CONTAINER TRAIN OPERATIONS BETWEEN PORTS AND THEIR HINTERLANDS: A UK CASE STUDY

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Abstract

As supply chains become increasingly global and companies seek greater efficiencies, the importance of good, reliable land-based transport linkages to/from ports increases. This poses particular problems for the UK, with its high dependency on imported goods and congested ports and inland routes. It is conservatively estimated that container volumes through British ports will double over the next 20 years, adding to the existing problems. Rail freight plays a major role in the inland transport of containers passing through the main British container ports, and potentially could play a more significant role in the future. However, there is little detailed understanding of the nature of this particular rail market, especially in terms its current operating efficiency. This paper investigates the potential for rail to become better integrated into port-based container flows, so as to increase its share of this market and contribute to a more sustainable mode split. Trends in container traffic through UK ports are identified and the role of rail within this market is established. The paper then examines container train service provision to/from the four main ports, based on analysis of a representative survey of more than 500 container trains between February and August 2007. The extent to which the existing capacity is utilised is presented, and scenarios by which the number of containers carried could be increased without requiring additional train service provision are modelled, to identify the theoretical potential for greater rail volumes. The challenges involved in achieving higher load factors are identified. The paper concludes that container movements between ports and their hinterlands are an important market for rail, with considerable growth potential but to realise this it is important that a number of constraints are overcome, otherwise the long-term prospects for this rail market will be compromised.

1. Introduction

The continued growth in the volume of international trade poses considerable economic and sustainability challenges, particularly as transport routes become more congested and concern grows about the role of transport movements in accelerating climate change. Global growth in the movement of international standard (ISO) freight containers has been particularly rapid, with a compound annual growth rate of 10.5% in the 1990s and 12.8% since 2000, resulting in global port volumes estimated at more than 400 million TEU in 2006, a significant increase on the 230 million TEU in 2000 (OSC, 2007). A TEU is a twenty-foot equivalent unit, meaning a standard 40 foot container is two TEU. Growth rates at British ports have been lower but still considerable, at around 5% per annum between 2001 and 2005 (Network Rail, 2007). The Eddington Transport Study (HM Treasury, 2006a) highlighted the role of efficient freight distribution in supporting the British economy, and specifically identified the importance of enhancing the performance of the major container ports and the inland transport corridors linking ports to their hinterland. There is a growing body of evidence that transport activity is a major, and growing, contributor to global climate change (see, for example, HM Treasury, 2006b; IPCC, 2007) and that urgent action is needed to reduce the environmental impacts of transport movement.

Rail freight currently plays a major role in the inland transportation of containers passing through the major British ports. Official rail freight statistics do not isolate port-based container flows, but they make up almost the entire domestic intermodal category. This category experienced growth of 16% in the number of tonne kilometres between 1999/00 and 2006/07, and accounts for 20% of all rail freight moved in Britain (ORR, 2007). In mid-2007, the ports that were served by dedicated container train services were Felixstowe, Southampton, Tilbury and Purfleet (both within the Port of London), Thamesport (Kent) and Seaforth (Liverpool); the former two are by far the most significant for both port container throughput and rail freight activity. Rail has the potential to play a more significant role in the future, for both economic and environmental reasons. As a result of varying assumptions, there is not yet a consensus on the precise environmental benefits of rail freight over road haulage, but the evidence suggests that rail has substantially lower carbon dioxide emissions per tonne kilometre than has road (McKinnon, 2007). In theory at least, rail may also provide an alternative to the increasingly congested road network, thus offering economic benefits through time savings and load consolidation. As carbon auditing of supply chains develops, there is likely to be a need for a more detailed and precise understanding of the nature of specific types of rail freight flow, which in turn demands a more sophisticated awareness of the operating characteristics at a more disaggregated level than has traditionally been the case.

The research analysed and discussed in this paper brings together two areas of research that are generally treated as distinct entities, namely the maritime and rail freight sectors. There has been some previous work combining the two sectors, but scope still exists for better understanding the relationship between the two in the light of evolving policy and operating environments. In the light of the relatively limited previous research in this specific area, the paper aims to develop a more detailed understanding of the interactions between container traffic through UK ports and the use of rail for associated inland movements. The specific objectives of this paper are:

1. to identify the nature of port-based container flows by rail in Britain, together with the trends in this market
2. to identify the current level of service provision, both in terms of number of trains operated and the container carrying capacity of these trains
3. to examine the extent to which the existing on-train capacity is utilised (i.e. load factor)
4. to model the theoretical potential for carrying greater rail volumes without requiring additional train service provision under a number of different scenarios
5. to set out arguments relating to the challenges involved in achieving higher load factors and longer trains
6. to assess the prospects for port-based container flows by evaluating the main opportunities and constraints

Sections 2 and 3 chart the growth of the British container market and the associated development of dedicated rail freight services, with the identification of recent trends from the combination of published statistics and original research. In Section 4, a review of literature relating to container train service provision and utilisation is presented. This is followed in Sections 5 and 6 by a detailed analysis of the original research into service provision and on-train capacity utilisation respectively. Section 7 then considers the scope for improving load factors of existing services, and Section 8 with a broader assessment of the future of the rail market for container movements between ports and their hinterlands. The paper ends with conclusions in Section 9.

2. Trends in the British container market

This section focuses on the development of the UK container market, particularly examining trends over the last 20 years. It considers the likely changes in this market over the next 20 years or so as a result of general growth in container volumes and new infrastructure developments that are expected to alter the pattern of flows.

In line with the global trend identified earlier, flows of containerised goods through UK ports have increased very rapidly in recent decades. Table 1 shows the trends in container volumes passing through the UK's ports since the mid-1980s. In tonnage terms, there was an increase of almost 140% between 1985 and 2004. While the rate of growth has slowed since the mid-1990s, there was a large annual increase (of almost 10%) between 2003 and 2004. In terms of the number of containers handled, the increase since 1985 (i.e. 130%) has been similar to that of tonnage, but the increase in TEU, at 162%, has been greater, reflecting the trend towards longer containers with 40' containers being increasingly dominant and 20' containers losing some of their market share. By 2004, just 36% of containers handled were 20' ones, compared to 43% in 1990 [35-36]. As can be seen, the number of TEU per container has increased fairly steadily, from 1.43 in 1985 to 1.63 in 2004. There have also been changes in container heights, with a general trend away from the use of 8'6" high containers to those that are 9'6" in height. For example, approximately 40% of 40' containers passing through Felixstowe in 2003 were 9'6" high [37]. At the UK level, there has been a significant increase in the proportion of containers handled that are empty, increasing from 15% in 1995 to 28% in 2004, presumably reflecting the growing imbalance between UK import and export flows.

Table 1: UK container traffic, 1985 - 2004

	1985	**1990**	**1995**	**2000**	**2001**	**2002**	**2003**	**2004**
Tonnage (millions)	23.7	34.5	47.6	51.6	51.7	51.1	51.3	56.4
Containers (millions)	2.13	2.84	3.64	4.32	4.45	4.49	4.51	4.90
TEU (millions)	3.05	3.97	5.36	6.71	6.98	7.22	7.30	7.99
TEU per container	1.43	1.40	1.47	1.55	1.57	1.61	1.62	1.63
% of containers empty	21	19	15	19	21	24	28	28

Source: based on DfT (2006)

Table 2 reveals the share of the market that each of the main container ports handles. Felixstowe is dominant, with one third of the total. Three quarters of all containers handled in 2004 passed through ports in South East England (i.e. from Felixstowe to Southampton inclusive) (DfT, 2006), so there is a high degree of geographical concentration, which has been strengthening over time. Of note is the rapid growth at the relatively new Thamesport container terminal, situated in the Medway group of ports and owned by the same port company as Felixstowe: essentially Thamesport has absorbed growth that would otherwise have been expected to occur at the congested Felixstowe port. The share of traffic handled by 'other ports' has dropped considerably since 1985, though there has been relative stability since the late-1990s.

Table 2: Container volumes at the main UK ports, 1988 – 2004 (% of total in each year)

Port	**1988**	**1993**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
Felixstowe	34	37	41	42	41	37	34	34
Southampton	9	11	13	16	17	18	19	18
London	12	10	10	8	11	12	12	12
Medway	0	4	7	8	7	7	7	8
Liverpool	4	8	7	8	7	7	8	8
Hull	4	5	3	4	3	2	4	4
Other ports	37	25	19	14	14	17	16	16
Total	100	100	100	100	100	100	100	100

Source: based on DETR (2000), DfT (2006); Tilbury is part of the London group of ports; Thamesport is part of the Medway group of ports

The growth trend in container volumes through British ports is expected to continue. National forecasts by MDS Transmodal (2006) anticipate TEU growth of 70% between 2004 and 2015, and of 180% by 2030. The increase in the number of units carried is likely to be slightly lower as the trend away from 20' units continues. There is general convergence of forecasts with, for example, Ocean Shipping Consultants (OSC, 2006) predicting growth of approximately 40% between 2004 and 2010. In addition to the trend towards longer containers, there is an expectation that virtually all 40' containers will be 9'6" high by 2011 (HPUK, 2003), since there are now virtually no 8'6" high 40' containers being manufactured.

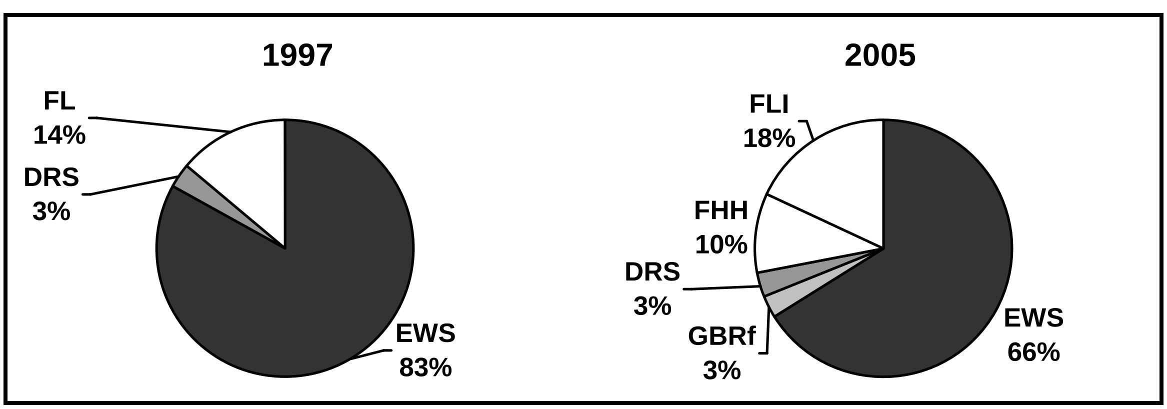
To cater for the predicted growth in volumes, a combination of the expansion of certain existing terminals and the construction of new container ports will take place, which is likely to lead to further concentration of volumes through the southern part of the east coast of England (MDS Transmodal, 2006). The main developments are the expansion of Felixstowe South Terminal, and new terminals at Bathside Bay (at Harwich, across the estuary from Felixstowe) and London Gateway, on north Thameside. An earlier application for a new container port near Southampton was refused. These approved developments will add capacity to handle almost 7 million TEU per annum. Given that the total handled by UK ports in 2004 was 8 million TEU, these three schemes alone will allow for significant growth. In addition, incremental enhancements to capacity are expected at a number of other container terminals. There seems little doubt that the potential market for rail freight will grow.

3. The port-based container rail freight market in Britain

This section first provides a brief overview of the development of the container rail freight market in Britain. It then presents a more detailed analysis of the changes that have taken place since 1997, primarily through the use of original desk-based research into service provision in the port intermodal rail freight market. This analysis considers the trends both at ports and inland terminals, so as to provide a comprehensive assessment of the nature of this rail freight sector.

The movement of ISO containers on Britain's rail network can be traced back to November 1965, with the first trains running under the Freightliner banner as a result of the Beeching Report into the future of the railways (Freightliner, 2006a). The initial routes were established to serve domestic markets (e.g. London to Scotland), but the network gradually evolved during the 1970s to focus on routes to/from the main ports. At the time of rail privatisation in the mid-1990s, all port-based container traffic by rail was handled by Freightliner; all other rail freight traffic was moved by English Welsh and Scottish Railway (EWS). This reflected the situation immediately prior to privatisation, whereby Freightliner had been a separate operating sector of British Rail. A detailed account of the privatisation process can be found in Clarke (2000). Each of the four other rail freight companies operating by 2006 (i.e. EWS, GB Railfreight (GBRf), DRS and Fastline) has moved into the port-based container sector within the previous five years: EWS commenced in 2001, with GBRf starting in 2002, DRS in 2005 and Fastline in May 2006. One of the key factors generally believed to have assisted with the British rail freight revival since the mid-1990s is the introduction of competition to the market. The effect of this at the overall level can be seen in Figure 1, with the lessening of EWS' dominance in terms of revenues received. The former Freightliner (FL) has separated into Freightliner Intermodal (FLI) and Freightliner Heavy Haul (FHH), with the former taking responsibility for the container traffic. This diagram hints at the growth of container flows, since Freightliner's Intermodal division has a larger market share in 2005 than Freightliner had in 1997 at a time when the overall rail market has grown. With the exception of Freightliner Heavy Haul, all operators shown in 2005 were active in the container market, compared to just Freightliner in 1997.

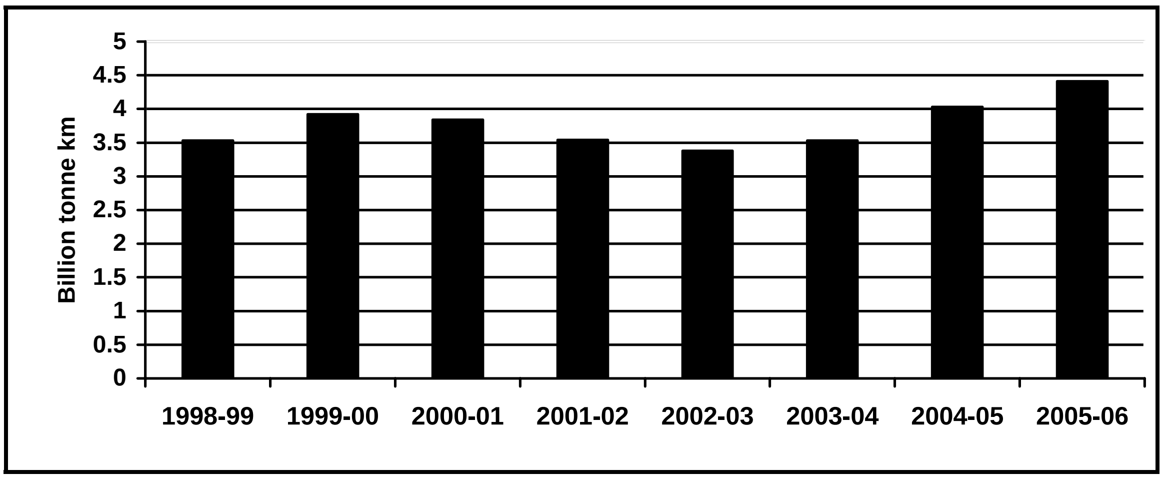
Figure 1: UK operators' rail freight shares by revenue: 1997 and 2005



Source: EIM/EFRA/ERFCP (2006)

Figure 2 displays the recent trend in domestic intermodal rail freight, this being the sector in official statistics that includes port-based container flows. These statistics have been produced on a quarterly basis since 1998/99; prior to that the official rail freight statistics referred only to coal and 'other', so it is not possible to monitor the longer-term trends in intermodal rail freight volumes. While port-based container flows dominate the domestic intermodal sector, other traffic is also included in the statistics. These are relatively small in number (generally Anglo-Scottish via the West Coast Main Line), although they have increased slightly in recent years, and so may contribute in some way to the 25% growth experienced by this sector between 1998/99 and 2005/06. This growth has been faster than in other sectors with the exception of coal and construction despite intermodal services being disproportionately affected by the network disruption following the Hatfield derailment in late-2000.

Figure 2: Domestic intermodal freight by rail in Britain (billion tonne kilometres)

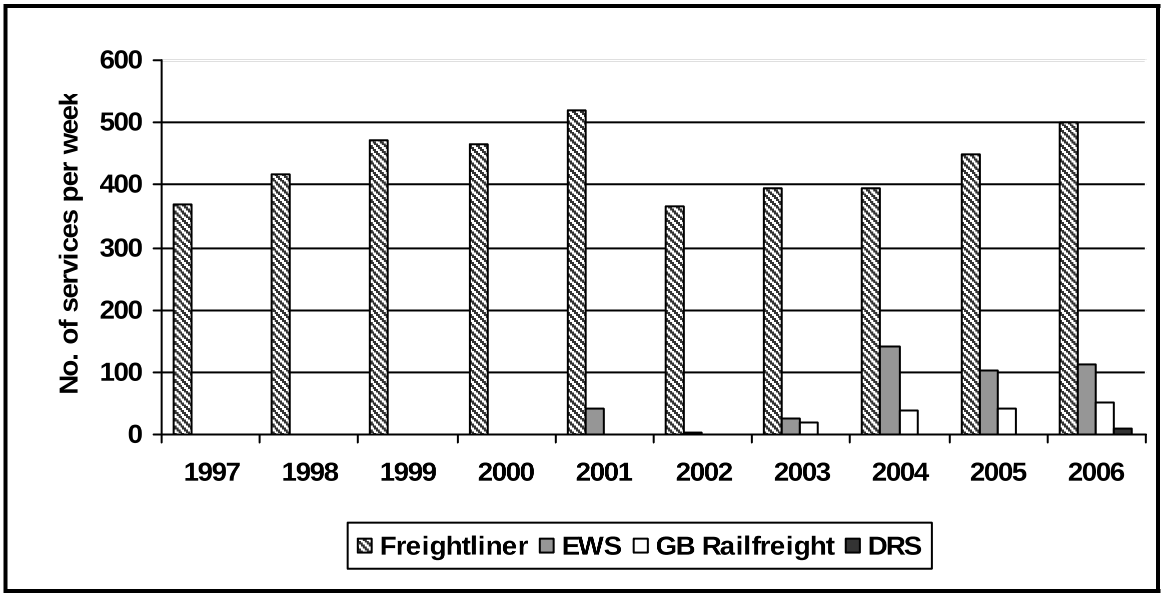


Source: ORR (2006)

The official statistics do not allow any greater disaggregation of trends, so the following analysis utilises the detailed information about service patterns contained within databases of rail freight provision constructed by the author. Figure 3 shows the number of container services operated each week by each of the rail freight companies every year from 1997 to 2006. This reveals an 80% increase in the number of services, and also makes evident the introduction into the market of new operators although Freightliner is clearly still the dominant operator. The growth rate appears to be significantly higher than shown by the official statistics because there was considerable growth in service provision between 1997 and 1999, prior to the start of the official statistics, and the Freightliner network has evolved from a hub-and-spoke one to direct service provision between port and inland terminal pairs. Again, the effect of the Hatfield derailment is marked: the January 2001 figure was very soon after the incident so does not reflect the decline in service provision, but significant cutbacks are evident within the following year, including the almost complete (temporary) withdrawal of EWS from this market.

Table 3 shows the changes in Freightliner service provision between 1997 and 2006 from the ports it serves, based on the database analysis. Over the entire time period, the total number of departures from the five key ports increased by approximately 60%. The 25% official growth rate from 1998/99 is broadly in line with the 23% shown below for the comparable time period. The four key ports in South East England have all experienced considerable expansion of service provision, with the greatest increase occurring at Felixstowe which has overtaken Southampton to offer the greatest number of departures per week to inland terminals. It appears that these increases in service provision mirror volume increases with, for example, Freightliner's volume handled at Thamesport increasing by 40% between 2003/04 and 2005/06 (Freightliner, 2006b) at a time when service provision went up by 50%. The reversal of the upward trend, as a result of the Hatfield derailment, can be seen clearly, with the 2002 figure little above that of 1997. Generally, subsequent years have seen the growth trend continue.

Figure 3: Total number of loaded services per week for port-based containers (both directions, plus feeders; Jan of each year, by operator)



Source: author's databases

Table 3: Freightliner container train services from deep sea ports (no. trains/week; Jan each year)

Port	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	% change 97-06
Felixstowe	50	70	66	66	68	67	78	80	81	98	96
Southampton	55	63	64	53	67	53	67	67	77	79	44
Tilbury	20	23	23	23	20	20	30	25	25	30	50
Thamesport	10	15	20	20	20	10	15	10	15	15	50
Liverpool	6	11	11	11	11	5	5	5	5	5	(17)
Total	141	182	184	173	186	155	195	187	203	227	61

Source: author's databases

Table 4 shows the growth of the non-Freightliner services, from just one service per week in January 2002 up to 70 services per week in January 2006, giving these other operators almost one quarter of the service provision and serving additional destinations such as Purfleet and Tees (in 2006) as well as the four key South East container ports. Freightliner's market share is likely to remain above 75%, but there now appears to be at least a degree of competition in the container market. In addition to the services shown, a number of EWS Enterprise less-than-trainload routes serve container ports and may be able to carry container traffic as necessary along with other types of consignment. In 2002, 55 Enterprise services operated from ports; by 2006, this had increased slightly to 60 services. For many of these services, however, containers are likely to be non-existent or negligible in terms of the composition of these trains, since the Enterprise network was set up to handle traditional rail wagons rather than containers and it is only more recently that some container movements have been handled by Enterprise.

Table 4: Other operators' container train services from deep sea ports (no. trains/week; Jan each year)

Port	2001	2002	2003	2004	2005	2006
Felixstowe	-	-	15 (5/10/ -)	25 (10/15/ -)	26 (10/16/ -)	30 (10/20/ -)
Southampton	-	-	5 (5/ - / -)	20 (20/ - / -)	20 (20/ - / -)	20 (20/ - / -)
Purfleet	-	-	3 (3/ - / -)	-	5 (5/ - / -)	5 (- / - /5)
Tees	-	-	-	5 (5/ - / -)	5 (5/ - / -)	5 (5/ - / -)
Thamesport	-	-	-	15 (15/ - / -)	5 (5/ - / -)	5 (5/ - / -)
Tilbury	-	-	-	-	-	5 (5/ - / -)
Avonmouth	-	1 (1/ - / -)	1 (1/ - / -)	1 (1/ - / -)	1 (1/ - / -)	-
Ipswich	10 (10/ - / -)	-	-	-	-	-
Harwich	5 (5/ - / -)	-	-	-	-	-
Liverpool	-	-	-	1 (1/ - / -)	-	-
Total	15 (15/ - / -)	1 (1/ - / -)	23 (13/10/ -)	67 (52/15/ -)	62 (46/16/ -)	70 (45/20/5)

Source: author's databases; numbers in brackets represent number of services operated by EWS/GB Railfreight/DRS respectively

While comprehensive data are not available, there is some evidence that rail has been increasing its share of the container market, in addition to the absolute growth in containers handled. For example, at Felixstowe rail increased its share of the inland container market from 20% in 2001 to 22% in 2004, an absolute increase of 25% in the number of containers handled (EERA, 2006). Tilbury has been less successful since, despite a 50% increase in the number of containers moved by rail, the mode share dropped marginally from 18% in 2001 to 17% in 2004 as a result of fast growth in container throughput at the port. However, the Port of Tilbury remains much smaller than Felixstowe, handling less than one third of the number of containers handled at its larger competitor. No reliable annual data have been found for the other key ports. Table 5 shows the changes that have taken place in inland terminal service provision by container trains from deep sea ports, aggregated across all four operators. For ease of comprehension, terminals located within the same region have been combined.

Table 5: Container train arrivals at inland terminals from deep sea ports (no. of trains/week; Jan each year)

Region	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	% change, 97-06
Midlands	15	14	25	30	40	25	41	73	72	78	420
Yorkshire	26	26	31	31	36	38	40	46	51	71	173
North West	61	56	66	76	86	67	79	86	97	92	51
South East	17	11	10	10	20	10	15	20	10	20	18
North East	10	5	10	10	12	12	11	11	12	11	10
Wales	11	15	20	15	10	10	15	16	13	10	(9)
Scotland	36	41	36	35	35	25	20	20	20	20	(44)
East Anglia	0	-	-	-	-	-	-	-	10	5	n.a.
Total	176	168	198	207	236	187	221	272	285	307	74

Source: author's databases

Of note is the huge growth in what could be considered to be the medium-distance market, catering for flows between the South East ports and the Midlands and Yorkshire in particular but also the North West, which was already well-served by container services in 1997 and has experienced considerable growth but at a lower rate than the other medium-distance regions. By contrast, the longer-distance corridor to Coatbridge, in Scotland, has experienced a considerable reduction in the number of services and has fallen from being served by the greatest number of trains in 1997 (jointly with Trafford Park) to sixth position in 2006. The long-distance Anglo-Scottish market was hit particularly hard by the post-Hatfield disruption and had still not recovered by 2006, most likely as a result of traffic transferring to coastal shipping services to/from Grangemouth and Greenock. The other long distance flow, from the South East to Teesside, has shown little growth. Cardiff has also experienced a decline in service provision with the withdrawal of the daily train from Felixstowe, perhaps because rail capacity constraints at the port mean that other destinations are favoured. It is clear that container capacity is now far more heavily concentrated on flows from the South East (particularly Felixstowe and Southampton) to the Midlands, North West and Yorkshire than in 1997. Many of the terminals in these regions have been constructed or expanded to cater for the increased flows.

This section has presented a range of different measures of activity in the port-based container rail freight market, both from published statistics and significant original analysis. Table 6 summarises the changes between 1998/99 and 2004/05), this being the period where full comparison is possible.

Table 6: Summary of key trends relevant to the containers-by-rail market, 1998/99 – 2004/05

Measure	**1998/99**	**2004/05**	**% change**
UK container traffic (million TEU)*	6.45	7.99	24
Domestic intermodal rail freight (bn tonne km)	3.53	4.03	14
No. of loaded services per week **	470	594	26
No. of departures per week from deep-sea ports **	184	265	44
No. of container train arrivals per week at inland terminals **	198	285	44

* - 1998 and 2004 calendar year figures; ** - January 1999 and 2005 figures

The key findings are:

- Container traffic has become an increasingly important rail freight sector, with a faster than average growth rate.
- Despite this, there is no clear evidence that rail is increasing its market share for the intra-UK distribution and collection of containers, since there has also been a significant increase in container trade in the same time period. The gaps in official data and differences in units of measurement make comparison difficult, but the official statistics show that the growth in tonne kilometres has been less than the growth in the number of TEU handled at UK ports.
- There is evidence, however, both anecdotally from other sources and from the analysis of service provision, that the number of TEU handled by rail has grown at a faster rate than the growth in tonne kilometres, since the market has become more focused on medium- rather than long-distance flows.
- It appears, therefore, that there may well have been some modest increase in rail's share of the intra-UK market, when measured by TEU carried.
- The recasting of the Freightliner network to provide more capacity and faster services, away from hub-and-spoke to point-to-point service provision, has further increased the number of services operated and the level of terminal activity, relative to the tonne kilometres moved.
- The Hatfield derailment in 2000 reversed the growth trend, but there has been considerable growth in rail activity in the subsequent years.

4. Literature review: container train capacity provision and service utilisation

There is a relatively long and informative history of investigating railway efficiency (see, for example, Gathon and Perelman, 1992; Cowie and Riddington, 1996; Preston, 1996), largely using econometric techniques at a national level, though tending towards passenger operations instead of freight. Interest in the topic has grown as the deregulation of rail systems has spread from North America to Europe and elsewhere. Chapin and Schmidt (1999) considered the effects on technical and scale efficiencies resulting from rail freight industry consolidation in the US, but did not consider operational capacity-related issues. Before progressing on to the specifics of rail capacity utilisation, it is important to clarify the terminology adopted for this paper, particularly given the varied uses in previous work. In the rail industry, capacity utilisation most commonly relates to the number of train movements over defined routes or sections of the network. In defining the term, Gibson *et al.* (2002) refers to the availability and utilisation of train paths on a track section, and this concept is widely used in rail operations and policy documents. Wagon utilisation typically relates to the number of journeys undertaken in a given time period (see, for example, IRIS, 2001), rather than referring to whether or not the wagon was loaded on any given journey.

There is a strand of previous research that has examined capacity issues relating to intermodal rail freight. Much of this attention has focused on intermodal terminal throughput and utilisation rather than the trains themselves. In two separate studies (Ferreira and Sigut, 1995; Ballis and Golias, 2002), the critical role of terminals in the performance of intermodal freight systems was argued and the effects of new types of facility were modelled. Through a literature search, Wiegmans *et al.* (1999) identified a range of characteristics that are instrumental in classifying terminals and determining their performance, but train load factors are not included as a relevant factor. Other authors have developed modelling techniques to assess aspects of the intermodal rail freight market. Macharis and Bontekoning (2004) provide a comprehensive review of operations research opportunities within the intermodal system and identify the challenge of load assignment to trains at terminals, while Corry and Kozan (2006) developed an assignment model for load planning, again highlighting the many variables that make this such a complex task.

There is no evidence that any European studies have identified and assessed different intermodal load factors through data collection and analysis unlike, for example, the study of the road freight sector conducted by Léonardi and Baumgartner (2004), who found that load factor improvements were one potential means by which environmental impacts could be reduced. In the US, Lai and Barkan (2005) evaluated different intermodal train loading combinations regarding their fuel efficiency, and the authors have subsequently developed this analysis to incorporate aerodynamic efficiency (Lai *et al.*, 2007). Load factors and container spacing were found to have significant impacts on fuel and aerodynamic efficiency, although the practicalities associated with improving load factors were not fully explored. In any case, the characteristics of the American intermodal market are distinct from those pertaining in Europe. There is a growing body of research comparing the environmental impacts of road haulage and intermodal freight. In their review of the topic, Kreutzberger *et al.* (2003) found that load factor was one of many attributes that influences the relative performance of the transport types, but that intermodal was almost always better performing than road haulage alone. Detailed comparisons of different load factors were not investigated. Janic (2007) has approached the topic from a cost internalisation model, focusing on a comparison of a road-rail system with road alone. The rail element assumes a 75% load factor, with no allowance for divergence from this. In an interesting application of the emerging life cycle analysis technique, Spielmann and Scholz (2005) compared road, rail and water, but explicitly stated that no adjustment had been made for different load factors.

Given the potential for variations in train load factors to affect both environmental and economic impacts of rail freight, it is surprising that no statistics are published relating specifically to this issue that could be used to inform debate and lead to a consensus on the extent to which load factors could or should be influenced through changes to the management of the supply chain or through public policy measures. By contrast, annual statistics relating to vehicle empty running and load factor (known as lading factor) are produced for the British road haulage sector (DfT, 2007a). The British government, Network Rail and the freight operating companies have recognised the importance of capacity utilisation in rail policy making and network management and operation. However, there is little consideration of freight train load factors in any published documents. As a consequence of the rapid growth in both freight and passenger volumes on the rail network since the mid-1990s, capacity issues have moved up the agenda and a policy document specifically addressing rail network capacity utilisation was developed by the Strategic Rail Authority (SRA, 2003). The major part of this document focused on the constraints on train pathing through the network and on measuring and understanding passenger train utilisation and crowding. The SRA acknowledged weaknesses in rail freight data, with greatest attention being focused on the ability to increase the number of freight trains operated and means by which freight trains can be lengthened, for example through infrastructure enhancements and increased locomotive power. A key element of the policy was to encourage the operation of the longest practicable trains, without any consideration of existing or potential load factors. As of late-2007, two recent policy documents define the approach to rail freight capacity and its utilisation, these being Network Rail's Freight Route Utilisation Strategy (RUS) (Network Rail, 2007) and the government's White Paper for railways (DfT, 2007b). Of note is the clear intention to accommodate growing rail freight volumes. Particular constraints that are identified are network availability, loading gauge restrictions and limitations on train lengths, weights and speeds.

Train lengthening has been identified as one potential way in which growth can be accommodated and, indeed, features as the most important capacity enhancing measure for container trains recommended in the Freight RUS. It argues, for example, that an increase in train length from the typical 24 wagons at present to 30 wagons on Felixstowe services would be possible in the longer term if certain infrastructure improvements take place (Network Rail, 2007). In its response to the RUS consultation phase, however, Freightliner (2006c), the biggest of the container train operators, argued that train lengthening would be a viable solution in some situations but it is not a universal capacity enhancing measure. The company argues that even if route and terminal infrastructure was enhanced, commercial considerations are in some cases likely to limit the desirability of longer trains due to insufficient volumes, while in other instances factors such as maximum trailing weights have been reached given the currently available motive power. Within existing overall train length constraints, there is potential to increase TEU capacity on trains that operate on routes where gauge enhancement to allow the movement of high cube containers on standard rail wagons has not yet taken place. In the most extreme cases, notably routes serving Southampton, carrying capacity can be reduced by one third (Network Rail, 2007), though in practice the reduction is not as great as this due to the mix of wagon types used. As high cube containers become more dominant (HPUK, 2003), the pressure for gauge enhancement of all core and diversionary routes increases and the implications for train capacity of non-clearance become more significant.

Given the attention devoted to capacity-related issues, it is surprising that only a small number of studies have considered existing intermodal load factors, and when they have the concept has been applied to specific flows or corridors. For example, the IRIS project conducted a cost comparison exercise for different options on a specific customer flow from Southampton with sensitivity testing using two different load factors (IRIS, 2001). Elsewhere, evidence to container port development Planning Inquiries has discussed load factors as well as the more common capacity utilisation considerations. One case, the Felixstowe South Reconfiguration Inquiry, stated that the existing load factor for container trains serving Felixstowe was less than 70% but would increase to 85% by 2016 (HPUK *et al.*, 2004) as a result of increasing volumes and improvements to the rail network to allow greater efficiency. It is not clear, though, whether this assumed increase was based upon any rigorous assessment. Overall, it is evident from this synthesis of the available literature that container train load factors have been largely neglected as a focus of attention, with the main emphasis being on network utilisation, terminal throughput and train lengths. This paper will focus on the potential role of improved load factors to carry a greater number of containers without recourse to the more expensive infrastructure and rolling stock related solutions.

5. Current container train service provision

The research is based on a survey of container trains serving the four principal rail-served ports (i.e. Felixstowe, Southampton, Tilbury and Thamesport). A total of 578 container trains were surveyed between February and August 2007, which is equivalent to one complete week's worth of scheduled trains operating to and from these four ports, or 4% of scheduled services to and from these ports during the survey period. The weekly scheduled service provision at the time the survey was conducted is shown in Table 7. Felixstowe and Southampton between them account for 84% of trains serving the four ports, with 44% and 40% respectively. At 9% of the total, Tilbury has a slightly higher share than Thamesport (7%), but it is evident that these two ports are far less significant than the other two. In train operator terms, the dominance is even more marked, with Freightliner operating 74% of trains. EWS, the second largest provider, has a 17% share of service provision. The other two operators, First GB Railfreight and Fastline, each serve just one port and have small shares at 7% and 2% respectively. Despite growing competition between operators, the port-based container train market remains highly concentrated, with over 60% of trains that operate to or from the four key ports in reality being operated by Freightliner and serving Felixstowe or Southampton.

Table 7: Composition of survey sample by port, freight operating company and direction of flow

	Import					Export					
Port	FL	EWS	GBRf	F'line	Total	FL	EWS	GBRf	F'line	Total	Total
Felixstowe	98	10	20	0	128	99	10	20	0	129	257
Southampton	81	35	0	0	116	80	35	0	0	115	231
Tilbury	20	5	0	0	25	20	5	0	0	25	50
Thamesport	15	0	0	5	20	15	0	0	5	20	40
Total	214	50	20	5	289	214	50	20	5	289	578

Key: FL – Freightliner; EWS – English, Welsh & Scottish Railway; GBRf – First GB Railfreight; F'line – Jarvis Fastline

The mean train length (as measured by the number of wagons) calculated from the survey data was 22 wagons, though considerable variation was observed, from a minimum of 10 to a maximum of 28 wagons. The extremes are relatively rare, however, with a standard deviation around the mean of just 2.9. At 19.5 wagons, Tilbury had the shortest mean number of wagons per train, while Southampton had the highest, with a typical train being 23 wagons long. Felixstowe had a mean train length of 22 wagons, while at Thamesport the figure was 21.5 wagons. If container trains were operated solely by standard 3 TEU wagons, the mean capacity provided per train across all ports would be 66 TEU. This is not the case, though, as Table 8 reveals, emphasising the importance of considering carrying capacity as well as train length. The observed mean capacity per train across the entire sample was 60 TEU, as a result of the use of non-standard (i.e. low floor and pocket) wagons to cater for high cube containers on routes that have not been gauge enhanced for high cube containers on standard wagons. This combination of an observed mean train length of 22 wagons and the inclusion of non-standard wagons in many trains gives a mean train capacity considerably lower than the 72 TEU that would result from all trains operated at the reported 'typical' length of 24 standard wagons. Observed train capacity ranged from 30 to 84 TEU, with a standard deviation around the mean of 9.7. This standard variation is higher than that for train length due to the varying combinations of wagon types used in different observations.

Table 8: Mean TEU capacity provided per train, by port and direction of flow

	Mean capacity per train (TEU)		
Port	**Import**	**Export**	**Both**
Felixstowe	62.44	62.97	62.71
Southampton	57.87	57.99	57.93
Tilbury	54.40	54.08	54.24
Thamesport	61.25	62.00	61.63
Total	59.83	60.15	59.99

Source: author's survey

As would be expected given the need to balance wagon utilisation, there was very little observed variation in train capacity by direction of travel. Overall, there was only around a 0.5% difference between import and export observed train length. With the exception of Thamesport, which had the smallest sample size of the ports, the individual port differences are less than 1% and are likely to arise from one or both of slight variations in train lengths during the survey period or minor variations in train sampling. Of more interest are the observed variations in average train capacity by port, as shown in Table 8, and by operator, as shown in Table 9. When considering the ports, Felixstowe has a typical observed capacity 16% greater than that of Tilbury, which has the lowest mean value. It would have reasonably been expected that Felixstowe and Tilbury would have higher mean train capacities than Southampton and Thamesport, since the latter two have a far greater reliance on non-standard wagons given the lack of a gauge cleared route for high cube containers, but the evidence does not support this expectation. Instead, the mean capacity for Thamesport trains is only very slightly lower than that for Felixstowe services. From Table 9, it can be seen that the variations between operators are more noticeable than are the differences between ports, with a representative EWS train offering just three quarters of the capacity of a typical Freightliner or First GB Railfreight service. It should be noted, though, that while EWS has the lowest average train capacity its wagon fleet is proportionally better able than other operators to cater for high cube containers on gauge constrained routes, so the data shown represent only TEU capacity and not more detailed capability considerations. Table 9 also shows disaggregated information relating to operators' typical train lengths at each of the ports that they serve. Only Freightliner and EWS serve more than one port. In both cases, their Tilbury services have lower mean carrying capacities than their trains at other ports. Freightliner services at Felixstowe and Southampton vary little in their mean train capacity, and the same is true for EWS services at these two ports.

Table 9: Mean TEU capacity provided per train, by port and train operator

Port	**Mean capacity per train (TEU)**				
	Freightliner	**EWS**	**First GBRf**	**Fastline**	**All operators**
Felixstowe	64.38	45.60	63.00	-	62.71
Southampton	62.61	47.22	-	-	57.93
Tilbury	58.00	39.20	-	-	54.24
Thamesport	64.17	-	-	54.00	61.63
Total	63.10	46.09	63.00	54.00	59.99

Source: author's survey

5. Container train capacity utilisation

Having identified the container carrying capacity of the sampled train services, this section deals with the third research objective, that being the extent to which the existing on-train capacity is utilised (i.e. the load factor). At this stage, no account is taken of the potential to lengthen existing trains or utilise different wagon types; instead, the analysis simply relates to how well the existing trains are filled. Table 10 shows that, in the complete sample, the mean load factor was 72% but that, as with train lengths, there was considerable variation between ports and, to a lesser extent, in the direction of flow. Overall, import services were more heavily loaded than export ones, most notably in the case of Southampton but also with Felixstowe. By contrast, export services were better loaded than import ones at both Tilbury and Thamesport. On a port-by-port basis, Felixstowe services performed best with a mean load factor of 80%, while at the other extreme the observed average load factor at Tilbury was only slightly more than 50%. At 31 percentage points, load factor variability between the ports was greater in the import direction than it was for export flows, where there was a difference of 20 percentage points.

In Table 11, the mean capacity utilisation is shown for each operator, both in total and disaggregated by each port that their trains serve; again, there are major variations in observed load factors. First GB Railfreight had the highest average load factor, with its trains from Felixstowe typically 90% full. Freightliner's mean load factor was observed to be 73%, though this ranged from 80% at Felixstowe and Thamesport down to just 58% at Tilbury. With the single exception of First GB Railfreight at Felixstowe, Freightliner services were more fully loaded than its competitors. In the case of Southampton, the difference between Freightliner and EWS was very small, but in the other instances Freightliner services were far better loaded than other operators' trains. It should be noted, though, that the lowest load factors tend to be found where service provision is also low, for example EWS with its single daily service in each direction at Tilbury and a similar situation with Fastline at Thamesport. Despite Thamesport being served by 10 fewer services per week than Tilbury, its estimated rail throughput of TEU is considerably greater than Tilbury's due to the much higher mean load factor at Thamesport. From this analysis of the load factors of the surveyed trains, it is evident that significant spare capacity exists at present, although the degree of under-utilisation of current capacity varies substantially dependent on the port and operator.

Table 10: Mean TEU capacity utilisation per train, by port and direction of flow

Port	Mean capacity utilisation per train (TEU carried as % of capacity)		
	Import	**Export**	**Both**
Felixstowe	81.82	78.74	80.27
Southampton	74.04	59.35	66.73
Tilbury	50.78	58.55	54.67
Thamesport	68.18	79.38	73.78
Total	75.07	69.32	72.20

Source: author's survey

Table 11: Mean TEU capacity utilisation per train, by port and train operator

Port	Mean capacity utilisation per train (TEU carried as % of capacity)				
	Freightliner	**EWS**	**First GBRf**	**Fastline**	**All operators**
Felixstowe	80.63	57.38	89.99	-	80.27
Southampton	67.09	65.83	-	-	66.73
Tilbury	58.01	41.34	-	-	54.67
Thamesport	80.35	-	-	54.07	73.78
Total	73.40	61.69	89.99	54.07	72.20

Source: author's survey

6. Scope for enhancing utilisation of existing service provision

The fourth objective is concerned with the theoretical potential for carrying greater rail volumes without requiring additional train service provision under a number of different scenarios. This is of considerable interest, given that the consensus from the literature reviewed earlier was that rail network capability needs to be enhanced to allow longer trains and more services to operate as the key way to allow further growth in this rail market. This section considers the additional volume that could be carried by the existing number of services with 100% load factors under three different scenarios, as follows:

- Scenario 1: existing service provision, with no change to the number of wagons per train or the mix of wagon types
- Scenario 2: existing number of wagons per train, but all have the standard 3 TEU capacity
- Scenario 3: all services operating with 24 standard 3 TEU wagons (i.e. train capacity of 72 TEU), which corresponds to current industry and government plans for the future of the port-based container market on rail

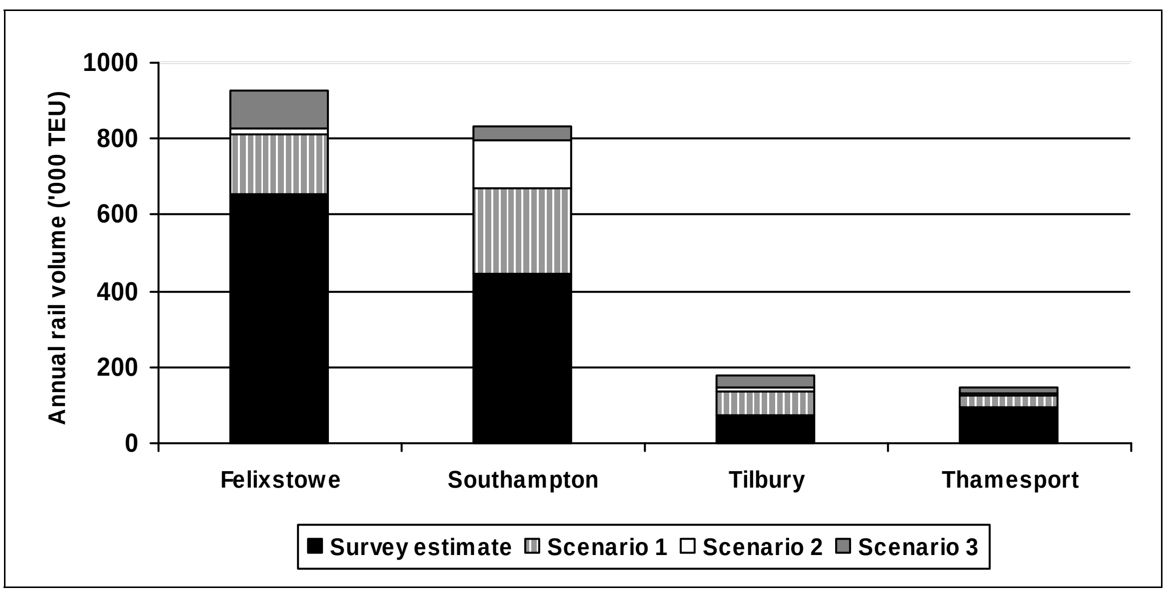
Scenarios 1 and 3 are perhaps more appropriate assessments than Scenario 2. Scenario 1 assumes that operators are able to fill every space on all existing services, thus achieving 100% load factors rather than the 72% observed in the survey. Scenario 3 presupposes that all corridors are able to support the movement of high cube containers on standard wagons and that all trains can operate at the current typical maximum of 24 wagons. Scenario 2 is, in effect, a hybrid option, where all current non-standard wagons can be replaced with an equivalent number of standard wagons as a result of the removal of gauge restrictions. While all three scenarios present hypothetical situations that are not likely to be replicated in reality, the direct replacement of non-standard wagons by standard ones is particularly unrealistic since the different wagon types are of differing lengths and capacities. Table 12 shows how implementation of each scenario would affect the total number of TEU moving to and from the four ports by rail each year compared to the annual estimate based on the survey data. By filling all current trains to their maximum (i.e. Scenario 1), it would be possible to increase the number of TEU by a sizeable 38%, taking rail's share of the existing port throughput of containers from 16% to 22%. Scenario 2 would result in rail volumes rising by 50% over current volumes, with mode share correspondingly rising to 24%. The measures assumed by Scenario 3 would lead to a 65% increase in volumes and 26% mode share.

Table 12: Impacts of each scenario on rail volume and mode share

	Survey estimate	Scenario 1	Scenario 2	Scenario 3
Rail volume ('000 TEU)	1,265	1,742	1,903	2,081
% change from survey	-	38	50	65
Rail mode share (%)	16	22	24	26

Figure 4 reveals how the various scenarios would affect rail volumes at each of the four ports, shown on a cumulative basis since, as Table 12 demonstrated, Scenario 1 would increase the volume from the survey estimate, and each subsequent scenario would increase the volume from the previous one. This holds true for each individual port as well as for all four combined. Taking Scenario 3 as the ultimate goal and the paragon of efficient operation, at least for the medium-term until more significant advances in train lengths may come to fruition, it is evident that Southampton and Tilbury in particular fall far short of that level of efficiency. At all four ports, filling existing capacity to the maximum (i.e. Scenario 1) would be the biggest contributor to increased rail volumes. The subsequent effects of standardising all operations using 24 standard wagon trains would be of lower significance, though still important.

Figure 4: Annual rail volumes (in thousand TEU) at each port under each scenario



For Scenario 3, the rail volume at Tilbury would more than double compared to the survey estimates. At Southampton, the rail volume would almost double, but this would be a much more significant absolute growth than at Tilbury as a result of the far greater throughput at the former port. As a logic check on the practicalities of what it would mean to achieve the volumes identified by Scenario 3, rail mode shares for Felixstowe and Southampton have been calculated based on the current throughput of containers. Felixstowe would see an increase in rail's mode share from 22% to 30%, while Southampton's rail share would rise from 30% to 55%. This difference in the magnitude of change is a reflection of Southampton's currently inefficient operation, against the criteria of train capacity and load factors, in comparison to Felixstowe. A 55% rail share at Southampton would be extremely difficult to achieve in practice.

As an alternative to this analysis of the three scenarios, it could be argued that there is over-provision of container train services at present, since the existing volume could be carried by fewer trains. There are three main reasons for not adopting such an approach in this assessment. First, the network of routes is relatively dispersed, making it difficult to rationalise service provision without fundamentally restructuring the way in which the services operate. Second, recent rapid growth in the movement of containers by rail makes it inadvisable to look at downsizing options when further growth would result in a requirement for the resurrection of withdrawn services. Instead of relating the impacts of the scenarios solely to current port volumes, it is prudent to bear in mind that, even to maintain mode share, rail will need to carry more containers in the future as a result of general growth in the container volumes passing through British ports. Linked to this is the third reason, with modal shift from road to rail being encouraged by government policy, so efforts to maximise rail's load factors are consistent with this approach. This section has therefore identified the potential for rail to carry greater volumes of containers through the assessment of the different scenarios which all assume the operation of the existing number of trains.

7. Achievability of higher load factors and longer trains

Thus far, the analysis has been fairly hypothetical in nature. The fifth objective aims to contextualise the quantified results by setting out arguments relating to the achievability in practice of higher load factors and longer trains, with the emphasis being on the former of these two issues. It has been shown that significantly greater volumes could potentially be moved on the existing services. There are many factors that prevent all services running with 24 standard wagons (i.e. 72 TEU capacity) and 100% load factors. These factors can be classified into those that are internal to the rail industry and ones that are external influences. Those that are rail-related include:

- trailing weight limitations – on services where there is a concentration of containers loaded with heavy goods maximum weight limits may be reached with a load of less than 72 TEU; trailing weight limits are typically influenced by locomotive type and route gradients
- rail network and terminal restrictions – the earlier literature review identified length constraints relating, for example, to terminal sidings or passing loops; further, in some cases, terminal handling equipment may not be able to cope with the unloading and reloading of 72 TEU within the current schedules, or be able to deal with the associated storage requirements
- route capability issues – loading gauge is the most significant issue, with the current inability to cater for high cube containers on standard wagons on many rail corridors, including all routes from Southampton and Thamesport
- wagon availability – even if the previous constraints do not apply, there may be an insufficient number of wagons in an operator's fleet to allow all trains to be formed of 24 wagons; this could clearly be rectified should there be a business case for expanding the wagon fleet

Potential external influences comprise:

- insufficient demand – there may be a mismatch between supply and demand, since it is rare for demand to materialise in 72 TEU quantities between particular destinations; in reality, though, rail shares demand with other modes, so could potentially market the available capacity to achieve the desired level of demand
- imbalance of flows by direction on specific corridors – it may be markedly more difficult to fill services in one direction than the other due to the relative volumes of containers involved
- government funding – funding to achieve environmental benefits is provided on certain routes but not others, which may influence or distort mode choice through effects on pricing

- daily or seasonal fluctuations in volumes – throughput at ports tends not be constant, but instead is subject to considerable peaks and troughs; this makes it more challenging to achieve a consistently high load factor on all services
- customer demands – short notice demands from customers make efficient load planning more difficult; where customers block book train capacity, the responsibility for filling the train typically passes to them as they have paid for the space, so rail freight operators may have a limited role to play in achieving higher load factors in such instances
- lack of strategic planning – in conjunction with the previous point, rail's potential to undertake block movements of containers is not exploited, for example in moving containers away from congested ports to inland terminals in advance of customers needing them; this could benefit port operations, by freeing up space, and customers, by having the consignments on hand
- mix of container lengths – the deep sea container market is increasingly dominated by 40' containers, while 100% load factors for standard wagons require at least as many 20' containers as 40' ones to fully utilise the space available; 30' and 45' containers are a further complication, though not currently significant in the deep sea market

These points are not intended to be exhaustive, but they provide an indication of the challenges involved in operating fully loaded, 72 TEU trains at all times. Looking within the rail industry, in terms of 'good practice' amongst the operators, First GB Railfreight was earlier identified as having the highest existing load factors, at 90%. If the other three operators achieved the same mean load factor, there would be a 23% increase in the total number of TEU carried by rail, assuming no changes either to the number of services operated or the wagon composition of these services. There are a number of reasons why other operators are unable to emulate First GB Railfreight's high loadings, not least the limited nature of the company's operations, based only on a small number of routes serving Felixstowe, and their use only of standard wagons resulting in an inability to carry high cube containers on routes that have not received gauge enhancement. More realistically, if EWS and Fastline were both able to achieve the same mean load factor as Freightliner, the total increase in TEU by rail would be a far more modest 2.5%. While some improvement in load factors is no doubt achievable through the efforts made by the operators alone, many of the constraining factors are beyond their direct control, and overcoming them would require assistance from the wider rail industry, government and customers. Greater rail network flexibility and capability would be expected to overcome many of the constraining factors but, in order to make more dramatic improvements in efficiency, there is a need for other parties involved (e.g. shipping lines, customers) to work in partnership with the rail industry in identifying supply chain configurations that will be more conducive to rail playing a larger part in the movement of containers between ports and inland locations (and vice versa). The nature of rail freight, with its fixed operating schedules and high capacity services, certainly in comparison to road, makes cooperation and planning vital to maximise the potential that exists.

8. Analysis of the prospects for port-based container traffic by rail in the UK

It is clear that container volumes through UK ports are likely to continue to grow considerably. This section presents a SWOT analysis of rail's role in the market for the associated inland movements. Table 13 summarises the key findings from this analysis, sub-divided into each of the four categories. A key uncertainty at present is the way in which container shipping services are likely to develop in the next 10 – 20 years. Further rationalisation of port calls by ever larger deep sea vessels trying to reduce their time within ports in Europe would be likely to lead to ongoing concentration of activity at a small number of ports mainly within the South East, assuming that the vessels still directly served Britain, placing additional demands on the rail network in this area but potentially generating sufficient numbers of containers to allow additional services to operate over new routes that are not currently viable. Feeder services may be attractive for some onward movement to other parts of Britain, but small feeder vessels may not be welcomed in the large container ports and, in any case, the key areas where containers originate from or are destined to tend to be inland (e.g. Midlands, Manchester, Leeds) and not easily served by coastal shipping.

Table 13: Summary of SWOT analysis

Strengths	**Weaknesses**
• Government and EU policies supportive of sea-rail integration. • Proven record of growth in this market, prior to, and more notably since, rail privatisation. • There is already a competitive rail freight market in this sector, with competition between all existing rail freight operators, thus giving customers choice of operators and access to a wider network of route and service options. • Considerable recent investment in locomotives and wagons, leading to better service capability and performance. • Addition of several new inland terminals, and upgrading of certain older ones, in recent years to provide additional capacity in key regions. • Commitments by ports to upgrade rail routes to provide additional capacity and capability • Growing number of long term contracts between rail operators and shipping lines, providing certainty for both parties involved	• Existing terminal and network congestion, leading to difficulties in running additional trains to/from ports and in obtaining additional train paths on certain sections of the rail network. • Requirement for special wagons to cater for 9'6" containers on many of the key corridors: only Felixstowe/Tilbury to terminals on West Coast Main Line corridor (via north London) currently cleared to gauge suitable for standard conveyance of these containers, leading to circuitous routings and/or additional rolling stock costs. • Train lengths are generally limited by siding and passing loop lengths, despite the locomotives being able to haul considerably more wagons per train. • Perception that rail freight is treated as inferior to passenger services in allocation of capacity. • Rail struggles to compete with feeder ships on the longer-distance flows, particularly to/from Scotland.
Opportunities	**Threats**
• Rapidly expanding sector, with further significant growth in containerised international trade predicted. • Capacity enhancements at rail connected ports (e.g. Felixstowe), or at new terminals with planning conditions encouraging the use of rail (e.g. Bathside Bay). • Possible government funding for rail upgrades, for example through the Transport Innovation Fund (Productivity). • Potential for further improvements in rail service capacity utilisation through measures to encourage smaller volume consignments (e.g. Freightliner's Logico, EWS' Enterprise). • Impacts of changing road conditions (e.g. congestion, Working Time Directive, driver shortages) on flows within Britain, favouring alternatives to road. • Increasing container trade through small number of ports would make it easier to generate viable trainload volumes on specific corridors • Development of east-west rail services elsewhere in Britain, particularly Trans-Pennine from Humber to the North West. • Potential for further long term contracts between rail operators and shipping lines.	• Lack of strategic direction within rail industry, so not well placed to counter weaknesses above. • Increasing rail network congestion, as a result of growth in both passenger and freight services. • Lack of consistency in government policy may mean capacity enhancements required are not provided, so weaknesses persist. • Continued growth of 9'6" containers' share of market, which rail will struggle to cater for from all key ports except Felixstowe and Tilbury (and new ports) until gauge enhancement work takes place: Southampton is especially critical. • Lack of diversionary routes even on corridors where gauge enhancement has taken place, thus limiting the flexibility and robustness of rail's service provision. • Competition from British feeder ships (and also direct calls at regional ports by European feeders or deep sea services) may reduce the inland market, both in terms of no. of containers to be moved and average distance from port to customer (thus favouring road).

More of a threat to rail would be a scenario whereby shipping lines reduce their number of direct calls at British ports, and rely on medium sized feeder vessels to serve a range of ports around the British coastline. This would reduce the average land distance movement per container, potentially threatening rail's viability. While there may be some examples in future of deep sea shipping lines choosing to avoid British ports, the planned increases in container handling capacity identified earlier at key ports in the South East that deep sea ships will be passing close to in any case is likely to ensure that the majority will still call in Britain and will therefore generate considerable volumes of containerised traffic to be moved over relatively long distances by land.

Focusing on the rail operations, it is evident that there too are many uncertainties about the future direction of port-based container traffic. It is feasible that incremental growth on the network can continue, for the foreseeable future at least, in the manner that it has done over the last decade. The increasing number of longer term agreements, specifying the provision of guaranteed container carrying capacity, between rail freight operators and shipping lines demonstrates the commitment to rail of both parties involved in each agreement (Anon, 2003; Freightliner, 2003a; Freightliner 2003b). More recently, a five year contract between Freightliner and Maersk covers the provision of 353 round-trip moves per day solely for the conveyance of Maersk containers (Freightliner, 2006d). It seems that such agreements are the favoured means by which shipping lines are seeking to protect or enhance their rail volumes. There is no evidence to suggest that the shipping lines themselves are keen to begin their own rail freight operations, unlike in some other parts of Europe. This is most likely due to the competition that already exists between rail operators in Britain which has led to improvements in service performance and capabilities and encouraged the development of partnerships between shipping lines and rail freight companies. The costs of setting up as a new rail freight operator are significant and, in the increasingly congested British rail network, there are problems of network and terminal access. It therefore appears likely that container services will continue to be operated by rail freight operators, though increasingly with contracted services or portions of services for specific shipping lines.

At a more strategic level, there is increasing evidence that significant changes will take place that will safeguard, and indeed enhance, the role of rail in this market. It should be borne in mind that even for rail to maintain its current market share will require the handling of far more containers in future due to the growth in containerised trade. Government policy should logically lead to an increase in rail's share, which will require a step change in provision. In 2005, a national gauging policy was developed (SRA, 2005) which proposed a strategic intermodal freight network. This has been further developed by Network Rail (2008), the rail infrastructure owner, which is commencing work on the Strategic Freight Network, which focuses strongly on the capacity and capability of links to major ports. Highest priorities for gauge enhancement are the routes from Southampton to the West Midlands and from Ipswich to Yorkshire. Both of these projects are due to be realised within the next five years.

Planning conditions associated with new terminal facilities are a key tool in encouraging rail use. Some of the measures contained in recent planning agreements will provide additional capacity and capability, for example through a greater range of routes cleared to carry 9'6" high containers or the ability to run longer trains as a result of changes to passing loop lengths and signalling systems. For example, the agreement relating to the Bathside Bay development includes a capping mechanism to limit the number of lorry movements associated with the movement of containers to and from the terminal (DfT, 2005). A mode share for rail of 22.5% of all containers travelling by land (i.e. excluding sea-to-sea transhipment) is set out in the agreement, and various measures are to be imposed in the hope that this level can be achieved and, ideally, exceeded. These include:

- provision of a rail terminal and associated facilities at Harwich, on an open-access basis (i.e. available to any rail freight operator that wishes to run a service), to be completed prior to the opening of the container terminal
- gauge enhancement for the direct route between Ipswich and Yorkshire via Bury St Edmunds and Peterborough
- additional infrastructure works on the route between Ipswich and Peterborough

These measures are expected to enable the rail network to cope with demand until around 2018, after which the further growth in trade in containerised goods will require additional train paths even to maintain rail's mode share. Even before this time, it remains to be seen what sanctions, if any, will be imposed on this or any other terminal that does not meet its rail targets. The UK government is showing willingness to invest directly in rail freight enhancements to improve national productivity (Alexander, 2006). Significant levels of finance are programmed for the Transport Innovation Fund (Productivity) from 2008/09, and strategic freight schemes which 'improve the capacity and resilience of the strategic national freight distribution networks, hence supporting international trade and competitiveness' feature strongly in the first short list of projects. Table 14 shows the schemes awarded funding in the first phases, four of which will benefit container movements to/from ports. All of this discussion relates to investments that have not yet been made. Of course, it will be necessary to implement the range of proposals to allow further growth in rail freight volumes. It is particularly critical that the gauge enhanced network is developed quickly, otherwise rail will find it increasingly difficult to compete in a market becoming dominated by 9'6 high containers. It certainly seems as though the momentum for network enhancement is building, and considerable attention is now being paid to the future requirements for port-based container traffic by rail.

Table 14: Impact of Transport Innovation Fund schemes on container flows to/from ports by rail

Scheme name	**Scheme details**	**Likely impact on rail-based container flows to/from ports**
Nuneaton - Peterborough	Gauge enhancement of east-west route to allow 9'6" containers to travel by rail on standard wagons	Provide an alternative route capable of carrying 9'6" from Felixstowe and Bathside Bay to Midlands/North, thus avoiding London
Southampton – West Coast Main Line	Gauge enhancement of main freight access route to/from Southampton allow 9'6" containers to travel by rail on standard wagons	Provision of a route from Southampton to Midlands/North capable of accommodating 9'6" containers, aiding continued growth in rail volumes
Gospel Oak - Barking	Gauge enhancement of short route within north London to provide second route for 9'6" containers on standard wagons	Alternative route across London for containers to/from north Thameside (i.e. Tilbury and Thames Gateway), providing additional capacity for these services and potentially freeing up capacity on the existing north London route for more Felixstowe services
Humber ports/ Immingham – East Coast Main Line	Rail capacity enhancements to allow more (and longer/heavier) trains	Fairly limited impact on containers in short term but potential for new services to/from Humber ports in longer term
Olive Mount rail chord (Liverpool)	Reinstatement of short section of rail line to allow direct access in to Port of Liverpool	Increase in route capacity and decrease in time taken for trains to access the Port of Liverpool, but implications for container services are not yet clear

There are other reasons to believe that rail's future is positive. The changing environment for road hauliers, generally reducing flexibility and increasing costs, is likely to lead to greater interest in rail. Feeder ships around the UK coast are also increasingly popular, which is affecting some of rail's markets. The majority of containers need to be moved into the heartland of Britain, however, which is a role not available to shipping. In terms of sustainability, it is beneficial for rail and coastal shipping to complement each other and reduce the overall requirement for road haulage. The rail freight market for containers is becoming increasingly competitive, with new routes and innovative marketing resulting in new-to-rail traffic. The rail freight operators generally are in a strong position to compete for traffic, as a result of large investments in locomotives and rolling stock since privatisation. New terminals have opened and infrastructure at existing ones has been enhanced. Further growth in service provision may lead to greater economies of scale, resulting in rolling stock and terminals being better utilised and leading to lower unit costs and a more competitive rail sector. It is clear that there has been a huge transformation since the mid-1990s, when Freightliner inherited much of the oldest and most unreliable equipment. There has been much progress in the container rail freight market, so much so that lessons from the experience in Britain are being disseminated on the European mainland (EIM/EFRA/ERFCP, 2006). It is vital, however, that the rail industry and government work together to demonstrate strategic thinking and continuity of approach in order to overcome any reluctance from shipping lines to commit further to rail.

9. Conclusions

It appears that rail has increased its volume of container movements broadly in line with the growth in container volumes through British ports in recent years. As a result, it seems unlikely that there has been any significant change in rail's market share, although it does appear that rail may have marginally increased its share of the market. There are clear opportunities to realise a higher share, but this is critically dependent upon enhancements to the capability and capacity of the network, most notably the ability to cater for large numbers of 9'6" containers on all main corridors and diversionary routes. The imminent development of additional port capacity in the South East will result in even greater reliance on already heavily-utilised routes, so measures to enhance capacity and reduce service delays will be required. Without these improvements, it is feasible that rail's share of the market will decrease substantially.

More specifically, this paper has provided an insight into the nature of the port-based container rail freight market in Britain, in terms both of the capacity provided and the extent to which that capacity is utilised. Three quarters of services surveyed had train lengths of 20 to 24 wagons; there was slightly greater variability in terms of TEU capacity as a result of the wagon mix. Considerable spare capacity was evident on existing services, with substantial variability by port and rail freight operator. If all existing services were fully loaded, there would be a 38% increase in TEU carried by rail and if all were operated with 24 fully loaded standard wagons, rather than the current mix of lengths and wagon types, the growth would be 65%. Ideally, further ways to reduce the unit costs of rail movement in order to be more competitive should be implemented, for example the quicker turnround of trains at terminals and longer trains allowing a greater number of containers per train. While the rail freight operators inevitably could be more efficient, there are limits on their influence given that many of the factors influencing train capacity and, more particularly, load factors are beyond their control. Further work is needed to determine actions that would have the greatest practical benefit, though a combination of rail network enhancements, favourable government policies and cooperation between supply chain parties is likely to be needed for significant improvements in train capacity or load factors. There are clear signs of progress, though considerable challenges remain in a mixed public-private sector setting, involving many players operating in a competitive market place and with a range of organisations being involved in strategic and operational decision making that will influence outcomes. Success, however, would lead to significant environmental benefits and greater operating efficiencies.

Some of these findings are specific to the British operating environment, but many can be generalised to the European level since they are influenced by similar factors such as European policies towards competitive markets and the growing concentration of deep sea container throughput at a relatively small number of key ports.

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