed"—see Box 8. Necessary, but not sufficient, ingredients for "viable" rail shuttles include, first, the need for dominant (or anchor) shippers with large, steady volumes; secondly, customers need to be drawn from localities drawn tightly around the inland terminal so as to minimise drayage; finally, the inland terminal (or terminal precinct) benefits from undertaking a range of logistics activities (or "value-adding").

Somerton has those attributes and yet the terminal has never seen regular rail shuttles.

Information from NSW inquiries points to Sydney's Yennora and Minto terminals having similar attributes to Somerton and yet short-haul shuttles operate from those terminals. Indeed, like Melbourne, NSW public inquiries have noted numerous terminal and railway operational and organisational deficiencies in Sydney that seem at least as challenging to short-haul viability as those that studies have identified as present in Melbourne.

The central reason for the failure of short-haul in Melbourne, compared to services being sustained in Sydney, lies in the difference in rail's relative competitiveness in the two cities. In particular, trucked containers moving between Somerton, or Altona, and the Port of Melbourne are relatively productive compared with Sydney. In particular, Melbourne's trucked boxes do not incur the congestion that is faced in moving containers between the hinterland and Port Botany—see Box 8. As has been noted, "road has proven more competitive than rail due to high quality road infrastructure supporting the port of Melbourne and its central location". (Essential Services Commission 2007, p. 235)

A supplementary factor for the failure may be the nature of consolidated movements and it may be that export–logistics consolidation tasks are more suited to short-haul rail than import–distribution-centre deconsolidation tasks. Key anchor customers are vital, especially entities that have consolidated goods flows, and large-volume single-commodity exports are especially suited to these movements and these feature strongly as anchor-customer tasks in other Australian short-haul movements. Despite the large commercial centres around the Somerton Intermodal Park—such as Northgate Distribution Centre, Austrak Business Park and Somerton Logistics Centre—it is conjecture that the tenants are mostly import-distribution firms rather than logistics–export consolidators.

Short-haul regional flows from Iron Horse Intermodal Freight Terminal, Merbein (Mildura)

Classification:	Regional terminal (616 kilometres to the Port of Melbourne—see Figure 67, p. 217).
Status:	operational
Terminal operations:	Intermodal rail quarantine-accredited; container packing; container storage; cold-store for disinfestation; grain packing.

Rail operations:	Three rail services per week from Merbein to the Port of Melbourne, for ex-ort-based container movements. Volumes are around 100 TEU per train. The rail operations also serve the Donald Intermodal Terminal. In 2012–13 9 880 containers were shifted from the terminal.[87] Asciano (Pacific National) operates the trains.
Driving organisation:	Wakefield Transport Group, with the international supply-chain company Seaway Logistics (with Seaway being shareholders in Wakefield).

The Iron Horse facility is the Sunraysia region's principal export facility, with some exports also being drawn from the Mallee region. The terminal commenced operations in 1985 and, following the awarding of government capital support (p. 194) in 2003, 2009 and 2010, the facilities were upgraded and expanded.

The facility undertakes a wide range of value-adding activities to process, package and prepare the goods for export. In this context, these value-adding activities essentially remove the drayage costs from the intermodal task (as discussed in Chapter 4). The terminal processes and handles various citrus fruits (oranges and lemons), avocados, grapes, dried fruits, cotton seed and cotton bales, almonds, carrots, legumes as well as wine and boxed mineral sands. There are sealed grain storage silos and a grain loading facility is used to pack specialty grains in containers, by Wakefield Grain Export Services. A cold store, with a rapid-chill facility, is used to maintain citrus and grape freshness and to ensure that fruit is free of fruit fly—a process known as disinfestation.[88] Empty containers are provided for packing. The on-site quarantine inspection by accredited staff and the Seaway Logistics management facilitate the container exports.[89]

Wakefield Transport Group has been the pivotal entity that has developed the intermodal operation.[90] The complementary logistics activities have drawn custom to the facility. For example, the development of the cool store and quarantine inspection services at Merbein can be less costly for producers than on-farm provision.[91] The terminal serves major shippers, such as Mildura Fruit Company and Australian Vintage Limited. These shippers' operations are supported by logistics operators, such as the 4PL operator, Hillebrand Global Beverage Logistics, who arrange the logistics for the international delivery of bulk wine.

The regional short-haul economics are thus driven by:

- **Value-adding at the Merbein facility, which essentially eliminates perceived drayage.** The diverse tasks performed at the Merbein terminal attract custom to the terminal and, thus, provide solid volumes for the rail operation.

87 Department of State Development, Business and Innovation 2013, p. 35.

88 The Export Fruit Disinfestations Treatment Facility, which opened in August 2015.

89 Actual Department of Agriculture and Water Resources staff (not accredited staff) are required for some countries where produce is exported to. (Parliament of Victoria. Rural and Regional Committee 2014b, p. 4)

90 The company has given evidence to inquiries into regional exports (Parliament of Victoria. Rural and Regional Committee 2014) and the proposed privatisation of the Port of Melbourne (Parliament of Victoria. Port of Melbourne Select Committee 2015c). The company has noted that its operations have been impeded by degraded track—leading to slow speeds, derailments and reduced equipment utilisation—and by what the company calls a "last mile" issue where container handling over the 100 metres between the rail track and the waterfront incurs costs amounting to "about 10 per cent of the cost of the whole journey from Mildura to Melbourne and return." The company believes that because railed boxes, unlike trucked boxes, do not go straight to the waterfront — "on-dock" — then rail incurs these additional costs. (Parliament of Victoria. Rural and Regional Committee 2014b, p. 3)

91 Increases in quarantine-registered inspection charges for packing sheds led some growers to shift their inspection to the Merbein facilities. (ABC Rural 2013, "Sunraysia grape growers avoiding higher packing shed quarantine charges", 15 March. http://www.abc.net.au/site-archive/rural/news/content/201303/s3716330.htm)

- **Consistent rail volumes.** While the facility draws on seasonal agricultural produce for shipment, the terminal consolidates a broad range of diverse products and non-seasonal (or counter-seasonal) throughputs such as wine, boxed grain and mineral sands. These volumes capture train economies of density and relative utilisation, with distances to port lying well beyond the day-return truck times.
- **Intermodal subsidies.** The service benefits from the Victorian Government's Mode Shift Incentive Scheme—discussed in Appendix C—which is a subsidy for each TEU shifted. State and Federal investment support has also been obtained for terminal capital works on rail infrastructure and in cold store equipment.

Figure 43 **Merbein (Mildura) intermodal train, Yatpool**

Note: The image shows the Merbein intermodal train, operated by Pacific National. The use of 20 foot containers is evident, with both 8 foot 6 inch and 9 foot 6 inch (high-cube) containers being used. In the middle section of the train are a number of bulk wine tank containers.

Source: Photograph courtesy of John Hoyle.

Outer Harbor, Adelaide

Box 9 Port Adelaide (Outer Harbor) rail service profile

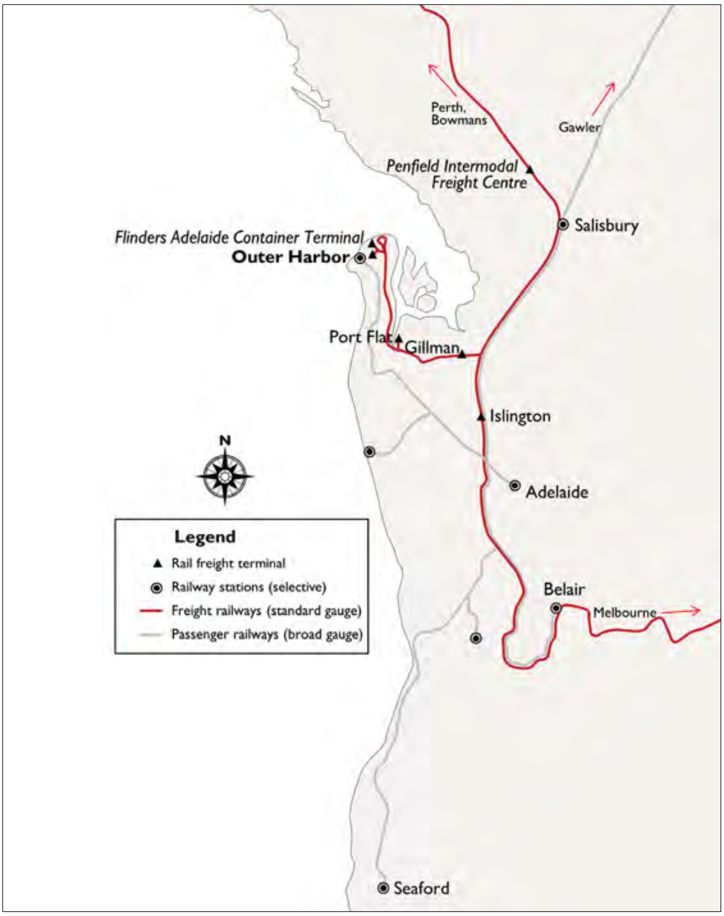
Hinterland terminals	Metropolitan: Penfield (30 km) Regional: Bowmans Intermodal (96 km); Port Pirie (176 km)
Map	See Figure 44 and Figure 69
Services	Intermodal and transmodal
Port rail terminals	Outer Harbor has on-dock rail terminals at Qube (not used) and Flinders Adelaide Container Terminal. Port terminal maps with updated rail service provision are presented in an Appendix to BITRE's Waterline series; that publication also presents railed and trucked container data.[92]
Mode share	n.a.
Background	Flinders Ports manages the Port of Adelaide—consisting of Inner and Outer Harbor. The port's container terminal, located at Outer Harbor, is Australia's fifth largest by volume, handling 0.4 million TEUs in 2013–14 (BITRE, 2015, p. 15). Flinders Adelaide Container Company is the terminal's stevedore, using two berths. Qube operate a nearby terminal and container park. The Outer Harbor container terminal is at the extremity of a 15 route-kilometre, freight-only railway between Outer Harbor, Port Adelaide and Dry Creek. The line is standard gauge with some sections of double track.[93] The Outer Harbor – Dry Creek line connects with the interstate network at Dry Creek. Nearby terminals include Asciano's at Port Flat and Islington; and SCT Logistics' Penfield terminal. On-dock rail facilities at the Outer Harbor terminal are two rail sidings and these serve the Flinders Adelaide Container Terminal. A second set of sidings serves Qube's terminal and container park.

Port rail operations

Port Adelaide (Outer Harbor) has two relevant port–rail links: a shuttle service between the port and the SCT Logistics facility at Penfield; and a regional service between the port and Bowmans Intermodal—with some of those services extended to Port Pirie to collect containerised ore.[94] The shuttle route is shown in Figure 44; the regional route is shown in Appendix E. In both cases the services are driven by the shippers (Balco/Nyrstar, Treasury Wines) connecting their export-based terminals with the port. The two services are now considered.

92 http://www.bitre.gov.au/publications/publications.aspx?query=s:"waterline"&link-search=true
93 A rail has been provided for broad gauge but was de-commissioned in 2014.
94 SCT Logistics operated a containerised iron ore train between Wirrida (northern SA) and the port between 2010 and 2014; the containers were not conventional ISO boxes, however, and the contents were dispensed into bulk vessels at the port, with the boxes then returned to Wirrida.

Figure 44 Port Adelaide (Outer Harbor) rail connections



Notes: For more detailed maps see SA Track and Signal, 2015; Rail SA, 2015.

The Penfield urban shuttle train

In April 2014 SCT Logistics began a short-haul urban service over the 30 kilometres between its Penfield Intermodal Freight Centre terminal and the on-dock rail facilities at the Flinders Adelaide Container Terminal at Outer Harbor. Four services operate each week with a fifth train run if traffic levels warrant it. (Carter 2014, p. 4) The standard train length (485 metres) approximates to around 44 TEU.

The rail service shifts containerised wine for export.

A broad range of value-adding logistics activities are undertaken at the Penfield terminal. In addition to handling domestic freight on the east–west corridor, on which the terminal is located, the terminal:

- operates as a freight consolidation and distribution centre;
- SCT Logistics warehousing;
- a beverage distribution centre (for SAB Miller); and

- a 25 000 square metre Treasury Wine Estates temperature-controlled distribution centre.

A fourth-party logistics provider, Trebuchet Logistics, uses the Treasury Wine facility to consolidate the wine for export. Placing the wine in containers includes specialised packing to maintain climate control when containers are transported. (Carter 2014, p. 6; Rail Express 2014, n.p.; SCT Xpress 2015, p. 2)

Important factors contributing to the viability of the Penfield "wine train" are as follows:

- **Rail traffic volume.** There is a large, single customer, providing a steady flow of export containers. Treasury Wines generates enough produce to underpin a regular rail service and, therefore, benefit from the economies of density that rail requires. Furthermore, the service is relatively simple in being underpinned by one large shipper, so that the logistics task, from "gate to wharf", is simplified, and service frequency meets the needs of that shipper. The port also imports empty 20 foot containers and it is likely that such containers are used for this service, thus providing a revenue-earning backflow.[95]
- **Minimal drayage.** The single large-volume customer simplifies the logistics task because the packed products originate at, and are destined for, the same points. The location of Treasury Wine's distribution centre, at the Penfield Terminal, consolidates and packs and processes. If the task can be called "drayage", it is limited to handling within the terminal area.
- **Value-adding at the inland terminal.** While the Penfield terminal is the rail head, it is also a tailor-made facility for temperature-controlled, consolidation, storage and packaging, with co-location of major producers' distribution centres.
- **Enhanced road vehicle productivity.** Transit time and asset utilisation are maximised. SCT Logistics found that turnaround time and fleet asset utilisation can be improved by avoiding port container terminal queues. (Carter 2014, p. 7; SCT 2015, p. 2)

The activities are consistent with what Bergqvist and Woxenius (2011, p. 163) describe as a "close dry port", which "offers greater possibilities for buffering containers and even synchronisation with the loading of an individual ship in the port".

Short-haul regional flows from Bowmans Intermodal Terminal

Classification:	Regional hinterland terminal (96 kilometres to Port Adelaide—see Figure 69.)
Status:	operational
Terminal operations:	Intermodal rail; quarantine-registered; container storage and cleaning; adjacent industrial-zoned land
Rail operations:	Rail services from Bowmans, with some additional traffic from Port Pirie, moves to Outer Harbor, with some transmodal (rail–rail) connections to the Port of Melbourne. There are approximately 25 services per month from Bowmans to Outer Harbor. In 2015 the terminal was handling containers at an annualised rate of over 25 000 TEU.
Driving organisation:	Established in 2003 by Balco Australia.

95 See Whittle 2015, p. 25.

Regional intermodal services operate between Bowmans Intermodal terminal and Outer Harbor. Some of those services are extended north from Bowmans, operating from Port Pirie to Outer Harbor (176 kilometres).

Bowmans Intermodal commenced operations in 2003, exporting a range of the region's cereal products (grains, hays and straws). The terminal has benefited from public funding, for example in 2005 when the Australian Government contributed $2 million towards a $4 million expansion of the terminal, under the AusLink Strategic Regional Programme. The Bowmans Intermodal terminal is operated by Patrick Portlink (SA) (a subsidiary of Toll Group). The terminal is owned by a joint-venture between Patrick Portlink (SA), Balco Australia (agricultural products exporter) and AGT Foods Australia (supplier of pulses and beans).

The Bowmans terminal undertakes a range of value-adding tasks. Agricultural products are trucked to the terminal, where they are stored, processed, baled (for hay and straw) and then packed into containers. The freight is consolidated into bulk units for railing to Port Adelaide (and, in some cases, to Melbourne) for export. Complementary ancillary activities include container maintenance and repair, cleaning and storage; and quarantine. (Wakefield Regional Council 2003, p. 17)

The boxed exports are agricultural products—coarse feed for livestock (hay from barley, oats and wheat), pulses, grains, pork bellies and wine.[96] The containers are moved for export through Melbourne and Port Adelaide. (BITRE, 2014a, p. 38) The short-haul regional port service benefits from export traffic emanating from AGT Foods Australia's grain facility, which is co-located with the Balco facility at Bowmans.

Traffic is supplemented by containerised lead and zinc that is railed, through Toll Logistics, from the Nyrstar lead smelter at Port Pirie; this traffic is exported through Outer Harbor. Traffic volumes are sufficient to form commercial volumes; the traffic is formed from Port Pirie and the exports from Bowmans. Some backhaul traffic has been handled: Bowmans handles imported containerised tuna food (bait). The movement of empty containers from Outer Harbor represents an important backflow.

The driving force behind the establishment of the operation was Balco (with Patrick Corporation as logistics provider), which exports its hay, destined for Japan and the Middle East. Balco's grain operation was sold to AGT Foods Australia, who saw the intermodal terminal as providing the company with "a significant logistical advantage", with its own export of pulses and beans.[97] That company now has financial interests in the terminal following restructuring of the facility's ownership structure. Also notable is the financial interests of the terminal operator and rail service provider, Patrick Portlink (SA), reinforcing service quality incentives.

The short-haul economics are thus driven by:

- **Strong, consistent, consolidated traffic volumes.** The common terminal owners–shippers generate (in aggregate) traffic volumes (Balco, AGT Foods Australia, the Nyrstar Port Pirie traffic) that sustain regular rail operations. The consolidation of freight into the large volumes being railed from the terminal captures the vital train economies of density;

96 Grain is also handled in hopper wagons, and moved on separate bulk trains.

97 http://midwestshippers.com/news_detail.php?article=639 Press release through the Midwest Shippers Association, 3 September 2010. "Alliance Grain Traders, Canadian multi-national pulse company, expands into South Australia with planned acquisition of Balco Grain facility located near container terminal". The company is now known as AGT Foods Australia.

- **Inland port value-adding.** The value-added activities (hay processing and container packing) that occur following drayage of the commodities to the terminal, making the terminal a destination in its own right; and
- **Transmodal.** For freight that is destined for Melbourne — transferred between trains in Adelaide — the effective railed distance is somewhat longer, improving those economics. Transmodal (rail–rail) traffic also improves the economics of the short-haul operation to Adelaide.

Fremantle

Box 10	Fremantle Inner Harbour rail service profile
Hinterland terminals	Metropolitan: Forrestfield (41 km) Regional: Leonora (950 km)
Map	See Figure 70
Services	Intermodal: the "Kewdale Intermodal Rail Supply Chain" via standard-gauge trains. Some freight is shifted by rail to the Inner Harbour from the Outer Harbour at Kwinana.
Port rail terminals	A dual-gauge (1 067mm and 1 435mm) on-dock rail terminal at North Quay Rail Terminal serves both the DP World and Patrick container terminals. Port terminal maps with updated rail service provision are presented in an Appendix to BITRE's Waterline series; that publication also presents railed and trucked container data.[98]
Mode share	13 per cent in 2014–15.[99] The government mode-share target is 30 per cent (Fremantle Ports 2015, web site).[100]
Background	Fremantle Ports, a trading enterprise of the Western Australian Government, manages the port. Container stevedoring is undertaken at North Quay, in Fremantle Inner Harbour, by Patrick and DP World. Fremantle is Australia's fourth largest container port, by volume, with total throughput of 0.7 million TEUs in 2013–14 (BITRE 2015, p. 16). A freight railway runs between the Inner Harbour and the Outer Harbour at Kwinana; and with container terminals at Forrestfield/Kewdale.[101] That latter line then joins the interstate network at Midland. A map of Perth's rail freight network and facilities is at Figure 45. The North Quay Rail Terminal at Fremantle Port is a central rail terminal serving the port's container terminal stevedores, Patrick and DP World. The Inner Harbour rail facility was commissioned in 2005. In 2014 the terminal's dual (standard and narrow) gauge rail sidings were lengthened, from 400 metres to 690 metres.

Port rail operations

The Fremantle Ports has two notable railed landside international container flows. There is a standard-gauge shuttle service between the Inner Harbour and an intermodal terminal at Forrestfield; and there are regional container flows from Leonora (nickel) and from Kalgoorlie. See Table 8. The urban shuttle train accounts for approximately 80 per cent of the port's railed containers.

98 http://www.bitre.gov.au/publications/publications.aspx?query=s:"waterline"&link-search=true

99 http://fremantleports.com.au/Operations/Landside/WAPOTFDocuments/2015%2008%20-%20August%202015%20meeting%20papers.pdf

100 For up-to-date mode share statistics, see the monthly meeting papers of the WA Port Operations Task Force, http://fremantleports.com.au/Operations/Landside/Pages/wapotf.aspx

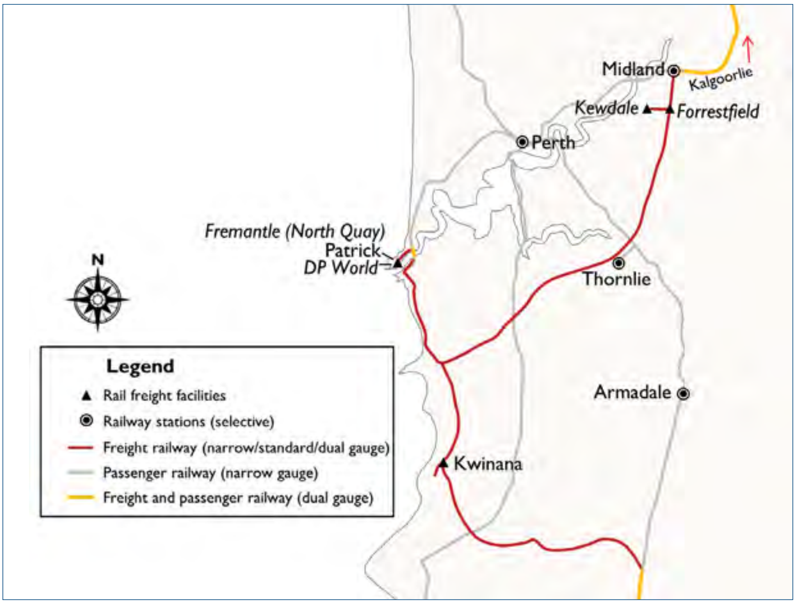
101 A new facility, Kwinana Intermodal Terminal has been proposed; an adjoining "Latitude 32" logistics centre is also proposed. See Newman and Hendrigan 2015 for further details.

Table 8 Short- and medium-haul containerised rail flows through Fremantle Ports

Terminal	Terminal operator	Rail service provider	Rail distance to port (kilometres)	Principal products
Short-haul regional				
West Kalgoorlie—Kwinana	Aurizon	Aurizon	691	Nickel, chemicals, industrial goods
Leonora—Fremantle North Quay	Aurizon	Aurizon	950	Lead
Short-haul urban				
Forrestfield—Fremantle North Quay	Intermodal Link Services	SCT Logistics	41	Grain, stock feed, mineral sands, paper, consumer goods
Kwinana–Fremantle North Quay	Aurizon	Aurizon	28	Concentrates

The short-haul shuttle service is reviewed here.

Figure 45 Fremantle Ports rail connections



The Forrestfield shuttle train

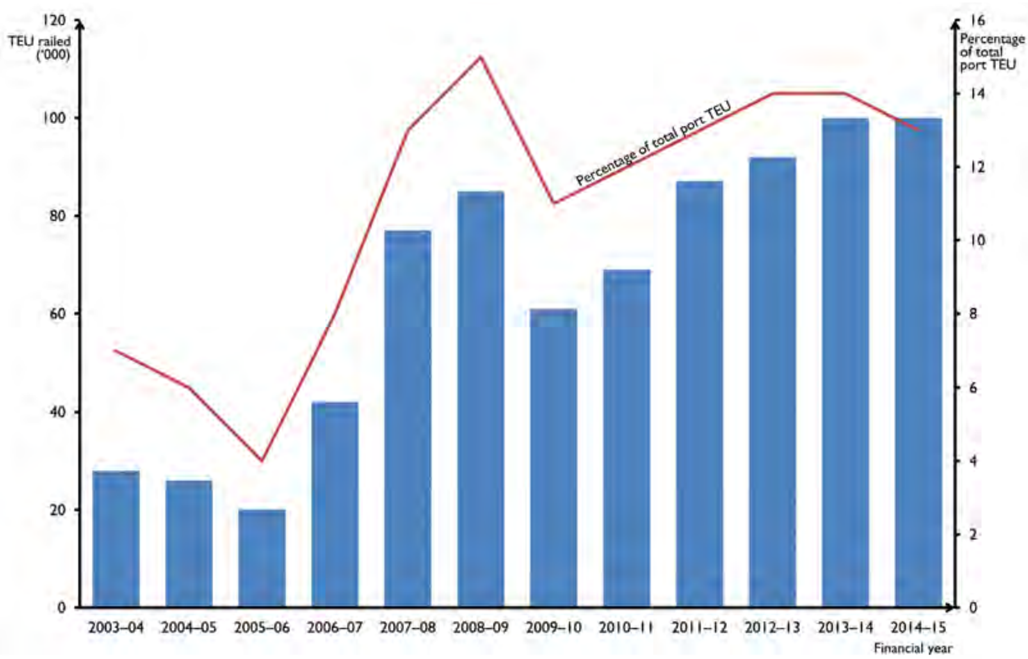
Intermodal Link Services has contracted SCT Logistics to manage and provide rail shuttle services over the 41 kilometres between the Forrestfield/Kewdale industrial zone in eastern Perth and the single, central North Quay Rail Terminal, which serves the DP World and Patrick container terminals at Fremantle Ports' Inner Harbour. Intermodal Link Services operates the North Quay Rail Terminal, the Forrestfield Intermodal Terminal and its adjacent intermodal Container Services empty container park.

The Forrestfield service accounts for approximately 80 per cent of the railed container volumes received at the North Quay rail terminal.[102] In 2012 there were 12 weekly return shuttle trips (Forrestfield – North Quay), with trains generally being 650 metres in length, with train capacity of 90 TEU.[103]

In 2002 rail accounted for 2 per cent of the containers moved to or from the port; see further background material on this on p. 194. By 2013–14 the share had risen to 14 per cent, and spiked in the last financial quarter, to 17 per cent, due to a large grain harvest (Fremantle Ports 2014, p. 31). This illustrates the importance of containerised grain for the shuttle service.

Fremantle Ports has acknowledged the important role of the State's financial support in achieving the mode shift. (Fremantle Ports, 2008, p. 24)

Figure 46 Railed containers through Fremantle Ports



The central factors contributing to the sustained shuttle operation are as follows:

- **Subsidy.** To date, the service has been underpinned by direct subsidies—it has not been self-sustaining without direct subsidies. Since 2006–07 the state government has provided an operating subsidy for each loaded container that is shifted between Forrestfield and the Inner Harbour.[104] The subsidy commenced at around $50 per loaded container, which is being scaled down over successive years, to $30 in 2017. Additionally, the government provides "in-kind" financial support such as access fees for using the North Quay Rail Terminal.[105]

102 The remaining 20 per cent is from Kalgoorlie/Leonora and Kwinana services. Note that Aurizon rails containerised concentrates from Kwinana to the Inner Harbour for export.

103 In 2014 it was reported rail services increased to 14 trains a week (Table Talk, July 2014, p. 7).

104 The subsidy has been on a sliding scale, dropping from $50 per loaded container.

105 It has also been reported that the State government stipulates that port tenants must each move a 30 per cent minimum rail mode share for "contestable" container traffic—see Skinner 2015, p. 39.

- **Infrastructure enhancements.** The State government funded the construction of port rail facilities, shifting the terminal from a near-dock facility to on-dock facility at the North Quay. (Victoria University 2012, p. 86; see also the policy discussion on p. 194). In February 2013, the Western Australian government announced the continuation of the subsidy to 2016–17 at a cost of $15.5 million.
- **Traffic volumes.** The service is underpinned by a dominant customer. The shuttle has imports (largely consumer goods) and exports (stock-feed [including hay], grain, paper and mineral sands), although exports dominate the flows. However, the commencement of containerised grain traffic provided a notable fillip. CBH Group cleans and then packs grain into containers at their Metro Grain Centre in Forrestfield. The commencement of this traffic underlies the doubling of railed traffic between 2006–07 and 2007–08 (Figure 46).[106] Such anchor customers provide key steady, consolidated, volumes that justify the operation of regular shuttles, even if other customer flows are irregular or involve slim volumes.
- **Empty container traffic.** The Forrestfield facility includes an empty container park; the co-location enables effective movement of empty containers for hire and de-hire.[107]
- **Inland terminal catchment area.** The Forrestfield terminal is located in an urban location that is a major source or destination of containers. Approximately 35 per cent of Fremantle's import containers and 25 per cent of export containers are unpacked and packed in the Forrestfield/Kewdale industrial area (Fremantle Ports, 2012, pp. 7-8). The Forrestfield–Kewdale–Hazelmere–Welshpool zone has major company warehouses and distribution centres, including those for Linfox, Coles, Woolworths and Bunnings. (Skinner 2015, p. 37) Rail has a greater chance of being competitive when the intermodal terminal is located in an area of concentrated demand and where drayage distances are low (Fremantle Ports, 2012, p. 13).
- **Drayage.** The proximity of the Forrestfield terminal to customers allows efficiencies in road fleet utilisation. The relatively short drayage between the intermodal terminal and shippers around Forrestfield offers better road fleet and driver utilisation than direct road haulage.

It would be difficult to capture additional rail market share unless additional shippers move into the catchment area, or are attracted by additional terminal value-adding. In a Port survey it was found that "where an exporter has to travel a considerable distance to the port, redirection to the rail terminal may add a costly additional leg to container transport without providing sufficient off-setting benefits". (Fremantle Ports 2012a, p. 4) Such benefits can involve value-adding at or around the terminal and where truck operators seek to avoid congestion to, or around, the port.

As with other case studies, the presumption is that the rail infrastructure charges are not set at levels that would recover long-run costs.

106 Expansion in the containerised grain trade has been a significant driver of rail volumes at Fremantle Port (Fremantle Ports 2008, p. 24; National Transport Commission 2008, p. 45). Indeed, the establishment of Intermodal Link Services was driven by the CBH group (Intermodal Group 2015; Fremantle Ports 2007, p. 25). For more information on the growing importance of containerisation in grain logistics see BITRE 2014, pp. 28–32).

107 http://www.intermodal.net.au/wp-content/uploads/Intermodal-Group-Press-Release_-Record-Breaking-Performance-240614.pdf (Intermodal Group press release of 24 June 2014.)

Port–hinterland terminal rail experiences overseas

This section considers a range of overseas port–hinterland terminal rail experiences. The case studies have been chosen to illustrate a range of experiences rather than necessarily present the "best" experiences. We note, for example, that the Port of Hamburg is acknowledged for its extensive hinterland terminals and complementary rail shuttle operations.

Port of Tauranga, New Zealand

Box 11 Port of Tauranga container rail service profile

Hinterland terminal	MetroPort Auckland (220 km)
Map	See Figure 47
MetroPort Services	Intermodal; full customs-bonded and approved by the Ministry for Primary Industries (MPI) for biosecurity requirements, with quarantine inspection and fumigation and door inspection areas; adjacent MetroPack packing/unpacking facility; adjacent to MetroBox Auckland empty container park.[108] Reefer container points. Operations have been based around imports through Tauranga, with some Auckland-originating exports and some Te Rapa (Hamilton) dairy exports.
Shuttle service provision	Four daily rail shuttle services are provided by the Port of Tauranga, and operated by KiwiRail; trains have capacity for 106 TEU.
Port rail terminals	On-dock rail terminal at Sulphur Point—the Tauranga Container Terminal
Rail mode share	The rail services shift 40 per cent of the port's throughput. In 2013 this included 180 000 TEU throughput. The rail operation has been simplified by using unit trains, where the train's wagons are not shunted or split. Thus, the wagons are moved between the terminals whether they are moving containers or not. (UNESCAP 2006, p. 43)
Background	In 1999 the Port of Tauranga initiated a rail service linking with an inland port, MetroPort Auckland, in Southdown, South Auckland. This location is the base for some of Auckland's largest exporters. (UNESCAP 2006, p. 40) In 2004 MetroBox Auckland was established adjacent to MetroPort; MetroBox offers container box storage and maintenance. MetroPort was expanded in 2005. In 2011 a container packing and unpacking facility, MetroPack, was opened at the inland port facility.

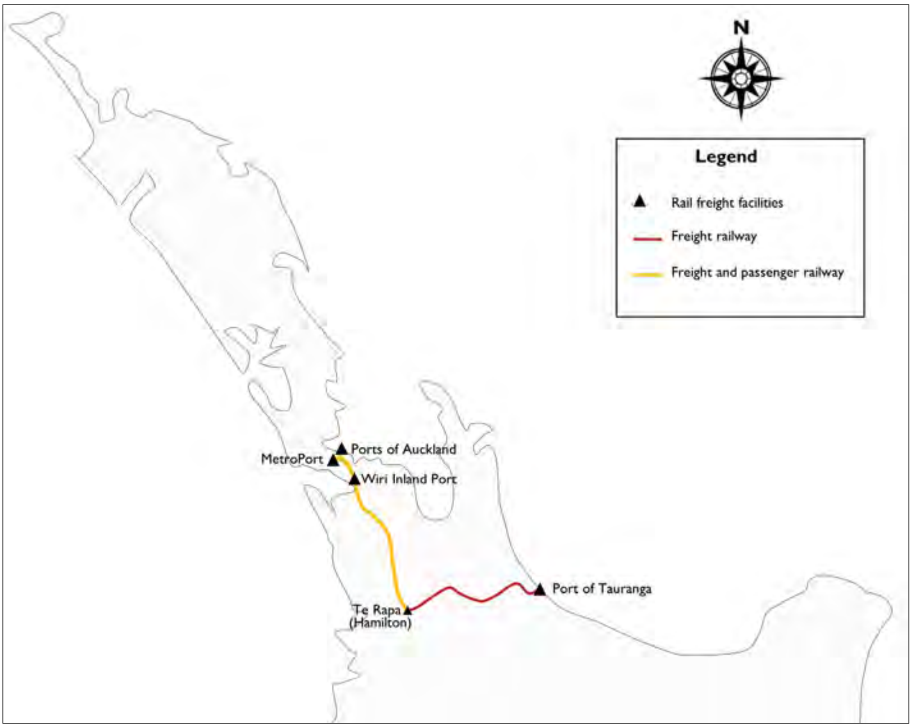
MetroPort Auckland shuttle train

A rail service links the MetroPort Auckland hinterland terminal with the Port of Tauranga. The motivation for the terminal and complementary rail service differs from those with the Australian case studies.

With MetroPort the port owner has endeavoured to expand their catchment area by providing the MetroPort and its value-adding activities, and with the rail shuttle between that facility and the port [109]

108 http://www.port-tauranga.co.nz/MetroPort-Auckland/
109 The topic of ports using hinterland facilities to make incursions into other ports' catchment areas is addressed in the OECD/ITF Round Table summary document OECD 2009.

Figure 47 Rail shuttle inland ports, North Island, New Zealand



Note: In August 2015, Ports of Auckland announced its intention to open a rail-served intermodal hub at Mount Maunganui, in Tauranga.

The following factors have been identified as contributing to the MetroPort–Tauranga service:

- **Proximity to catchment/drayage minimisation.** The terminal operators argue that the location of the facility is the key to its success. The terminal is well connected to roads and two motorways. It is in proximity "in the heart of" Auckland's main industrial, warehouse and distribution areas, which suppresses drayage haulage lengths. (MetroPort undated, p. 4)
- **Encompassing oversight of shuttle operation.** One factor that has been cited as bringing about the success of the MetroPort rail operation is that the Port of Tauranga has oversight over the terminals–rail operation. (UNESCAP 2006, p. 43)
- **Strategic link, expanding the port catchment.** The inland container port/rail service means that the Port of Tauranga is competing directly with the Ports of Auckland from the heartland of the latter's customer base, complemented by Tauranga's provision of alternative port and shipping services. It has also been noted that Tauranga offers a greater choice of shipping lines, departure dates and routes than the Ports of Auckland. (UNESCAP 2006, p. 45) (Both ports have strong container traffic, although Tauranga's original focus was on containerised exports and the Auckland port's focus was on containerised imports for its city.)
- **MetroPort value-added activities.** The terminal offers a range of port-related activities (full customs-bonded and approved by the Ministry for Primary Industries for biosecurity requirements, with quarantine inspection and fumigation and door inspection areas) as well as having the MetroPack container packing/unpacking facility adjacent to the site and the

adjoining MetroBox Auckland empty container park.[110] Imported boxes are available at the terminal for re-use in export flows.

- **Enhanced linehaul productivity through minimisation of backhaul issues.** Imports have formed the traditional flow through Tauranga. However, MetroPort taps into Auckland-area export market and this is facilitated by re-hiring of the empty containers. A residual number of empty containers is then shifted south from MetroPort, to the Te Rapa (Hamilton) intermodal terminal, where the containers are made available for dairy exports (for Fonterra), that are then railed onwards to Tauranga, again, helping to balance inbound and outbound flows and reducing unit linehaul costs.
- **Poor truck productivity.** It has been argued that exporters using MetroPort saves exporters "the time, inconvenience and cost of crossing the city on a relatively congested road system to Auckland Port". (UNESCAP 2006, p. 40)

MetroPort and the (related) impact of Auckland road congestion competes with Ports of Auckland's trade. The Ports of Auckland have responded to the MetroPort–shuttle operation into its catchment, by strengthening links in its own hinterland with its port.

Wiri Inland Port shuttle train

In response to the Port of Tauranga's competition, in 2009 Ports of Auckland opened Wiri Inland Port, in the same catchment area as MetroPort. Initially the terminal was linked to the Ports of Auckland by a road-based shuttle. In 2010 Ports of Auckland commenced a metropolitan rail shuttle over the 25 kilometres between Wiri and Ports of Auckland—see Figure 47.

As with nearby MetroPort, Wiri is an industrial and manufacturing area of Auckland. Wiri offers a range of value-added services to attract shippers: the terminal processes empty containers, quarantine and customs functions, demurrage options, storage and unpacking (aurecon 2013, p. 36).

The facility's function is described thus: "it mainly acts as a consolidation point for freight where longer-term dwell times are not a significant commercial concern", reflecting the relatively low rail services linking with the port. (NZIER 2015, p. 34) The service level is modest compared with the regional MetroPort–Tauranga service. While the latter service is four-daily trains of 106 TEU capacity, the Wiri–Auckland service in 2015 is 16 weekly services of 23 wagons (up from four weekly services of 23 wagons in 2010). Average loadings are approximately 88 TEU, with train capacity of 112 TEU. (NZIER 2015, p. 18, 51) A further nine trains per week served the port from other locations. Rail's regional and shuttle mode share at the port was 7 per cent. (NZIER 2015, p. 51)

In 2015, in a similar competitive strategy to that at Wiri, the Ports of Auckland announced that would open an rail-connected intermodal terminal at Mount Maunganui. This terminal is to be in heartland of Tauranga's catchment, being located adjacent to that port. The rail connection opens the prospect that the port will rail containers between the terminal and Auckland.

110 http://www.port-tauranga.co.nz/MetroPort-Auckland/

Port of Göteborg, Sweden

Box 12 Port of Göteborg container rail service profile

Hinterland terminals	Metropolitan: Göteborg Norra (12 km) Regional: shuttle services throughout Sweden, and to Norway, including Stockholm land-bridging
Map	Figure 48
Terminal services	Transmodal; Norra terminal with cargo consolidation/deconsolidation, and transmodal shifts with regional terminals
Port rail terminals	On-dock facilities.
Mode share	40% rail, 2008 (Port of Göteborg 2010, p. 7); approximately 50% in 2013 (Port of Gothenburg 2014, p. 9)
Background	The Port of Göteborg initiated rail shuttles linking intermodal terminals in Göteborg, Stockholm, other regional terminals and terminals in Norway. Services are offered by ten different rail operators. Large-volume customers include the major retailer, H&M, served by a frequent shuttle between the port and the retailer's central warehouse in Eskilstuna. (Bergqvist and Woxenius 2011, p. 163) Since 1998, a metropolitan shuttle has operated over a 12 kilometre route. Two trains operate each day between the Norra terminal (in Central Göteborg) and the Göteborg Norra (and Kombiterminal) container terminal at the port—see Figure 48. Rail container trains operate between the Port of Göteborg and central Göteborg, with Stockholm and other Swedish centres, and with centres in Norway. The rail shuttles serve 25 terminals, marketed under the "RailPort Scandinavia" brand. Rail shuttle traffic levels between the port and hinterland terminals (the number of which having increased over time) are shown in the chart below. Railed container traffic tripled between 2001 and 2008. The level of direct and indirect subsidies is not known; the latter subsidies would be observed through track access charges that do not fully recover costs. Rail transport is encouraged over road due to it having relatively lower adverse effect on the environment (The Port of Göteborg 2010, p. 18).

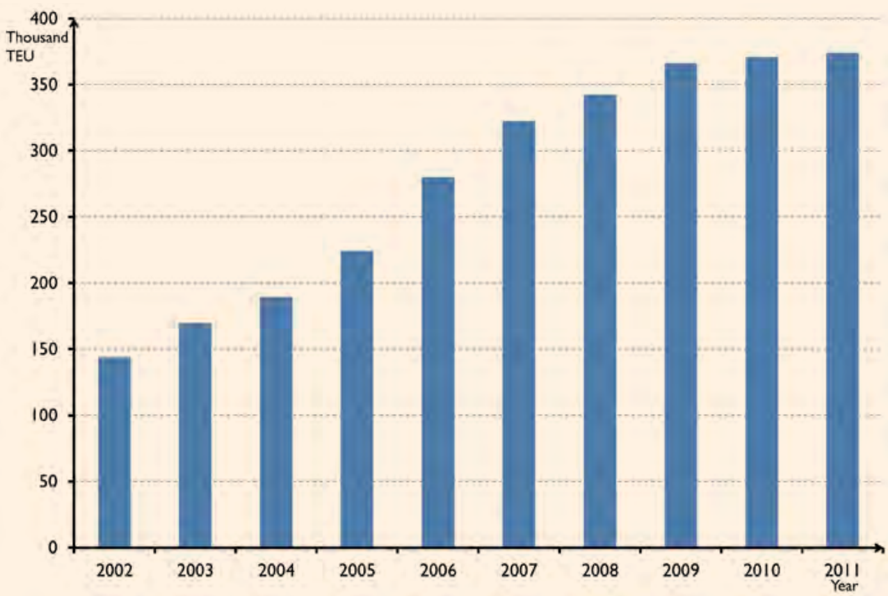


Figure 48 Göteborg shuttle route

Göteborg urban shuttle

The following factors have been identified as contributing to the shuttle service provision:

- **Road congestion/truck productivity.** It has been argued that the reason why the 12 kilometre shuttle service succeeds in Göteborg is due to road congestion:

  Why the shuttles operating in the short distance segment can be operated without loss is explained by time savings compared to truck transport getting stuck in traffic jams in road connections to and in Gothenburg. (Beach, Engström and Liu 2013, p. 54)

- **Terminal value-adding and transmodal activities.** Activities at Göteborg Norra are not intermodal activities. Instead, the terminal involves transmodal movements—where cargo from regional freight services is handled (including container packing of break-bulk rail freight, for exports)—and cargo consolidation, deconsolidation and storage.[111] That is, the terminal is not an intermodal terminal; it is a transmodal and transloading facility. (Woxenius, and Bergqvist 2011, p. 683; Bergqvist, Falkemark and Woxenius 2010, p. 289)

More generally, Bergqvist and Woxenius note that rail shuttle services have benefitted from improvements in rail productivity, while road competitiveness has suffered due to shortages of trucks, of truck drivers and road congestion. (Bergqvist and Woxenius 2011, p. 165)

As elsewhere, the presumption is that rail infrastructure charges are not set at long-run cost recovery levels.

111 http://www.greencargo.com/en/our-services/transshipment-and-storage-at-terminals/

San Pedro Bay Ports (Los Angeles – Long Beach), USA

Box 13 San Pedro Bay Ports rail service profile

Terminals	Feeder shuttle trains operate between on-dock terminals and off-dock terminals—the Union Pacific Commerce Yard, the BNSF Railway Hobart Yard, and other yards—for transfer of wagons to and from transcontinental trains.
Map	See Figure 49
Terminal services	Transmodal: (a) Shuttle rail services between on-dock terminals and the Commerce Yard or BNSF Hobart Yard, for transfer to or from transcontinental trains; (b) The Union Pacific near-dock rail facility, Intermodal Container Transfer Facility—ICTF, for transloading between international containers and domestic containers, and for re-loading international containers to or from transcontinental trains. Containers are conveyed to the ICTF by road drayage. Pacific Harbor Line provides all rail services over tracks owned by, and within, the two ports.
Port rail terminals	On-dock rail facilities, and Union Pacific's near-dock ICTF. The proposed BNSF Southern California International Gateway terminal, near the ICTF, was approved in 2015. All nine of the LA port terminal have on-dock rail access via four railway yards; five of the six Long Beach port terminals have on-dock rail. Long Beach redevelopments involve additional on-dock facilities. The BNSF Hobart Yard and the Union Pacific East Los Angeles Yard are notable off-dock facilities.
Mode share	30 per cent of Port of Los Angeles containers move by on-dock rail; 28 per cent of Port of Long Beach containers move by on-dock rail.[112] About 43 per cent of all San Pedro Bay Ports is handled through on-dock and near-dock rail terminals. (Caltrans 2014; San Pedro Bay Ports 2006, p. 15).[113] Most (70 per cent) of imported boxes go to destinations beyond Los Angeles. (Department of Transport [Victoria] 2010, p. 40) The trend has been for a shift from near- and off-dock to on-dock rail: in 2003 the on-dock share was 16 per cent and near/off-dock was 23 per cent; in 2008 the on-dock was 24 per cent and the near/off-dock was 19 per cent.[114]
Background	The Board of Harbor Commissioners adopted an official Rail Policy in 2004; the policy seeks increased rail usage in order to alleviate traffic congestion and air emissions. The two ports have active policies to encourage on-dock rail; the umbrella scheme for the two ports is their Rail System Program. One-quarter of the Port of Long Beach's ten-year capital improvement budget is allocated to rail projects. The ports own jointly the 29 kilometre Pacific Harbor Line, PHL, system of rail tracks and on-dock rail services. PHL facilitates impartial on-dock railed container movements around the port. In addition, in 2014 the Port of Long Beach introduced a "Incremental On-Dock Intermodal Incentive Program", where shippers are paid US$5 per loaded TEU for new cargo above the 2013 baseline level that is rail-shifted through the Port's on-dock facilities.

112 http://www.polb.com/news/displaynews.asp?NewsID=1482&TargetID=1
113 From 2005 the containers shifting by road during nominated peak periods were subject to a fee, the PierPass. This has encouraged the transfer of some traffic to (extended) opening in off-peak periods. (https://www.pierpass-tmf.org/). This will also influence uptake of rail haulage.
114 http://www.portoflosangeles.org/pdf/Rail_Workshop_Presentation.pdf

Figure 49 Key rail links and facilities for the San Pedro Bay ports (schematic)

Note: ICTF: Intermodal Container Transfer Facility.

Overview of San Pedro Bay rail operations

Intermodal rail services through the San Pedro Bay ports are sometimes presented as illustrating successful hinterland–port operations. What is important to note, however, is that the railed containers themselves are moving on long-haul journeys, not short-haul flows. While short-haul rail movements do occur (notably, between the on-dock terminals and the off-dock terminals), the containers are then only transferred to/from long-distance rail services. However, the Transportation Research Board justly describes the service as long-haul as "it is an end-point shuttle feeding inland trains", where the boxes are transferred between rail services as "transmodal" movements. (TRB 2007, pp. 81–2) That is, the short-haul movements form part of a longer train journey—a transmodal transfer—rather than a shift between road and rail—an intermodal transfer.

In seeking to reduce port-road traffic's congestion and environmental—pollution, noise—impact, the ports encourage use of rail for boxed containers that need to move between the ports and the near-dock and off-dock terminals. In the context of this report, therefore, we note that the ports are not seeking to convert trucked containers that are moving to or from local areas.

There are three notable initiatives that have been pursued since the turn of the century to reduce the congestion and environmental impacts of the landside freight task:

- development of on-dock rail terminals, albeit that some of those terminals are shared between container terminal operators;[115]
- improving the rail freight flow between the ports and the hinterland through the construction of the 64 kilometre Alameda Corridor—as shown in the map at Figure 49; and

115 In 2014 the Port of Long Beach implemented an on-dock rail incentive scheme ("Incremental On-Dock Intermodal Incentive Program") http://www.polb.com/civica/filebank/blobdload.asp?BlobID=6866

- development of BNSF Railway's near-dock Southern California International Gateway facility, which was approved in 2015.

Assembling transcontinental traffic volumes and undertaking value-added activities are easier to undertake at near-dock or off-dock terminals, or simply at any site away from the port-authority area. It is effective to dispense boxes to diverse locations away from the port by road, though this adds to road congestion. Further, because individual on-dock terminals often have insufficient box volumes to form a full-length transcontinental trains, then yards away from the port can be used to assemble long trains. (This was discussed earlier, in Chapter 5).

Concern about the impartiality of distributing and assembling (shunting) the wagons between the various on-dock terminals led the ports to purchase the railway tracks within their ports area. They then contracted Pacific Harbor Line to undertake all the rail tasks within the port area.

Inland Empire rail shuttle

There has been some consideration given to establishing rail shuttles between the port and the eastern side of the Los Angeles metropolitan area, notably the region known as the Inland Empire, the destination of approximately 20 per cent of the imported containers (San Pedro Bay Ports 2006, p. 13). Given the relatively large volumes involved, it would seem at first glance to be a natural market for short- or medium-haul rail. Figure 49 shows the location of Inland Empire relative to the ports. The Inland Empire is a sprawling warehouse and distribution centre that is located approximately 80–120 kilometres east of the ports. The Inland Empire would handle those imports as well as handling transloading (with cargo destined for eastern USA), rather than that task being undertaken in downtown Los Angeles. (Gallagher 2004, p. 30) However, despite protracted consideration of the concept, the shuttles have not proceeded.

Major challenges and issues for realising the Inland Empire shuttle include:

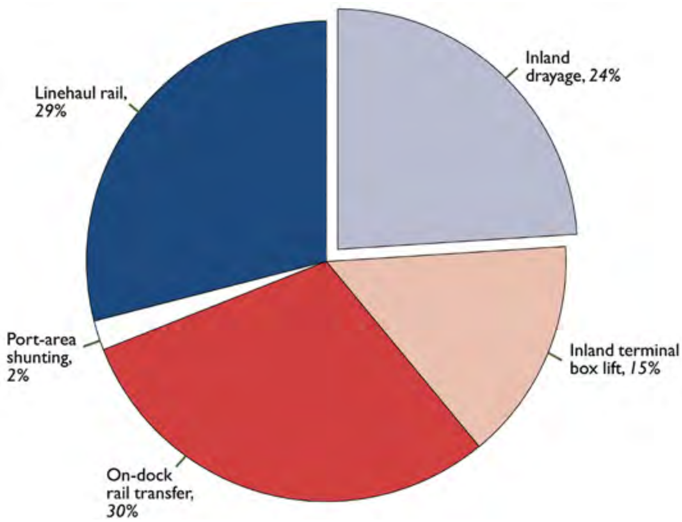
- **Truck productivity not enhanced and drayage not reduced.** A study established that while the concept was technically sound, it would not result in large net reductions in truck distances. This is because the direct transport between the ports and dispersed locations in the region would be replaced by considerable local drayage within the much dispersed Inland Empire region. (Tioga Group 2008, p. 1) Toyota has a distribution centre in the Inland Empire but it is noted that an 80 kilometre rail shuttle with onwards road haulage to Toyota would cost more and take longer than a straight road journey. (Mongelluzzo 2004, p. 54)
- **Adverse impact on other intermodal–rail services.** It was also noted that assembling those shuttle train consists at the San Pedro ports would also "hinder the assembly and operation of higher-priority long-haul container trains".[116] (Tioga Group 2008, p. 2) In that context, growth in long-distance trains, leading to track capacity saturation, would mean that shuttle trains would compete with those trains for track capacity. (Doherty 2006, n.p.)

116 "The long-term limitations on port-area rail capacity is a serious barrier to implementation of a rail shuttle. Cost aside, it appears unlikely that the port-area rail network will ever be able to support assembly and breakup of multi-terminal rail shuttles without disruption to higher-priority movements." (Tioga Group 2008, p. 118)

- **Increased maritime rail service complexity.** Efficiently assembling the dispersed containers and wagons from the numerous container terminals at the port end would be an operational challenge for the port railway operator, Pacific Harbor Line.[117]
- **Insufficient rail on-dock capacity.** It is envisaged that each shuttle train would need to shift up to 750 containers. To accumulate that quantity of containers would require substantially more storage space at the ports' rail lands than is available at present. (Tirschwell 2015, n.p.)
- **Practical difficulties of hinterland terminal siting.** It was not possible to find the necessary space for the shuttle terminal within the Inland Empire. (Doherty 2006, n.p.)
- **High linehaul costs.** To access the ports, the railways use the Alameda Corridor, a 32 kilometre dedicated freight railway that opened in 2002. The investment in the line is being recouped partly through a levy on each container shifted along the corridor; the levy for empty containers is around one-quarter of the full-container rate. The levy inevitably impedes short-haul competitiveness because it sets a fixed linehaul charge that is incurred irrespective of the rail length-of-haul.
- **Shuttle services are not viable.** It was noted that, for such short distances, a rail shuttle would require public subsidy.[118] (Mongelluzzo 2005, n.p.) A subsidy of US$100 per container shift was cited for the year 2004. (Mongelluzzo 2004, p. n.p.)

The relevant cost estimates are presented in Figure 50. The cost challenge for such a rail service is evident. With rail's strength lying in the linehaul rail operation, the linehaul rail costs represent less than one-third of the total costs whereas the inland drayage costs, for example, represent almost one-quarter of the costs and yet there is no equivalent cost incurred by a direct road transfer.

Figure 50 Cost estimates* of operating a rail shuttle between the San Pedro Bay ports and the Inland Empire



Note: * Data presented are for a one-hundred TEU train.

Source: Data extracted from chart in Tioga Group 2008, p. 126.

117 See, also, the intended "neutral" third-party train operator that has been sought to move wagons within the Port of Antwerpen http://www.railwaygazette.com/news/freight/single-view/view/port-of-antwerpen-seeks-last-mile-operator.html

118 Cost estimates that were given in 2003 were a rail cost of US$360–380 for moving a container between an Inland Empire distribution centre and the port compared with US$250–290 by truck. (Mongelluzzo 2003, p. 32)

Union Pacific Railroad has been positive about the shuttle concept in the past, but less so as track capacity has been absorbed by growing transcontinental traffic. Apart from the increasing opportunity cost of the railway capacity—that is, the potential for short-haul services to displace higher-yielding transcontinental traffic—the economics of short-haul remain challenging for the shuttles. Finally, with commercial railway businesses, the track access charge would be set to full cost recovery, unlike the less-than-full cost recovery of access fees on railways outside of North America.

There were reports in 2015 that the various parties involved in port operations are re-examining the concept of the short-haul. The reconsideration has arisen from the adverse impact of increasing road congestion, which in turn can improve railway haulage economics. This concern was reinforced by the arrival of an 18 000 TEU container "mega-ship" in December 2015, with consequent implications for the dispersal and collation of containers between the dockside and the hinterland. (Tirschwell 2015, n.p.)

Port of Tacoma and Port of Seattle, USA

Box 14 Port of Tacoma and Port of Seattle rail-shuttle services profile

Hinterland terminals	Long-haul intermodal-rail services, including Chicago. Regional services linking Portland, Oregon, with the ports of Tacoma and Seattle, Washington state, distances of 210 km and 272 km, respectively.
Map	See Figure 51.
Shuttle service provision	Three services per week in each direction, in 2013. Double-stack wagons are attached to long-haul intermodal trains at Portland.
Port rail terminals	Long-haul services use on-dock facilities; regional services use near-dock facilities at Union Pacific's Tacoma South Intermodal Facility, TacSim and at BNSF Railway's South Seattle Intermodal Facility.
Mode share	Not known. An estimated 440 000 containers were using domestic and international services through the Port of Tacoma in 2012.
Background	Services have been operated by Northwest Container Services since 1986. The operation is commercial. Shipping lines that do not serve the Port of Portland apply a nominal fee to cover the rail–intermodal transfer costs from Portland to the Tacoma or Seattle ports.

Port rail operations

A short-haul intermodal–rail service is operated by Northwest Container Services between its Portland, Oregon, terminal and the separate near-dock terminals serving the ports at Tacoma and Seattle—see the map in Figure 51. That "Daily Direct" service has operated since 1986 in conjunction with Union Pacific Railroad. Northwest Container Services arranges the drayage of the containers to its Portland terminal.

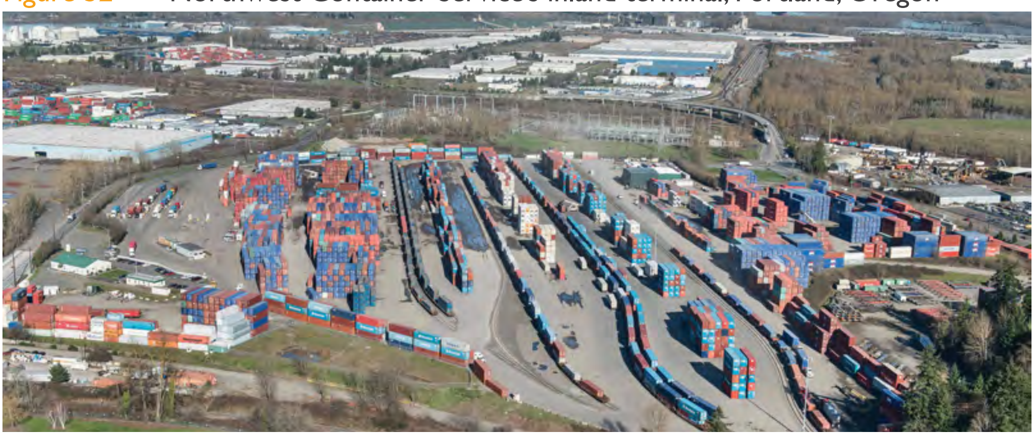
Figure 51 Regional rail shuttle, Portland and Tacoma–Seattle

The operation is profitable: a Northwest Container Services business manager noted that the operation earns a profit without subsidies, and had made "good money every year". (Mongelluzzo 2004, n.p.) There are a number of features that enable this outcome:

- **incremental linehaul costs.** The linehaul cost to Northwest Container Services is incremental as wagons are added to existing, long-distance intermodal trains. Separate shuttle trains are not operated—"the large western railroads wouldn't offer such a service on their own". (Mongelluzzo 2004, n.p.) Instead, the wagons are attached to the passing scheduled long-haul intermodal services, and then conveyed to the ports in Tacoma and Seattle, and vice versa.
- **Complementary linehaul volumes.** For most of the railway route the trains carry both Tacoma and Seattle traffic, thereby having the two ports reinforcing the economies of density of the individual ports.
- there are linehaul economies due to the use of **double-stacking** loading and sufficient train loadings to justify the track capacity used;
- **Constrained road productivity.** Road movements are impeded for some containerised goods to the extent that road weight limits constrain movements over specific roads.
- **Adequate service frequency.** Rail's typical intermodal time (terminal loading and unloading; linehaul transit) disadvantage relative to truck-only operation is less at the Tacoma and Seattle ports due to necessary padding of shipping times. "Sailing schedules create slack time at either the origin or destination of every load, covering for the terminal handling and dray delays attendant to rail, and allowing it to compete against 4-hour highway drive times in a way the domestic market does not allow. Rail intermodal can meet the ship schedule without being as fast as a truck door-to-door…". (NCHRP 2007 p. 84)

Traffic volumes between Portland and the two Washington ports have been enhanced as the Port of Portland's own shipping operations have weakened. This has grown the pool of traffic diverted to the northern ports from which intermodal traffic can be attracted. The service functions as a feeder service to the Tacoma and Seattle ports. This international feeder operation received increased importance in 2015 when the last two major container shipping companies withdrew their Portland container services. This may lead us to conclude that the Portland traffic is a form of mini-land-bridging.

Figure 52 Northwest Container Service's inland terminal, Portland, Oregon



Source: Photograph courtesy of Northwest Container Service.

Value-adding tasks performed at the Portland terminal include maintenance and repair, customs bonding, container storage and provision of drayage. While the terminal's catchment area is unknown, in many senses the operation does function as a substitute for the Port of Portland.

While Tacoma and Seattle are served by long-haul and regional-haul intermodal trains, dispersion of Tacoma and Seattle shipping containers is undertaken by road. The Port of Seattle has advanced a proposal to operate shuttle trains over the 13 kilometres between the Port of Seattle and South Seattle Yard Intermodal terminal.[119]

119 http://esci-ksp.org/project/south-seattle-yard-intermodal-freight-strategy/

Port of Virginia, USA

Box 15 Port of Virginia regional rail services profile

Hinterland terminals	Virginia Inland Port at Front Royal—approximately 330 km by road to the port.
Map	Figure 53 shows the locations of the Front Royal and Greensboro terminals.
Services	Double-stack services, run by Norfolk Southern, operate five times per week between the Front Royal facility and the port. The Front Royal terminal is the port's principal hinterland facility. Since 2011 a six-day-a-week service has also operated between the port and a facility at Greensboro, North Carolina. In total the sea port is served by 16 inland rail facilities, including terminals in Chicago and Columbus. Containers are moved by rail between Front Royal and the port based on their steamship bill of lading, that is, Front Royal provides a port-based service with extended-gate services.
Port rail terminals	The maritime rail facilities are on-dock. The container-based terminals are Norfolk International Terminals, and the APM [Mærsk] Terminal at Portsmouth.
Mode share	The port's rail market share in 2015 was 33 per cent, reflecting a diverse range of box origins and destinations. Annual throughput at the Front Royal terminal was 36 060 TEU in 2015.[120]
Background	The Virginia Inland Port, which opened in 1989, is the earliest existing hinterland facility in the USA. Norfolk Southern's rail service operates along the company's Heartland Corridor, between the Virginia Inland Port and Lynchburg and the Crescent Corridor between Lynchburg and Front Royal; and between Greensboro and the port. Virginia Inland Port is complemented by a range of distribution centres, which have developed since the facility opened in 1989. CSX operates trains between the Port's APM Terminal and the Northwest Ohio Intermodal Terminal, near North Baltimore.

Port rail operations

The Port of Virginia is the USA's sixth largest container port. The port is in the harbour of Hampton Roads, at the mouth of the James River. The port facilities are at Newport, on the northern side of the river, and at Norfolk and Portsmouth. The port has an on-dock marine rail facility at Norfolk. The Port purchased an on-dock rail yard in 2010 and constructed a high-capacity rail yard at the port's Norfolk Intermodal Terminal in 2011. (JLARC 2013, p. 24) The principal railways serving the port are Norfolk Southern and CSX.

The Virginia Inland Port at Front Royal is 330 kilometres by road from the port, but the rail distance is approximately double this distance. (Tioga Group 2003, p. 158)[121] The terminal location is shown in Figure 53. The State-government facility was opened in 1989.[122] Initially the traffic was handled by being attached to the longer-distance Norfolk–Detroit trains. This arrangement reduced the train-operating costs by securing train economies of density—that is, sufficient train volumes to bring down unit costs.

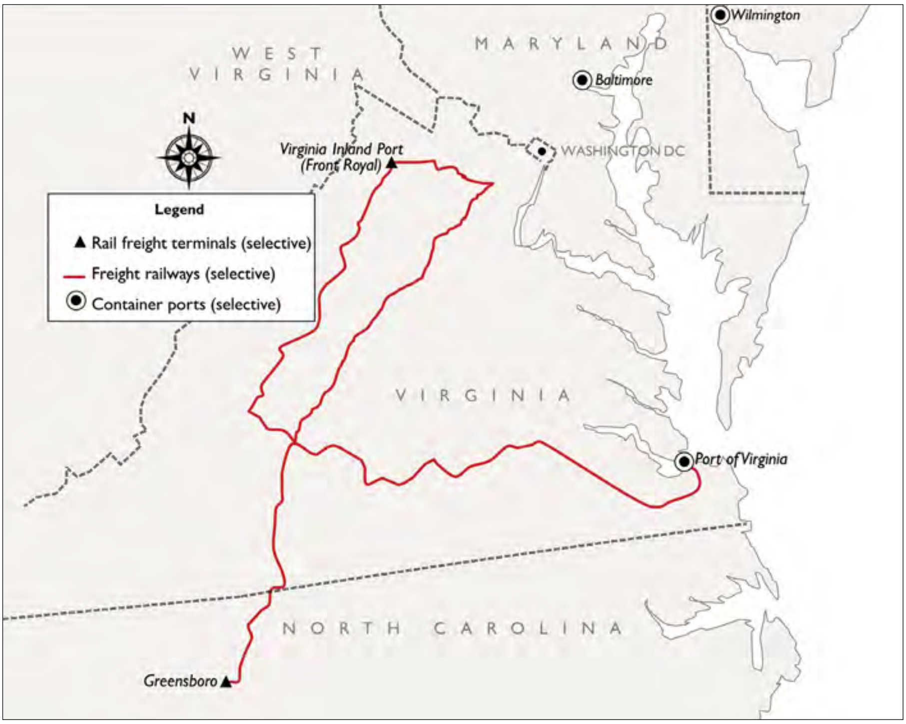
The Front Royal facility was essentially a greenfield site, with very modest volumes for quite a period of time after the terminal opened. An important development was the opening in 2003 of a Home Depot distribution centre, which led to a doubling of traffic. The terminal had 39 warehouse and distribution centres around it by 2012. (Tioga Group 2003, p. 160; Szakonyi 2013, n.p.)

120 Port of Virginia 2015

121 The port, at the estuary of the James River, has distinct areas, including Portsmouth and Norfolk on the south side of the river and Newport News on the north side of the river.

122 An earlier inland port concept was pioneered in 1984 at Charlotte Intermodal Terminal in western North Carolina, linking with the Port of Wilmington. Only one train a week was scheduled and the rail operation ceased in the early 1990s. It is planned to resume this service in the first half of 2016.

Figure 53 The Port of Virginia and key inland ports



The publicly-owned port subsidises the transport costs between the inland and marine terminal in order to broaden the catchment area into the Ohio Valley, to capture container traffic that would otherwise move by road or barge through the Port of Baltimore, the Port of Wilmington, and the Port of New York/New Jersey. (British Columbia 2006, p. 12; JLARC 2013, pp. 15, 18; Port of Virginia 2014, pp. 3, 9[123]) The objective of the inland terminal is that, in attracting custom to the port, it would then increase the appeal of the maritime port to shipping lines:

> *The market expansion was intended to be a powerful sales tool in convincing additional ship lines to add Norfolk to their schedules or to increase their business in Virginia. (Tioga Group 2003, p. 156)*

The Front Royal has a relatively high import volume—other hinterland terminals in this study tend to be export-based. In 2005 the containers handled through the terminal were 40 per cent loaded imports, 14 per cent loaded exports, and 47 per cent empty containers.

The inland ports and rail services have been effective at both attracting port custom and in reducing congestion at the maritime port. The attractiveness of the operations have been boosted by the choice of the location of the terminals relative to the transport networks and the markets:

123 "Virginia taxpayer inventive of $25 per TEU moved by rail is available. Must meet eligibility requirements." (Port of Virginia 2014).

> *One major factor that has allowed VPA [Virginia Port] to successfully compete for markets in the Midwest is the high quality of its rail connections. Shippers and ocean carriers that send rail shipments through VPA indicated that the quality of its rail connections are among the best on the East Coast, and VPA and the surrounding area are not as routinely congested as some northern ports. (JLARC 2013, p. iii)*

Another other key attribute for the terminal–rail operation is the competitive rail freight rate. Several shipping lines noted that they used the Port of Virginia due to that port's rail prices being lower than competing ports. (JLARC 2013, p. 45) The rail freight rate has been set far below the road rate, compensating for the greater rail route length. (Tioga Group 2003, p. 158) It has been noted that Norfolk Southern had a "commitment to run the train and absorb the train operating cost even during the long start up period" (Tioga Group 2003, p. 161) It has been reported that favourable rail rates are set in order to capture economies of hauling double-stacked container trains, enabling unit costs to be reduced. (JLARC 2013, p. 22)

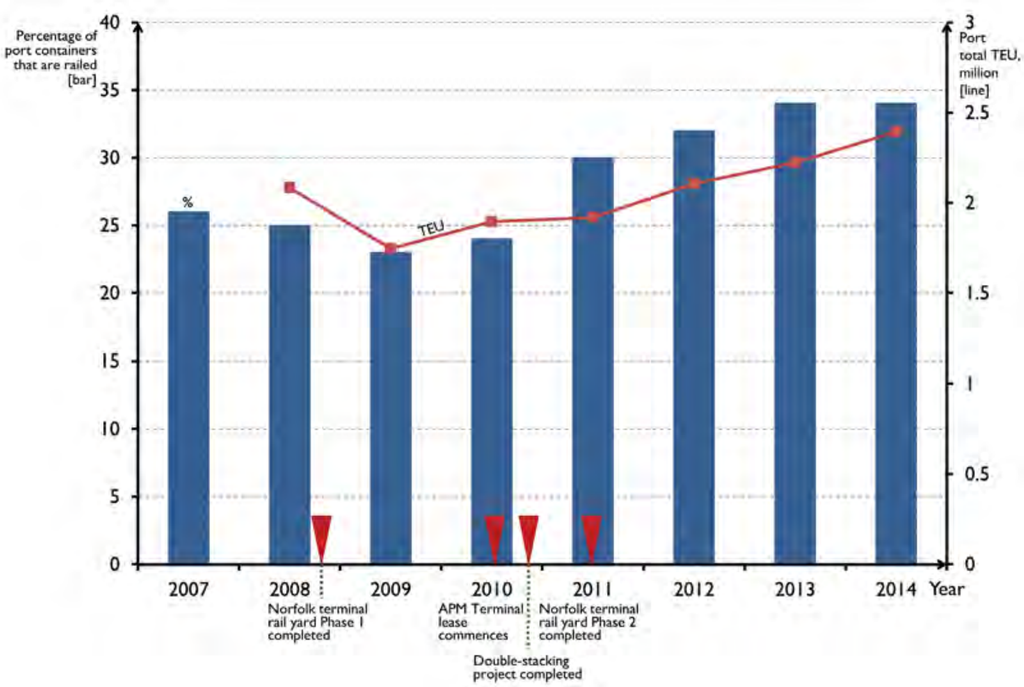
A final key factor in attracting custom to the terminal–rail operation is the terminal services offered. Virginia Inland Port provides value-added services, including extended-gate port functions, such as a full range of customs services, while ship lines offer a bill of lading to or from the terminal.[124] This option has led most Front Royal shippers to adopt contracts with the relevant shipping line, who take responsibility for the shipment from the point of origin to the destination, rather than using a port-to-port contract. (JLARC 2013, p. 2)

The Port of Virginia extended its hinterland strategy in 2011 by establishing a second inland port at Greensboro, in North Carolina. The facility is aimed at enlarging the Port of Virginia's catchment, with rail transport costs being less than trucking costs for markets hitherto served by the ports of Charleston, Savannah and Wilmington. (JLARC 2013, p. 22) Early estimates suggested that one-half of the volume through Greensboro was new traffic to the maritime port. (JLARC 2013, p. 22) By contrast, an estimated 95 percent of the Front Royal business up to 2003 was captured from other ports. (Tioga Group 2003, p. 160)

The port's other notable hinterland rail facility is CSX's Northwest Ohio Intermodal Terminal, North Baltimore, which opened in 2011. The terminal is aimed at transmodal loadings—that is, rail–rail—to and from locations beyond the intermodal terminal.

124 This is a document that is issued by a carrier that details the cargo and specifies the ownership of the goods.

Figure 54 Containers that are railed between the Port of Virginia and the hinterland, and total port TEU



Notes: Redrawn from JLARC 2013, p. 42. The chart as presented makes no reference to the new inland port at Greensboro, with rail services operating from 2011. The double-stacking project improved the economics of running intermodal trains along the "Heartland Corridor", from various long-distance destinations, including Chicago and Columbus [Rickenbacker Intermodal Port]. TEU data are from "Port Stats" at http://www.portofvirginia.com/excel/Port%20of%20Virginia%20Statistics.xlsx . TEU data are not available for 2007.

The experience at the Port of Virginia's inland terminals has strong parallels with the objectives of Tauranga's MetroPort facility in New Zealand, where expansion of the port's catchment area has driven the decision to operate a strictly loss-making rail shuttle.

The 2013 review of the port's hinterland rail shipment strategy concluded that the strategy "appears reasonable because it allows the port to grow beyond its small regional market", while noting that the incentives that the Port Authority offers for such traffic "reduces profit margins". (JLARC 2013, p. iv) Indeed, the port's reviewers noted that the downside of the success in attracting rail-based traffic is that the containers are more 45 per cent more costly to handle than those that are trucked—which are offset by port subsidies. On this basis, it was estimated that the added cost of handling railed containers added approximately seven per cent of the ports operating expenses (as quoted, for 2012). (JLARC 2013, p. 43)

On the upside of the strategy, the port pursues its required objective of supporting Virginia's development by encouraging manufacturers, retailers and distribution centres to base themselves in the State. Further, the port reviewers noted that:

> *By attracting rail cargo to and from the Midwest, VPA [Virginia Port Authority] increases the total container volume that passes through the port, which attracts a larger selection of ocean carriers with connections to more international markets. (JLARC 2013, p. 42)*

Figure 55 Virginia Inland Port, Front Royal, Virginia

Note: The 65-hectare inland port site is shown. The mainline (Norfolk Southern) railway operates across the top-right of the picture, with access tracks leading from it to the facility. The DuPont distribution centre lies just outside the bottom-side of the image. The Baugh Northeast Co-Op (Sysco) distribution centre is in the top-left corner.

Source: Photograph courtesy of Virginia Port Authority.

Conclusions

The Port of Virginia's intermodal–rail operations to its two inland ports are sustained by the following factors:

- **subsidy.** The port subsidises the rail operations, albeit increasing the port's overall box handling costs. The railway operator also levies unusually low tariffs to the Port for operating the service;
- **incremental linehaul costing.** The rail traffic on the trains are not exclusive to the inland ports, with other intermodal traffic also being carried. This low-cost service provision was particularly important for the regular train service between 1989 and 2003, when volumes were still very modest. In 2003 the large Home Depot distribution centre at Front Royal doubled the rail traffic. Double-stacking the boxes improves the train capacity, reducing the possibility that the short-haul operation does not take capacity from more lucrative longer-haul traffic.
- **drayage** Front Royal has been sustained by the development of distribution centres that have been attracted to the precinct and are clustered around the terminal, thereby minimising drayage.
- **added-value hinterland.** The terminal itself offers customs clearance and the shipping lines offer bill of lading. Imports and empty containers dominate the facility's traffic, reflecting the distribution centres that have been established around the terminal.
- **motivations.** From the inception of Front Royal, the port has used the inland ports as a mechanism to expand its catchment area, in competition with other ports' catchments. By generating higher volumes the port believes that it can attract more shipping lines and more shipping destinations.

These factors are particularly important as the facility commenced at a greenfield site, with logistics operations locating around Front Royal in response to the new rail operation. That necessarily-protracted lagged response then places added importance in interest group commitments — with broader motivations than a rail service provision — and with acceptance of the need for ongoing subsidies while traffic builds up.

Port of Miami and Port Everglades (Florida), USA

Box 16 Port of Miami and Port Everglades regional rail services profile

Hinterland terminal	Jacksonville (560 km)
Map	See Figure 56, below.
Services	Double-stack container trains operating between Miami and Jacksonville, where there are transmodal connections with Norfolk Southern Railway and CSX (railroad). Traffic is based on transmodal connections at Jacksonville, but also "relay" drayage hubs beyond Jacksonville, for intermodal hubbing at Jacksonville. Rail services connect between the Port of Miami, Port Everglades and Jacksonville. Domestic intermodal freight—containers and piggyback—and international containers are shifted. Wal-Mart is a key customer at an important domestic terminal at the South Florida Logistics Center, which is adjacent to Miami International Airport.
Port rail terminals	On-dock rail terminal was completed at Miami in late 2014 as shown in Figure 57. An on-dock rail facility was completed at Port Everglades in July 2014. Containers at the Miami on-dock terminal are shifted by shuttle trains between that facility and the nearby Hialeah Intermodal Terminal, where container wagons are attached to linehaul trains (including domestic intermodal), or where imported containerised goods are transloaded into larger (53 foot) domestic containers for onwards rail movement and empty international containers then returned to the port.
Mode share	Rail, 10 per cent (100 000 TEU) at Miami; 10 per cent share at Everglades.
Background	The Port of Miami—also known as PortMiami—and Port Everglades have on-dock rail facilities, both opening in 2014. East Coast USA ports are planning on the basis that some West Coast-based Pacific trade will shift to East Coast ports. In anticipation of this, the Port of Miami has deepened its sea channel, and this was completed in northern summer 2015. Florida East Coast Railway and the Port of Miami have part-funded the on-dock rail facility.

Port rail operations

The Port of Miami is the USA's eleventh largest container port. The port, and neighbouring Port Everglades, is linked to an intermodal terminal at Jacksonville at the northern end of the State of Florida via the 560 kilometre Florida East Coast Railway, FEC. Domestic containers and piggyback traffic is hauled on intermodal trains. (CSX also operates a network of railways on the peninsula.) Forty-two per cent of the railway's intermodal freight moves less than 560 kilometres.

The Jacksonville terminal has a few notable functions. It is the interchange point between FEC and the major east coast railways, Norfolk Southern and CSX. That is, Jacksonville is a key transmodal point for international containers. The terminal also serves domestic transmodal container traffic. Finally, the terminal operates as a road hub point, notably with containers and trailers shifting by rail to the south of the terminal and by road to the north and west of Jacksonville.

FEC offer a road drayage service from other States, to Jacksonville, for transfer to and from the railway. The company believes successful short-haul relies upon the company providing a "truck-like service". Offering a single pair of hands to manage the service improves the intermodal reliability and influences how that reliability is perceived. Pick-up and delivery drayage must be "new flawless" and priced "effectively". Historically, and crucially for short-haul operation, there has been little drayage involved at the port end of the journey which gives the intermodal operation a better chance of success. (Solomon 2012, passim.) Since the opening of the Miami and Everglades on-dock rail facilities in 2014, even that drayage has been eliminated.

Figure 56 Port of Miami rail operations

Note: Florida East Coast Railway serves other ports in Florida; these are not shown.

Complementary domestic and international intermodal flows, and the transmodal operation (that is, rail–rail) through Jacksonville, provide linehaul traffic volumes that generate the viable regional operation. For example, despite the short distances, Anheuser Busch uses the railway to shift beer from its Jacksonville brewer to wholesalers in south Florida.

The railway is less exposed to the freight backhaul issue that is endemic in Florida's transport links with its northern states. (Gross 2015, passim.) Thus, when international containers from other ports move south through Jacksonville; historically it created a significant backhaul problem for the return northern movements. The empty northbound movements have been particularly challenging for road haul economics. The overall regional railway intermodal operation is supported by the poor road backhaul problem: it has been cited by FEC that for every four loads heading south, there is only one load heading north. Compounding this, the road network serves an extensive urbanised area, having some of the USA's heaviest congestion; FEC claims that its intermodal operating times are equal or better than the direct truck times, and that the company's reliability is superior.[125]

Backhaulage issues (northbound) has provided a useful competitive edge for the Florida ports. The Port of Miami and Port Everglades have sought to expand international trade through their port, by increasing their catchment areas to other States; this has provided useful backhaul traffic for FEC. FEC can offer low backhaul rates from the ports, to the north, and thereby complement imports through the ports to a wider USA hinterland area.[126] In this context,

125 Cited at: http://www.miamidade.gov/portmiami/portmiami-fec-connection.asp. See also Logistics Capital & Strategy 2013, p. 7)
126 Leach 2012, n.p.

for road operators it is argued that "By repositioning trucks to serve more opportunistic markets, [road] carriers can yield significant gains in revenue generated per hour of operation". (Logistics Capital & Strategy 2013, p. 1)

Both ports recently completed on-dock rail facilities, removing what were expensive dray movements across congested built-up areas between the port and the railway. The Port of Miami had legacy facilities at the dock (which lay unused from 2006), but these were replaced by new bespoke railway facilities, a short distance from to the container stacks—see Figure 57. The new layout permits simultaneous loading of two trains on parallel tracks, with a side-apron (hardstands) adjacent to each track. The Port Everglades developments allow the on-dock facilities to handle a full-length mainline train.

Conclusions

Intermodal developments with the port and the railway are still in their early stages so it is too soon to ascertain the efficacy of the port investments and rail operations.[127] Nonetheless, the case study illustrates key factors influencing the ability of rail to provide viable quality-superior intermodal services over distances that would seem to lie well below the prevailing sweet spot:

- **poor road linehaul economics.** The road haulage between other USA States and the south of Florida are characterised by an imbalance of traffic, with far more freight being southbound than northbound. This leads to poor truck economics, with empty movements and slow and underutilised trucks and drivers. This results in rail being relatively more competitive.
- **service standard — reliable operation.** The regional service operates through heavily built-up areas with congested roads. The railway has its own transport corridor and is consequently not directly exposed to congestion. As a result, the railway can provide a congestion-free, reliable service.
- **advantageous rail linehaul economics.** The railway operation has relatively lower cost for linehaul operation, so it can be undertaken at lower cost than road haulage. That is, the railway can sustain lower revenue movements than road. High-capacity double-stacked trains operate on a heavy-axle railway. (Figure 34) The rail service captures train economies of density by combining domestic and international freight—the latter with traffic from other ports, to Florida, and from the Miami and Everglades to the north.
- **rail's lower exposure to backhaulage issues gives it lower linehaul costs.** The railway can offer relatively low rates for containers imported through the Port of Miami and Port Everglades that move north, for onwards transloading at Jacksonville or onwards intermodal with road at Jacksonville or ancillary "relay" road stations.
- **new bespoke on-dock** rail facilities at the Port of Miami (Figure 57) and Port Everglades reduce container handling and rail shunting. Operations use these facilities and are not impeded by legacy layouts and equipment.
- **motivation.** The two ports support the railway operation, which extending their customer base into competing northern ports' catchment areas.

127 In the first year since the Port Everglades on-dock facility was completed, intermodal throughput increased by 26 per cent. See https://www.fecrwy.com/news/volumes-26-first-year-new-fecr-intermodal-facility-port-everglades

Figure 57 Florida East Coast Railway's on-dock intermodal terminal at the Port of Miami

Source: Photo courtesy of Florida East Coast Railway.

Port of Rotterdam, The Netherlands

Box 17 Port of Rotterdam intermodal service profile

Hinterland terminals	Regional terminals at Venlo in The Netherlands and Duisburg in Germany, distances of 192 km and 260 km from the port, respectively. Other container rail services include links with Antwerp, Amsterdam and Swarzędz (Poland). Large quantities of containerised traffic are shifted short distances by waterways between the port and dominant customers, such as between Heineken's brewery in Zeebrugge and the Port, a distance of about 40 kilometres.
Map	See Figure 58
Services	In 2014 there were 250 two-way trains serving the port each week. Some Duisburg containers are transloaded between port rail–shuttle services and long-distance German and international services. The Venlo facility is complemented by distribution centres.
Port rail terminals	On-dock facilities are provided at the port.
Mode share	Rail mode share at the port was 9 percent in 2005, rising to 10 per cent in 2010. Inland waterway barging shares were 31 per cent, and 33 per cent, respectively.[128]
Background	The motivation of the national government and Port of Rotterdam to promote the use of rail is driven by the expectation that not to do so would result in road congestion that would lead to the diversion of trade through the Port, to other ports. The need for additional railway capacity led to the decision to construct a freight railway, the Betuweroute, between the port and the German border—beyond which much of the port's catchment lies. The Betuweroute railway opened in 2008. Terminal—stevedore—operators and their associated shipping lines have recognised the importance of the quality (including reliability) of hinterland links. This has encouraged the development of the regional Venlo facility and the major transmodal facility at Duisburg. These facilities are complemented by offering Port functions at these terminals. The functions offered at the terminals include customs. This approach is seen as beneficial in shifting activities from the congested area around the docks. The Port of Rotterdam works with VITO (an association of inland terminals) to provide information to shippers on inland terminal and intermodal options, and seeks to minimise empty container movements. van Schuylenburg and Borsodi (2010) outline how the Port of Rotterdam seeks to increase waterway mode share through a "Container Transferium" policy, where containers are shifted by barge between the port and a near-port facility, where containers are shifted between barges and trucks. This shift removes trucks from the congested near-port roads. The BCTN Container Transferium Rotterdam-Oost commenced operation in June 2015.[129]

Port rail operations

The Port of Rotterdam is the world's eleventh largest container port, and is Europe's largest container port, followed by the port of Hamburg. Rotterdam has six deep-sea container terminals. There are two APM (AP Møller–Mærsk Group) terminals, the second having opened in December 2014 at the new Maasvlakte II port area. The Rotterdam World Gateway terminal—DP World and four shipping lines—opened in May 2015. The other three container terminals are operated by European Container Terminals; ECT is part of Hutchison Port Holdings.

With heavy road congestion impeding port accessibility, a strong coalition of interest groups seek to promote hinterland terminals and the complementary rail services. Foremost amongst those interest groups are the port operator, the container terminal operators and the shipping lines.

128 Web site: http://www.faq-logistique.com/EMS-Livre-Corridors-Transport-15-Port-Rotterdam.htm
129 Web site: http://rotterdam-oost.nl/en/

In 2008 the railed container throughput at the port was eight per cent. (Brooks, Pallis and Perkins 2015, p. 29). Two illustrations of the support provided for railed containers are:

the Port of Rotterdam's "Rail Incubator" policy, where support is given to facilitate the establishment of new rail services; and

the opening in 2008 of a 160 kilometre new dedicated freight railway to the port, the Betuweroute. In a sense that railway has similar features to the Californian Alameda Corridor. However, the specific Dutch rail capacity constraint arose because much of the existing rail line capacity was allocated to passenger trains. The Betuweroute can be used for shuttles to the hinterland terminal at Duisburg, but not the shuttles to the Venlo hinterland terminal. It is proposed that more of the freight railway would be used for shifting boxes by re-routeing the Venlo trains via a new chord at Meteren Junction, which is identified in Figure 58.

Figure 58 The Port of Rotterdam and medium-haul inland terminals

Note: The Transferium hinterland terminal involves value-added user and port activities for transfer of full containers between truck and barge, and collection of empty containers.

While Betuweroute facilitates the development of port catchments, its primary role is to shift freight from the parallel A15 road, where there has been serious congestion from the 1990s. (Zhang, Wiegmans and Tavasszy 2009, p. 22) Thus, not only does the road freight vie with personal road users for the limited road capacity but it also has the potential to strangle the freight movement on the port's only road lifeline:

> *…stimulating modal shift is necessary in order to guarantee the accessibility of the port of Rotterdam. Improving the accessibility of rail and barge is the strategy being employed. (Zhang, Wiegmans and Tavasszy 2009, p. 24)*

As Europe's largest container port it is notable that the Port of Rotterdam's catchment area is very extensive so can attract consolidated volumes that are conducive to viable regional inland ports. The hinterland operations benefit from the interest groups' support, which is inspired not least by road congestion that reduces truck productivity and undermines the attractiveness of the port. The coalition of interest groups, including government, have common interests in promoting hinterland terminals and complementary port connections. Against this setting, the shuttles benefit from projects that have amplified track capacity to the ports—the Betuweroute—to facilitate shuttle operation. Further, the shuttles benefit from relatively low access charges that do not recover long-run costs. Finally, the shuttles serve terminals that attract throughput because of their value-adding tasks, such as customs, consolidation and deconsolidation, and transloading.

Venlo and Duisburg shuttles

There are two medium-distance inland terminals with shuttle rail services. ECT has rail-served inland terminals at:

- ECT Venlo (TCT, Trimodal Container Terminal) at Venlo in The Netherlands, 192 kilometres from the port; and
- [ECT's part-owned facility of] Duisburg Container Terminal in Germany, 260 kilometres from the port.

The Port of Rotterdam established the Venlo terminal in 1982 as a joint venture with banks and transport organisations as a way to preserve and enhance the port's market competitiveness. (NCHRP 2007, p. 57) Activities at ECT's Venlo Trimodal Container Terminal include box consolidation and deconsolidation. This task is undertaken for a number of shipping lines, with boxes being railed between Venlo and the port of Rotterdam. Imported boxes are railed away from Rotterdam and at Venlo are processed and shifted onwards by road. Venlo also has empty container storage, and container maintenance, repair and cleaning. Customs clearance is undertaken in a bonded warehouse. (Rodrigue, Debrie, Fremont, Gouvernal 2010, p. 525)

It has been observed that:

> *ECT has fully incorporated the Venlo facility into ECT's container control system at [Rotterdam], allowing for seamless scheduling and handling of containers that successfully allows users to view the inland port as an extension of the main port. (NCHRP 2007, p. 58)*

The multi-modal container terminals—for road, rail and barge—at Duisburg, Europe's largest inland port, handled three million containers in 2013. Duisburg has a substantial scale of operation with an array of tasks performed. In the first instance it is, indeed, an inland port in the literal sense as it serves as a port on the Rhine river. Second, Duisburg has the intermodal-rail facilities, for containers railed to and from Rotterdam, with road conveyance beyond. Finally, Duisburg undertakes rail-transmodal services, where containers are transloaded between port–Duisburg trains and trains serving origins and destinations beyond Duisburg.

A number of Rotterdam marine terminal operators use the inland ports, acting as extended gates of the ports, with port services such as customs clearance. (Notteboom and Rodrigue 2009, p. 21) The extended gates concept involves the marine terminal operator—in other words, the stevedore—having a more active role in the hinterland activity. The inland gate offers closer interface between the port and the shipper, offers relief of some congestion-based stress that applies to the main port and its surroundings, expands the competitive hinterland, and offers shippers a lower cost structure and higher service level. (Bergqvist and Woxenius 2007, p. 3) Operational benefits flow to the ports:

> *Inland terminals are increasingly incorporated as <u>extended gates</u> to seaport terminals and as such can help reducing container dwell times at seaport terminals by transferring it inland. (Rodrigue and Notteboom 2009, p. 181)*

This terminal role facilitates operators in pooling the volumes of competing shipping lines, which creates the critical mass for expanded intermodal operations. (Rodrigue and Notteboom 2009, p 14) The ability to operate this extended gate can be frustrated, however, due to the regular occurrences where the stevedore does not know the ultimate inland origin or destination of goods flowing through the inland terminal. (Rodrigue and Notteboom 2009, p 15)

It is argued that the success of the rail shuttle operations are the relatively high frequency (three or four per day) and the administrative integration of the activities of the marine terminal, the rail service and the inland terminal. Further, the service is regarded as cheap and time-competitive—while the road service is marginally faster, it is less reliable due to motorway congestion. This has encouraged shippers in the Venlo hinterland to consolidate their boxes through the inland port, thereby ensuring the volumes required to justify the rail service frequencies. (Veenstra, et. al. 2012, p. 16)

The shuttle services are therefore sustained by the port authority and user needs to maintain the competitiveness of the facility; by the adoption of an extended-gate policy of shifting port activities into the hinterland and away from the port (to save scarce port land) and leading to increased attractiveness of the hinterland terminals due to their value-adding; by the relatively high freight volumes that can sustain regular train services; and by the relatively unproductive truck movements due to road congestion.

Alpherium and Transferium barge shuttles

The Port of Rotterdam is notable in its extensive use of barges for hinterland access and egress. An example of a relatively short-distance freight operation is the Heineken Brewery's 40 kilometre barge shuttles. Since 2010 containers have been trucked 15 kilometres from Heineken's Zoeterwoude brewery to the Alpherium intermodal terminal in Alphen aan den Rijn, where they are transferred to barges for onwards movement to the port. The barge service is available to other shippers. Attributes of the operation that support the barge movement are the high levels of road congestion around the port, and with dominant-shipper high-volume traffic available from the commencement of the intermodal operations. There are four barge movements each day, each shifting 50 boxes (85 TEU). The project is supported by Heineken, the Alphen terminal operator (Van Uden Group), governments (national, provincial, municipal), the Port of Rotterdam, and the rail track manager (ProRail).[130]

In 2015 a contrasting short-distance barge movement was introduced, from the purpose-built Alblasserdam "Container Transferium" in Rotterdam-Oost, to the port—as identified in Figure 58. The national government, the port corporation, the terminal operators and their shipping lines support the facility, not least because of problems with the main transport artery into the port, threatening the collective interests of the diverse entities. The A15 motorway that links the facility and the port is highly congested; three-quarters of the port's road containers are shifted along the A15.[131]

130 A similar approach was also adopted with container exports by Philips Lighting. Boxes are conveyed by road from the Roosendaal factory, to the Mærsk Line's extended gate in the port of Moerdijk (a distance of around 30 kilometres), and then by barge to the Port of Rotterdam (a distance of around 35 kilometres). The flows are relatively modest, with around 600 containers being conveyed this way each year.

131 The project is backed by shipping lines, including Maersk Line, Hapag-Lloyd, Evergreen, MOL and APL. Other backers are the ECT and APM terminals at the Port of Rotterdam, and DHL Global Forwarding and hinterland inland terminal operators. (Barnard 2009, n.p.)

The hinterland facility is aimed at passing export-based traffic that would otherwise continue on to the port along congested roads. Thus, unlike the consistent, high-volume Heineken barging, the Transferium has opened without large anchor shippers with pre-determined transport arrangements.

Shuttle barges operate between the Transferium and the port container terminals, notably the new Maasvlakte II terminals (on reclaimed land). The terminal operator, Binnenlandse Container Terminals Nederland—BCTN—states that the terminal "is intrinsically connected to the Maasvlakte expansion, and, primarily, retaining access thereto".[132] The barge operation is interlinked with the port expansion at Maasvlakte, making that operation practicable and avoiding an increase in the burden on the motorway.

The barge operation is marketed on the assumption that road traffic will divert to the Transferium when faced with adverse prevailing road conditions. The port's intention is to provide information to drivers to assist them in assessing the merits of using the terminal rather than continuing to the port by road. The operators intend that

> *…gradually our information systems will become so sophisticated that truck drivers will be able to work out how long it will take to get from this point to the terminal, and estimate how long it will take for the containers to be handled at the terminal. They can then work out whether it is faster and cheaper to drop the container at Rotterdam East or proceed by road to the terminal. Moore (2015, p. 28)*

The proponents argue that the operation can be cost-effective for users because time can be saved in making the 50 kilometre journey to the Maasvlakte II terminals, and the return 50 kilometre journey.[133] It is argued that transport cost savings of up to fifty per cent can be achieved, amounting to time savings of up to four hours.

Barge traffic will be based on this diverted traffic, but it is hoped that traffic will subsequently be generated from the development of logistics operations around the Transferium. As part of the plan distribution centres are to be encouraged around the site.

Thus, the attraction of the service at present is based around the travel-time savings and reliability that the Transferium offers, with the aim being to attract value-adding logistics. The Transferium does offer some aspects of the extended gate system, including maintenance and repair, container degassing, customs clearance, and an empty-container pick-up area. (van Schuylenburg and Borsodi 2010, p. 3)

It is likely that there will be a protracted period for traffic to build up to sustainable levels. The Transferium is notable in that its operation opened without being anchored to specific existing dominant customers, unlike the Alpherium operation, where services commenced with Heineken as the anchor customer. Instead the Transferium business model focuses on truck drivers evaluating the merits of using the barge service in order to avoid the road congestion to the port.

132 From the BCTN web site, http://rotterdam-oost.nl/download/pdf/BCTN-ENG_LR.pdf

133 The port's intention is to provide information to drivers to assist them in assessing the relative merits of using the terminal. Moore (2015, p. 28) reports that "gradually our information systems will become so sophisticated that truck drivers will be able to work out how long it will take to get from this point to the terminal, and estimate how long it will take for the containers to be handled at the terminal. They can then work out whether it is faster and cheaper to drop the container at Rotterdam East or proceed by road to the terminal."

Thus, given the nature of shippers sought—requiring behavioural changes by truck drivers, and development of logistics facilities around the terminal—it means that slow traffic development will involve sustained financial losses. (This issue of traffic build-up is discussed in Box 5.) Traffic data on the Transferium are as yet unavailable (in 2015).

Conclusions

Several key factors underpin Rotterdam's intermodal experiences:

- **Motivations.** Rail operations through the Port of Rotterdam are encouraged so as to maintain the port's competitiveness, especially with other European ports offering close substitute services. Road congestion is a particular threat to the port's appeal. The port authority, governments, shippers, stevedores and shipping lines are therefore motivated to encourage intermodal operations.
- **value-adding hinterland terminals.** Venlo and Duisburg serve as processing points for imported containers, offering container maintenance, repair and cleaning, customs clearance. Onwards movement for imports is by road. The terminal illustrates the European "extended gate" concept, where port activities are undertaken at remote facilities, as well as cargo deconsolidation and consolidation. Export containers are treated similarly.
- **transmodal operations provide linehaul volumes.** Container volumes on rail services between the port and Duisburg include rail–road and rail–rail movements. That is, Duisburg serves as a transmodal hub for onwards intermodal freight trains. This practice bolsters the linehaul economics of Rotterdam–Duisburg linehaul shuttles. These volumes then facilitate the regular rail operation, improving the attractiveness of the hinterland facility.
- **shortcomings in road haulage.** Due to road congestion, the road linehaul is relatively unreliable. The rail service is more reliable. This has encouraged consolidation of cargo at Venlo, using intermodal–rail between the terminal and the port. The development of the "Transferium" terminal 50 kilometres from the port terminal uses the "extended gate" value-added terminal services, and assumes that some truck drivers will prefer the facility due to the low productivity they would otherwise incur in accessing the port's terminals.

English ports

Box 18 English port rail service profile

Hinterland terminals	A range of rail intermodal services operate between English ports and hinterland terminals. The principal container ports are Felixstowe, Southampton, Tilbury and Thamesport.
Map	Figure 59 illustrates the containerised rail services between the principal English ports and the hinterland; smaller flows operate from other ports.
Services	Services between hinterland terminals and container ports are operated by a range of agents; these include: • freight train operators (Freightliner, DB Schenker, Direct Rail Services, First GB Railfreight); • [diversified] road haulage operators (Maurice Hill, Maritime Transport); • 3PL operators (W H Malcolm, Eddie Stobart, J G Russell, Potter Logistics); • shippers (Ford UK); • and port operators (Associated British Ports [ABP]).[134] (Bergqvist and Monios 2014, p. 24; Network Rail 2013)
Port rail terminals	There is a wide range of hinterland terminals; some are illustrated in Figure 59.
Mode share	Rail is estimated to have a mode share of around one-quarter of container traffic that moves through ports in Great Britain. The container task is essentially imports, apart from the export of containerised paper and scrap metal (Office of Rail and Road 2015, p. 7)
Background	Railed international containers have been promoted since the advent of containerisation. Since the establishment of explicit track access charging systems, on mixed passenger–freight lines this traffic has been supported by the use of incremental cost charging—except where trains operate on freight-only lines, where higher charges are set.

Port rail operations

Despite modest distances within Great Britain, around one-quarter of the inbound containers are conveyed by rail between ports and hinterland destinations. It has been estimated that 350 kilometres is the "sweet spot" distance for rail services under the current railway cost recovery and road congestion environment. (Brooks, Pallis and Perkins 2015, pp. 28-9) Rail conveyance has been encouraged by a range of factors, including low railway access charges (usually set at avoidable costs, except in the rare situations where freight is the prime user of the railway), by railway infrastructure investment (to raise clearances to enable unrestricted movement of 9'6" boxes on main lines), by a range of investment and operational-subsidy grants, and by favourable terminal investments by train operators, ports, shipping lines and inland terminal operators.[135] [136]

Some of the inland ports have a single terminal and are used exclusively by the operator for their own traffic; other facilities (such as at Hams Hall) are open-access facilities for multi-users.

Ownership—as distinct from operation—of ex-British Rail terminal facilities is generally vested in the track manager, the publicly-owned Network Rail.

134 Associated British Ports owns and operates Hams Hall Rail Terminal, the country's busiest inland terminal. See http://www.abports.co.uk/Our_Locations/Hams_Hall_Rail_Terminal/

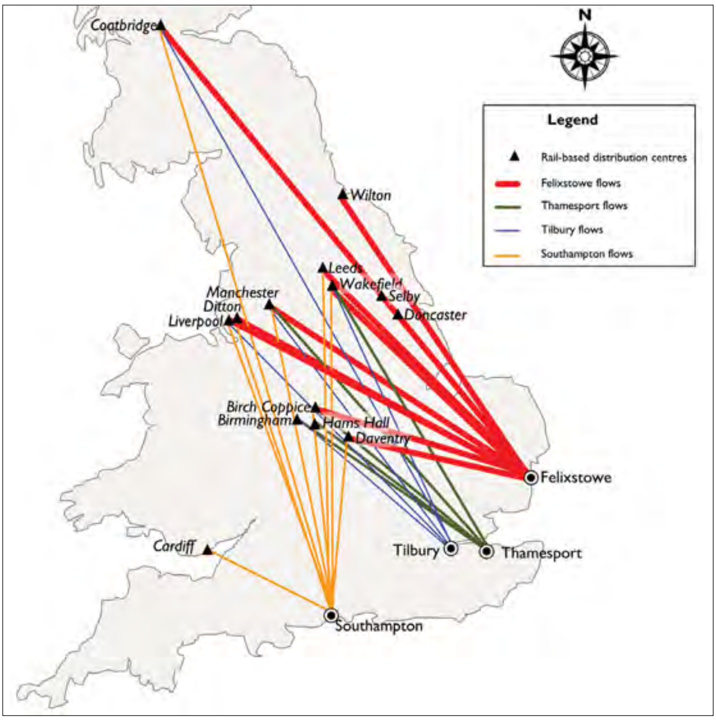
135 ITF (2015a, p. 28) notes that these charges "usually cover only wear and tear and operational management costs. They do not currently reflect capital investment costs as freight is rarely the prime user of rail tracks in the UK".

136 These grants have included investment support from the Transport Innovation Fund (for loading gauge enhancements), investment from the Freight Facilities Grant (a capital payment for rail freight facilities improvements, ending in England in 2011), and revenue support coming from the Rail Environmental Benefit Procurement Scheme — replaced in 2010 by the Mode Shift Revenue Support Scheme — for conveying containers between sea ports and inland ports. (OECD/ITF 2015, p. 87; Office of Rail and Road 2015, p. 19)

Ports and shipping lines sometimes offer an integrated maritime and landside capability in order to enhance their competitiveness. The inland rail terminals extend a port's catchment area and competitiveness as well as enhancing the shipping line's competitiveness. The English port of London Gateway is served by DB Schenker Rail UK's shuttle services to inland terminals at Manchester (Trafford Park) and at Daventry (near Rugby). See Figure 59.

The nature of the container distribution is conducive to rail haulage because much of the freight moves through distribution centres rather than moving directly between port and origin or destination. It has been reported that the "vast majority" of inbound containers are bound for general distribution centres or for dedicated distribution centres for imported goods. These distribution centres are located at strategic locations for local and national distribution. (OECD/ITF 2015a, p. 82) Such network systems are amenable for the consolidated movement of containers from the port to the distribution centre—more so than if the import flows bypassed the distribution centres.[137] In a similar way, rail opportunities are being enhanced as manufacturers are aggregating less-than-container loads into boxes at hubs, and consolidating container flows, both of which favour the operation of frequent, longer trains. (OECD/ITF 2015a, p. 83)

Figure 59 Hinterland intermodal connections from Felixstowe, Southampton, Tilbury and Thamesport



Note: Derived from chart in Department for Transport 2008, p. 66.

137 OECD/ITF 2005a (p. 82) notes, however, that in recent times some distribution centres have been built at locations in the vicinity of the port: this "port-centric logistics" all-but-eliminates the opportunity to run trains of consolidated goods between the port and the consolidation centre. Port-Centric Logistics is discussed further in Independent Transport Commission 2014, pp28–35.

The rail services are typically underwritten by the port operators and by allied shipping lines. Particularly where longer domestic distances are involved, shipping lines often contract with domestic transport providers to move goods inland to the inland customer destination. A number of shipping lines operating in Great Britain offer rail shuttles between ports served by the shipping company and inland terminals. There are a considerable number of inland intermodal terminals serving each shipping company's ports. An example is Mærsk's shuttles, operated by Freightliner UK, over the 320 kilometres between the Port of Felixstowe and the inland terminal at Ditton (Widnes). The MSC UK shipping line has contracted GB Railfreight to operate shuttles between Felixstowe and Hams Hall (West Midlands) and Selby (North Yorkshire). Similarly, OOCL provides shuttles between the Port of Southampton and Birmingham, operated by Freightliner UK.

Conclusions

A multitude of intermodal shuttles operate between English ports and the hinterland. The following are key factors sustaining the operations:

- **rail linehaul costs.** Linehaul infrastructure charges are relatively low for most of the network trackage used. This is because rail infrastructure charges are set at avoidable costs rather than average costs.
- **subsidy.** The UK government offers the Mode Shift Revenue Support subsidy for eligible port–rail flows.
- **hinterland terminal value-adding.** English hinterland terminals incorporate distribution centres for onwards distribution of imported goods.
- **road productivity.** Road congestion has reduced road vehicle utilisation.
- **motivation.** Inland terminals are used by ports and shipping lines to extend ports' catchment areas.

Port of Ningbo, China

Box 19 Port of Ningbo rail service profile

Hinterland terminals	The Port of Ningbo has ten hinterland terminals served by rail. The hinterland terminals range from around 70 kilometres from the port, to almost 1 200 kilometres.
Map	See Figure 60
Services	not available
Port rail terminals	not available
Mode share	The hinterland terminals were established from around 2009; in 2010 the rail market share was 0.3 per cent.
Background	National and regional government policies seek to improve port links, to reduce congestion and to facilitate regional economic developments.

Port rail operations

The Port of Ningbo in China was the world's fifth busiest container port in 2014, and was the largest port in overall cargo tonnage.[138] Ningbo is China's second largest port, after Shanghai. Beginning in 2002, a number of Chinese ports have established dry—that is, inland or hinterland—rail-based ports. Ningbo's efforts are illustrative of that trend.[139] We note, however, that shifts between ocean-going vessels and inland-waterway barges are the principal intermodal form.

Figure 60 Inland ports serving the Port of Ningbo

Note: There are multiple rail routes linking with the hinterland, particularly between the Xiangyang inland port and Ningbo; one such Xiangyang route is shown here for illustrative purposes.

* These inland ports are not directly linked to the railway—see Monios and Wang (2013, p. 901).

◊ The port of Zhoushan is incorporated within the Port of Ningbo.

Source: Background material for compiling this map has come from Li, Dong and Sun (2015, p. 644).

138 See the port web site: http://www.nbport.com.cn/portal/wps/portal/en

139 Li, Dong and Sun (2015, p644) list a number of coastal ports with dry ports: Tianjin port with 25 dry ports, Qingdao port with 10 dry ports, Rizhao port with 2 dry ports, Lianyun port with 2 dry ports, Dalian port with 4 dry ports, Yingkou port with 1 dry port, Ningbo port with 10 dry ports, Xiamen port with 12 dry ports, Guangzhou port with 4 dry ports, Shenzhen port with 5 dry ports, and Zhangjiang port with 1 dry port.

Ningbo and its associated inland ports are shown in Figure 60. Road distances between Ningbo and its ports range from relatively short distances such as 70 kilometres from Yuyao and 108 kilometres from Shaoxing, to 685 kilometres from Nanchang and 1 188 kilometres from Xiangyang. That is, the port is served by short-, medium- and long-haul inland ports.

The motivations to improve the port's hinterland links by intermodal links—both barge and rail—have emanated from a range of objectives:

- the provinces seek to improve international transport links with through the ports;
- the port seeks to improve its competitiveness with other regional ports by enhancing logistics by establishing dry ports, with the added appeal of rail services to the port; and
- the Beijing government seeks to improve inland transport links within, and overland between countries. This is embedded in the "One Belt One Road" policy adopted by the Beijing government in 2013. Sea–rail and sea–river options are two of the desired alternatives to road-based hinterland.

In addition, Li, Dong and Sun (2015, p. 642) conclude "the core function of dry port is to expand the seaport function to the hinterland and achieve the 'big clearance' mode". The latter term is a form of extended gate in that it refers to undertaking customs functions at the inland port, called the "One Checking" system. The inland port is allocated a range of public checking functions, including customs and also inspection and quarantine, while agents using the facility include shipping lines, freight forwarders and seaport owners.

The adoption of the dry ports initiative dates from around 2009. In 2010, intermodal movements at Ningbo was 0.3 per cent. (Monios and Wang 2013, p. 905) Acquisition of sufficient railway track capacity to operate regular container trains has been a major issue. (Monios and Wang 2013, pp. 903–04) In this context, the development of separate high-speed railways may release capacity to expand intermodal train services. It has been suggested that congested infrastructure and administrative inefficiencies are impeding the inland port development. (Acciaro and Mckinnon 2013, p. 16)

Use of the ten inland ports remains relatively modest, with 135 000 TEU transported by rail in 2014. To put this in context, overall port TEU exceeded 20 million in 2014, from an unstated geographic area.

To facilitate the uptake of the services, the port has subsidised the rail services. The port is also planning to construct a more direct (248 kilometres) railway between the port and Jinhua—see Figure 60. It has been noted that diversion of traffic to inland ports also relies upon a realignment of existing freight forwarding and logistics systems. Further, it has been noted that while the extended gate "big clearance" system seeks to improve port functioning, it is not clear as to whether such transfers of activity then translate into "raising logistics efficiency and reducing the comprehensive logistics cost". (Li, Dong and Sun 2015, p. 642) Inevitably, then, with commercial benefits remaining unclear, the conclusion is that non-government investment—such as from seaports, railways, logistics companies—is regarded as less than expected.

Zeng, et. al. argue that dry port development has yet to develop in China because of insufficient funding of the necessary terminal infrastructure. That inadequacy arises, they argue, from the high risk associated with the investment and the lack of coordinated action by the beneficiaries of the investment: the various levels of government, the ports, the terminal operators, train operators, road hauliers, producers and storage facilities. (Zeng, et. al. 2013, pp. 246, 249, 251).

Conclusions

The short-, medium- and long-haul rail–intermodal operations are sustained by policy goals:

- **government policy for regional development.** The governments seek improved links between hinterland and ports, to encourage regional development.
- **policy to shift port-related activities away from the maritime area.** The central government's "One Checking" policy seeks to shift customs and quarantine functions away from the port area.
- **subsidy.** Rail–intermodal services have been subsidised to encourage traffic.

The efforts to increase intermodal–rail have been impeded by a lack of railway capacity to accommodate the trains, with passenger and bulk freight trains taking precedence. Similar capacity issues have arisen with fostering rail traffic through the port of Shanghai.[140]

Table 9 Illustrative rail-served inland ports

Inland port	Port	Terminal operator	Rail operator	Rail mode share	Distance from port, km	Principal activity
Garden City Terminal, Cordele (Georgia) [2013]	Port of Savannah (Georgia Ports Authority)	Cordele Intermodal Services	Heart of Georgia; Georgia Central		320	Agricultural exports
CentrePort Canada, Winnipeg, Manitoba [2009]	Churchill		Canadian Pacific, Canadian National		1 710	Distribution centre for imports
Venlo	Port of Rotterdam	European Container Terminals			160	
Appalachian Regional Port (Chatsworth, Georgia, USA) [Announced 2015; open 2018]	Port of Savannah (Georgia Ports Authority)	Georgia Ports Authority	CSX		570	Imports, exports and domestic freight targeted
Greer [2013]	Port of Charleston	South Carolina Ports Authority	Norfolk Southern	4.3*	320	Manufactured goods (exports); distribution centres (imports)

Notes: * This is a figure for September 2015, based on railed box moves of 7 214 out of a total port TEU for the month of 167 549.

140 Zhang, Wiegmans and Tavasszy 2009, p. 18.

Summary

The case studies provide a range of examples of rail–intermodal port operations. With relatively strong competitiveness, we have taken as given the experiences of regional and land-bridge rail–intermodal services.

We focus, instead, on short-haul rail–intermodal services, on the premise that they should not operate, based on expected costs relative to road; we therefore invert the analysis and ask why such services are offered.

General conclusions that can be derived from the case studies are as follows:

- **Shuttle trains can make inland terminals viable.** The provision of the rail shuttle service is often intertwined with the inland terminal operation. The attractiveness of the terminal depend on what services it offers. In consolidating/deconsolidating cargo the shuttle provides the essential container volumes that feed regular shuttle services that makes the facility work. This is particularly evident with the inland ports at Venlo, Duisburg and Willebroek, which form extended gates to the Port of Rotterdam.
- **Trains and hinterland terminals are supported by diverse agents.** With diverse agents involved in different aspects of shifting boxes, there is an array of objectives for promoting inland terminals. The port may promote the inland terminal because it can extend a port's catchment area, as illustrated with the Port of Virginia's inland port at Front Royal Norfolk's, the Port of Tauranga's MetroPort, and the Port of Rotterdam's Duisburg terminal. Vibrant inland terminals also provide train operators with business, as with CRT's Altona shuttle and Norfolk Southern's support for the Virginia Inland Port. Inland terminals can alleviate road congestion and environmental impacts around the port, as with the Forrestfield terminal in Perth, as with Göteborg Nora terminal in Göteborg, and as with the Venlo terminal serving the Port of Rotterdam. The inland facility can simply be a virtuous efficient business operation, as with the Treasury Wines facility at SCT Penfield, Adelaide. The terminals appeal to shippers, such as Balco's Bowmans Intermodal Terminal, where cargo is consolidated and processed for export. Finally, governments encourage inland terminals, such as the NSW Government's establishment of the Minto terminal, to shift freight from congested roads.
- **Some rail shuttle examples are actually long-haul flows.** Some short haul services are actually transmodal, rather than intermodal. That is, the shuttle train conveys containers that are transferred to or from other rail services. That is, the shuttle service is not a genuine short-haul service but, rather, part of a long-haul movement. This applies to railed containers through the Port of Los Angeles and the Port of Long Beach; and is presented as the virtue of the Göteborg Nora terminal, with its box stuffing and destuffing.
- **Rail shuttles can achieve sustainable volumes by assembling freight flows from other sources.** The linehaul economics of some short-haul operations are enhanced by drawing on freight from other flows, benefitting both freight activities. The Tacoma and Seattle short-haul freight is attached to long-haul freight trains. The modest Donald (Victoria) freight flows can be sustained by, and help to sustain, the Merbein (Mildura) intermodal operation. The Balco–Bowmans short-haul operation benefits from regular traffic from Nyrstar (Port Pirie). The Miami–Everglades traffic supplements, and is supplemented by, domestic intermodal traffic. These examples illustrate how critical traffic volumes—and service frequency—can be achieved by merging freight flows.

- **Terminal value-adding tasks effectively eliminate hinterland drayage costs.** Value-adding and product consolidation at the inland terminal makes the terminal a destination in itself and generates the volumes needed for operating shuttles. A common theme to all the case studies is that stuffing and destuffing and consolidating/deconsolidating and other value-added activities are undertaken at the inland terminals. Such value-adding, especially with dominant customers, accumulates rail freight that provides the volume that ensures that rail can capture economies of density and run regular, "long" trains. Dominant, large-volume shippers, such as Balco, process and consolidate their cargo on-site, providing consistent export flows to sustain regular shuttles. Useful volumes are built from acquiring shipments of bulk-commodities-in-boxes, such as containerised grain from adjoining facilities (Forrestfield to Fremantle) or malted grains (Minto to Port Botany).
- **Unless the hinterland terminals offer strong value-adding then short hinterland drayage is essential.** Long shipper–inland terminal drayage distances can undermine inland terminal attractiveness, especially if the terminal offers limited value-adding. The length of drayage between the shipper's facility and the inland terminal can be critical to the attractiveness of using an inland port and, thus, in using the rail shuttle. Evidence used to assess the proposed Inland Empire shuttle—linking with the Ports of San Pedro Bay—indicated that there is too much dispersion of warehouse, stuffing/destuffing, transloading and distribution centres within the Inland Empire. The result is that drayage distances within the Inland Empire catchment area rival the direct road distances between the port and the facilities dispersed around the broad catchment area.
- **Rail shuttle sustainability can rely upon poor truck productivity.** Road competitiveness is undermined by the combination of long road haulage between hinterland and port, by slow and unreliable transit, and by empty backhaul movements. Road competitiveness should not be presumed to be invariant; road congestion undermines truck/driver productivity and this can rebalance short-haul rail economics. This is the business model for the Transferium short-haul barge service to the Port of Rotterdam. Road congestion can alter the economics of intermodal, notably by undermining the road economics—reducing truck driver and vehicle utilisation and reducing road reliability. Short-haul rail shuttles can then be competitive in circumstances where long metropolitan drayage to the port is required along congested roads; illustrations are the short-haul shuttle trains between Minto and Port Botany and between Wiri Inland Port and the Ports of Auckland. By contrast, where the distance between the inland terminal and the port is relatively low, where hinterland terminal value-adding is modest, where there are no dominant anchor shippers and where congestion is relatively low, then road retains its competitiveness. This is illustrated by the ill-fated experiences with Somerton and Altona hinterland terminals. Finally, backhaul—empty return movements—undermine road and rail transport costs, but particularly road operations. Rail operations serving the Port of Miami and Port Everglades are relatively competitive because their backhaul penalty is lower and they can attract backhaul flows.
- **Dominant, anchor, shippers are the keystone of sustainable operations.** Most of the terminal–rail operations have been characterised by dominant, anchor, shippers from the outset. The BMW flows between Greer and the Port of Charleston have underpinned strong flows on the rail shuttle from the outset. The Bowmans–Port Adelaide operation also flourished from inception, being underpinned by regular Balco agricultural exports. Similarly, Fletcher International's meat exports provide key anchor traffic for Dubbo–Port Botany short-haul. Where operations do not rely upon existing freight flows, such as the

Front Royal–Port of Virginia shuttle, then sustainability is undermined and it took a number of years before an anchor shipper could help to secure the train and terminal operations.

- **Implicit or explicit subsidies generally underlie the operations.** The evidence is that shuttle trains that operate are usually charged track access fees that do not cover long-run costs. This is a subset of the broader use of subsidies to encourage rail–intermodal, such as is evident with subsidised loaded containers on the Fremantle shuttle, and regional short-haul operations in Victoria. Nonetheless, it should not be ignored that generally trucks do not incur usage-reflective road-usage charges, as is discussed in Chapter 6.

The case studies are generally silent, or provide inconsistent evidence, on maritime rail terminals. It is likely that optimal terminal siting is location-specific. Some ports use both on-dock rail facilities and near-dock, such as with the San Pedro Bay Ports. Other ports have central rail facilities, such as Brisbane and Perth, some container terminals share rail facilities, such as at Los Angeles, and other container terminals have dedicated rail facilities, such as the DP World and Patrick facilities in Melbourne. Typically these systems are based on legacy land and equipment usage. Only rarely are new layouts and equipment applied, such as at the Port of Miami, and Port Everglades.

Finally, the case studies reveal that there is an inexorable link between viability of inland terminals and rail shuttles. However, viability of the terminals certainly does not necessarily mean sustainability of the rail operation. Development of inland terminals supports the movement of large volumes of freight over short distances, thereby supports the train economies of density that support sustainable operation of regular short-haul services.

APPENDIX B

Development of container systems and logistics

This appendix provides an overview of intermodal containers and the complementary development of logistics systems. Containers have been used for more than two centuries to offer intermodal transport. Understanding the domestic roots of intermodal-rail and its expansion into international box movements helps to explain the attributes that favour intermodal-rail. The container is also central to the logistics systems that have become the standard method for international non-bulk freight over the last 30 years.

As is discussed in Chapter 4 and Chapter 5, the efficiency of transferring containers between modes at the intermodal terminal is crucial: accessing the terminal and processing the containers through the terminal are resource-intensive activities that readily negate rail's strong linehaul benefits. Technology is often seen as the way to suppress those costs, resulting in systems such as the Flexi-Van (Figure 21) and the RoadRailer (Figure 19); Woxenius (1998, 1998a) provides an extensive audit of intermodal technological systems.

The efficiency of container systems is therefore central to the viability of intermodal. The adoption of international containers has been accompanied by changes to those systems, in technology and the scale of provision. These enhancements have wrought changes in international trade and in business models.

Our focus is on container-intermodal but, for completeness, we provide an overview of the other key intermodal system. This is the piggyback system of a road trailer (with, or without, the prime mover) on a train. See further discussion in Box 2. Containers and piggybacks are part of a broader intermodal terminology, which is sometimes called "combined transport"—see the Definitions and abbreviations section.

The appendix looks at the development of domestic containers and international (maritime) containers and of the equipment systems that go with the containers.

Development of domestic containers

Intermodal movements using containers are not confined to any specific commodity and, in fact, container movements have their roots in bulk freight, rather than the non-bulk conveyance that we associate with boxes. (Current container freight often consists of boxed agricultural, minerals, ores and processed metals.)

The advantage of using boxes for goods using multiple transport modes was evident from the early days of the Industrial Revolution. The first common usage of containers was in Britain in the 1780s, when containers were used to enable the economical transfer of coal between canal barges and road carts. Containers were similarly used for rail–cart transfer in 1830 with the opening of the Liverpool and Manchester Railway.

The container's crucial merit lies in its efficient labour-saving transfer of goods between modes. Additional benefits came to be valued: they could be used to minimise damage to the goods in transfer between modes, they could provide secure parcelling of goods, and they could provide an efficient way to control the environment in which perishables are shifted. In this context, early applications included:

- **Damage minimisation.** In 1841, Isambard Kingdom Brunel, the famous railway engineer, developed containers. These boxes were used for coal. Their bottom-discharge doors enabled the gentle release of the coal at the Swansea Docks, which reduced crumbling (and thus degradation) of the soft coal that was being extracted from collieries in the Vale of Neath.
- **Secure packaging.** From 1900, containers were developed in Britain for the storage and the safe and integral conveyance for house-content and furniture movements by road and rail. Similarly, when New York Central Railroad introduced containers in 1921, postal items and valuable clothing materials were conveyed.
- **Climate protection.** Protection for spoilage during transit was the underpinning of the chilled-food containers that were introduced by the South Australian Railways in 1890 for the transport of butter. (McKillop 2013a, p. 7) Similarly, in 1929, England's Southern Railway introduced insulated containers to convey meat. (McKillop 2013a, p. 4)

The use of the container was encouraged with, and complemented by, the development of container handling systems at railway yards. These developments were spurred in land-freight movements in part because the container was seen as a way to combat road-freight non-bulk competition. With improved roads and vehicle technology, road freight became a strong direct competitor to rail freight for long-distance door-to-door conveyances.

The new rail–container system convey non-bulk freight in containers channelled through intermodal terminals. By contrast with previous systems, aggregating goods into large boxes provided an effective way to shift the goods between short-distance drayage vehicles and line-haul rail vehicles. This gave the railways a system of offering a door-to-door service.

Following the adoption of this system, there was a complementary advancement in container lifting, vehicles and container management systems. Finally, the container itself became the central component of a bespoke freight system, leading to the formal development of systems of intermodal terminals. From the mid-1960s British Rail's "Freightliner" service offered such a product, with tailor-made rakes of wagons/trains, terminal equipment and facilities. (British Rail 1965, *passim*).[141]

Australian intermodal-rail developments echoed those found overseas, first with the application of conventional piggyback systems, then with the "Flexi-Van" system, followed by the spread of domestic and international containers and conversion of many louvre-van services to

141 Various forms of container had existed on British Rail (such as the 1961 Speedfreight, on BR's London Midland Region), and its predecessor companies, but none of these systems had the comprehensive national coverage nor the specialised trains, wagons, containers, terminals nor formalised drayage connections that Freightliner provided.

containers, and with the conversion of piggyback operations to containers. Interstate freight movements in containers increased from 32 per cent of the total rail interstate freight in 1983, to 66 per cent in 1991. (Buckley, et. al. 1992, p. 4) SCT Logistics' extensive logistics operations using pallets-in-louvre vans are a fundamental exception to this trend.

Development of maritime containers

The development of international container movements relied on the widespread acceptance of standard specifications, and then on complementary investment at a network of ports. Substantial investments in vessel and landside facilities were required. Suitable vessels and on-board storage and crane equipment were needed. The landside challenge was to invest in systems of containers, crane-loading facilities, storage, rail and road links and vehicles. From an early stage in this development it was recognised that efficient handling of containers in multiple ports and vessels and land vehicles required uniform standards of container specifications.[142]

The establishment of, and work by, the Paris-based International Container Bureau in the early 1930s initiated efforts to develop a universal container that would be suitable for international transport (McKillop 2013a, p. 4). Efficient international container movements rely upon standardised container, and container-handling, systems. Efficiency is lost if handling equipment has to be continually adjusted to fit different container lengths and widths; differing performance standards (notably, weight and width limits and box-corner fixtures) would also undermine the flexibility of use of the stock of containers on all routes. The International Organization for Standardization (ISO) worked from the early 1960s until 1970 to establish universal container specifications, culminating in 2.438 metre (8 foot) wide containers with lengths of 6.1 metres or 12.2 metres (20 foot or 40 foot[143]). There is no specified standard container height, although 8 foot 6 inches (2.59 metres) is common; "Hi-cube" containers are one-foot higher (at 9'6", or 2.90 metres). (See Levinson 2006, pp. 127–49 for a discussion of the container standard-setting deliberations.)

The commercial application of container packaging in seaborne traffic had its roots in the USA, in 1956; the first international container ship voyage was in 1960, when the *Santa Eliana* sailed from USA to Venezuela.[144] The subsequent adoption of maritime containers was rapid, such that by 1973 the non-bulk traffic was almost entirely container and roll-on/roll-off ships (Muller 1999, pp. 28, 31).

Development of intermodal systems

The intermodal systems in place today have their origins in traditional inland and port railway yards that had historically provided loose-freight traffic services. This applies to both domestic container movements and international (maritime) container movements. Intermodal systems consist of:

- terminal functions;

142 This was a contrast with the relatively low-scale domestic container flows in the various countries, where the container was captive to a given local movement (or customer) and so might be built to a unique standard.

143 The ISO standard container range also includes a 14.8 metre (48 foot) container, use of which is increasing.

144 Levinson's book, *The box. How the shipping container made the world smaller and the world economy bigger,* describes the birth and evolution of the maritime container, spurred by Malcolm McLean, who commissioned the first vessel and container operation.

- terminal locations;
- railway wagons; and
- lifting equipment.

Each of these elements is now considered.

1. Terminal functions

The rapid adoption of containers for international non-bulk movements and the embracing of national and international logistics systems brought new terminals and new roles to those terminals.

As discussed in Chapter 4, the growing use of the container initiated and facilitated the broader logistics task; this has widened the scope of tasks undertaken at terminals. The terminal is no longer simply a transfer point of goods between different modes.

The use of containers in domestic freight operations brought new specialisations of equipment and service, the importance of which escalated when international container movements commenced. This importance arose, not least, because the maritime and inland terminals became the interface between domestic distribution systems and global distribution systems. (Rodrigue and Notteboom 2010, p. 495)

International container growth (as outlined in Chapter 2) has created its own challenges in undertaking the full range of activities within confined port precincts. This has encouraged the development of "inland port" or "extended gateway" terminals located away from the maritime area. Incentives to manage activities away from the port have arisen due to, firstly, congestion arising from limited port land; the desire to balance those port demands with urban dwellers who are affected by the port-based activities; and the limited road links funnelling into the port. The activities that may be shifted from the port precinct include the storage of empty containers, the consolidation of cargo (and other logistics tasks at and around the terminal), and customs and quarantine tasks. Indeed, logistics activities have almost inevitably had to take place away from the port as those activities have mushroomed and with typically little spare commercial-zoned port land.[145]

The services provided through the hinterland intermodal terminal have thus been transformed. In the early 1980s in North America the intermodal terminal was essentially only the "circus ramp" that provided the simple transfer task for shifting a road trailer between the road prime-mover and the railway flat wagon. As has been observed, particularly in the days of piggyback (TOFC) the "terminals were simple and widely scattered… Physical needs were minimal: any length of track would do" along with a ramp for loading/unloading road trailers".[146] (Zimmer 1994, p. 99) The end-train loading and unloading via a ramp was replaced subsequently by investing in more-efficient side-loading equipment (see Definitions and abbreviations; Figure 20). Indeed, the ramp was regarded as inefficient (relative to side-loading) for TOFC and was incapable of handling COFC traffic.[147] (Slack 1990, p. 75)

145 The Port of London Gateway, near the estuary of the River Thames in London, is a rare exception to that land constraint. The port was opened in 2013 using land released after the closure of an oil refinery. With no urban incursions, the port has been able to develop its London Gateway Logistics Park.

146 Trailer on Flat Car [wagon].

147 Container on Flat Car [wagon].

The shift from terminals handling road trailers to container-based sites has transformed intermodal-handling equipment as has the trend in logistics, which has enhanced intermodal-rail's competitiveness. As illustrated by the pioneering "integrated intermodal rail logistics hub" at Alliance, Texas, the importers, retailers and third-party logistics companies ("3PLs") using the hub can "reduce supply chain costs by combining import and regional distribution functions at the same facility". (Mongelluzzo 2010, p. n/a)

Hinterland terminals are often logistics hubs. There is no single definition of the tasks of a modern logistics terminal but it can involve production, storage, consolidation for export, deconsolidation for distribution, trans-loading and, of course, shifting between modes. In the context of those value-added functions at terminals, the drayage-cost component to the terminal/distribution centre might be detached from the onward linehaul mode choice.

Ironically, in one sense the terminal may re-invent the private siding that once formed a key transport facility for manufacturing. As the Whirlpool example below, (p. 198) illustrates, the railway interface has been brought back to the centre of the transport/logistics interface, overcoming "one of the centuries-old disadvantages of intermodal—lack of accessibility" (p. 198). Of course, the freight volumes at these terminals are train-lengths, not wagon-lengths (unlike the private sidings of the pre-1950s period) and so capture the railway economies of density that can make the terminals viable to be serviced.

The diverse evolution and provision of hinterland terminals demonstrates that the terminal has no optimal design or equipment: each terminal caters for different customers, freight tasks and markets. The terminal can take many forms where that form is optimised by reference to proximity to markets, to the marine terminal and to other railway and road facilities.[148]

The conclusion from this review is that the maturing and widespread adoption of logistics have resulted in terminals with functions that add value—functions that lie far beyond the relatively simple task of goods transfer between modes. As has been argued,

> …*transport terminals are achieving an additional level of integration within supply chains that goes beyond their conventional transshipment role. (Rodrigue and Notteboom 2009, p. 167)*

Containerisation, computerisation and deregulation have re-formed the freight flows. Because terminals are no longer just transfer points, it is no longer a simple principle to say that transhipment costs drive whether freight is shifted directly door-to-door by road or whether intermodal systems are used. (This is discussed in Chapter 4.)

2. *Terminal locations*

The location and siting of intermodal terminals has evolved with intermodal developments; the terminal location influences the efficacy and attractiveness of the facility. Primary considerations in choice of sites have been land availability, proximity to customers, and to transport hubs. As noted above (p. 181), early terminals were simply modifications to existing railway yards. To meet an identified freight market, the terminal placement is strongly influenced by the

148 This topic is explored further in Zimmer (1994).

availability of a long rectangle of land beside or within reach of existing railway tracks; to adjoining land-uses and to the quality of road links near the site.[149]

Types of terminals

More generally, the spectrum of potential rail terminal locations has developed with the broadening of container traffic into international container movements. These international container terminals include (with some degree of overlap in terms and terminal functions):

- **Maritime container terminals.** These include four principal types (or functions) of terminal, the first three types being based on the distance of the rail terminal from the maritime terminal—see also Box 20:
  - *on-dock maritime rail terminals.* On-dock facilities have grown out of the traditional non-bulk freight operations at the dockside. However, despite railway sidings being in vicinity to the vessels, it is rare for terminal cranes to shift containers directly between vessel and rail wagon; the on-dock operations at the Port of Montréal are a notable exception. Normally, then, on-dock rail operations require an intermediate vehicle or point of rest—the container is "grounded". The major policy benefit of on-dock is that there is no drayage—no public road movement beyond the port perimeter.[150] However, on-dock facilities absorb scarce port land. Unless rebuilt since the advent of containerisation, the sites are often constrained, with short railway sidings. This limited capacity results in operational challenges to the assembly of optimal train volumes; it also means that there is a very limited ability for container storage at the site. These issues are factors underlying the 2015 "optimisation" work at the Port of Burnie, where dockside rail sidings were removed and container handling transferred to a less-constrained rail terminal site further from the dock. (House of Assembly [Tasmania] 2014, p. n.a.).[151] The result, then, is that the constrained on-dock locations often impede efficient train handling and this also undermines reliability. Ultimately, with growing traffic the maritime on-dock terminal can then be a capacity bottleneck.[152]
  - *near-dock maritime rail terminals.* These facilities lie a relatively short distance beyond the port boundary—there is no specific distance quoted in the literature. They therefore normally involve some public road drayage, although this may be avoided if containers can be moved through the "back fence" of the port boundary. With less pressure on land usage, we might expect the rail facilities to be less constrained than an on-dock terminal; being less constrained, the terminal can then be better designed. However, in

149 One USA study suggested that "Conventional intermodal terminals typically approach 300 acres [121 hectares], and require both main line access and an appropriate site configuration (essentially a long rectangle). (Tioga Group, et. al. 2008, p. 107)

150 For further reading, Prince (1998, 1999) provides a critical assessment of on-dock operations. By contrast, Ashar is more positive; in his 1988 paper he assessed the relative costs of intermodal movements between the ports of Los Angeles/ Long Beach and the different rail maritime terminals.

151 Pacific National Tasmania reported, similarly, that "An on wharf rail loading facility is available at Burnie. Growth in volumes at that site and limited opportunity for expansion however means that this is only utilised for a small proportion of the containerised freight. The majority of the containers are shuttled between the wharf area and a rail terminal by road. The rail terminal is poorly set out and requires excessive shunting and double handling of containers." (Pacific National Tasmania 2005, pp. 5–6.) In practical terms, trains accessing the dock need to go beyond the dock and then reverse into the dock sidings, while also splitting the train to fit into the short sidings. (House of Representatives 2007, p. 81) Similarly, it has been noted that trains have needed to be broken into three sections and the wagons then queued along the beach. In spite of the on-dock operation, the containers still needed to be double-handled from wagons, to trucks, to vessels, or triple-handled when stored. (MMC Link 2012, p. 8)

152 Union Internationale des Chemins de fer 2009, p. 333.

moving boxes between terminal and vessel there can be a need for more container lifts and placements than with on-dock sidings. (Committee for Study on Landside Access to Ports 1993, pp. 154, 169)

» *off-dock maritime rail terminals.* Sometimes the rail terminal can be some considerable distance beyond the port boundary. The convention for an "off-dock" classification in the USA is a distance of five miles (eight kilometres). Considerable road drayage is required to shift containers between the port terminals and the rail terminal. Operating outside the port boundary also involves additional processing through the port gates. The facility may include port functions (such as customs) that would otherwise occur at the port. Moving that activity away from the terminal can reduce pressure on the scarce port land. Nonetheless, containers are moved between the port and the terminal by road drayage — and therefore those costs are incurred — and the drayage can generate road congestion on public roads around the port. It should be stressed that the role of these distant off-dock rail facilities is to serve long-distance rail trips, not to serve the intermediate hinterland.

» *empty container terminals.* These facilities are used for regulating the inflow and outflow of maritime containers, either being delivered empty for subsequent export (empty) or for delivery to firms for subsequent export (full).

- **Hinterland container terminals.** It is central to the analysis in this report to note that hinterland container terminals can have a narrow or broad range of activities. These terminals—sometimes called "dry ports" or "inland" terminals—may simply serve as origin or destination of the containerised goods, or they may operate more generally as consolidation, storage and distribution centres.[153] These wider, often non-transport, tasks fall within the logistics activities, discussed in the next section.[154]

153 One observation on dry ports has noted that "The definition of dry ports is rather ambiguous and has been used to indicate any sort of transmodal facility from simple inland container deposits to advanced intermodal distribution and logistics parks". (Acciaro and Mckinnon 2013, p. 18)

154 It is acknowledged that maritime ports can be fed from traffic of other ports—such as some Adelaide exports being railed to the Port of Melbourne and then shipped through that port—and is known as land-bridging.

Box 20 Defining on-dock and near-dock rail terminals

There is no standard definition of "on-dock" and "near-dock". This has particular relevance for consideration of drayage and the numbers of box movements. This is particularly relevant when government policy focuses on mode shares: how close to the dockside does a train need to be for the container to be classified as having been shifted by rail? This is an important consideration when comparing ports' mode shares. It is also a relevant consideration when implementing policy: local congestion and pollution issues around the port perimeter may not be addressed if containers are shifted through "near-dock" facilities.

The on-dock definition used in this report assumes that the rail terminal lies within the port perimeter (Ashar 2004, p. 60). We have noted that in North America only Montréal's port shifts boxes directly between the vessel and the rail wagon, that is, without the boxes being grounded; in most cases boxes are stacked or shifted to a rail wagon some distance away from the dock. The implication of this definition is that while Yard Cranes may be used to shift a container between the dock and the rail wagon, it is also possible that trucks are used—an intra-terminal dray.

The definition of near-dock assumes that rail sidings lie just beyond the port boundary. The main consequence of such a location is that there is limited drayage on public roads. The near-dock facilities at the San Pedro Bay ports (Los Angeles and Long Beach) are within a three-mile radius of the port. (Ashar 2004, p. 60) In this location the drayage between the dockside and the rail facility involves movement on public roads and, thus, has road congestion consequences.

Finally, while the terms "on-dock", "near-dock" and "off-dock" prevail, the less ambiguous terms of on-terminal and off-terminal (with distance-based "remote", "nearby" and "adjacent" terms) have been suggested but have never been in vogue. (Ashar 1991, p. 108)

Optimal maritime terminal facilities

There is no consensus as to the superiority of on-dock or near dock; it is likely that this arises because the optimal location arises from location-specific factors. The direct transfer of box between vessel and rail wagon would seem to have unquestionable superiority over other systems where the box goes via the dockside stacks. That is, the direct movement involves removing at least one box lift.

In principle, the on-dock terminal is preferred as it can "reduce cost, time, and administrative efforts required to shift containers between ships and railroads" (Union Internationale des Chemins de fer 2009, p. 333): there is no cost of drayage and lower handling costs as the number of container lifts is fewer than for other terminals. Each container shift also involves a time resource and, therefore, potential added unreliability. The US port of Tacoma, the sixth largest container port in North America, was a pioneer of on-dock terminal facilities in the 1980s; 73 per cent of the port's container traffic was classed as "intermodal" in 2005. (Leach 2006, p. 29) The port (with the port of Seattle) has a daily rail service with Portland, Oregon, a distance of around 270 kilometres. At North America's largest —adjoining—container ports (Los Angeles and Long Beach) the on-dock throughput was around 25 per cent in 2007 and the ports have sought to increase this proportion. (Mongelluzzo 2007, p. 1).

However two key factors undermine on-dock systems. Land use is especially constrained around the docks, constraining the "optimal" track layout that would otherwise prevail without the constraint; and the direct vessel–rail transfer is more challenging when the intermediate box-grounding task is not undertaken, because the transfer needs to incorporate sorting containers (for ultimate vessel/inland destinations). On-dock terminals provide their own logistics challenges for train and vessel loading:

> *Neither trains nor vessels are typically loaded in ways that facilitate on-dock transfer. Inbound vessels are usually loaded to maintain vessel balance and without regard to the positions containers will occupy on outbound trains. Similarly, inbound trains are generally blocked in a way that expedites the train's movement to the dock, without regard for the necessary vessel loading sequence. (Burton 2011, p. 20)*

As a consequence, box movements via stacks enables a degree of sorting of boxes for ultimate placement in the vessel or (for imports) in inland destinations. For an individual trainload, boxes will originate from different vessels and be bound for different importers; similarly, export trainloads will be consolidations of traffic from different exporters and be destined for different vessels.

Different managements of on-dock and near-dock operations can influence the productivity of the terminals; in particular, it is argued that incentives are weaker when intermodal tasks are performed by the stevedores. Prince argues that on-dock terminal operators [stevedores] in the USA have no incentive to control expenses in handling boxes. He cites one East Coast USA on-dock operation where the contract stipulates that the railway must absorb all on-dock cost increases. (Prince 1998, n/p) Near-dock and off-dock terminals, by contrast, provide rail operators with greater control over service standards.

Apart from box sorting, the movement of the box between vessel and train affords the opportunity to undertake other tasks. For Australia at least, the stack movements provide an appropriate opportunity to undertake customs and biosecurity controls. (These activities are easier to control and should ideally be undertaken at the maritime port rather than at a hinterland terminal.) That is, grounding the box and stacking it at a near-dock facility provides logistics and procedural opportunities.

Bespoke trains that are suitable for the constrained on-dock sites have been tested but failed. On-dock facilities are often land-constrained sites, which compromises both effective railway siding design and scale, and container handling. The *Cargo Sprinter* train (p. 65, p. 207) was devised to work within those constraints, using a short train that could be easily accommodated within constrained port areas. The *Cargo Sprinter* was designed for operating frequent short-distance port shuttles and consisted of a short, fixed-formation train (up to 40 TEU) with powered driving cabins at each end of the train.[155] This design was intended to obviate the need for shunting and train coupling/decoupling, especially within the maritime rail terminal. The wagons and driving units were of a lightweight design with the intention of the train operating at passenger-train speeds and therefore not impeding the passenger train flows when Cargo Sprinter was slotted into paths between those services. As noted elsewhere in this report, however, (page 207), the train concept worked against the core principles of

155 (VCEC 2006, p. 339). The European Commission describes the original German *Cargo Sprinter* capacity, with "5 units" [each unit holding 2 TEU], with a capacity of 10 TEU but a capability to couple Sprinter sets. The Commission noted that the technology involved high investment costs, "low loading capacity" (even by what would be very modest European freight train length standards) "and the ability to spread the associated costs". In specification terms, the Commission concluded that the *Sprinters* had "low power, low acceleration and low adhesion limits", which "were recognised as major weaknesses of this technical concept". (European Commission 2012, p. 43)

railway economics: that viable train operations need at the very least to have either a high payload density or long distance. The *Cargo Sprinter* had neither.

As discussed in Chapter 5, there is no single industry view of the merits of, or trend towards, on-dock versus near-dock. Clearly, though, the near-dock incremental drayage and road congestion costs must be weighed against the operating benefits of the less-constrained near-dock site. Similarly, there is no consensus on the merits or otherwise of central maritime railway terminals or dedicated terminals for each stevedore. It is notable that the Port of Long Beach incorporates an element of both systems, with multiple rail terminals but with each terminal being shared between a cluster of container terminal operators. A similar system applies at the Port of Rotterdam.

3. *Railway wagons*

The efficacy of the box transfer at terminals is a function of a range of factors, including the terminal design, the trackside lifting equipment and the wagon equipment or wagon design. We stress that the following discussion relates more to the development of bespoke wagons for long-distance intermodal operation than for short-haul operations.

The design of the rail wagon lies at the core of intermodal transport, with the focus on:

- minimising effort at the terminal, especially when transferring containers between the truck (or terminal stack) and the rail wagon; and
- on maximising payload (by volume and/or mass [weight]).

Bespoke wagon systems developed to facilitate box transfer are considered elsewhere in this report—see, in particular, we discuss the *Flexi-Van* (p. 64, p. 189), the *RoadRailer* (pp. 63, 237 and photo on p. 63) and Britain's Freightliner (p. 196). Those wagon systems have generally been applied to long-distance intermodal operations, not to short-distance operations. Except in particular market niches (such as that provided by the USA's Norfolk Southern [railroad's] *Triple Crown Services*), there has been a rejection of such bespoke equipment, and towards standard equipment, particularly the ISO container.[156]

As noted above and elsewhere in this report (p. 207), the *Cargo Sprinter* was aimed at port-shuttle services in order to minimise terminal effort, not by reducing box handling effort but by reducing wagon shunting at terminals.

Railway developments in containerised intermodal-rail traffic have focused on improving payloads. The most famous of these enhancements is container double-stacking (p. 88). Well wagons, rather than flat wagons are used with double-stacking. Well wagons improve the opportunity for double-stacking to be feasible (that is, within the height loading gauge of a railway). The floor of a flat wagon lies above the bogies (wheel sets) whereas the well wagon floor is recessed to a level between the bogies. The stacking of the containers involves more effort at terminals (stacking and applying the placement of containers) but can potentially lead

156 Matthews (2011) outlines the applications of the RoadRailer in the USA. Until late 2015 the *Triple Crown Services* centred on a hub at Fort Wayne, with spokes to Minneapolis, Kansas City, Toronto, Bethlehem (Pennsylvania) and Jacksonville. From late 2015 the service has been reduced to a Detroit – Kansas City operation, with other spokes being converted to traditional containerised freight. The service uses the Mark V design — see the Australian National application on p. 83 — that uses rail bogies rather than bespoke rail wheels attached to the road trailer. While *Triple Crown Services* initially sought shorter-haul *high-value* traffic, this has been lost and conventional long-distance intermodal traffic is at the heart of the business.

to up to double the wagon payload.[157] The potential incremental payload from the system depends on the axle-load/speed that is permitted on a given railway; Australian interstate track axle loads are around 20 tonnes/axle, which compares with a standard 33 tonne/axle in North America.

The development of articulated wagons has also enhanced payloads. Articulation involves wagon bogies being shared with adjacent wagons. Thus, for instance, a five-pack articulated wagon set involves using six bogies rather than ten bogies (that is, two bogies per wagon). By reducing the tare weight of wagons it enables train operators to increase their payloads.

4. *Lifting equipment*[158]

As discussed throughout this report, the transfer of containers between road and rail is a cost-component of intermodal rail that does not apply to direct road transfers. In 1985 a crucial advancement of the container–lift crane was introduced in the USA. The Translift rubber-tyred gantry crane provided a much higher level of durability than earlier cranes; it became the standard equipment for North American intermodal terminals.

Over time the marine terminals have developed a range of handling equipment, usually based on two distinct types of container cranes:

- the Quay Crane, which conveys containers between vessels and the quayside; and
- the Yard Crane, which move containers within the terminal areas (including between the stack and the rail or road body).

The yard crane types (in the order in which they increase the handling capacity) are the reach stacker, side loader, straddle carrier, rubber-tyred gantry, and rail-mounted gantry (NCFRP 2011, p. 7).[159] Those yard cranes are also used in hinterland terminals.

5. *The impact of trends in organisational systems*

The development of rail–intermodal systems, and the development of containerisation more generally, has occurred against a background of an evolution — or revolution — in transport and the entities within the transport system. Containerisation has fuelled the logistics revolution. As noted by Centin:

> *Seaports can evolve from a pure import/export and transhipment centre to a complex of trade and industrial functions within a logistics system. … They are the value-adding transfer points and central links in complex supply and logistics and transportation chains, providing seamless transport facilities, with a strong interface with other modes of transport services. [The seaports then require] a high level of coordination and inter-connectivity capabilities… (Centin 2012, p. 236)*

The development of intermodal systems depends, in the first instance, on the underlying organisational structure of service providers and the initiators of the systems—the "agents". Beyond the interests of the railways themselves (desiring rail traffic), the rail–intermodal has

157 van Geldermalsen and Leviny (2005) discuss the principles of loading different box sizes and weights on well wagons.
158 Woxenius (1998) provides an extensive list and discussion of a range of transhipment technologies that have been applied to pursue cost-effective transfers between modes.
159 Note that forklifts may also be used to shift containers within the yard.

been spurred by the rise in logistics and in trends in port competition, in road congestion and in port congestion.

Development of rail–intermodal has been driven by shippers, freight forwarders/logistics companies/distribution centres, railway companies/train operators, port authorities, stevedores, shipping lines and governments (of various levels). This disparate range of interest groups have adopted and invested in rail–intermodal systems, driven by a range of objectives.

The rail–intermodal system has developed by the actions of this wide range of entities across the world. From the early 1960s British Rail had a strong interest in developing an intermodal system, Freightliner, to boost its flagging freight market. During the same period, railways in the USA sought to capture port traffic. Since those early days, the types of entities seeking to offer rail–intermodal has widened, such as with port corporations using the system to enlarge their catchment area relative to competitors. (The Port of Tauranga case study — see above, page 143 — provides one such illustration.)

While it is clear that additional rail traffic has appeal to railways—if such services can be provided profitably—the motives that drives other entities is less clear, and changes over time. For example, Roso (2011, p. 48) argues that port service providers' motives can be summed up in the "three-C" trends:

- rising inter-port *Competition*;
- rising *Congestion*, and
- the *Central* location of some ports (in response to rising port throughput).

The port competition drives efforts to improve port attractiveness. Road congestion and port congestion encourage ports to consider ways to shift the landside box task away from the ports and away from roads. The central urban location of ports means that rising port activity increases the environmental impacts on nearby residential areas and this leads to calls for amelioration of the interfaces or shifting of port activities.

While there is a drive by various agents for intermodal–rail, it involves players with different objectives and activities. Each intermodal–rail agent faces unique interfaces with other entities in the supply chain; the interfaces must be aligned and coordinated and these factors become more important as volumes and congestion rise:

- Just as there need to be complementarity in physical equipment, so too do the players in intermodality need to have a degree of alignment of incentives. The consequences of mis-alignment are apparent at operational interfaces, for instance if the commodity shipper seeks to use rail but the stevedore finds it easier to handle trucked containers.[160]
- Railed containers involve more interfaces than trucked containers, so success of the intermodal system relies on good coordination. This facet of intermodalism has sometimes led to the establishment of formal logistics-chain coordination entities.

The developing role of the various players in the landside logistics is directly linked to that coordination role: to what extent does each player have incentives to ensure the optimisation of the supply chain? Booz & Co's paper for the National Transport Commission argues that shipping lines are the lead participant in the supply chain but that stevedore operations "are potentially the highest value capture component". (Booz & Co 2008, p. 35). It is concluded

160 In this context, note the views of Prince (1998) on adverse stevedore incentives, as discussed on p. 75.

that individual ports may have mechanisms "to incentivise the stevedores' landside operations", such as performance deeds at the Port of Brisbane and (the-then) proposed changes to container terminal leasing structures at Port Botany. It is concluded, however, that "from a whole of chain perspective, there still exist a significant barrier to supply chain performance between the stevedore's land-side operations and the road/rail component of the chain". (Booz & Co 2008, p. 36)

APPENDIX C

Australian and international intermodal–rail schemes

This appendix sketches intermodal–rail developments in Great Britain, the USA and Australia. We noted in Chapter 1 that the maritime container was developed some time before the complementary intermodal conveyance.

It should be observed that the focus of intermodal provision in Great Britain was the container whereas the initial mainstream intermodal system in the USA and Australia was piggyback operation. Until container volumes and economics were transformed in later years, the piggyback was seen as the most competitive system.[161] It was largely a default decision that Britain chose container-intermodal as the British network has severe loading gauge restrictions, notably with height restrictions, which apply across virtually all lines. Those restrictions curtail most conventional opportunities to convey road trailers on rail wagons.

If there is any common thread in the intermodal-rail experiences in Britain, the USA and Australia it is that efforts have abounded over the years for easing the road–rail terminal interface task. What has won out, however, is conventional crane equipment, and wagons that maximise payloads.

Australia

Australia's intermodal-rail developments echoed the North American pattern, with an early post-war recognition that there should be investment in piggyback; and later, that containerised intermodal should be adopted. As elsewhere, intermodal systems were aimed at minimising the transfer time and financial costs that are incurred at terminals, with the objective of simple — almost seamless — transfer systems.

In the context of the short-haul maritime container movement aspect of this report, however, the history of Australia's intermodal traffic almost entirely relates to interstate and regional domestic intermodal activity and to land-bridging. However, by 2007 the international container movements was estimated to account for almost one-half of Australia's intermodal TEU.[162]

A 1983 report by the Australian Railway Research and Development Organisation concluded that rail's shortest break-even — sweet-spot — distance was 350 kilometres. (This was cited in Inter-State Commission 1987, p. 61.)

161 As discussed in footnote 8, relative piggyback costs became particularly high with the advent of double-stacked containers.

162 Booz & Co. estimated 5.598 million TEU of international containers, 5.967 million TEU interstate and 0.946 million TEU intrastate. (Booz & Co 2008, p. 12)

In his paper that was presented to the 1956 Summer School of the Australian Institute of Political Science — *Australia's transport crisis* — Schumer observed:

> *Road transport is naturally complementary to rail transport, providing the movements between commercial premises and railheads, but in many instances a tendency towards complete movement by road is created by difficulties at the transfer points… Improvements in facilities at transfer points would assist to a great extent in reducing diversions of traffic from the railways… [including resiting and reconstructing railway "yards"—not described as "terminals"—and handling goods in larger units, such as new piggyback systems such as the Flexi-Van service, which came six years later (p. 64)] (Schumer 1956, p. 141)*

The intermodal investments depended, ultimately, on the actual or prospective volumes that could be expected to pass through a terminal. The investments in terminal facilities themselves depended upon the intermodal technologies and, related, to the freight volumes. (Inter-State Commission 1987, p. 85)

Apart from earlier, small-scale container traffic, Australia embraced US technology, first with the Flexi-Van and later with the RoadRailer. While Australian loading gauges were not as restrictive as those in Great Britain, they often constrained conventional piggyback operation. There were restricted loading gauges on the key interstate route between Sydney and Melbourne. (Laird 1990, p. 47) The Inter-State Commission concluded that "The main physical constraint on the establishment of intermodal services is sufficient overhead clearance on rail routes". (Inter-State Commission 1987, p 62)

Conventional piggyback was possible on some other routes, such as the Trans-Australian Railway, and was applied by the Commonwealth Railways from 1956. (Inter-State Commission 1987, p. 27) While there was "significant growth" in this traffic from inception through most of the 1960s, it declined during the 1970s. The decline was possibly due to the sealing of the Eyre Highway, with its consequent effect in lowering road vehicle operating costs. (Inter-State Commission 1987, p. 27) From 1982 there was some resurgence in piggyback on the route, between Adelaide and Perth, after Adelaide was connected to the standard gauge network. (Inter-State Commission 1987, p. 28)

Bespoke piggyback systems were available to carry road trailers on other routes. In 1962 Australia commenced using the Flexi-Van piggyback technology of road trailers on rail. (McKillop 2013b, p. 7) Services operated between Melbourne and Adelaide, and on the new standard-gauge services between Sydney and Melbourne; customers included TNT and Ansett Freight Express. (McKillop 2013b, pp. 9, 12) The Flexi-Van had been developed for the New York Central in 1957, which operated the piggyback system between New York and Chicago, and, later, with some maritime applications. The system used custom road trailers, consisting of a bespoke container and a wheel undercarriage. Special rail flat wagons were also needed, with the flat bed of the wagon being able to be swivelled 90 degrees to enable the container (minus its undercarriage) to be slid onto the wagon. (Levinson 2006, pp. 155-56)

Piggyback was not favoured, subsequently, when freight forwarders contracted the railways to provide their own trains. In 1970, the freight forwarder Thomas Nationwide Transport ("TNT"), contracted the NSW and Victorian railways to operate a train each night in each direction between Sydney and Melbourne. However, finding "a number of problems", TNT did not use the prevailing Flexi-Van system. TNT opted to equip its terminals with traditional overhead gantry cranes and using bespoke containers—which did not conform to international standards. (McKillop 2013c, p. 11) When Mayne Nickless copied its TNT rival's service in 1972, it used Flexi-Van containers. Subsequently, however, the company switched to new bespoke containers and, in 1978, a complementary new terminal for container transfers and storage in Melbourne. (McKillop 2013c, p. 12)

The RoadRailer was the second major piggyback investment, with Australian National Railways (AN) introducing this USA technology from 1990. AN applied two variants. The Mark IV involved transferring the entire trailer to rail, with the trailer being equipped with a single-axle rail wheel set. The Mark V trailer excluded that rail wheel set; the trailer would be mounted on a two-axle rail bogie that was rolled under and away from the trailer at terminals—see Figure 19. (McKillop 2013c, p. 4) Pacific National withdrew the system in 2004. The topic is discussed further in McKillop 2013b, (p. 9).

The intermodal-rail container has undergone similar experiences as piggyback, beginning with non-standard systems before converging to conventional equipment. One key container initiative was The Railways of Australia Container Express, "RACE". This was a system that was based around a bespoke container that was developed for (essentially) domestic use across the railway network from 1974. The container was wider than the ISO international container so as to accommodate two Australian pallets abreast.[163]

The application of RACE was somewhat more limited than rail container systems in Britain. Unlike British Rail's Freightliner intermodal system, RACE did not extend to the broad comprehensive terminal design and complementary wagon and terminal equipment; also, there was a limited level of high-priority inter-city services. One benefit of the container was that it could reduce the impact of the remaining interstate breaks-of-gauge at the transhipment points, such as on the Sydney–Adelaide and Melbourne–Perth via Adelaide routes.[164]

Conventional container systems have endured. The Superfreighter container-based interstate services commenced operation between Sydney and Melbourne in 1983, with other capital cities following later. The Inter-State Commission suggested in 1987 that the "outstanding development in intermodal services" had been the introduction of Superfreighter container-based interstate services. (Inter-State Commission 1987, p. 46)

Key innovations in intermodal systems have focused on improved payloads:

- In 1985, Australian National introduced the five-pack articulated container flat-wagon, where the wagons share bogies. This meant that six bogies were used across the five wagons instead of ten bogies. Thus, this system reduces the tare—that is, the empty—weight of the five-pack unit, thereby increasing payloads.
- Investments by Australian National, in 1990, and by National Rail, in 1994, involved the use of well-wagons rather than flat-wagons, enabling double-stacking of containers to be undertaken. This enhances wagon payloads, subject to track axle-load limits.

The intermodal systems that have endured are those that maximise payloads, use conventional equipment and standard containers—even if they involved investing in additional terminal-lifting equipment. The deficiencies of the withdrawn intermodal systems have arisen from the need for investment in bespoke road trailers/containers and wagons and investment in bespoke terminal equipment, and due the high wagon tare weights to carry the intermodal

163 The Australian Standard Pallet.

164 By this time (1970) the common, standard (1 435 mm) gauge linked Brisbane–Sydney–Melbourne and Sydney–Perth (via Broken Hill).

equipment (and therefore compromises on payloads). The features of technology that have prevailed include high-payload palletised cargo in vans (as used by SCT Logistics), high-payload double-stack container well wagons, and conventional ISO containers using conventional terminal equipment.

Figure 61 Door-to-door operation, Australia, 1968

Source: Photograph courtesy of National Archives of Australia. Reference: NAA B941/2, RAILWAYS/FREIGHT/1.

Specific services and specific initiatives have been directed at international container movements by rail. The interstate land-bridging and the regional maritime developments are now considered.

Land-bridge maritime services

The development of international container traffic has spurred railways and freight forwarders to provide rail "land-bridging" services. The market attraction of shifting the international containers by rail has been that containers can be moved from an existing port-served city to a port in another city that provides the shipper with a superior shipping service.

A number of dedicated land-bridge services have been operated or proposed over the last 40 years:[165]

- **Fremantle–east coast proposals.** In 1966 the WA Commissioner for Railways put the case for a land-bridge between Fremantle and Eastern States that was based on the USA's land-bridging rail services linking that country's west coast with Chicago and with south-eastern states (Wayne 1966, p. 17). Subsequently, however, the BTE reviewed the business case, concluding that the land-bridging would incur considerable losses. The BTE did note, however, that land-bridging had attractions where shipping lines sought to reduce the number of port calls or reduce ship frequency at specific ports. (BTE 1975, p. 16) The cited considerations for and against rail land-bridging remain relevant.

165 Note that some railway organisations offered non-dedicated interstate rail services linking with ports, such as National Rail's "SeaTrain" facility (which also included a dedicated Brisbane – Port Botany train).

- Nullarbor Land-bridge. From the mid-1970s Railways of Australia operated a rail land-bridge service between Fremantle and the Eastern States — the "Nullarbor Landbridge" — with some success.[166] (McKillop 2013c, pp. 3, 7). This success occurred in spite of the absence of on-dock rail facilities at the Fremantle Inner Harbour; containers had to be conveyed by road between the Harbour and marshalling yards and then by shuttle train to Kewdale, a distance of around 40 kilometres. (McKillop 2013c, p. 7)
- Linertrains. In 1987–88 a "Linertrains" international container service ran from Sydney to Melbourne, that is, in a south-direction only. (State Transport Authority 1988, p. 18)
- Brisbane–Sydney. In the 1980s there was growth in international container movements that were land-bridged between Brisbane and the port in Sydney, through an arrangement between Australian National Line and the railway systems. (Inter-State Commission 1987, p. 46). A Brisbane–Sydney "SeaTrain" operated from 1994.[167]
- Adelaide–Darwin. When the Darwin railway was opened in 2004, efforts were made to introduce land-bridge services. The intention was that shipping lines would serve the Port of Darwin, with maritime containers moving between that port and southern capitals by rail. A number of ship–rail movements were operated as a trial, but the market did not develop.[168]
- Sydney–Melbourne–Tasmania. The railway between Sydney and Melbourne carries some Bass Strait land-bridge traffic, that is, traffic that could be shifted between Sydney and Tasmania by sea but which is actually shifted by rail between Sydney and Melbourne and by ship between Melbourne and Tasmania.[169] Specific inter-capital maritime rail services are not operated. The rail operation is not directly linked to the maritime operation. In 1986 a rail link was opened to Webb Dock, the primary Melbourne freight dock for Tasmanian freight; the link was closed in 1992.
- Melbourne–Adelaide. International container traffic between Adelaide and the Port of Melbourne is one of the two dedicated interstate land-bridge corridors that operated in 2015. As noted in BITRE 2014 (p. 74), the number of land-bridge services between these capitals halved between 2009 and 2014. As a major port, Melbourne offers a larger number direct shipping services linking with overseas ports than Adelaide. Thus containers had moved through Melbourne, with Adelaide containers moving by rail; since the mid-1990s services have been operated by Patrick, by Pacific National and by P&O Trans Australia. However, since 2009 the trend has been for a much higher proportion of containers to be shipped directly through Adelaide, with containers being transhipped at major foreign port hubs.
- Hobart–Burnie. The other notable land-bridge intermodal service that operated in 2015 is TasRail's intermodal service between Hobart's Brighton terminal and the Port of Burnie

166 The Railways of Australia was a coordinating umbrella organisation representing Australia's railways, with some cross-border freight and passenger services marketed under that banner, as well as common issues such as technical and safety standards. In 1994 the entity became the basis of the peak industry body, the Australasian Railway Association.

167 In the context of the efficiency of the SeaTrain operation, a representative from Sydney Ports Corporation noted in 1998 that "…the operation at the Port Botany end is by no means as efficient as it needs to become. That is primarily in regard to the efficiency of unloading and loading, not so much of the train operation itself. … there is no opportunity for freight traffic to move through part of the system and onto and off that line between something like six and 10 in the morning and then between three and six or seven in the evening." (House of Representatives 1998, p. CTMR 462)

168 In 2005 the freight forwarder, Hai Win Shipping, found that trial shipments to Adelaide could save almost ten days but it did not justify the additional freight charges unless the freight had high value. (World Cargo News 2005)

169 One report suggests that "Current non-bulk rail freight between Melbourne and Sydney contains a high proportion of goods to or from Tasmania". (Australian Rail Track Corporation 2010, p. 26)

(linking with the Port of Melbourne). Containers with paper products are also moved from the Norske Skog paper mill at Boyer (near Brighton) to Burnie, for shipment. In 1998 the container volumes on the corridor were boosted by the withdrawal of the Holymans Coastal Express service that had served the port of Hobart. (McKillop 2013d, p. 14) In 2006 the Burnie land-bridge was estimated to carry around 130 000 TEU, with 50 000 TEU to Burnie, 45 000 TEU (in the reverse direction) to Hobart, and 35 000TEU of paper products from Boyer. (Booz & Co. 2008, p. 27) In 2013–14 the land-bridged container contents included retail goods, finished products and raw materials. (TasRail 2014, p. 34)

Policy initiatives on short-haul and regional maritime rail services

The growth in international container movements through ports has put pressure on arterial roads around the ports and put pressure on limited port land. This has led to calls (especially by affected communities) to encourage those boxes to be shifted by rail; and, where feasible, for the transfer of some port activities to locations away from the dockside. Each capital city/state government has examined the potential for that mode shift, with some complementary inquiries—see Appendix D. Apart from government, port authorities are the other entity that can provide an umbrella environment to encourage container movements by rail.[170]

Notable services and policies that have been adopted are:

- FreightCorp *Portlink*, regional- and short-haul services between inland terminals and Port Botany;
- Intermodal Link Services' *Rail Shuttle*, Forrestfield Intermodal Terminal – North Quay Rail Terminal, container movements from, and through, Perth, to the Fremantle Inner Harbour; and
- the Victorian Government's regional intermodal subsidy strategies.

These government policy initiatives in Australia are considered here.

NSW Portlink strategy

The Portlink strategy was a NSW government policy initiative in the 1990s, aimed at encouraging the shift of container movements from road to rail, both for international and domestic markets. Infrastructure and rail service were addressed by the government rail authority, with complementary terminal and feeder-road operator tasks being undertaken by private sector partners. The strategy was implemented by the NSW Government's State Rail Authority, and then transferred to newly-formed FreightCorp in 1996. It has been argued that at the time FreightCorp's operations had incurred "substantial commercial losses as a result of excessive fixed costs; poor utilisation of assets; one-way loading; poor pricing and weak 'power' relationships with customers and port operators". (Department of Transport 2010, p. 36) It was observed that being "Unable to withdraw from the sector due to Government policy, FreightCorp adopted a deliberate strategy of expanding its market share in an attempt to earn additional revenue and to lower its unit operating costs". (Department of Transport 2010, p. 36)

170 For example, the Port of Melbourne has supported development of on-port rail terminals by appropriate land allocation and by supporting common-user access to rail terminals. (Port of Melbourne Corporation 2009, p. 33)

During the 1990s intermodal terminals were opened in NSW regions and in Sydney. From 1994 the rail operator "developed a number of strategic partnerships with the private sector to provide rail infrastructure and services". (Productivity Commission 1999, p. 142) In 1998 the international container focus of the intermodal developments was formalised in the PortLink strategy. FreightCorp's approach was then to work with road transport and terminal operators to provide "bundled" rail–road services. (Department of Transport 2010, p. 36) The Corporation considered that the success of the strategy "depend[ed] on the establishment of efficient port/rail and road/rail interfaces". (FreightCorp 1998, p. 7)

The Blayney intermodal terminal—289 kilometres west of Port Botany—opened in 1994 and was the first facility opened under the approach. This was prior to the adoption of a formal PortLink policy. The freight forwarder company, FCL, operated the terminal and the related road distribution. The terminal is focused principally on exports. In 2012 rail facilities at the SeaLink site at Blayney were developed, complementing the onsite cold store warehouse.

Regional freight centres and operations were subsequently developed on brownfield (existing rail yard) sites throughout NSW, and were being "developed and managed through key alliances". (FreightCorp 1999, p. 3) Other regional terminals that were developed included Dubbo, Griffith and West Tamworth with new regional terminal development being limited to Narrabri, Moree and Parkes. (FreightCorp 1999, p. 4; Sea Freight Council of NSW Inc. 2004, p. 17)

Investment in urban Sydney terminals was also undertaken along with implementing shuttle services between those inland terminals and Port Botany. There were services between the Sydney Yennora terminal and Port Botany and with White Bay. (FreightCorp 1998, p. 12) In 2015 Yennora was linked with Port Botany by up to three scheduled shuttle trains each day.

As part of the Portlink strategy, FreightCorp indicated in 2000 that it was "building two container terminals, for instance, at the moment at Minto and St Marys in west and south-west Sydney, where there is significant industrial growth occurring and we are looking at running small shuttle trains between the port and these two centres". (Legislative Council 2000, p. 48). The Minto terminal was built on a greenfield site as a joint investment by FreightCorp and Bowport Allroads. The terminal is now operated by Qube Holdings who operates up to three scheduled shuttle trains each day that link with Port Botany.[171]

The PortLink operations became part of Patrick's operations when FreightCorp was privatised in 2002. A setback for port–rail policy arose in June 2010 when Patrick withdrew from operating Port Botany rail services. (ACCC 2010, p. 47) At the same time, Patrick announced an increase in its rail service charge for its container lifting service at Port Botany; the charge was to have risen from $15 per container lift, to $42, having risen from $10 the previous year. The State government regulated to cap the charges, for both stevedores, at $15. (Transport for NSW 2012, p. 34) It is notable, also, that most of Patrick's port–rail operations were then taken over by other rail operators. (The intended increase in rail lift charges coincided with the withdrawal of Patrick's rail-mounted gantries, with consequent additional rail-container handling—see Box 3.)

The levels of railed container volumes between the port and the hinterland are presented in Figure 41.

171 The St Marys terminal no longer operates, although Asciano has proposed to recommence shuttle services between a reopened terminal and Port Botany.

Building on the Portlink strategy with rail links, there are two notable key metropolitan inland terminal facilities being developed. The Intermodal Logistics Centre at Enfield opened in July 2015.[172] When fully operational, it was intended that the centre would include an intermodal terminal, empty container storage, warehousing and a light industrial and commercial area, with rail shuttles linking with Port Botany's three terminal operators.[173] An agreement was reached for Hutchison, a stevedore at Port Botany, to operate the Centre but in July 2015 that company relinquished its interest. In December 2015, Aurizon signed an agreement with NSW Ports to operate the Centre.[174] The intention is that Aurizon will relocate its Yennora intermodal operations to Enfield.

The Moorebank Intermodal Terminal facility, in south-west Sydney, will include an international container terminal, a domestic interstate terminal, and warehousing. It is also intended that the facility will operate as a bonded facility, enabling the direct movement of imported containers from the port through to the terminal. (ARTC 2015, p. 19) Shuttle trains will operate between the facility and Port Botany. The facility will be operated by a consortium consisting of Qube Holdings and Aurizon Holdings.

WA Fremantle rail shuttle

The WA government initiated a Metropolitan Freight Strategy in 2002, at a time when rail's port mode share for containers was 2 percent. (Pal 2014, p. 11) A key objective was to increase the rail share of international container movements between the hinterland and the container terminal facilities at Fremantle's Inner Harbour. There had been only belated provision of on-dock rail tracks to that Harbour. Standard gauge train shuttles between the Harbour and Kewdale intermodal terminal commenced in 1998 with narrow gauge tracks and the North Quay Rail Terminal being opened in 2006. (McKillop 2013d, p. 16) Facilities at that terminal were enhanced in 2014. (Hansard [WA] 2004, p. 5890b, para. 2930) The government thought (in 2004) that it could achieve its rail container mode share growth—rising to 30 per cent by 2013—"without the need for incentives", but in 2006 it introduced a per-loaded-TEU subsidy, with Intermodal Group being contracted to provide the logistics. (Hansard [WA] 2004, p. 5890b, para. 2930; Intermodal Group, n.d.)[175] The government has committed to retaining the subsidy through to 2016–17. (See, also, the Fremantle case study, p. 196.)

The number of railed containers has risen. It has been reported that the volume rose from 5 per cent, to 17 per cent, between 2007 and 2008. This growth was attributed to the (then) $50 per TEU subsidy and to the "surge" in containerised grain exports, which are packed in the vicinity of the Forrestfield terminal.[176] (Booz & Co 2008, p. 45)

172 http://www.nswports.com.au/assets/Misc/Meda-Release-Enfield-ILC-HLA-July-2015.pdf

173 The Enfield Intermodal Logistics Centre "…would be used for the transfer and storage of container freight to and from Port Botany, packing and unpacking of containers within the proposed warehouses and storage of empty containers for later re-use or for return to the Port". (Sydney Ports 2005, p. 1-4)

174 http://www.aurizon.com.au/Media/MediaRelease/Pages/Aurizon-signs-agreement-for-new-intermodal-hub-in-Sydney.aspx

175 Twenty-foot Equivalent Unit—see Definitions.

176 Rail's percentage market share for the years between 2003–04 and 2013–14 was 7, 6, 4, 8, 13, 15, 11, 12, 13, 14 and 14. Against rising port container throughput, the rail volume rose: in 2003–04 there were 28 000 TEU and in 2013–14 there were 100 000 TEU railed. (Fremantle Ports 2014, p. 33)

Victorian Government intermodal initiatives

In 2009, the Victorian Government introduced a two-year temporary subsidy for railed container freight to promote rail freight. The funding was a response to the reduced rail traffic, reflecting drought-related reductions in agricultural output. Eligible traffic were containers to Melbourne from Warrnambool, Horsham, Mildura and Shepparton/Tocumwal. The subsidy structure used distance-based rebates and intermodal operations attract differential track access charges. (Victoria University Institute of Supply Chain Logistics 2012, p. 70) There was a benchmark rate of $100 per TEU, which is adjusted for volume and distance. (Booz & Co. 2008, p. 24)

This scheme was followed by the Mode Shift Incentive Scheme, based on the earlier principles; the budgeted expenditure on the scheme is $5 million per annum, for the four years from 2014–15.

The Victorian Government allocated $20 million in its 2014–15 Budget, with $38 million from the Commonwealth, towards developing a Port–Rail Shuttle, as part of the State's "Metropolitan Intermodal System". The System envisages locating intermodal terminals in freight and logistics precincts in the south-west, north, and south-east of Melbourne. It has been envisaged that shuttle trains would operate in off-peak periods.[177] (Victorian Government 2013, pp. 26, 59) Terminals have been planned in Somerton, Altona and Dandenong South/Lyndhurst, linking with the Port Rail Shuttle terminal at the port.

The Victorian Government has also funded capital works at intermodal terminals under its Regional Growth Fund, which was established in 2011, and its Regional Intermodal Freight Infrastructure Program. The initiatives were also part-funded by the Commonwealth Government. (See Department of State Development, Business and Innovation 2013) Funding included upgrades at Ironhorse Intermodal, at Warrnambool, and at Donald, as well as contributing towards construction of the new facility at Dooen (replacing the terminal that adjoined Horsham town centre).

Initiatives in Great Britain

As discussed in Appendix B, British international intermodalism developed through domestic initiatives. The introduction of domestic intermodal operations was the response by the nationalised British Rail to the growing road competition and as a more cost-effective service to the traditional loose-handling freight — shunting and splitting and coupling of wagons. Fundamentally, the intermodal was seen as a substitute for the high handling costs incurred with non-containerised freight.[178]

A notable British Rail scheme was the introduction in 1961 of Speedfreight, a London–Manchester domestic container service. However the service lacked coherency in terminal, container, wagon and service. Existing rail yards were used and only the yards with suitable cranes could be served. The container wagons were attached to conventional freight services.

Subsequent initiatives, dating from 1963, are notable for their comprehensive application of principles to all aspects of intermodal economics. This included bespoke terminals in strategic

177 http://www.dtpli.vic.gov.au/transport/freight/intermodal-terminals/port-rail-shuttle
178 The initiative was spurred by the 1963 "Beeching" report into strategies for improving railway finances. (British Railways Board 1963)

locations, built-for-purpose rail wagons, complementary terminal equipment, and frequent intermodal services.

Freightliner illustrates an early focus on catering for the needs of intermodal services as something other than a bolt-on service that would be added to existing railway yards and freight train services. Freightliner was based on tailor-made facilities:

- new **terminals**. These facilities, at strategic new locations, were unconstrained by historical operations to enable bespoke layouts, with rubber-tyred "Travelift" container-lift cranes to provide a direct box transfer between the road vehicle and the rail wagon.
- modular, low-slung flat **wagons** that were designed for carrying containers on lines with restricted loading gauges, with special bogies to improve ride, increase train speeds to fast-train schedules.
- permanently-coupled wagons forming **unit trains,** obviating the need for coupling and decoupling of wagons.
- container specifications were aimed at compliance with the then-developing ISO draft specifications.[179] While Freightliner was initiated as a domestic (British) service, the aim was to use **universal container standards**, which would ensure that handling and rail/road equipment could be used interchangeably for domestic and international services. (British Rail 1965, pp. 4–11)

These facilities and equipment then underpinned the new container services. High-frequency, high-speed services operated between the new, bespoke terminals. High wagon utilisation improved freight economies by drastically reducing the numbers of wagons that were required. British Rail argued that the qualities of the product would not just rival road but would "surpass anything known by rail or road" and would capture traffic from road and be able to "handle remuneratively traffics which are at present carried at a loss on rail". (British Railways 1963, p. 142)

British Rail introduced the Freightliner product for domestic freight services in 1965, with international services commencing a year later. By the mid-1990s the Freightliner business was almost entirely international flows.

Initiatives in the USA

The US railways were pioneers in intermodalism. Early domestic operations included the conveyance of wagons/carts on Long Island Railroad in the 1880s while the Chicago, Burlington & Quincy Railroad (now part of BNSF Railway) offered piggyback operations in 1941. The Inter-State Commission noted that the early development of intermodal-rail was initiated by the railways as "an attempt to compete with trucks by reducing handling costs of LCL [Less-than-Container-Load] traffic". (Inter-State Commission 1987, p. 215)

Development of railway intermodal freight was impeded by exceptionally strong regulation of the railway industry. There was no marked development of intermodalism until after the Federal Government's deregulation, through the passing of The *Staggers Rail Act of 1980* and

179 The final ISO-standard container varied from the original Freightliner boxes; the latter were progressively replaced by ISO-standard boxes.

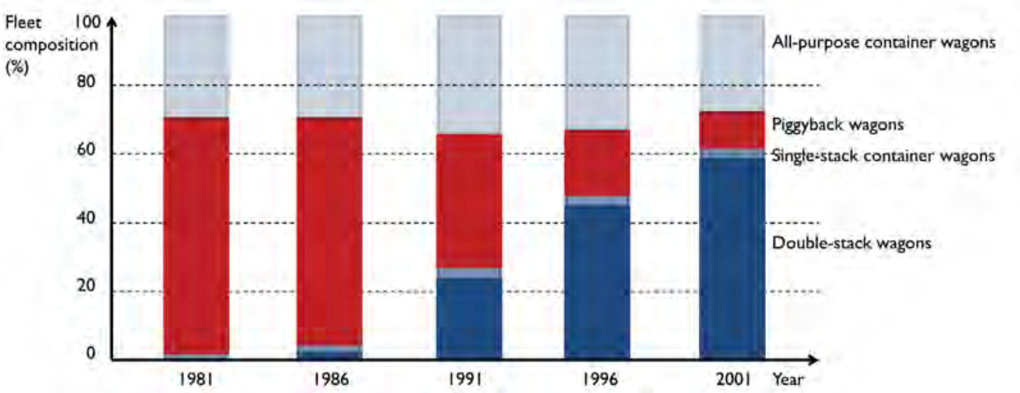
the *Motor Carrier Act of 1980* (for road freight).[180] An early, important, regulatory breakthrough had occurred in 1954 when the New York, New Haven & Hartford Railroad received approval (from the regulator, the Interstate Commerce Commission) on pricing and systems to operate trailers and containers on flat wagons.[181] The ruling opened a small window in the ability to levy fees for through-road/rail combined services. (Muller 1999, p. 17) This was facilitated by the removal of the regulation that prohibited cross-modal ownership. The industry players' new freedoms generated "a strong impetus towards intermodal cooperation". (Rodrigue and Notteboom 2009a, p. 3)

Much was required to alter the perception that intermodal was inferior in cost and service quality to a single all-road movement. (paraphrased from Martin 1996, p. F) Reflecting on the railways' intermodal services in the 1950s and 1960s, a then-intermodal manager in Pennsylvania Railroad observed that the service was "at best, ragtag". He noted that:

> *Proper loading and unloading equipment, cranes, and intermodal ramps did not exist; trailers were marshalled at old yards which were scattered almost anywhere and not convenient to intermodalism… Efficient intermodal service was still a thing of the future. (Martin 1996, p. F)*

The early applications of intermodal freight involved transferring the road trailer onto a rail flat wagon: the piggyback (or "Trailer On Flat Car", TOFC) concept. At terminals the piggyback could be used with very simple ramps at the end of sidings (called circus-loading—see the diagram in Box 2). In the late 1970s, less than one-quarter of the terminals were mechanised. However, effective containerised intermodal requires mechanisation and, with the growth in boxes, it led to rationalisation of terminals and consolidation of traffic in fewer terminals where there was sufficient throughput to justify the investment in mechanisation. (Inter-State Commission 1987, p. 241)

Figure 62 Trend in North American intermodal wagon fleet



Source: This figure is derived from a chart in Prince 2001, p. 79.

180 While it is not appropriate for our research publications to imply subjective judgement, the description of the railway regulation here reflects various official government reports since that deregulation. The successor railway regulator, the Surface Transportation Board, notes "In essence, the Staggers Act gave railroads more flexibility to set prices and adjust services as the market requires and thuse enabled them to act more competitively". (STB 1997, p. 2) It has been reported that since deregulation the average rail freight rates have fallen by 45 per cent, that rail accident rates are down by 76 per cent and rail volumes have almost doubled. (Intermodal Association of North America 2014, p. 21) See also Shashikumar and Schatz 2000, for a discussion of the impact of U.S. regulatory changes on international intermodal flows.

181 Muller (1999, p. 45) notes that "Prior to rail piggyback deregulation, long-haul truckers were able to price services below rail piggyback".

United Parcel Service (UPS) was an early convert, in 1969, to piggyback. UPS uses rail services on trunk routes, where there are high volumes. Similarly, in 1990 two of the largest trucking companies, J B Hunt and Schneider National, shifted to piggyback for their high-volume routes.

While piggyback became the favoured rail intermodal option for some time, it has been declining for some years in Canada and the USA as the economics of domestic and international container rail traffic — COFC, Container On Flat Car — have improved. This is illustrated by the trend in the intermodal wagon fleet, in Figure 62, with a marked decline in the proportion of piggyback wagons.

The trend away from conventional trailer-on-wagon piggyback was evident in the early 1980s. At that time intermodal was split into two core systems: new trailer technologies for use on road and rail, and the growth in container transport. Systems of bespoke trailers were developed that would ease the transfer of the trailer onto rail. For example, RoadRailer technology eliminated the need for placing trailers on flat wagons as the trailer became part of the rail-wagon frame. (Australian National's 1990 version is shown in Figure 19.) The RoadRailer is sometimes described as a "bimodal" vehicle.

A pivotal development that changed the economics of railed containers was the advent of double-stacked container movements.[182] The system could effectively double the payload capacity of the train because the stacking enables up to double the payload per rail wagon (where loading gauge and wagon axle-loads permit).[183] The Inter-State Commission referred to the "astonishing flip-flop the business has experienced" as a result of double-stacking.[184] (Inter-State Commission 1987, p. 215) In particular, until the advent of double-stacking it had been the container that had been giving traffic ground to the piggyback. However, with the increased payload afforded by double-stacking, the container returned to vogue, bringing about a steady decline in piggyback traffic.

On long-distance line-haul movements the stacking was estimated to achieve cost-savings of up to 40 per cent, greatly improving rail's competitiveness relative to road. (Martin 1996, p. J) The first notable double-stacking service was offered by the shipping and transport company American President Lines (APL) in 1984, between Chicago and Los Angeles. By 1992 the volumes of containerised intermodal rail exceeded that of rail–piggyback. By 2011 the double-stack rail wagon represented 80 per cent of the aggregate US railways' intermodal wagon fleet. (DeBoer 2011, p. 37)

Intermodal rail has increasingly become part of supply chains of growing complexity that have come with logistics systems. In response to the growing economies of intermodal freight, various manufacturing and parcel-delivery firms have responded by co-locating at rail-based logistics centres or building facilities that are adjacent to railway tracks; these actions enhance intermodal economics (through increasing the economies of density in train operation) and justify investments in sites and equipment that enhance productivity and market reach. For instance, Schulz noted that in 2009 the whitegoods manufacturer, Whirlpool, had:

182 Multiple-unit double-stack wagons reduced effective tare weight — further improving payloads over single-unit double-stack wagons — and the improved performance in motion reduced the risk of damage to goods. The Inter Box Connector (IBC), which secure boxes together on ships, were applied to these multiple units. Tare weight fell from 35 tons, on a conventional flat wagon, to 17 tons on each new wagon. (Resor and Blaze 4002, p. 46)

183 The genesis of the double-stack concept, and its early application, is set out in DeBoer 2011.

184 Until the advent of double-stacking it had been the container that had been giving traffic ground to the piggyback; with the increased payload afforded by double-stacking, the container returned to vogue since when the piggyback traffic has steadily declined.

> *…conquer[ed] one of the centuries-old disadvantages of intermodal—lack of accessibility. It did this by building 10 new distribution centers, all with rail docks in key locations near mainline or short haul tracks and close to highway access. Whirlpool now reports that it's using fewer trucks, products are moving uninterrupted, and there's less damage when shipped by rail. (Schulz 2011, p. 32)*

The USA was also a pioneer in international maritime intermodal movements; in 1929 Seatrain Lines (the trading name of Over-Seas Shipping Company) commenced the conveyance of loaded rail wagons on its specially-built ships between USA and Cuba; loading and unloading the cargo took 10 hours compared with up to six days with traditional cargo-handling. (Muller 1999, p. 13) Seatrain Lines as also the first liner company to initiate an international container ship service, in 1972; the service linked the USA, the Far East and Europe via the USA's domestic railway network. (Yoon, Pak and Kwon 2008, p. 10). The later development of international intermodal container rail services reflects the more recent application of containers to maritime freight driven by the growth in international trade, especially as manufacturing has developed in China. The mid-1980s development of the major near-dock Intermodal Container Transfer Facility by the Port of Los Angeles/Port of Long Beach was a vital step to the widespread application of rail marine container movements, complemented by the double-stacking revolution. By 2014 around one-half of the country's container movements were international flows.

For 2013, US and Canadian intermodal—that is, piggyback and container—traffic was 15.6 million units, up from 5.7 million units in 1988. When measured in units, in 2013 the container traffic represented 90 per cent of this traffic. (*Railway Age*, various issues)

APPENDIX D
Australian inquiries into the port landside task

This section outlines key findings and conclusions of a number of Australian inquiries and reports into landside aspects of port activities.

A. *Inquiry into the integration of regional rail and road networks and their interface with ports (Federal)*

This inquiry was undertaken by the House of Representatives' House Standing Committee on Transport and Regional Services. The report was published in 2007. (House of Representatives 2007)

Inquiry objective

The Standing Committee Inquiry was requested to inquire into the role of regional arterial road and rail networks in the national freight task, their links with ports, and policies and measures that could facilitate achieving greater efficiency.

Information and views

The inquiry considered a comprehensive range of planning, organisational structure and infrastructure issues that affect rail and road network efficiency. The following views are particularly relevant for this report:

- **Port access.** The Australian Rail Track Corporation (ARTC) commented upon rail capacity constraints to the Port of Brisbane's facilities on Fisherman Islands: "It is very difficult to get capacity into the port because it has to fight with capacity on the urban passenger system". (House of Representatives 2007, p. 55) Similarly, the Queensland Government noted that "rail freight capacity from the west of Brisbane, through the suburban network and thence to the Port of Brisbane is becoming a critical issue". (House of Representatives 2007, p. 55) By contrast, the Brisbane Port Corporation considered that the road connections to the port were very good, apart from the last few kilometres [which were subsequently upgraded as a motorway and opened in 2013]. (House of Representatives 2007, p. 56)
- **Supply chain coordination.** The Committee recognised the challenge of coordinating supply chains, such as intermodal container movements. It was noted that to achieve its coordination, the collaboration of erstwhile-competitors in the Hunter Valley coal logistics

chain had required special permission from the ACCC, and that the challenge of coordinating intermodal container movements was "immense". (Australian Logistics Council cited in House of Representatives 2007, p. 174–75) (This issue was discussed earlier in the report, using the Woxenius diagram, Figure 12.)

- **Short-haul prospects.** Evidence taken by the Committee included information about the (then) new intermodal terminal at Somerton, on the northern side of Melbourne. The representative from P&O Australia indicated that the company had taken a long-term lease over a rail siding at the terminal, in order to run a shuttle the 20 kilometres to Port Melbourne. It was cited that there were a number of major exporters and importers in the area; it was seen as a "very good example… of an intermodal facility that is guaranteed to succeed". (House of Representatives 2005, p. 32) In this context the inquiry also noted that the Australian Logistics Council had reported that "industry opinion is split between those concerned that distances between urban terminals and the Port are too short to be commercially viable, and others convinced that this obstacle can be overcome".[185] (House of Representatives 2005, pp. 200–01)

Conclusions

The Inquiry was provided a range of views and evidence that led it to establish a number of factors that are essential for intermodal flows. One submission cited six key criteria to be considered for regional terminal viability:

- sufficient volumes;
- back-up freight volumes if the freight is seasonal;
- adequate distance from the port;
- suitable terminal investment;
- competitive advantages over other supply chain options; and
- economic and social impacts.

In urban areas, securing suitable land for the terminal was often seen to be a major challenge. Addressing community amenity and environmental issues was seen as important in both regional and urban terminals. (House of Representatives 2007, pp. 170–71) Finally, the inquiry noted that value-adding services at and around the terminal were necessary:

> *What makes major hubs work is accumulating as much logistics and distribution activity [storage, distribution and associated value-adding services] as you can in the immediate proximity of your intermodal terminal. (View of Meyrick Consulting Group, cited in House of Representatives 2007, p. 171)*

That value-adding process included the role of terminals as facilitating exchange and storage of empty containers: "empty container storage is one of the key value-adding activities crucial to IMT [Intermodal Terminal] viability". (House of Representatives 2007, p. 172)

185 Austrak describes its Somerton Business Park and rail strategy at http://www.austrak.com.au/business-parks/somerton/strategy

Recommendations

The Committee recommended that the principles of the Hunter Valley supply chain logistics coordination could be applied to other transport chains. It recommended that the Government should investigate the most efficient means of storing and distributing empty containers. The Committee recommended that government should facilitate intermodal facility planning, development, upgrading and, where necessary, public funding. Finally, it recommended that the government should investigate and encourage strategic land banking in order to secure land for future intermodal developments. (House of Representatives 2007, p. xvi–xviii)

B. Railing Port Botany's containers (NSW)

This inquiry was undertaken by NSW's Freight Infrastructure Advisory Board and the report was published in 2005. (Freight Industry Advisory Board 2005)

Inquiry objective

In December 2004 the NSW government announced the establishment of a Freight Infrastructure Advisory Board to examine ways of increasing rail's mode share of containers moving through Port Botany.

Information and views

A submission to the Board by the Sea Freight Council of NSW highlighted the coordination issues in the container supply chain. By implication there were unnecessary container movements because information about container origins and destinations was not shared between the various supply chain players — the stevedores, empty container park operators, shipping lines and road and rail hauliers. It was also noted that terminal operating hours were not consistent with windows of access to the railway network. (Freight Industry Advisory Board 2005, p. 32)

Conclusions and recommendations

The published report contained a range of observations and recommendations; these included:

- **Supply chain coordination.** The Advisory Board noted the success of the Hunter Valley Coal Chain Logistics Team in improving the productivity of coal movements in the Hunter Valley. The Board noted that the port supply chain logistics were somewhat different in product and more complex in industry structure but, nonetheless, it saw merit in the logistics coordination. (Freight Industry Advisory Board 2005, p. 32)
- **Levy on peak-time trucked containers.** The report's authors recommended a levy on each TEU imported and exported. However it was suggested that railed containers would receive a full rebate as would trucked containers that moved at designated off-peak night-time periods. (Freight Industry Advisory Board 2005, p. 36)
- **Provision of sufficient rail terminal capacity.** The Board also recommended that the State government pursue a railed container market share of at least 40 per cent. In that context,

it was stressed that the government should ensure that there was sufficient intermodal terminal capacity to meet that target. (Freight Industry Advisory Board 2005, p. 4)

C. *Reforming Port Botany's links with inland transport. Review of the interface between the land transport industries and the stevedores at Port Botany (NSW)*

This inquiry was undertaken by the Independent Pricing and Regulatory Tribunal of NSW, between 2007 and 2008. (The final report is IPART 2008.)

Inquiry objective

The inquiry investigated claims of some stakeholders about inefficiencies in the flow of containers into and out of stevedore premises at the Port of Botany. The particular concern was the claims that the inefficiencies resulted in congestion, particularly for road transport. (IPART 2008, p. 1)

Information and views

Data presented to the Inquiry showed that rail had relatively high market shares in metropolitan and, especially, regional exports. These are presented in Table 10.

Table 10 Port Botany rail market share estimates, 2005–06

Origin or destination	Rail '000 TEU	Total '000 TEU	Rail market share
Metro imports	85	671	13%
Regional imports	0	4	0%
Metro exports, loaded	113	211	54%
Regional exports, loaded	90	110	81%
Empty exports	0	334	0%
Total	288	1 340	21%

Source: ARTC 2007, p. 7.

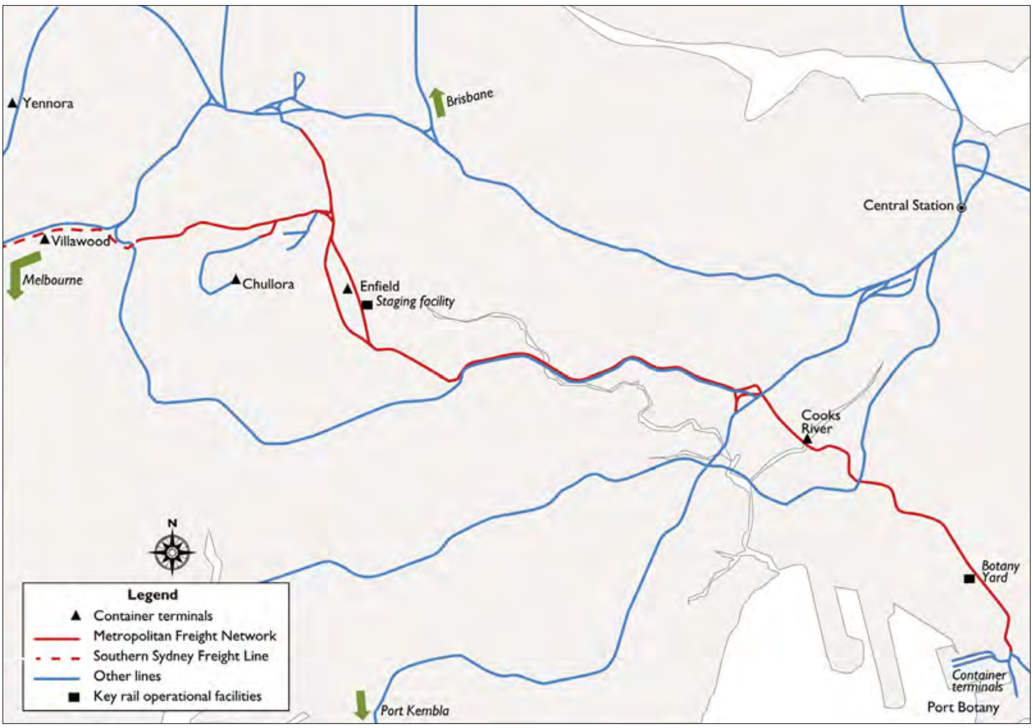
A number of relevant observations about railed international containers were made:

- rail traffic captured a "high proportion of full export containers" from regional areas but that the "majority of empty export containers and [loaded] import containers" (which comprised two box flows that totalled 75 per cent of all port container traffic) were from within the Sydney metropolitan area and were shifted by road. (IPART 2008, p. 93)
- industry participants suggested that rail's failure to move empty containers was due to the empty container parks being too close to the port to make rail competitive with road and that rail was insufficiently reliable to deliver containers "just in time". (IPART 2008, p. 94)
- the participants suggested that rail's failure to capture more import container traffic arose for two key reasons. First, rail delivered poor service quality (including poor reliability and container prioritisation). Secondly, railed-container costs were higher than for road. (IPART 2008, p. 94)

- the Inquiry concluded that service quality deficiencies arose from:
  - configuration deficiencies in the Botany rail yard;
  - inadequate siding lengths at the DP World terminal;
  - slow loading and unloading of the trains at the maritime rail terminals by the stevedores;
  - poor coordination of train movements, causing delays and preventing optimisation of the rail logistics; and
  - inability to move trains along passenger train routes at peak times. (IPART 2008, p. 95)

The context of the service quality deficiencies is a function of the legacy infrastructure configuration. Trains serve multiple yards at the port. There are the stevedore terminals at DP World and Patrick and, from 2013, at Hutchison; and there is the now-Qube-owned empty container park. Serving these multiple yards leads to complex (and, relatively low productivity) shunting movements, which increases costs and undermines reliability. Due to security and customs restrictions, trains with loadings for more than one stevedore are split offsite (usually in Botany Yard) and shunted into each terminal. Trains heading for the DP World terminal may require further splitting due to its shorter sidings. (See Figure 63.) The overall process for a train to serve all these facilities is time-consuming and complex, reducing flexibility in operations, undermining reliability and reducing efficiency in asset utilisation. IPART 2008, p 95) described the Port Botany rail system as a "sequence of bottlenecks".

Figure 63 Sydney's railway Metropolitan Freight Network



Conclusions

The inquiry made the following conclusions:

- **Unreliable service, stemming from poor operational and poor coordination to address infrastructure deficiencies.** (IPART 2008, pp. 3, 11). The establishment in 2009 of the Port Botany Rail Logistics Team, consisting of the key infrastructure and service providers in port–rail logistics, was a response to those coordination concerns.[186]
- **Rail was not price-competitive, with underlying low stevedore productivity.** It was concluded that rail had poor price-competitiveness (IPART 2008, p. 99). The Inquiry found that the costs incurred by rail were higher than those for containers shifted by road: IPART provided illustrative calculations, with a rail cost range of $560–710 per railed TEU compared with $468–520 per trucked TEU (IPART 2008, p. 108). It was noted that the service quality and reliability issues reduced equipment and train crew productivity. (IPART 2008, p. 99) Stevedores' then-installed rail terminal equipment resulted in railed containers having one additional lift than containers shifted by truck. The DP World facility also had an additional box move.[187] (See Figure 24.) It was also noted that the stevedores used rail-specific workers for railed boxes; such costs were being spread over relatively low rail throughputs. (IPART 2008, p. 100) IPART noted, however, that trucking activity around the port imposed social costs that were unpriced—that is, not factored into road freight costs. Those social costs include road congestion (with particular mention of the impact on passenger cars), increased accident risk, and pollution. (IPART 2008, p. 100)
- **Charges faced by port users were not reflective of financial and economic costs.** IPART noted a number of examples where the true cost of services is not reflected in the price. It found that the rail window booking fee "does not appear to be reflective of the costs of providing a window and associated services". It concluded that shipping lines were not facing the full cost consequences of their decision on locating empty container de-hiring facilities; and that road hauliers were not facing the full social cost consequences of their activities. (IPART 2008, p. 101) Finally, the Inquiry noted that there appeared to be no train scheduling mechanism to prioritise high-value freight over passenger trains (IPART 2008, p. 102).

While the (at the time, under-construction) Southern Sydney Freight Line would provide new dedicated freight capacity through southern Sydney in peak time, the inquiry noted that the Minto terminal would not be connected to that new line. That is, the new line would not resolve the peak-period accessibility issues for that particular terminal (IPART 2008, p. 96).

Recommendations

The Inquiry considered a range of options to try to transfer boxes from road to rail. It was averse to subsidising railed boxes, including applying a Freight Infrastructure Charge to trucks and using the proceeds to subsidise rail. (IPART 2008, p. 111)

186 In 2014 the Cargo Movement Coordinator commenced, subsuming the Port Botany Landside Improvement Strategy and establishing a Rail Operations and Coordination Committee. The objective of that Committee is to improve rail's reliability and efficiency through the Port Botany supply chain. (pwc 2014, p. 18)

187 The Inquiry estimated that each additional lift cost stevedores $30 while DP World's additional box move costs was $30. (IPART 2008, p. 102). IPART considered that Patrick's lift costs would fall once its Rail Mounted Gantries became fully functional. (IPART 2008, p. 107)

D. Inquiry into rail freight use by the agriculture and livestock industries (Queensland)

This inquiry was undertaken by the Queensland Parliament's Transport, Housing and Local Government Committee, in 2013–14. (The final report is Queensland Parliament. Transport, Housing and Local Government Committee 2014)

Inquiry objective

The inquiry was undertaken to identify ways to encourage the agriculture and livestock industries to make greater use of the railways.

Information and views

Given the Inquiry's focus on local agricultural products, the context of the information considered here relates to exported container traffic. The principal commodities are, in descending order of containerised traffic, meat, cotton and grain.

The Inquiry noted that freight market have pursued higher payloads, with more reliable, faster and more timely deliveries. These market developments were set against rail path capacity problems (from other rail network users) and rail's ongoing rail infrastructure deficiencies. It was concluded that rail's service has increasingly been out of phase with the market, whose needs have been catered for by road freight, with enlarged permitted road vehicle dimensions.

The Inquiry noted key elements of railway infrastructure that undermine competitiveness. The Inquiry's focus on the Toowoomba line is relevant as Toowoomba has been considered as a suitable location for an inland terminal. (Queensland Parliament 2014, pp. 6, 87)

- **Restricted tunnel heights.** Train height restrictions, to the west of Brisbane, rule out the use of high-cube containers (9' 6''). The 8' 6'' container, with its smaller volume and potential payload, must be used, against a background of declining use in international trade. (Port of Brisbane 2014, p. 9)
- **Low axle loads.** Payloads are also constrained by relatively low wagon axle loads—it is 15.75 tonnes per axle on the Toowoomba line. (On the interstate main lines the axle loads are generally 20 or 21 tonnes; on main line railways of North America it is around 33 tonnes per axle.)
- **Restricted train lengths.** Train lengths are also restricted on the Toowoomba line to 650 metres (which compares with an unconstrained 1 500 metre train length between Brisbane and Melbourne).
- **Restricted line capacity.** Toowoomba line capacity is constrained by the limited number of passing loops on the single-track railway. The inquiry found that in the preceding ten years, agricultural rail services had faced greater competition from coal and minerals haulage for the limited train paths.
- **Permitted truck payloads raised.** In the decade preceding the inquiry that period road competition increased, with larger road vehicles (with higher payloads), and delivering greater service reliability, flexibility and responsiveness.

The restricted container sizes, wagon weight and train length have the cumulative effect of undermining linehaul train economies of density: train and wagon payloads are suboptimal. By contrast, linehaul truck economies were improved as road hauliers responded to the increase in permitted road vehicle sizes (and, thus, in their payloads).

There are no urban short-haul rail movements serving the Port of Brisbane. The Port of Brisbane noted that in the ten years prior to 2014 the rail share of container traffic through the port had declined from 15 per cent to less than 5 per cent. (Port of Brisbane 2014, p. 1) There are regional short-haul rail export traffic to the Port of Brisbane. Around 16 per cent of containerised meat (in refrigerated containers — "Reefers") is delivered to the port by rail, from the central and north Queensland abattoirs at Biloela, Rockhampton and Mackay. (Port of Brisbane 2014, p. 5)

Cotton lint is exported in 40 foot containers, with 70 per cent of the box packing occurring outside of Brisbane. At the time of the inquiry, however, of that non-Brisbane traffic, only 14 per cent was being shifted by rail with all of that railed cotton coming from one location, Goondiwindi. Cotton had previously also been railed from Dalby and Oakey. Some cotton seed is exported in containers, with 86 per cent of which being boxed in regional areas; 5 per cent of that boxed cotton seed was being delivered by rail.[188] (Port of Brisbane 2014, p. 4)

Grain market deregulation has led some exporters to containerise some grain (as it provides "more market flexibility") and three-quarters of this grain is boxed in regional centres, but none of those boxes are moved by rail. (Port of Brisbane 2014, pp. 2–3) One-quarter of the exported containerised grain is packed in Brisbane, some of which arrives at the packing facility at the port by bulk trains, using hopper wagons.

Despite the broad range of railway infrastructure deficiencies that the Inquiry identified, it was noted that the Brisbane Multimodal Terminal "can load and unload with extreme efficiency". In the Inquiry proceedings a contrast was drawn between that single terminal and the three terminals at Port Botany, with the suggestion being that serving just one rail terminal was more efficient. (Queensland Parliament 2014, p. 95)

Conclusions and recommendations

The Inquiry concluded that the rail service was a "shambles" due to out-dated and inefficient infrastructure; limited access to train paths; inefficiencies in the supply chain; and inefficient, unreliable and inflexible rail services. This situation was exacerbated by improvements in road freight. (Queensland Parliament 2014, p. xi)

Recommendations that the Inquiry made that are relevant to this report include identification and prioritisation of infrastructure needs (maintenance and upgrading of existing railways and construction of new railways); investigation of prospects and locations for inland ports and government facilitation of such projects; and upgrading and re-opening loading and unloading facilities at existing facilities. (Queensland Parliament 2014, pp. xiii, xvii).

188 After the release of Inquiry findings, it was reported that Namoi Cotton, the Goondiwindi producer, had shifted its operation to road transport in 2014 when the train operator raised its haulage charges in its new contract terms. (Railway Digest 2015a, p. 18)

E. Review of port planning: final report (Victoria)

The inquiry was undertaken by the Essential Services Commission [Victoria] in 2007. (Essential Services Commission 2007).

Inquiry objective

The focus of the inquiry was to review the impact of port planning on competition in stevedoring and related port services.

Information and views

The Essential Services Commission (ESC) assessed the factors that would encourage shuttle trains. The ESC put the case for a light-handed regulation of terminal access, noting that "intermodal terminals will tend to have localised market power", and arguing that access regimes would be better than controlling ownership.The Commission's subsequent conclusion is noteworthy:

> *Indeed, vertical integration of terminal ownership, rail operations and intermodal terminal operation may help develop shuttle train operations. (ESC 2007, p. 19)*

The ESC concluded that "critical success factors" for the inland terminals included that they be well-located near, and accessible to, main line railways, and that they should undertake value-added activities.The Commission determined that terminals need to:

- have a "substantial scale";
- have a "wider scope of operations than only urban freight movements";
- be "located adjacent to interstate rail lines and are used or usable by interstate rail services";
- involve a wide range of container-related services and other value-added activities; and
- incorporate empty container movements through the terminal. (ESC 2007, pp. 19, 226)

The Commission identified a number of deficiencies in the rail facilities at the port;

- **Deficiencies in rail maritime terminal configuration.** The ESC concluded that "the current rail terminal configuration [in Melbourne] is the reason for a cost differential that currently exists between rail and road for the handling of boxes at the port terminal". (ESC 2007, p. 19)
- **Higher stevedore costs, partly because of box double-handling.** Stevedore costs for loading/unloading railed containers were higher than for road containers, which "may be higher for rail, in part, because of the cost of transporting containers from the cargo marshalling areas within the container terminal to the nearby rail terminals, and the associated double handling". (ESC 2007, p. 226) In this context, the ESC decided that Pacific National had reduced its costs by establishing the rail facilities on-dock, "through greater efficiencies in the integrated operation with Asciano [Pacific National's parent company] at the port. (ESC 2007, pp. 23, 253)

Other rail provision configuration issues at the port included:

- the long distances between sidings and container stacks;

- the need for the West Swanson containers to be shifted between the terminal and the stacks by road vehicle rather than by Port Precinct Vehicles (PPV) as the boxes need to be moved across a public road.(ESC 2007, pp. 47, 225)
- when there was congestion at the East Swanson terminal, boxes have to use the Dynon rail terminal (beyond the port perimeter); there was a lack of train stabling and marshalling facilities in the Dynon precinct. (ESC 2007, pp. 48, 230)
- containers moving through the East Swanson terminal that are destined for West Swanson have to be delivered by truck; ARTC proposed a direct rail connection between the two terminals (ESC 2007, pp. 47, 229).

For successful port shuttle services, the ESC suggested that there should be sufficient train paths (that is, track capacity) on the metropolitan network for 30–40 train services per day. Two services per day from each of three inland terminals was envisaged, with train lengths of around 500–600 metres in length (that is, around 60 TEU) (ESC 2007, p. 234).

Asciano were sceptical of operating short shuttle trains, noting how the economics of running short shuttle trains worked against CRT's *Cargo Sprinter*. Asciano commented that, to be competitive, the shuttle trains need to "have either 'density or distance'. Short distance shuttles of short trains clearly have neither." (ESC 2007, p. 235)

Conclusions and recommendations

The ESC made a wide range of recommendations. A key aspect of the port planning was the recommendation to facilitate the development of rail-port shuttles. The ESC recommended work on enhancing port and inland terminals, rather than subsidising rail shuttles. (ESC 2007, p. 20) A Melbourne Intermodal Terminal, located to the north of Footscray Road, was proposed, complemented by three metropolitan terminals (Altona, Somerton, Lyndhurst). (ESC 2007, p. 19)

The Commission noted that rail traffic was likely to be biased towards exports (as at present) and therefore that there would be a back loading problem (that is, relatively few containers moving from the port to the metropolitan terminals). It was suggested that changes to the management of empty containers — that is, using the empty trains from the port to shift the empty containers — could provide the necessary traffic to facilitate cost recovery. (ESC 2007, p. 236)

The development of shuttle trains and metropolitan terminals has since been developed in the State's Metropolitan Intermodal System.

F. *Inquiry into managing transport congestion (Victoria)*

In 2005 the Victorian government initiated an inquiry into managing transport congestion.

Inquiry objective

The objectives of the inquiry were to identify the nature and incidence of transport congestion, to identify the impact of that congestion on businesses and supply chain efficiency, to identify regulatory and institutional barriers to achieving progress in tackling that congestion, and to identify approaches adopted overseas. (Victorian Competition & Efficiency Commission 2005)

Information and views

In its submission to the Inquiry, the Port of Melbourne Corporation presented data on the market shares and distribution of port-railed containers—see Table 11.

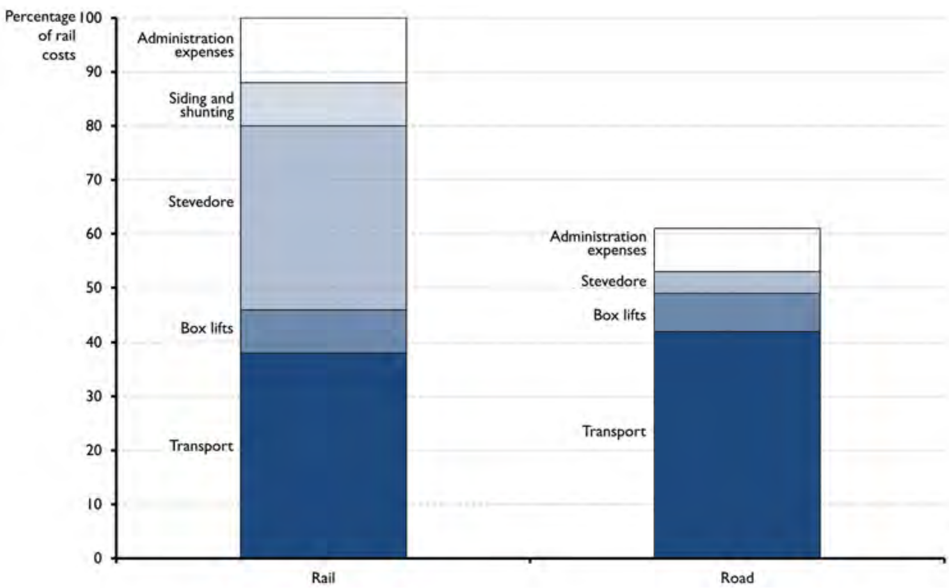
Table 11 Rail share by journey length and type, 2002, percentage

Journey type and length	Import containers	Export containers	All containers
Metropolitan	1	1	1
Victorian country, under 250 km	8	82	53
Victorian country, over 250 km	24	97	95
Interstate	84	92	90
Total	4	87	46

Source: Port of Melbourne Corporation 2005, p. 9.

In its submission to the Inquiry, Westgate Ports (now part of Qube Holdings) reported that it had undertaken comparative road and rail costs for haulage between the Port of Melbourne and metropolitan terminals. The results varied in accordance with the road and rail vehicles used. However, Westgate found that the additional rail cost for moving a TEU ranged from around $51–$60 for an 11–15 kilometre zone from the port (Altona), to $50–$112 for a 36–40 kilometre zone (Lyndhurst). The company attributed the cost differential to the drayage at each end of the journey.[189] (Westgate Ports 2005, p. 7)

Figure 64 Relative rail and road costs of moving a TEU between Altona and the Port of Melbourne



Notes: This chart is redrawn from that presented in CRT Group 2005, p. 6. The rail stevedore fee is a charge for accessing rail infrastructure while the road stevedore fee is a "slot booking fee".

189 Subsequently, in 2007–08, the company installed (dual-gauge) rail tracks to its Victoria Dock operations, since when it has been linked by daily (excluding Sunday) rail services from Maryvale in eastern Victoria. The track to the company's Maryvale factory have also since been upgraded.

The logistics company, CRT, made a submission to the Inquiry that provided calculations on the relative costs of operating its port-shuttle service between Altona (in western Melbourne) and the Port of Melbourne. CRT offered estimates of rail and road costs, concluding that at mid-2006 the corresponding road freight rates could be 40 per cent lower than rail. (CRT Group 2005, p. 6) The relative cost itemisation for moving a TEU container was presented (as illustrated in Figure 64). (As discussed earlier (p. 88), however, the per-TEU costs should fall substantially if there were higher traffic volumes. That the costs would fall if economies of density in train operation could be realised.)

CRT Group noted the difference between the stevedore's rail and road fees. The company indicated that its rail infrastructure access fees were invariable with train length and this worked against the use of the company's *Cargo Sprinter* short-train operation between Altona and the port. Other factors also worked against the operation, such as with a one-hour transit time for the 22 kilometres between the Altona North terminal and the port. To recover its costs, including rail siding investment, the company required load capacity utilisation of 85 per cent but its import utilisation in 2004–05 was only 42 per cent and its export utilisation was only 58 per cent. As a result, the company withdrew that shuttle service. (CRT Group 2005, pp. 6–7)

In its submission, P&O Ports noted its establishment of its Somerton Intermodal facility, 20 kilometres north of the port. The company indicated that its facility:

> *…benefits from a strong natural catchment for container volumes, which together with reasonable rail freight access to the port is key to the success of such a venture… and, in 2006, we expect to contract in a port rail shuttle service to handle the bulk of volumes to and from the port." (P&O Ports 2005, pp. 4–5)*

P&O Ports considered that rail mode share would occur with efficient terminal interface, minimal train splitting and shunting, and shuttle services that are not unduly affected by passenger-train prioritisation.

Conclusions and recommendations

The Inquiry concluded that the potential of inland ports is not being realised and that the main impediments to be resolved were the lack of track access to the port, the operation of the rail access regime, and that for short distances the rail costs were higher than road costs. (Victorian Competition & Efficiency Commission 2006, p. 336)

The Commission did not support the proposal to rebalance the cost differential between rail and road by imposing a levy on containers shifted by road (Victorian Competition & Efficiency Commission 2006, p. 344.

G. *Metropolitan intermodal terminal study 2011 (national)*

This study of maritime-based intermodal terminals was conducted by a staff member of Shipping Australia Limited in 2011.

Study objective

The study examined the practical and commercial issues that it identified as needing to be addressed to ensure the success of intermodal terminals. Case studies in Sydney and Melbourne were used to inform the study. The study drew on quantitative material from the Sea Freight Council of NSW's report into container movements. (Sea Freight Council of NSW, 2004)

Information and views

The report illustrated the relative costs of road and rail handling. An estimate was presented of average road and rail handling costs between urban locations and Port Botany: road costs between a shipper's facility and the port stack were estimated at $458; road costs between a shipper's facility and the port stack via a transport depot were estimated at $634; and rail costs via an intermodal terminal were estimated at $476. (Shipping Australia 2011, p. 12)

The study concluded that a forecast rise in road congestion would increase costs, reduce pickup and delivery reliability, and lead to higher vehicle operating costs. (Shipping Australia 2011, pp. 12–13)

The study emphasised that future rail viability relied upon attracting higher volumes [to achieve economies of density].

Conclusions

The report concluded that at Port Botany rail operations incurred a mismatch between times for stevedore handling windows and linehaul train paths. It was reported that the efficacy of the stevedore windows was being undermined because of the "large number" of shunting moves required at the maritime facilities. (Shipping Australia 2011, p. 15) It was argued that overall rail efficiency could be improved by establishing a coordination committee that would facilitate better timing of operations.

The authors believed that establishing a single train operator at the port would reduce shunting and improve coordination; this approach would be similar to that adopted with the Pacific Harbor Line operation at the Ports of Los Angeles/Long Beach—see p. 85. It argued for:

> *Dedicated stevedore rail services to minimise shunting activities and guarantee seamless 24/7 rail movements at the port terminals. (Shipping Australia 2011, p. 30)*

It was argued that there was "significant operational inefficiency" at Patrick's Appleton rail terminal serving East Swanson Dock in the Port of Melbourne, with track capacity to load or unload one train at a time. Further, "previous attempts" to run rail shuttle services between Somerton/Altona and the port faced prioritisation of passenger trains over the shuttles. (Shipping Australia 2011, p. 20)

The study concluded that rail services had high operating costs and poor service quality (especially in slow and unreliable services). Principal factors cited included:

- linehaul: high track access fees;
- terminal: higher handling costs for railed containers;

- service quality: intermodal services are constrained because passenger trains are given priority; and
- service quality: mismatch between stevedore train handling windows and linehaul train pathing increased terminal costs and unreliability.

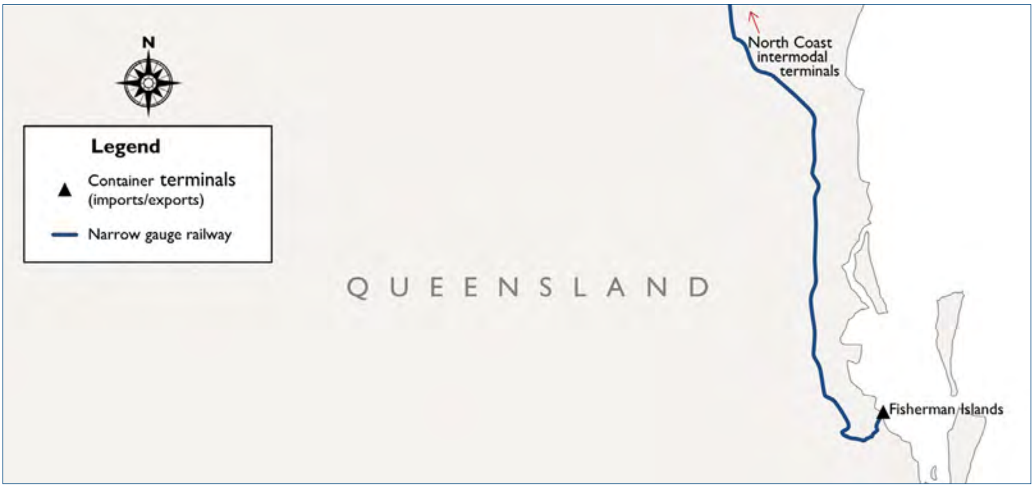
The higher handling costs arise from low terminal productivity at terminals. This arises for a number of reasons. First, there is double-handling of containers (relative to road-based handling). Secondly, the layout of current rail facilities and port–rail interfaces at both ports lead to excessive shunting and inspection. Thirdly, there is a mismatch of timing for maritime terminals box handling and timing for linehaul rail pathing.

APPENDIX E

Port rail services in Australia

This appendix presents maps showing port rail container services to the major ports. Where boxed commodity flows are known, they are denoted as "E" for exports and "I" for imports.

Figure 65 Rail container operations serving the Port of Brisbane (Fisherman Islands)



Port-based intermodal operations, with shipper and commodities listed, includes:

Biloela/Rockhampton	Theys Brothers/Cargill — refrigerated meat [E]

Figure 66 Rail container operations serving Sydney Ports (Port Botany)

Port-based intermodal operations, with shipper, or logistics operator, and commodities listed, include:

Coonamble	Agrigrain — grain, lupins, chick peas, faba beans [E]
Narrabri	Viterra, AGT Foods Australia — cotton, grain, chick peas [E]
Warren	Namoi Cotton, Auscott — cotton seed/lint[E]
Nevertire	Auscott — cotton seed/lint [E]
Wee Waa	Namoi Cotton — cotton seed/lint [E]
Trangie	Namoi Cotton — cotton seed/lint [E]
Narromine	Namoi Cotton — cotton seed/lint [E]; Agrigrain — grain [E]
Dubbo	Fletcher International Exports — refrigerated meat, grains, pulses [E]
Manildra	Manildra Flour Mills — flour [E]
Forbes	Mountain Industries (part of Asciano) — agricultural products
Harefield/Junee	Visy Pulp and Paper — paper (cardboard) [E]
Bathurst	P F Olsen — logs [E]
Kelso	Grainforce Commodities — logs, grain [E]
Newcastle	Crawfords Freightlines (at Sandgate) — sawn timber, aluminium ingots, refrigerated meat, pet food, oils, sand [E]
Goulburn	International Primary Projects — logs [E]
Canberra	Access Recycling Services — scrap metal [E]
Bomaderry	Manildra Flour Mills — starch, gluten [E]
Yennora	Woolworths [I] — unknown; Australian Wool Exchange — wool [E]
Minto	Cargill — maltings [E]; Kimberly-Clark — paper [E]; Sunbeam — electrical appliances [I]

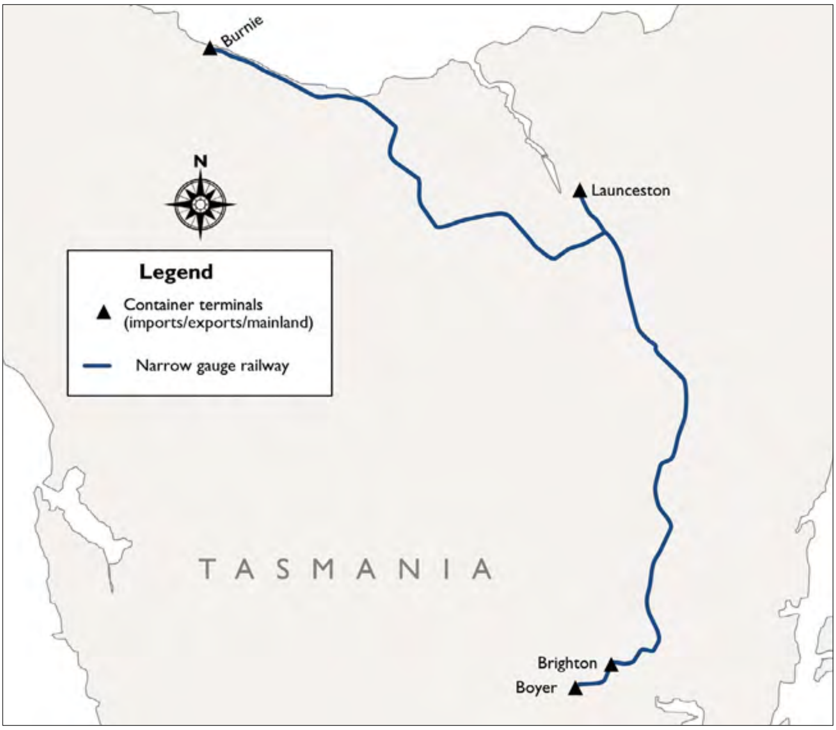
Figure 67 Rail container operations serving the Port of Melbourne

Port-based intermodal operations, with shipper, or logistics operator, and commodities listed, include:

Deniliquin	Rice Growers' Co-operative (Sunrice) Co-op — rice [E]
Tocumwal	Grays Intermodal — grains and other agricultural products [E]
Ettamogah (Albury)	Manufacturing and grain [E]
Donald	Peaco (Peagrowers Co-operative) — faba beans, chick peas and other pulses [E]
Merbein (Mildura)	Wakefield Transport with Seaway Logistics — grains, wine, dried fruits, oranges, grapes, cotton bales and seed, almonds, other agricultural products, mineral sands [E]
Dennington (Warrnambool)	Wettenhalls (formerly Westvic) — dairy and meat [E]
Dooen	Johnson Asahi (hay), with terminal operator Wimmera Container Line (a subsidiary of SCT) — grains, pulses, hay [E]
Bomen	Teys, JBS Swift, Heinz Watties, Riverina Oils & Bio Energy (ROBE) — agricultural products [E]
Mooroopna (Shepparton)	agricultural products [E]
Griffith[190]	Casella Wines/Coca-Cola Amatil — wine and beer; Southern Cotton — cotton; grain, meat [E].
Wumbulgal	Western Riverina Intermodal Freight Terminal, operated by consortium including Australia Grain Link, United World Enterprises, and Shanghai Dairy Group — grains, oaten hay, cotton, walnuts [E]
Leeton	Sunrice—rice [E]
Maryvale	Australian Paper (Nippon Paper) — paper products [E]

190 Note, also, on the outskirts of Griffith, the Widgelli Rail Hub was approved in 2015. It is being developed by Colin Rees Group. It is intended that the hub will be served by the company's Regional Connect rail shuttles to Junee and Cootamundra, where freight will be attached to mainline rail services. Further material is available at http://ettamogah-hub.com.au/2015/09/21/a-new-rail-hub-for-griffith/.

Figure 68 Rail container operations serving the Port of Burnie[191]



Port-based intermodal operations, with shipper, or logistics operator, and commodities listed, include:

Boyer	Norske Skog — paper
Brighton (Hobart)	Toll —
Launceston	not known

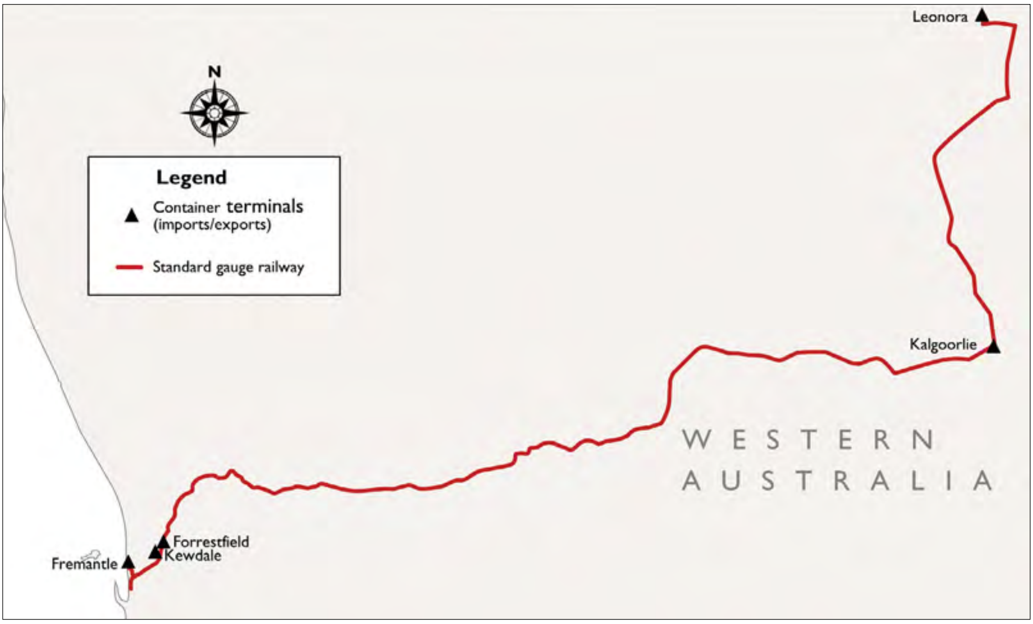
191 In September 2015 TasRail opened the George Town Freight Terminal, and the operator seeks to run intermodal trains serving the facility, to link with the nearby port of Bell Bay. (http://cg.tas.gov.au/__data/assets/pdf_file/0017/123803/Bell_Bay_Industrial_Precinct_Prospectus.pdf)

Figure 69 Rail container operations serving Port Adelaide (Outer Harbor)

Port-based intermodal operations, with shipper, or logistics operator, and commodities listed, include:

Bowmans	Balco Australia (joint-ownership with other parties) — coarse feed, grain, pulses, wine [E]
Port Pirie	Nyrstar — lead, zinc [E]
Direk/Penfield	Treasury Wine Estates — wine [E]

Figure 70 Rail container operations serving the Port of Fremantle



Notes: Nickel Matte from Leonora is exported through Fremantle Outer Harbour (Kwinana).

Tracks between Northam (in the Avon Valley) and Fremantle's ports are dual standard and narrow gauge but the intermodal trains operate on standard gauge.

Port-based intermodal operations, with shipper, or logistics operator, and commodities listed, include:

Forrestfield	Metro Grain Centre (part of the CBH Group) — grain, hay (E)

References

ACCC—see Australian Competition & Consumer Commission

Acciaro, M and McKinnon 2013, *Efficient hinterland transport infrastructure and services for large container ports, Discussion paper 2013-19*, International Transport Forum, Paris. http://www.internationaltransportforum.org/jtrc/DiscussionPapers/DP201319.pdf

Anderson, A 2013, "Improved settings for ports—the national ports strategy requires a more definitive approach", *Shipping Australia*, Autumn, pp. 88–90. https://shippingaustralia.com.au/wp-content/uploads/2012/07/Annual-2013.pdf

Armstrong, J H 1978, The railroad—what it is, what it does. The introduction to railroading, Simmons-Boardman Publishing Corporation, Omaha.

ARTC—see Australian Rail Track Corporation

Asciano 2009, *Submission to the Essential Services Commission. Review of the Victorian Rail Access Regime–Draft Report*, http://www.esc.vic.gov.au/getattachment/c2c6fd34-8ea2-49d8-809e-5fcb09a8ca45/Asciano.pdf

Ashar, A 1988, "On-Off Dock Intermodal Transfer, The Perplexing Case of Long Beach", *World Wide Shipping* (WWS), September, pp. 46–51.

Ashar, A 1992, "On-off terminal ship-to-rail transfer", *ASCE/PIANC Port's '92 Conference Proceedings*, Seattle, July, pp. 108-31.

Ashar, A 1997, "Counting the moves", *Port Development International*, November, pp. 25–9.

Ashar, A 2004, "Reversals of fortune", *Containerisation international*, January, pp. 58–61.

Ashar, A and Swigart, S 2007, *A comparative analysis of intermodal ship-to-rail connections at Louisiana deep water ports*, Report prepared for Louisiana Department of Transportation & Development. http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Multimodal/Marine_Rail/Misc%20Documents/A%20Comparative%20Analysis%20of%20Intermodal%20Ship%20to%20Rail%20Connections%20at%20Louisiana%20Deep%20Water%20Ports.pdf

Ashar, A 2009, "The de-intermodalization of Southern California ports", *White paper*, University of New Orleans Ports and Waterways Initiative, http://www.asafashar.com/De-Intermodalization%20(3).pdf

Auditor General NSW, 2013. *NSW Auditor General's Report to Parliament, Volume 8, Ports Overview*. http://www.audit.nsw.gov.au/ArticleDocuments/291/04_Volume_Eight_2013_Ports_Overview2.pdf.aspx?Embed=Y

aurecon 2013, *Research into freight hub/inland port development in the Waikato Region*, Report prepared for Waikato Regional Council, http://www.waikatoregion.govt.nz/PageFiles/19549/

Appendix%20iii%20(Item%203)-%20%20Freight%20Hub%20Inland%20Port%20Research%20Doc%20%232382462.pdf

Austrak 2015, *Submission to Inquiry into the proposed lease of the Port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Submissions/Submission_59_-_Austrack.pdf

Australian Competition & Consumer Commission 2010, *Container stevedoring monitoring report no.. 12*, http://www.accc.gov.au/system/files/ACCC%20container%20stevedoring%20monitoring%20report%20no%2012%202009-10.pdf

Australian Competition & Consumer Commission 2013, *Container stevedoring monitoring report no.. 15*, http://www.accc.gov.au/system/files/Container%20stevedoring%20monitoring%20report%20no.%2015%20-%20October%202013.pdf

Australian Competition & Consumer Commission 2015, *Container stevedoring monitoring report no.. 17*, http://www.accc.gov.au/system/files/Container%20stevedoring%20monitoring%20report%202014-15%20-%20word%20version.pdf

Australian National Railways Commission 1990, *Annual Report 1989–90*, ANRC, Adelaide.

Australian National Railways Commission 1992, *Annual Report 1991–92*, ANRC, Adelaide.

Australian National Railways Commission 1993, *Annual Report 1992–93*, ANRC, Adelaide.

Australian Rail Track Corporation 2007, Submission to the Independent Pricing and Regulatory Tribunal. Review of the interface between the land transport industries and the stevedores at Port Botany, http://www.ipart.nsw.gov.au/files/ef9504de-fb64-4ebb-912a-a291008bea46/Submissions_-_ARTC_-_Port_Botany_Review_-_13_June_2007_-_Terry_Bones_-_APD.pdf

Australian Rail Track Corporation 2010, *Melbourne–Brisbane Inland Rail Alignment Study. Final report. Appendix B. Market take up*, Report prepared by ACIL Tasman, http://www.artc.com.au/library/IRAS_Appendix_B.pdf

Australian Rail Track Corporation 2015, *2015–2024 Sydney metropolitan freight strategy*, http://www.artc.com.au/uploads/2015-Sydney-Metro-Strategy-Final.pdf

Barnard, B 2009, "Euro view: inland shipping makes plans to lure cargo", *Journal of commerce*, 18 February. n.p.

Beach, R, Engström, O and Liu, H 2013, "Direct short sea shuttle concept", Paper prepared for Master Thesis at Department of Technology Management and Economics, Chalmers University of Technology, Göteborg.

Beresford, A, Pettit, S, Xu, Q and Williams, S 2012, "A study of dry port development in China", *Maritime economics and logistics* 14, 1, pp. 73–98.

Bergqvist, R and Monios, J 2014, "The role of contracts in achieving effective governance of intermodal terminals", *World review of intermodal transportation research 5, 1, pp. 18–38*.

Bergqvist, R, Falkemark, G and Woxenius, J 2010, "Establishing intermodal terminals", *World review of intermodal transportation research* 3, 3, pp. 285–302. http://gup.ub.gu.se/records/fulltext/125546/125546.pdf

Bergqvist, R and Woxenius, J 2011, "Hinterland transport by rail—the story of Scandinavia and the Port of Gothenburg", *Journal of interdisciplinary economics* 23, 2, pp. 161–175.

BITRE—see Bureau of Infrastructure, Transport and Regional Economics

Bontekoning, Y M and Priemus, H 2004, "Breakthrough innovations in intermodal freight transport", *Transportation planning and technology* 27, 5, October, pp. 335–45.

Booz & Co 2008, *Capacity constraints & supply chain performance — intermodal. Working paper #1—understanding the intermodal supply chain*. Paper prepared for the National Transport Commission, Melbourne, http://ntc.wdu.com.au/filemedia/Reports/BoozCoInterSCWkgPap1App1Mar09.pdf

Booz Allen Hamilton 2006, *International approaches to tackling transport congestion. Paper 12 (final): urban freight*, Paper prepared for the Victorian Competition and Efficiency Commission, http://www.vcec.vic.gov.au/files/ef72b1fe-df54-48ed-a448-a35d00c3c3c9/International-approaches-to-tackling-transport-congestion-Paper-12-Urban-Freight-12-April-2006.pdf.

British Columbia 2006, *Inland container terminal analysis. Final report*, http://www.th.gov.bc.ca/PacificGateway/documents/061215_Inland_Container_Terminal_Analysis.pdf

British Rail 1965, Freightliner, British Railways Board, London. www.railwaysarchive.co.uk/documents/BRB_Freight1965.pdf

British Railways Board 1963, *The reshaping of British Railways.* [The Beeching Report] HMSO, London

Brooks, M R, Pallis, T, Perkins S 2015, "Summary of discussions", Paper in *Port investment and container shipping markets, International Transport Forum Roundtable Report 157*, http://internationaltransportforum.org/2015/free-publications/02.pdf

BTE—see Bureau of Transport Economics

BTRE—see Bureau of Transport and Regional Economics

Buckley, A, Hussey, F, Lazzari, L 1992, "Improving rail's market share. The issues—train reliability", Report prepared for the Australian Rail Industry Advisory Council.

Bureau of Infrastructure, Transport and Regional Economics 2012, Trainline 1. *Statistical report*, www.bitre.gov.au/publications/2012/files/trainL_001.pdf

Bureau of Infrastructure, Transport and Regional Economics 2014, Trainline 2. *Statistical report*, https://www.bitre.gov.au/publications/2014/files/trainline_002.pdf

Bureau of Infrastructure, Transport and Regional Economics 2014. *Waterline 54*. https://www.bitre.gov.au/publications/2014/water_054.aspx

Bureau of Infrastructure, Transport and Regional Economics 2015. *Waterline 55*. https://www.bitre.gov.au/publications/2015/water_055.aspx

BITRE—see Bureau of Infrastructure, Transport and Regional Economics

Bureau of Transport and Regional Economics 2003, *Rail infrastructure pricing: principles and practice, Report 109*, http://www.bitre.gov.au/publications/2003/files/report_109.pdf

Bureau of Transport and Regional Economics 2006, *Optimising harmonisation in the Australian railway industry. Report 114*, www.bitre.gov.au/publications/2006/files/report_114.pdf

Bureau of Transport Economics 1975, *The economics of an Australian landbridge*, BTE, Canberra, http://www.bitre.gov.au/publications/1975/files/report_015.pdf

Bureau of Transport Economics 1975, *Transport Outlook Conference*, Canberra, 29–30 July.

Bureau of Transport Economics 1979, *The long distance road haulage industry*, www.bitre.gov.au/publications/1979/files/report_041.pdf

Burton, M 2011, U30: evaluation of freight vehicles in short-haul intermodal lanes. Report produced for National Transportation Research Center, Inc., USA.

Butcher, L 2009, "Lorry sizes and weights", *House of Commons Library Standard Note SN/BT/654*, http://researchbriefings.files.parliament.uk/documents/SN00654/SN00654.pdf

Carter, M 2014. "All aboard the wine train". *Catch Point*, November, pp. 4-7.

Centin, C K 2012, "Port and logistics chains: changes in organizational effectiveness", Paper presented in Song and Panayides (eds), *Maritime logistics. A complete guide to effective shipping and port management*, Kogan Page, London.

City of Melbourne 2012, *Transport strategy 2012. Planning for future growth*, http://www.melbourne.vic.gov.au/AboutCouncil/PlansandPublications/strategies/Documents/TransportStrategy/Transport_Strategy_2012.pdf

Clarke, D B 2014, "Railway intermodal transportation", Paper presented to *Railroad Engineering Education Symposium*, The American Railway Engineering and Maintenance-of-Way Association, Kansas, http://www.engr.uky.edu/~jrose/ce433presenatations/CE%20433%20RR%20PPs/REES%202014-Railway%20Intermodal%20Transportation.pptx

Colin Rees Group 2015, "Public submission by Colin Rees, Ettamogah Rail Hub", *Submission to Inquiry into the proposed lease of the Port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Submissions/Submission_56_-_Colin_Rees_Group.pdf

Committee for Study on Landside Access to Ports 1993, *Landside access to U.S. ports*, Special Report 238, Transportation Research Board, National Academy Press, Washington, D.C.

CRT Group Pty Ltd 2005, Submission (36) to *Inquiry into managing transport congestion*, held by the Victorian Competition & Efficiency Commission, http://www.vcec.vic.gov.au/files/fda9e12e-418d-4e33-a2c8-a3a401084cce/36-CRT-Group-Pty-Ltd.pdf

Cullinane, K, Bergqvist, R and Wilmsmeier, G 2012, "The dry port concept — theory and practice" (Guest Editorial), *Maritime economics & logistics* 14, March (special supplementary issue) pp. 1–13.

Davies, P 2013, "Container terminal reservation systems design and performance", Paper presented to the *METRANS international urban freight conference*, Long Beach, California, 8 October, http://wavepointconsulting.ca/wp-content/uploads/2013/10/Container-Reservation-Systems-2013-Davies-Final.pdf

DeBoer, D 2011, "Stacking the deck. In railroading's darkest hour, a handful of men figured out how to make expensive-to-run trains profitable", *Trains 71*, 11 (November), pp. 32–37.

de Langen, P W 2008, "Ensuring hinterland access: the role of port authorities", *International Transport Forum Research Round Table*, Paris, 10–11 April and Discussion Paper 2008–11, March, http://www.internationaltransportforum.org/jtrc/discussionpapers/DP200811.pdf

Department for Transport 2008, *The container freight end-to-end journey*. http://webarchive.nationalarchives.gov.uk/20090224155131/http:/www.dft.gov.uk/about/strategy/transportstrategy/tasts/userexperience/containerfreight.pdf

Department of Infrastructure [Victoria] 2007, Victorian rail freight network review. Switchpoint: the template for rail freight to revive and thrive!, Department of Infrastructure, Melbourne.

Department of State Development, Business and Innovation, Victoria 2013, *Evaluation of regional rail and intermodal projects under Regional Development Victoria's Infrastructure Fund*. Report prepared by AECOM. https://www.rdv.vic.gov.au/__data/assets/pdf_file/0011/1164872/RDV-Reg-Rail-Final-22-Nov-13-FINAL.pdf

Department of Transport [Victoria] 2010, A discussion paper. Shaping Melbourne's freight future. Proposals for an intermodal solution to service Melbourne's growing containerised freight task.

Department of Transport, 2010. Melbourne's freight future: proposals for an intermodal solution to service Melbourne's growing containerised freight task, Melbourne: Department of Transport, Victoria.

Department of Transport and Regional Services 2002, Review of domestic and international pallet standards and ongoing operational and cost implications to Australian domestic and international logistics. Final Report. Report prepared by Sd+D [Strategic design + Development], http://s3.amazonaws.com/zanran_storage/www.infrastructure.gov.au/ContentPages/4697829.pdf

Doherty, J 2006, "Interview with John Doherty, Alameda Corridor Transportation Authority, *Journal of Commerce*, 28 August.

DOTARS — see Department of Transport and Regional Services

Ducruet, C and van der Horst, M 2009, "Transport integration at European ports: measuring the role and position of intermediaries", *European journal of transport and infrastructure research* 9, 2, pp. 121–42.

ECMT—see European Conference of Ministers of Transport

Economic and Social Commission for Asia and the Pacific 2006, *Improvement of transport and logistics facilities to expand port hinterlands: policy guidelines*, United Nations, New York. http://www.unescap.org/sites/default/files/pub_2299_fulltext.pdf

ESCAP—see Economic and Social Commission for Asia and the Pacific

Essential Services Commission 2007, *Review of port planning: final report*, Melbourne.

European Commission 2012, *Spectrum. Deliverable D1.2. Market based operational requirements for new rail freight services*, Report for the European Commission with the Seventh Framework Programme, http://www.transport-research.info/Upload/Documents/201211/20121127_164425_70434_Market_based_operational_requirements_for_new_railfreight_services.pdf

European Commission 2012, *Study on urban freight transport*, Report prepared by MDS Transmodal with Centro di ricerca per il Trasporto e la Logistica, http://ec.europa.eu/transport/themes/urban/studies/doc/2012-04-urban-freight-transport.pdf

European Commission 2013, *Operational challenges to port interfaces in the multi-modal transport chain (maritime and hinterland connections)*, Report prepared by Amber Coast Logistics, as part of the Baltic Sea Region Programme 2007–2013.

European Conference of Ministers of Transport 1984, *The cost of combined transport*, OECD, Paris.

European Railway Review 2011, "Freightliner signs multi-million pound contract with Maersk Line", *European Railway Review*, 29 April. http://www.europeanrailwayreview.com/9112/rail-industry-news/freightliner-signs-multi-million-pound-contract-with-maersk-line/

Evers, PT 1994, "The occurrence of statistical economies of scale in intermodal transportation", *Transportation journal* 33, 4, pp. 51–64.

Franc, P and Ven der Horst, M 2010, "Understanding hinterland service integration by shipping lines and terminal operators: a theoretical and empirical analysis", *Journal of transport geography*, 18, pp. 557–66.

Freight Infrastructure Advisory Board 2005, *Railing Port Botany's containers. Proposals to ease pressure on Sydney's roads*, http://www.planning.nsw.gov.au/plansforaction/pdf/fiab_report.pdf

FreightCorp 1998, *Annual Report 1997/98*, FreightCorp, Sydney.

FreightCorp 1999, "Submission to the inquiry into infrastructure and the development of Australia's regional areas", Submission to the House of Representatives Standing Committee on Primary Industries and Regional Services (for report *Time running out: shaping regional Australia's future*, March 2000. www.aph.gov.au/parliamentary_business/committees/house_of_representatives_committees?url=primind/rdinq/sub174-e.pdf

Fremantle Ports 2012, Fremantle port landside container study, http://www.fremantleports.com.au/SiteCollectionDocuments/Fremantle%20Port%20Container%20Movement%20Study%202012%20full%20version.pdf

Fremantle Ports 2012a, "Fremantle Port Exporter Survey 2011. off-port facilities", Brochure presented to *WA Operations Task Force*, 2 February, http://www.fremantleports.com.au/Operations/Landside/WAPOTFDocuments/2012%2002%20-%20February%202012%20meeting%20papers.pdf

Fremantle Ports, 2007. *Annual report 2006-07*, Perth.

Fremantle Ports, 2008. *Annual report 2007-08*, Perth, Fremantle Ports.

Fremantle Ports, 2012. Container Movement Study 2012, Perth

Fremantle Ports 2014, *Annual report 2013–14*, http://www.fremantleports.com.au/News/Publications/AnnualReport/Documents/2014%20Annual%20Report%20-%20Full%20Report.pdf

Fremantle Ports, 2015. *Rail Services*. http://www.fremantleports.com.au/Operations/Landside/Pages/Rail-Services.aspx

Froyland, G, Koch, T, Megow, N, Duane, E and Wren, H 2008, "Optimizing the landside operation of a container terminal", *OR Spectrum* 30, 1, pp. 53–75. https://people.mpi-inf.mpg.de/~nmegow/papers/froylandKMDW08-container-terminal.pdf

Fully Loaded 2012, "Toll and AMG take shares in Bowmans Intermodal", 21 September, http://www.fullyloaded.com.au/industry-news/1209/toll-and-amg-take-shares-in-bowmans-intermodal

Gallagher, J 2004, "Rivals for capacity", *Traffic world*, 29 November, pp. 29–30.

Game-Lopata, A 2015, "The right mix. Iconic home appliance manufacturer Breville has doubled productivity in its new, high-tech distribution centre", *Australasian Transport News*, No. 342, April, pp. 67.

Gans, J S 2006 (from version of 1995), "Inside the black box: a look at the container", *Prometheus* 13, 2, December, pp. 169–83.

Geldermalsen, T van, and Leviny, D 2005, "Viability of providing double stack access on railway lines in southeast Australia, Paper presented to *28th Australasian Transport Research Forum*, Sydney, http://atrf.info/papers/2005/2005_vangeldermalsen_leviny.pdf

Ghaderi, H, Cahoon, S, Nguyen, H-O 2015, "An investigation into the non-bulk rail freight transport in Australia", *The Asian journal of shipping and logistics* 31, 1, March, pp. 59–83.

Gouvernal, E and Daydou, J 2005, "Container railfreight services in north-west Europe: diversity of organizational forms in a liberalizing environment", Transport reviews 25, 5, pp. 557–71.

Gross, L 2009, "Short-haul stacks: can it work?", *Trains 69*, 11 (November), pp. 7–8.

Gross, L 2015, "Florida East Coast Railway. Academic Case Study", Paper prepared for the Intermodal Association of North America. University of North Florida. https://www.intermodal.org/about/docs/2015compcase.pdf

Guimarans, D Harabor, D and Van Hentenryck, P 2015, "Simulation and analysis of container freight train operations at Port Botany", *Computing Research Repository*, Cornell University, http://arxiv.org/pdf/1512.03476v2.pdf

Günther, H and Kim, K 2006, "Container terminals and terminal operations", *OR Spectrum* 28, September, pp. 437–445.

Hansard [WA] 2004, "Transport, Fremantle, transfer of goods from road to rail", http://www.parliament.wa.gov.au/Hansard%5Chansard.nsf/0/e7c7d33e8cea5fe6c82575700016e9a4/$FILE/A36%20S2%2020040914%20p5890b-5891a.pdf

Hansen, I 2010, "Automated shunting of rail container wagons in ports and terminal areas", *Transportation planning and technology* 27, 5, October, pp. 385–401.

Harris, R G 1977, "Economies of traffic density in the rail freight industry", *The Bell journal of economics* 8, 2 (Autumn), pp. 556–64.

Hearsch, J 2008, *Rail productivity information paper*. Paper prepared for the National Transport Commission, Melbourne.

Hoyle, J 2015, "Loading on the main line in NSW", *Railway digest* 53, 7, pp. 30–33.

House of Assembly [Tasmania] 2014, Hansard of the House of Assembly, Government Businesses Scrutiny Committee — Tasmanian Ports Corporation Pty Ltd, 5 December. http://www.parliament.tas.gov.au/ctee/House/Transcripts/HA%20Friday%205%20December%20 2014%20-%20TasPorts.pdf

House of Representatives — House Standing Committee on Transport and Regional Services 2005, *The great freight task: is Australia's transport network up to the challenge?*. Official Committee Hansard, Sydney, 21 November 2005, http://parlinfo.aph.gov.au/parlInfo/download/committees/commrep/8897/toc_pdf/4396-2.pdf;fileType=application%2Fpdf#search=%22committees/commrep/8897/0000%22

House of Representatives — House Standing Committee on Transport and Regional Services 2007, *The great freight task: is Australia's transport network up to the challenge?*. Report for "Inquiry into the integration of regional rail and road networks and their interfaces with ports" http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=/trs/networks/report/fullreport.pdf

House of Representatives. Standing Committee on Communications, Transport and Microeconomic Reform 1998, Public hearing on the inquiry, *Role of rail in the national transport network*, Sydney, 18 February, http://www.aph.gov.au/binaries/hansard/reps/commttee/r1527.pdf

Hutchins, R 2015, "US Southeast ports expand inland reach", *Journal of commerce*, 10 August, n.p.

Independent Pricing and Regulatory Tribunal of New South Wales 2007, *Review of the interface between the land transport industries and the stevedores at Port Botany*. Issues paper. http://www.ipart.nsw.gov.au/files/20e3bb70-2ae8-4cd9-97e1-a291008860c4/Issues_Paper_-_Review_of_the_Interface_between_the_Land_Transport_Industries_and_the_Stevedores_at_Port_Botany_-_May_2007.pdf

Independent Pricing and Regulatory Tribunal of New South Wales 2007a, *Review of the interface between the land transport industries and the stevedores at Port Botany*. Hearing transcript of 18 July, in Sydney, http://www.ipart.nsw.gov.au/files/assets/website/trimholdingbay/transcript_-_review_of_the_interface_between_the_land_transport_industries_and_the_stevedores_at_port_botany_18_july_2007_-_apd.pdf

Independent Pricing and Regulatory Tribunal of New South Wales 2008, Reforming Port Botany's links with inland transport.. Review of the interface between the land transport industries and the stevedores at Port Botany. Final Report of inquiry. http://www.ipart.nsw.gov.au/files/f0830d40-1766-476b-b304-a2910087c87e/Final_Report_-_Reforming_Port_Botanys_links_with_inland_transport_-_March_2008.pdf

Independent Transport Commission 2014, *Improving the efficiency of freight movements: the contribution to UK economic growth. Interim report*, http://www.theitc.org.uk/wp-content/uploads/2011/03/ITC-Freight-interim-report-July-14.pdf

Industry Commission 1991a, *Rail transport. Volume 1: report*, Report No. 13, Australian Government Publishing Service, Canberra.

Intermodal Association of North America 2014, An introduction to the Intermodal Association of North America, http://www.intermodal.org/about/docs/mediakit.pdf

Intermodal Group n.d., *Capability statement*. http://intermodal.net.au/wp-content/uploads/IG-Capability-Statement.pdf

Intermodal Group, 2015. *Intermodal Link Services*. http://www.intermodal.net.au/ils-rail/.

Inter-State Commission 1987, *An investigation into a potential extension of intermodal rail services*, Australian Government Publishing Service, Canberra.

IPART—see Independent Pricing and Regulatory Tribunal of New South Wales

ITF—International Transport Forum — see Organisation for Economic Cooperation and Development

Jansson, J and Shneerson D 1982, "The optimal ship size", *Journal of transport economics and policy* 16, 3, pp. 217–238.

JLARC—see Joint Legislative Audit and Review Commission

Joint Legislative Audit and Review Commission 2013, *Review of the Virginia Port Authority's competitiveness, funding, and governance*, Report to the Governor and the General Assembly of Virginia, House Document No. 17, Commonwealth of Virginia, http://jlarc.virginia.gov/pdfs/reports/Rpt446.pdf

Jones, W B, Cassady, C R, Bowden, R O 2000, "Developing a standard definition of intermodal transportation", *Report to the National Center for Intermodal Transportation, University of Denver*, http://ncit.msstate.edu/PDF/FinalReportDevelopingaStandardDefinitionforIntermodalTransportation.pdf

Kain, J 1995, *A Spirit of Progress? Assessing Australian rail transport policy. Research report No. 31 1994/95*, Parliamentary Research Service, Parliament House, Canberra. https://www.aph.gov.au/binaries/library/pubs/rp/1994-95/95rp31.pdf

Kulisch, E 2009, "Sweetening the 'sweet spot'. Short-haul intermodal movements pick up steam", *American shipper*, June, pp. 38–41.

Laird, P 1990, "Improving land freight transport efficiency in Australia", Paper presented to the 15th Australasian Transport Research Forum, Sydney, pp. 39–54, http://www.atrf.info/papers/1990/1990_Laird.pdf

Leach, P 2006, "Room to grow at Tacoma", *Journal of commerce*, 7 August, p. 29.

Leach, P 2012, "Officials hope to turn Port of Miami, Everglades into transshipment hubs", *Journal of commerce*, 25 May, n.p.

Legislative Council (NSW) 2000, *Privatisation of FreightCorp. Parliamentary Paper Number 576*, Paper prepared for General Purpose Standing Committee No. 4. <http://www.parliament.nsw.gov.au/Prod/parlment/committee.nsf/0/40f7d7ce807d4a3aca256cfd002ad1f0/$FILE/Committee%20Report%2021%20December%202000%20-%20Inquiry%20into%20Privatisation%20of%20Freightcorp.pdf>

Leue, M, Luzzi, C and Godbold, L 2012, *Ports of Long Beach – Los Angeles Rail Enhancement Program*, Paper presented to AREMA Conference (The American Railway Engineering and Maintenance-of-way Association), https://www.arema.org/files/library/2012_Conference_Proceedings/Ports_of_Long_Beach-Los_Angeles_Rail_Enhancement_Program.pdf

Levans, M 2008, "Ready to get on board?", *Logistics management* 47, 3 (March), pp. n/a.

Levinson, M 2006, The box. How the shipping container made the world smaller and the world economy bigger, Princeton University Press, Princeton, New Jersey.

Li, Y, Dong, Q and Sun, S 2015, "Dry port development in China: current status and future strategic directions", *Journal of coastal research*, Winter, 73, pp. 641–46.

Lloyd's List Australia 2015, "Port of Ningbo sets on rail", *Lloyd's List Australia*, 2 July, p. 14.

Logistics Capital & Strategy 2013, "The case for intermodal in South Florida", A study undertaken by the authors for Florida East Coast Railway, http://www.logcapstrat.com/pdfs/Case%20for%20Intermodal%20in%20South%20Florida.pdf

López-Navarro, M Á 2013, "The effect of shared planning by road transport firms and shipping companies on performance in the intermodal transport chain: the case of Ro-Ro short sea shipping", *European Journal of Transport and Infrastructure Research* 13, 1, pp. 39–55, http://www.ejtir.tudelft.nl/issues/2013_01/pdf/2013_01_02.pdf

Martin, J D 1996, "Intermodal transportation: evolving toward the 21st century", *Transportation & Distribution*, 37, 2, February, pp. A–X.

Matthews, J 2011, "RoadRailer", *Trains 71*, 11, November, pp. 60–1.

Maunsell Australia 2003, *Double stack access in South Eastern Australia*. Phase I report, Report prepared for Department of Infrastructure [Victoria] and Department of Transport and Regional Services [Canberra].

McKillop, B 2013a, "Australian railways and the container revolution. Part 1: tentative beginnings—the 1920s and '30s", *Australian railway history* 64, 907, May, pp. 3–12.

McKillop, B 2013b, "Australian railways and the container revolution, Part 2: reshaping interstate transport", *Australian railway history* 64, 909, July, pp. 3–14.

McKillop, B 2013c, "Australian railways and the container revolution, Part 3: linking with the world", *Australian railway history* 64, 911, September, pp. 3–12.

McKillop, B 2013d, "Australian railways and the container revolution, Part 4: the age of deregulation and greed", *Australian railway history* 64, 913, September, pp. 3–19.

MetroPort Auckland (undated), *MetroPort overview*, http://www.port-tauranga.co.nz/images.php?oid=3009

Meyrick and Associates, Arup 2006, "National intermodal terminal study", Report prepared for Department of Transport and Regional Services, Canberra.

MMC Link 2012, "Containerised freight specialisation at the Port of Bell Bay: A cost–benefit analysis", Report prepared for Northern Tasmania Development Board, http://www.northerntasmania.org.au/client-assets/Latest%20Reports/Bell%20Bay%20Report%20-%20FINAL.pdf

Mongelluzzo, B 2003, "Rail shuttle idea gains traction", *Journal of commerce*, 20 October, pp. 32–33.

Mongelluzzo, B 2004, "Port to distribution center, by rail", *Journal of commerce*, 21 June, pp. 54–55.

Mongelluzzo, B 2005, "Inland handoff", *Journal of commerce*, 14 February, pp. n/a.

Mongelluzzo, B 2007, "Space savers", *Journal of commerce*, 16 April, pp. n/a.

Mongelluzzo, B 2010, "The port moves inland", *Journal of commerce*, 13 September, pp. n/a.

Mongelluzzo, B 2015, "Long Beach CEO: cargo surges are ports' biggest issue", *Journal of commerce*, 19 October, pp. n/a.

Monios, J and Wang, Y 2013, "Spatial and institutional characteristics of inland development in China", *GeoJournal* 78, pp. 897–913.

Moore, R 2015, "European ports up the ante on ULCVs and hinterland", *Container shipping and trade*, 1st quarter, pp. 28–28. http://content.yudu.com/Library/A3h4zh/ContainerShippingand/resources/30.htm

Morlok, E K 2004, Discussion paper adjunct to Resor, R R and Blaze, J R, "Short-haul rail intermodal: can it compete with trucks?", *Transportation Research Record* 1873, pp. 45–52.

Morlok, E K and Spasovic, L N 1994, "Approaches for improving drayage in rail–truck intermodal service", Department of Systems Engineering, University of Pennsylvania and U.S.A. Department of Transport Mid-Atlantic University Research Transportation Center, Working Paper.

Morton, R 2005, "Inland ports ease the pressure on coastal ports", *Logistics today* 46, 12, December, pp. 26–29.

Muller, G 1999, *Intermodal freight transportation, 4th Edition*, Eno Transportation Foundation and Intermodal Association of North America, Washington, D.C.,

National Transport Commission 2006, "Twice the task". *A review of Australia's freight transport tasks*, A report prepared by Meyrick and Associates, SKM, UniSA, for the NTC, http://www.ntc.gov.au/Media/Reports/(ACE851FA-DB45-BC37-62B5-F1E9FEBFCEE4).pdf

National Transport Commission, 2008. Capacity Constraints & Supply Chain Performance: Working Paper 1 — Understanding the Intermodal Supply Chain, Canberra: s.n.

NCFRP—see Transportation Research Board of the National Academies. (National Cooperative Freight Research Program)

NCHRP—see Transportation Research Board of the National Academies. (National Cooperative Highway Research Program)

Network Rail 2013, *Intermodal rail terminals in Britain*, Published by Network Rail. http://www.networkrail.co.uk/Intermodal-rail-sites.pdf

New Zealand Institute of Economic Research 2015, *Port study 2. Final report, to Auckland Council*. http://nzier.org.nz/static/media/filer_public/3b/65/3b652ac8-ab9d-42be-bdcc-4a56905d40fe/nzier_port_report__4_february_2015.pdf

Newman, P and Hendrigan, C 2015, "Perth Freight Link: making the right investment in Perth's Freight Task", *A position paper for the City of Fremantle*, http://www.fremantle.wa.gov.

au/files/1867bf80-e370-4d99-a55d-a4b9011d8180/Perth_Freight_Link_Making_the_right_investment_in_Perths_Freight_Task_-_8_June_2015.pdf

Notteboom, T 2008, "The relationship between seaports and the intermodal hinterland in the light of global supply chains: European challenges", Paper presented to OECD/ITF Research Round Table 143 "Port Competition and Hinterland Connections", Paris, 10–11 April.

Notteboom, T 2010, "Concentration and the formation of multi-port gateway regions in the Europe and container port system: an update", *Journal of transport geography*, 18, July, pp. 567–83.

Notteboom, T and Rodrigue, J-P 2009, "Inland terminals within North American and European supply chains", *Transport and communications bulletin for Asia and the Pacific* 78, pp. 1–39. http://people.hofstra.edu/jean-paul_rodrigue/downloads/Inland%20Terminals%20within%20NA%20and%20EU%20supply%20chains.pdf

NSW Government 2013, *NSW freight and ports strategy*, http://freight.transport.nsw.gov.au/documents/tfnsw-freight-and-ports-strategy-high-res.pdf

NSW Ports 2015, *Navigating the future. NSW Ports' 30 year master plan*, http://www.nswports.com.au/assets/Publications/NSW-Ports-Master-Plan-2015.pdf

NTC—see National Transport Commission.

NZIER—see New Zealand Institute of Economic Research.

OECD—see Organisation for Economic Cooperation and Development.

Office of Rail and Road 2015, *Provision of Deep Sea Container rail transport services between ports and key inland destinations in Great Britain*, http://orr.gov.uk/__data/assets/pdf_file/0011/20351/orr-commitments-decision-2015-12-18.pdf

O'Neil, S 2014, "The Sandgate operation of Crawfords Freightlines and Sydney Rail Services", *Railway Digest*, July, pp. 28–30.

Organisation for Economic Cooperation and Development/international Transport Forum 2009, Port competition and hinterland connections, Round Table 143, Paris, 10–11 April, http://www.internationaltransportforum.org/Pub/pdf/09rt143.pdf

Organisation for Economic Cooperation and Development/International Transport Forum 2010, *Improving reliability on surface transport networks*, Organisation for Economic Co-operation and Development (OECD), Paris. http://www.internationaltransportforum.org/pub/pdf/10Reliability.pdf

Organisation for Economic Cooperation and Development/International Transport Forum 2011, *Moving freight with better trucks: improving safety, productivity and sustainability. Research Report*, OECD Publishing, Paris, http://www.internationaltransportforum.org/jtrc/infrastructure/heavyveh/FreightBetterTrucksFullReport.pdf

Organisation for Economic Cooperation and Development/International Transport Forum 2015, *The impact of mega-ships*, OECD Publishing, Paris http://www.internationaltransportforum.org/Pub/pdf/15CSPA_Mega-Ships.pdf

Organisation for Economic Cooperation and Development/International Transport Forum 2015a, *Port investment and container shipping markets*, ITF Round Tables, No. 157, OECD Publishing, Paris.

P&O Ports 2005, Submission to inquiry into managing transport congestion, conducted by the Victorian Competition and Efficiency Commission, http://www.vcec.vic.gov.au/files/7c17c409-e969-41f8-a86d-a3a401084fa0/41-PO-Ports-1.pdf

Pacific National Tasmania 2005, *Submission to inquiry into integration of regional rail and road networks and their interface with ports*, http://www.aph.gov.au/Parliamentary_Business/Committees/House_of_Representatives_Committees?url=/trs/networks/subs/sub007.pdf

Pal, M 2014, "Case study—Shorthaul landside seafreight intermodal operations", Paper presented to conference, *Intermodal Asia 2014*, Melbourne, 27–28 February.

Parliament of Victoria. Rural and Regional Committee 2014, *Inquiry into increasing exports of goods and services from regional Victoria. Final report*. Parliamentary Paper Number 343. http://www.parliament.vic.gov.au/file_uploads/RRC_Final_Report_Inquiry_into_Increasing_Exports_of_Goods_and_Services_from_Regional_Victoria_jy6F7m3H.pdf

Parliament of Victoria. Rural and Regional Committee 2014a, *Inquiry into increasing exports of goods and services from regional Victoria. Transcript of hearing at Shepparton, 2 July 2014*. Witness, Mr T Hall, http://www.parliament.vic.gov.au/images/stories/committees/rrc/IEGS/Transcripts/T._Hall.pdf

Parliament of Victoria. Rural and Regional Committee 2014b, *Inquiry into increasing exports of goods and services from regional Victoria. Transcript of hearing at Shepparton, 2 July 2014*. Witness, Mr K Wakefield, http://www.parliament.vic.gov.au/images/stories/committees/rrc/IEGS/Transcripts/K._Wakefield.pdf

Parliament of Victoria. Rural and Regional Committee 2014c, *Inquiry into increasing exports of goods and services from regional Victoria. Transcript of hearing at Moe*, Witness, Mr B McLean, http://www.parliament.vic.gov.au/images/stories/committees/rrc/IEGS/Transcripts/B._McLean.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015, "Transcript of evidence of the hearing of Monday 13 October, with representatives of Australian Paper." *Inquiry into the proposed lease of the port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Transcripts/Proof_Transcript_Australian_Paper.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015a, "Transcript of evidence of the hearing of Tuesday, 29 September, with representatives of Colin Rees Group." *Inquiry into the proposed lease of the port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Transcripts/Geelong_PMSC_Colin_Rees_Into_the_proposed_lease_of_the_port_of_Melbourne_29_September_2015.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015b, "Transcript of evidence of the hearing of Tuesday 29 September, with representatives of Kreskas Bros/KB Logistics" *Inquiry into the proposed lease of the port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Transcripts/Geelong_PMSC_C4GS_Into_the_proposed_lease_of_the_port_of_Melbourne_29_September_2015.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015c, "Transcript of evidence of the hearing of Tuesday 27 October, with the Managing Director of Wakefield Transport" *Inquiry into the proposed lease of the port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Transcripts/Wakefield_Transport-PROOF-PMSC_Port_of_Melbourne_27_October_2015.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015d, *Inquiry into the proposed lease of the Port of Melbourne*, http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Other_Docs/PMSC_58-01_Final_report_WEB.pdf

Parliament of Victoria. Port of Melbourne Select Committee 2015e, "Transcript of evidence of the hearing of Tuesday 27 October, with representatives of Johnson Asahi", http://www.parliament.vic.gov.au/images/stories/committees/pomsc/Transcripts/Corrected-Johnson_Asahi-27_October_2015.pdf

Paixão, A C and Marlow, P B 2003, "Fourth generation ports—a question of agility?", *International journal of physical distribution & logistics management* 33, 4, pp. 355–76.

Patrick Corporation Limited 2007, "Submission to the IPART review of the interface between the land transport industries and the stevedores at Port Botany", http://www.ipart.nsw.gov.au/files/assets/website/trimholdingbay/submissions_-_patrick_corp_ltd_-_james_dorney_-_apd.pdf

Payne, J S 2013, "The inland, dry port trend", *Journal of commerce* 18 September, pp. n/a.

Perry, N 2010, "The state of truck/rail modal share: an analysis for transportation customers", Paper prepared for U.S. Xpress Enterprises. http://www.usxpress.com/~/media/Files/Featured%20Documents/Truck%20Rail%20Study.ashx

Port of Brisbane 2014, *Submission by Port of Brisbane Pty Ltd* to the Queensland Parliament Inquiry into rail freight use by the agriculture and livestock industries. http://www.parliament.qld.gov.au/documents/committees/THLGC/2013/INQ-RAIL/submissions/010_Port%20of%20Brisbane.pdf

Port of Göteborg 2010, *Göteborgs Hamn. The Port of Scandinavia*, Slide presentation.

Port of Gothenburg 2014, *Railport Scandinavia*, Port brochure.

Port of Los Angeles 2004, *San Pedro Bay Ports Rail Market Study*, Report prepared by Parsons Transportation Group, http://www.portoflosangeles.org/DOC/REPORT_SPBayPortsRailMarketStudy.pdf

Port of Melbourne Corporation 2005, *Submission to the Victorian Competition and Efficiency Commission. Inquiry into Managing transport congestion*. http://www.vcec.vic.gov.au/files/a6f99252-e0a2-47e7-a1d9-a3a401085701/53-Port-of-Melbourne-Corporation-1.pdf

Port of Melbourne Corporation 2009, *Port development strategy. 2035 vision*. https://www.maribyrnong.vic.gov.au/Files/21.08.6_Port_Development_Strategy_2035_Vision.pdf

Port of Melbourne Corporation 2010, Port of Melbourne and Dynon Rail Terminals. 2009 Container Logistics Chain Study. Full Report, Port of Melbourne Corporation.

Port of Tacoma 2013, Presentation to Pacific Northwest Association of Rail Shippers, 19 September. http://www.pnrailshippers.com/pnwars_pdfs/2013_reilly_presentation.pdf

Port of Virginia 2014, Inland Briefing. *Virginia International Terminals, Inc.* http://www.geminishippers.com/documents/threads/PortofVA052014.pdf

Port of Virginia 2015, *Annual report 2015*, http://www.portofvirginia.com/wp-content/uploads/2016/01/2015-Annual-Report-Final.pdf

Prince, T 1998, "On-dock rail: off-base?", *Journal of commerce*, 26 June, pp. n/a.

Prince, T 1999, "On-dock: under the covers", *Containerisation international*, May, pp. 75–9.

Prince, T 2001, "Towards an international intermodal network", *American shipper*, November, pp. 77–80.

Prince, T 2012, "Intermodal and tomorrowland", *Journal of commerce*, 6 November, pp. n/a.

Productivity Commission 1999, *Microeconomic reforms and Australian productivity: exploring the links*, Commission research paper. Volume 2: case studies. http://www.pc.gov.au/__data/assets/pdf_file/0017/8207/meraap2.pdf

Productivity Commission 2006, *Road and rail freight infrastructure pricing. Productivity Commission Inquiry Report 41*, Productivity Commission, Canberra.

pwc 2014, *Containerised cargo demand assessment. Riverina and South West Slopes and Plains*. Report prepared for Transport for NSW, http://freight.transport.nsw.gov.au/documents/tfnsw-containerised-cargo-demand-assessment-final.pdf

QR National 2007, *QR National's response to the review of the interface between the land transport industries and the stevedores at Port Botany*, Submission to IPART inquiry. http://www.ipart.nsw.gov.au/files/ea2f4f5b-9043-4ef7-9d7f-a291008cd0a9/Submissions_-_QR_National_-_Jim_Noble_-_APD_Web.pdf

Qube Holdings, 2014. *New South Wales*. http://www.qube.com.au/logistics/facilities/new-south-wales

Queensland Parliament. Transport, Housing and Local Government Committee 2014, *Rail freight use by the agriculture and livestock industries. Report No. 45*, June, http://www.parliament.qld.gov.au/documents/committees/THLGC/2014/INQ-RAIL/rpt_rail_16June2014.pdf

Rahimi, M, Asef-Vaziro, A, Harrison, R 2008, *Integrating inland ports into the intermodal goods movement system for Ports of Los Angeles and Long Beach*, Project 07-01 of METRANS Transportation Center, http://www.thetransitcoalition.us/grid/images/Inland_Ports_METRANS.pdf

RailCorp 2007, Review of the interface between land transport industries and the stevedores at Port Botany. RailCorp submission to the IPART review.

Rail Express, 2014. *SCT's Penfield Rail Freight Centre on Track*. http://www.railexpress.com.au/archive/2014/september-2014/september-3-2014/top-stories/sct2019s-penfield-rail-freight-centre-on-track

Rail SA, 2015. *Rail SA*. http://www.railsa.org/maps/rail-network/

Railroad–Shipper Transportation Advisory Council 2011, "Short haul rail: challenges and opportunities". *Council position paper.* Washington, D.C., http://www.stb.dot.gov/stb/docs/RSTAC/RSTAC%20Short%20Haul%20Rail%20102911.pdf

Railway Digest 2015, "Rail freight returns to Canberra", March, p. 8.

Railway Digest 2015a, "Goondiwindi cotton haul lost to road transport amidst calls for Toowoomba line tunnel lowering", December, p. 18.

Resor, R 2006, "Short-haul intermodal service: can rail compete with truck?", Presentation given to *Transportation Research Forum*, 23 March.

Resor, R and Blaze, J R 2004, "Short haul rail intermodal: can it compete with truck?", Paper presented to the *Transportation Research Board Annual Meeting, Transportation research record: Journal of the Transportation Research Board*, No. 1873, pp. 45–52.

Rickett, T G 2013, *Intermodal train loading methods and their effect on intermodal terminal operations*, Thesis. University of Illinois at Urbana-Champaign, Urbana, Illinois, http://railtec.illinois.edu/CEE/pdf/Thesis/TristanRickettThesis.pdf

Rimmer, P J 1970, *Freight forwarding in Australia*. Publication HG/4 of the Research School of Pacific Studies, Australian National University, Canberra.

Robinson, R 2006, "Port-oriented landside logistics in Australian ports: a strategic framework", *Maritime economics and logistics* 8, pp. 40–59.

Rodrigue, J-P and Hatch, A 2009, "North American intermodal transportation: infrastructure, capital and financing issues", The Equipment Leasing and Finance Foundation, Washington DC.

Rodrigue, J-P and Hesse, M 2010, "North American logistics", in D. Waters (ed) *Global Logistics: New Directions in Supply Chain Management*, 6th Edition, London, Kogan Page, pp. 477–504.

Rodrigue J-P and Notteboom 2010, "Guest editorial: comparative North American and European gateway logistics—an introduction", *Journal of transport geography* 18, 4, July, 495–496.

Rodrigue, J-P 2013, *The geography of transport systems.* Third edition, Routledge, New York. http://people.hofstra.edu/geotrans/index.html

Rodrigue, J-P and Notteboom, T 2009, "The terminalization of supply chains: reassessing the role of terminals in port/hinterland logistical relationships", *Maritime Policy and Management* 36, 2 (April), pp. 165–83.

Rodrigue, J-P and Notteboom, T 2009a, "The geography of containerization: half a century of revolution, adaptation and diffusion", in *GeoJournal* 74, pp. 1–5.

Rodrigue, J-P and Slack, B 2013, "Intermodal transportation and containerization" in Rodrigue, J-P (ed), *The geography of transport systems. Third Edition*, Routledge, New York.

Rodrigue, J-P, Debrie, J, Fremont, A, Gouvernal, E 2010, "Functions and actors of inland ports: European and North American dynamics", *Journal of transport geography* 18, 4, July, pp. 519–29.

Roso, V, Woxenius, J, Olandersson, G 2006, "Organisation of Swedish dry port terminals", Division of Logistics and Transportation, Chalmers University of Technology, Göteborg. http://

www.gu.se/digitalAssets/1344/1344736_2006_meddelande_123_-_sustaccess_-_dry_ports_in_sweden.pdf

Roso, V., 2008. Factors influencing implementation of a dry port. *International Journal of Physical Distribution & Logistics Management*, 38(10).

Roso, V 2011, "The battle for the sea is won inland", *Logistics Times*, July, pp. 46–48.

Rural Industries Research and Development Corporation 2005, *Evaluating logistics chain technology—Australian farmgate to port*, A report by Access Economics, and Mausell. https://rirdc.infoservices.com.au/downloads/04-188

Russnogle, J 2008, "Grain bins to go. Cargo containers serve a market in the Orient", *Farm industry news* 41, 1, January, pp. 80–1.

SA Track and Signal, 2015. Australian railway track and signal drawings and signal locations. http://www.sa-trackandsignal.net/.

San Pedro Bay Ports 2006, *San Pedro Bay Ports.* Rail study update, Report prepared by Parsons for The Port of Long Beach and The Port of Los Angeles. http://www.polb.com/civica/filebank/blobdload.asp?BlobID=7599

Schulz, J D 2011, "Intermodal looks marvelous!", *Logistics management*, May, pp. 30–32.

Schumer, L A 1956, "Road transport", (pp. 134–58) in Wilkes, J (ed), *Australia's transport crisis*, Angus and Robertson, Sydney.

SCT 2015, "Wine makers raise their glass to the Penfield facility", *The SCT Xpress* (newsletter), Summer, p. 2. http://www.sctlogistics.com.au/wp-content/uploads/2015/02/SCT-Xpress_Summer-2015.pdf

Sd+D consult 2009, "Intermodal terminals and their networks. Rail perspectives. Sydney as a case study", http://www.masterresearch.com.au/downloads/pdfs/Rail_Terminals_Matthews.pdf

Sea Freight Council of NSW 2004, *Regional intermodal terminals — indicators for sustainability,* Report prepared by Sd+D [Strategic design + Development] http://www.transport.nsw.gov.au/sites/default/files/b2b/publications/SFCNSW-Regional-Intermodal-Terminals-Sea-Freight-Council.pdf

Sea Freight Council of NSW 2005, *Landside infrastructure capability. International containers*, Report prepared by Sd+D for the Sea Freight Council.

SEC—see Securities and Exchange Commission

Securities and Exchange Commission 2014, *Fortress Transportation and Infrastructure Investors LLC Amendment No.* 1, http://www.sec.gov/Archives/edgar/data/1590364/000119312514021745/d616610ds1a.htm

Shashikumar, N and Schatz, G L 2000, "The impact of U.S. regulator changes on international intermodal movements", *Transportation Journal*, 40, Fall, pp. 5–14.

Sheffi, Y 2012, "Are you tapping into the benefits of logistics clusters", *Area development site and facility planning* 47, p. 7.

Shipping Australia Limited 2011, *Metropolitan intermodal terminal study 2011*, https://shippingaustralia.com.au/wp-content/uploads/2012/07/Intermodal_Terminals_WEB.pdf

Shipping Australia Limited 2012, Industry standard for packing of grain in containers. Information for shipping companies and packers of containers. Fact Sheet Number 10-2012, https://shippingaustralia.com.au/wp-content/uploads/2012/01/Packing-of-Grain-in-Containers_10-2012.pdf

Shipping Australia Limited, 2013. *Shipping Australia*, Melbourne: s.n.

Skinner, S 2015, "Intermodal movers", Australasian Transport News (ATN), December, pp. 36–40.

Slack, B 1990, "Intermodal transportation in North America and the development of inland load centers", *Professional geographer* 42, 1, pp. 72–83.

Smith-Peterson, T 2006, "Railroading's new economy: part 2 of 2. The spigot. How commerce flows from Southern California ports onto U.S. rails", *Trains* 66, 9, September, pp. 34–41.

Solomon, M B 2012, "Intermodal struggles to crack short-haul market. Taking share in the under-500 mile category will be an uphill climb", *DC Velocity*, 16 November.

Solomon, M B 2014, "'Siding' up to intermodal. As intermodal traffic grows, more companies look to plant their DC site flags alongside rail facilities", *DC Velocity*, 6 January.

Stagl, J 2014, "Parts for BMW's South Carolina plant drive up auto business for Norfolk Southern", *Progressive railroading*, September. http://www.progressiverailroading.com/intermodal/article/Parts-for-BMWs-South-Carolina-plant-drive-up-auto-business-for-Norfolk-Southern--42002

State Transport Authority 1998, *Report of the State Transport Authority for the year ended 30 June 1988*, http://www.parliament.vic.gov.au/papers/govpub/VPARL1988-92No43.pdf

STB—see Surface Transportation Board

Steenken, D, Voß, S and Stahlbock, R 2004, "Container terminal operation and operations research—a classification and literature review", *OR Spectrum* 26, pp. 3–49.

Stephens, B 2003, "Short-haul intermodal. Can railroads compete?", *Trains* 63, 1 (January), p. 38.

Stopford, M 2002, "Is the drive for ever bigger containerships irresistible?", Paper presented to Lloyd's List Shipping Forecast Conference, 26 April. http://www.clarksons.net/archive/research/freestuff/ci_paper_april2002.pdf

Strunsky, S 2014, "Port Authority weighs selling ship-to-rail operation", New Jersey.com, http://www.nj.com/news/index.ssf/2014/01/port_authority_weighs_selling_ship-to-rail_operation.html

Surface Transportation Board 1997, *Overview: abandonments & alternatives to abandonments,* http://www.stb.dot.gov/stb/docs/Abandonments%20and%20Alternatives1.pdf

Sydney Ports 2005, *Intermodal Logistics Centre at Enfield*. Environmental assessment, http://www.sydneyports.com.au/__data/assets/pdf_file/0016/3067/Chapter_1.pdf

Sydney Ports Corporation 2013, http://www.sydneyports.com.au/__data/assets/pdf_file/0010/30025/D13_38682_Sydney_Ports_Annual_Report_2012_13_Final_v1.0_23_October_2013.pdf

Szaknoyi, M 2013, "Inland ports offer cost-effective intermodal options", *Journal of commerce*, 15 August, n.p.

Szakonyi, M 2014, "Shippers increasingly opening distribution centers near intermodal hubs", *Journal of commerce*, 19 August, n.p.

Table Talk, July 2014. Table talk: Australasian timetable news. Issue 263.

TasRail 2014, *TasRail Annual Report 2013–2014*, http://www.tasrail.com.au/client-assets/downloads/annual_reports/2013-2014%20Annual%20Report%20with%20Financials.pdf

Tauriello, G 2013, "Treasury Wines Estates' national distribution centre being built at Penfield", *The Advertiser*, 15 April, http://www.adelaidenow.com.au/business/sa-business-journal/treasury-wine-estates-national-distirbution-centre-being-built-at-penfield/story-e6fredel-1226620893153

Tellier, P 1996, "Intermodal's elusive ingredient: profit", *Railway Age* 197, 6, p. 57.

Tioga Group, Railroad Industries and Iteris 2008, Inland port feasibility study. Project No. 06-023. Final report. *http://tiogagroup.com/docs/Tioga_Grp_SCAGInlandPortReport.pdf*

Tioga Group, The 2003, *Project 99–130: goods movement truck and rail study. Executive summary.* Report prepared for the Southern California Association of Governments, January. http://www.freightworks.org/Documents/Goods%20Movment%20Truck%20and%20Rail%20Study.pdf

Tioga Group, The 2004, Short-haul intermodal service: can rail compete with truck?, Paper prepared for Transportation Research Board's Alternative freight capacity workshop, 11 January.

Transport for NSW 2012, *Ports and Maritime Administration Regulation 2012. Regulatory Impact Statement*, http://www.transport.nsw.gov.au/sites/default/files/b2b/publications/ports-and-maritime-admin-final-regulatory-impact-statement.pdf

Transportation Research Board of the National Academies 1992, *Intermodal marine container transportation: impediments and opportunities*. Special report 236, Transportation Research Board, Washington, D.C.

Transportation Research Board of the National Academies 2007, National Cooperative Highway Research Program Report 586. *Rail freight solutions to roadway congestion—final report and guidebook*, Transportation Research Board, Washington, D.C. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_586.pdf

Transportation Research Board of the National Academies 2011, *Truck drayage productivity guide*. National Cooperative Freight Research Program Report 11, http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_011.pdf

Travers Morgan 1992, Australian rail freight performance measured against international best practice. Report prepared for the Bureau of Industry Economics.

TRB—see Transportation Research Board of the National Academies.

Tirschwell, P 2015, "LA–LB ports revisit short-haul rail to beat congestion", *Journal of commerce*, 22 December.

UNCTAD—see United Nations Conference on Trade and Development

UNESCAP—see United Nations Economic and Social Commission for Asia and the Pacific.

Union Internationale des Chemins de fer (UIC) [International Union of Railways] 2009, *DIOMIS. Benchmarking intermodal rail transport in the United States and Europe*, http://www.uic.org/diomis/IMG/pdf/DIOMIS_Benchmarking_Intermodal_Rail_Transport_in_the_US_and_Europe.pdf

United Nations Conference on Trade and Development 1991, *Handbook on the management and operation of dry ports*, UNCTAD/RDP/LDC/7, Geneva.

United Nations Economic and Social Commission for Asia and the Pacific 2006, *Improvement of transport and logistics facilities to expand port hinterlands: policy guidelines*, United Nations, New York, http://www.unescap.org/sites/default/files/pub_2299_fulltext.pdf

United Nations Economic and Social Commission for Asia and the Pacific 2007, *Regional shipping and port development*, http://www.unescap.org/sites/default/files/pub_2484_fulltext.pdf

van Geldermalsen, T and Leviny D 2005, "Viability of providing double stack access on railway lines in Southeast Australia", Paper presented to *Australasian Transport Research Forum*, Sydney, pp. 1–17. http://www.atrf.info/papers/2005/2005_vanGeldermalsen_Leviny.pdf

van Schuylenburg, M and Borsodi, L 2010, "Container Transferium Rotterdam: an innovative logistic concept", Paper presented to *PIANC conference in Liverpool*. (The World Association for Waterborne Transport Infrastructure). http://repository.tudelft.nl/assets/uuid:f8b2b14e-1f04-457a-92e8-43ba90573f1b/Container_transferium_Maurits_van_Schuylenburg.pdf

Veenstra, A, Zuidwijk, R and van Asperen, E 2012, "The extended gate concept for container terminals: expanding the notion of dry ports", *Maritime economics & logistics 14*, 1, pp. 14–32.

VFLC—see Victorian Freight and Logistics Council.

Victoria University Institute of Supply Chain Logistics (unpublished), 2012. *Port rail intermodal supply chain operations and performance overview (unpublished)*, Canberra: Report produced for the Bureau of Infrastructure, Transport and Regional Economics.

Victorian Competition & Efficiency Commission 2006, *Making the right choices: options for managing congestion*, Final Report of the inquiry. http://www.vcec.vic.gov.au/files/e55f9edc-0251-49b5-b047-a35d00c25b7a/Managing-Transport-Congestion-Final-Report.pdf

Victorian Freight and Logistics Council 2007, A toolkit for the development of intermodal hubs in Victoria, Melbourne.

Victorian Government 2013, Victoria. *The freight state. The Victorian freight and logistics plan.* http://www.dtpli.vic.gov.au/__data/assets/pdf_file/0017/220355/VFLP-Victorian-Freight-and-Logistics-Plan.pdf

Wakefield Regional Council 2003, *Annual report 2002–03*, http://www.wakefieldrc.sa.gov.au/webdata/resources/files/20022003AnnualReport1.pdf

Wakeman, T 2008, "Marine transportation of international freight for the Northeast Corridor", Paper presented to Institute for Public Administration's 2007 Public Policy Forum at the University of Delaware, and published in *Anticipating 2025 in Northeast Corridor Transportation: aerial, highway, marine, and rail technologies & linkages*, pp. 38–59.

Wayne, C G E 1966, *Overall review of transport in Western Australia.* Report by the WA Commissioner of Transport, to the Government of Western Australia, Perth.

Westgate Ports Pty Ltd 2005, Issues paper submission. *Victorian Competition and Efficiency Commission. Inquiry into managing transport congestion*, http://www.vcec.vic.gov.au/files/fee5853d-d13c-4014-b7e6-a3a40108473f/25-Westgate-Ports-Pty-Ltd.pdf

Whittle, M 2015, "Port connections are vital to competition", *Shipping Australia*, Autumn/Winter, pp. 24–26.

World Bank, The 2005, "How do differing standards increase trade costs? The case of pallets", *World Bank Policy Research Working Paper 3519*, https://openknowledge.worldbank.org/bitstream/handle/10986/8837/wps3519.pdf

World Cargo News 2005, "Landbridge costs too high", *World Cargo News*, November.

World Cargo News 2010, "Patrick abandons RMG gate", *World Cargo News*, July, p. 6.

Woxenius, J 1998, "Development of small-scale intermodal freight transportation in a systems context", *Report 34*, Department of Transportation and Logistics, Göteborg, http://www.gu.se/digitalAssets/1344/1344712_1998_dissertation_woxenius.pdf

Woxenius, J 1998a, "Intermodal transshipment technologies—an overview", Appendix to author's dissertation, *Development of small-scale intermodal freight transportation in a systems context*, Department of Transportation and Logistics, Chalmers University of Technology, Göteborg http://www.gu.se/digitalAssets/1344/1344731_1998_transshipment_technologies_part1.pdf

Woxenius, J and Bergqvist, R 2007, "Hinterland transport by rail—a success for maritime containers but still a challenge for semi-trailers", Paper presented to the *Logistics Research Network Annual Conference*, Liverpool, 10–12 September. http://gup.ub.gu.se/records/fulltext/87585/87585.pdf

Woxenius, J and Bergqvist, R 2011, "Comparing maritime containers and semi-trailers in the context of hinterland transport by rail", *Journal of transport geography* 19, pp 680–88.

Woxenius, J, Roso, V and Lumsden, K 2004, "The dry port concept—connecting seaports with their hinterland by rail", Paper presented to the *1st International Conference on Logistics Strategy for Ports*, Dalian, China, 22–26 September, http://www.fek.handels.gu.se/digitalAssets/1344/1344857_2004_iclsp_dalian_wox-ros-lum.pdf

Yoon, Y, Pak, M and Kwon, J 2008, "Multimodal transport and land bridges in the global supply chain: the case of the ALB", *Journal of Korea Trade*, 12, 2, (No. 74), pp. 1–27, ktra.ccpshost.com/h_board/download.php?&bbs_id=e12&page=&type=1&doc_num=74

Zeng, Q, Maloni, M, Paul, J, and Yang, Z. 2013, "Dry Port Development in China: Motivations and Challenges", *Transportation Journal* 52, 2, pp. 234–63.

Zhang, M, Wiegmans, B and Tavasszy L A 2009, "A comparative study on port hinterland intermodal container transport: Shanghai and Rotterdam", Paper presented to Fifth Conference of the Advanced Forum on Transportation of China, Beijing, 16–17 October.

Zimmer, R N 1994, "Designing intermodal terminals for efficiency". Paper presented to the National conference on the intermodal freight terminal of the future, 7–9 December, and published in the *Transportation research circular* 459, printed in 1996.

Zumerchik, J, Rodrigue, J-P, Lanigan, J 2009, "Automated transfer management systems and the intermodal performance of North American freight distribution", *Journal of the Transportation Research Forum* 48, 3 (Fall), pp. 59–76. http://people.hofstra.edu/jean-paul_rodrigue/downloads/BetterConnectorsPaper3_JPR.pdf

Definitions and abbreviations

Term or Abbreviation	Description
3PL	3PL is a short term for Third-Party Logistics. The shipper appoints a 3PL as an agent who organises a range of packaging, storage and distribution activities that would otherwise be undertaken within the shipper's organisation. Typically, the entity owns and manages distribution centres and transport modes. However, the 3PL may also hire carriers, such as rail and trucking companies (which are termed a "2PL" entity) to transport the goods. By organising such tasks for a number of shippers, the 3PL can lower costs through consolidating shipments. 3PLs include freight forwarders.
4PL	A 4PL — Fourth Party Logistics — provider is an integrator of the resources of producers, retailers and 3PLs. The shipper contracts to a single fourth party to coordinate the activities; the 4PL provides organisational expertise in supply chain management. The 4PL is essentially a <u>non</u>-asset-owning service provider.
ARTC	Australian Rail Track Corporation
Automated Stacking Crane	This automated system, ASC, is an overhead gantry crane that works within a fixed rectangular yard. Within the area, containers are stored and retrieved by computer systems. Containers are delivered either to the long-rectangular side of the stack, as with a 'cantilever' design of ASC, or as an end-loaded ASC, where the containers are loaded through the short side of the stack.
AutoStrad™	AutoStrad™ is an automated straddle carrier system, where the straddle carrier is operated by computer systems. The trade-mark system has been developed by Kalmar Global, and has been implemented in Patrick's Fisherman Islands and Port Botany container terminals. See "Straddle carriers", below for further description of operations. See, also, an alternative system, the Automated Stacking Crane.
Bill of lading	In essence, a bills of lading is a certificate of ownership for cargo, ensuring that exporters receive payment for their goods and that the importers receive the denoted cargo.
Cars [rail]	In the North American context, a rail wagon is known as a "car".
Chassis	A North American term for a truck's trailer, which is used for shifting containers.

COFC	Container On Flat Car; a term used in North America. An equivalent term is a container on a flat wagon, that is, a wagon with a flat base and no sides.
Combinatorial pricing	The 'combinatorial' aspect of the pricing sets the floor or ceiling revenue to be the combined floor or ceiling revenue of all the operators on a given line segment, for which a specific access charge is being allocated.
Combined transport	This has been defined as "the carriage of freight by two or more successive modes where the vehicle or part of it used in the connecting transport is transferred together with the freight it contains into or onto another vehicle which will be used for the transport over the trunk or main trip distance. This definition also covers the piggy-back systems." (ECMT 1984, p. 80)
Demurrage	Demurrage is essentially a container parking charge. It is a fee that is charged by the stevedore when the container is held at the port beyond a certain period, such as after an import container is discharged from a vessel. The first x days after the container's discharge will be free, followed by the demurrage fee until the container is removed.
Distribution centres	Rodrigue and Hatch (2009, p. 7) describe distribution centres as being a distinct category of intermodal terminals, with three major types of function in the USA. For Australia these functions are: Firstly, goods are transferred from containers to other domestic units. Secondly, goods are sorted and transloaded to their final destinations. Finally, goods are stored, with the centres acting as buffers and consolidation–deconsolidation within the supply chain.
DOTARS	Department of Transport and Regional Services (former).
Double-stacking	Double-stacking involves having a rail wagon with a payload of one container resting on top of another container.
Drayage	Drayage is the road task between the customer's facility (factory or warehouse) and the intermodal terminal—it is the local truck pick-up and delivery task.
Dry port	Dry ports, hinterland terminals and intermodal terminals form an array of terms that relate to inland terminals that undertake a range of transmodal (cross-modal) goods transfers. Such transfers may involve simple box transfer between road and rail, through to complex distribution centres and logistics parks. See also extended gateway, gateway, hinterland terminal, inland port, inland terminal, intermodal terminal

Economies of density	With economies of density the incremental costs decline as usage increases. In above-rail production the increases in traffic volume occurs with a less-than-commensurate increase in fuel and manpower. Similarly, in below-rail production, increases in traffic volume (over a fixed network size) occur with less-than-commensurate increases in infrastructure maintenance. Harris (1977, p. 557) notes the confusion between economies of scale and economies of density, noting that "Economies of scale refer to a long-run average cost curve which declines as the size of the firm increases, i.e., the larger the firm, the lower the cost per unit of output. [whereas with economies of *density*] "we want to know what happens to average cost as output increases holding the route system, or miles of rail line constant. A small firm with high traffic density may very well have lower average costs than a large firm with low density."
Extended gateway	With an extended gateway system, a range of port activities are moved to a hinterland multimodal terminal. tasks such as customs and the release or delivery of the box are shifted to that location. Larger vessels increase the maritime terminal peaks, and the peak is reduced by having the boxes processed away from the port. See also dry port, gateway, hinterland terminal, inland port, inland terminal, intermodal terminal
Gantry loading	Gantry loading of a rail wagon involves using a travelling overhead crane that straddles both road and railway to transfer the container between the two modes. This is illustrated in Figure 23.
Gateway	A "gateway" is, in essence, the maritime port itself. This contrasts with the "extended gateway", which is the inland (or dry) port that some of the port functions have been transferred. See also dry port, extended gateway, hinterland terminal, inland port, inland terminal, intermodal terminal.
Hinterland terminal	The hinterland terminal is a generic definition for an intermodal facility that lies away from the port. The terminal may function as a dry or inland port or as an extended gateway (with specific port-based functions), as a logistics centre for exports or an import-based distribution centre, or may have little functionality other than as a box transfer point between road and rail. See also dry port, extended gateway, gateway, inland port, inland terminal, intermodal terminal

Inland port	TRB (2007, p. 55) describes an inland port as "a remote freight processing facility and body of infrastructure that provides advanced logistics for ground, rail, and marine cargo movements outside the normal boundaries of marine ports". Rahimi, et. al., (2008, p. 11) describes inland ports as "clusters of distribution and logistic centers located on a transportation corridor". See also dry port, extended gateway, gateway, hinterland terminal, inland terminal
Inland terminal	See hinterland terminal. See, also, dry port, extended gateway, gateway, hinterland terminal, inland port, intermodal terminal
Intermodal	We adopt the definition established by Jones, Cassady and Bowden (2000, p. 8) which is that intermodal is "the shipment of cargo and the movement of people involving more than one mode of transportation during a single, seamless journey". Explicit mention of containerisation is omitted so as to allow for the possibility of non-containerised movement. This definition is consistent with that adopted in BITRE 2014a (p. 9).
Intermodal terminal	At its simplest, the intermodal terminal has been a location to transfer boxes between road and rail (or any other mode-transfer). Latterly, however, the terminal has additionally has taken on logistics tasks and, sometimes, port-related activities such as customs and quarantine.
IPART	Independent Pricing and Regulatory Tribunal
ISO	International Organization for Standardization
JLARC	Joint Legislative Audit and Review Commission [of Virginia]
Loading gauge	This is the profile of allowable width and height of a rail freight load, taking account of minimum clearances required inside the structure gauge. (Inter-State Commission 1987, p. 312)
LTL	Less-than-Trailer-Load services
NCHRP	National Cooperative Highway Research Program (of the Transportation Research Board)
Near-dock	See Box 20 for a discussion of the terminology of on-dock, near-dock and off-dock.
NTC	See National Transport Commission
On-dock	See Box 20 for a discussion of the terminology of on-dock, near-dock and off-dock.
Off-dock	See Box 20 for a discussion of the terminology of on-dock, near-dock and off-dock.
Piggyback	"Piggyback" refers to a road vehicle (with, or without the prime mover) on a rail wagon. It is otherwise known as TOFC.

Platform	The platform is a North American term for container wagon capacity. The wagon capacity is defined in terms of the number of platforms, which is the equivalent of one road trailer, or one container (or two forty-foot containers in the case of a double-stack wagon).
PPV	Port Precinct Vehicles. These are essentially off-road vehicles for moving containers within the defined port precinct and do not move on public roads.
Reach stacker	A reach stacker is a rubber-tyred based vehicle with an overhead hydraulic lifting arm, raising boxes from above. A reach stacker is illustrated in Figure 20 and in Figure 57.
RoadRailer	This is highway freight trailer that fits directly onto a rail bogie, obviating the need for a flat wagon—and is sometimes called a "carless technology" (Muller 1999, p. 93). Early applications of the technology had the bogie incorporated into the trailer while later applications involved removal of the bogie when the trailer operated on the road.
Shipper	A shipper is the owner of goods being transported. In the context of this report the shipper represents the consignor of the goods.
Side loading	The traditional form of side-loading a container between road vehicle and rail wagon involves sliding the container across between the vehicle and wagon. The Flexi-Van system, illustrated in Figure 21, is an earlier example of this approach. A later transfer system, involves using forms of forklifts or reach-stackers to transfer the boxes; a reach-stacker is illustrated in Figure 20.
Staggers Act	The 1980 Staggers Act in the USA deregulated (or loosened) railway freight tariffs, allowed railways and shippers to negotiate terms of carriage and service (including railway abandonments). This railways deregulations complements the objectives and principles set out in the Motor Carrier Act of 1980 (which deregulated the trucking industry).
Stevedores	IPART has defined stevedores as being "the intermediaries between the shipping lines and the transport operators. As well as undertaking stevedoring activities (lifting cargo on and off vessels — the "ship side" activities), they also provide terminals for container transit and for the loading of containers on and off trucks and rail (the "landside" activities)." (IPART 2007, p. 8) Stevedores are also known as "container handlers" and as "Terminal Operating Companies" (that is, not exclusively maritime terminals).
Straddle carrier	The straddle carrier is used to shift containers between stacks and dockside gantry cranes, or between stacks and landside collection areas. Straddle carriers moved bestride the container, which is then lifted using lifting points in the four top corners of the container.

TEU	This stands for Twenty-foot Equivalent Unit, a measure of container lengths; a 20-foot container is therefore one TEU while a 40-foot container is two TEUs. The standard-length international maritime container (ISO) has a 20-foot length (6.1 metres). The other standard-length maritime container has a 40-foot length (12.2 metres), or twice the length of a 20-foot container. Thus the 40-foot container can be reported as being the equivalent of two TEU. The width of the containers is 8-foot (2.438 metres). The "standard" height is 8 foot 6 inches (2.591 metres) but a "hi-cube" container is common, having a 9 foot 6 inch height (2.896 metres). Gross weights of containers vary, but a 20-foot container is usually around 24 tonnes and the gross weight of a 40-foot container is around 27 tonnes. The tare weight of these containers is around 2 tonnes, and 3.5 tonnes, respectively.
TL	Truck Load
TOFC	Trailer On Flat Car; an alternative North American term for "piggyback"
TrailerRail	See RoadRailer
Transloading	Transloading involves breaking a goods movement at a terminal, re-packaging bundles of goods. For example, goods imported in containers into the USA are often consolidated from (smaller) international containers into larger (53 foot) domestic containers. As well as being longer, those containers are relatively lighter; because they are not stacked six-high (as is the case with international containers in vessels), they do not require the same strength. The result is that the domestic containers have a relatively low tare weight.
TRB	Transportation Research Board

www.bitre.gov.au

ISBN 978-1-925401-15-8