EFFICIENCY OF INTERMODAL PORT HINTERLAND FLOWS: A CASE STUDY OF UK RAIL OPERATIONS

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ABSTRACT

Port hinterland links are increasingly seen as the principal bottleneck in global sea-based supply chains, with their costs often outweighing the maritime costs for long distance flows despite the land-based leg(s) generally being over a relatively short distance. The significant long-term growth in global trade prior to the global economic downturn in 2008 has put substantial pressure on land-based transport infrastructure. Greater attention is now being focused on the efficiency and cost of hinterland operations, both to enhance supply chain performance and reduce the environmental and societal impacts of freight movements. As the first part of the paper demonstrates, the UK intermodal rail freight market has been growing strongly. Greater use of rail is generally seen as beneficial, but there is little reliable, disaggregated data in the UK or other countries to allow a thorough assessment of rail's current performance to be undertaken. In an attempt to allow an evidence-based analysis of this market, a representative survey of more than 550 container trains serving the four key deep-sea ports was conducted by the author in 2007. The survey collected a large volume of original information relating to train capacity and load factors at a disaggregated level. This paper presents the findings from an analysis of capacity provision and reveals considerable differences in the utilisation of intermodal train services. It then concludes with an assessment of the potential supply chain and wider environmental and societal benefits that could result from improvements in the efficiency of intermodal rail freight, together with discussion of the achievability of such improvements. The empirical data analysed in this paper provide a stronger basis for supply chain decision making and public policy formulation to make port hinterland flows more efficient and sustainable through a combination of 'soft' (e.g. collaborative ventures) and 'hard' (e.g. infrastructure-based) measures.

Keywords: Intermodal Freight Transport, Rail Freight Efficiency, Containerisation, Freight Transport Policy

INTRODUCTION

The long-term 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. While the global economic situation since 2008 has resulted in a drop in trade volumes, long-term growth in the movement of international standard (ISO) freight containers was particularly rapid, with a compound annual growth rate of 10.5 per cent in the 1990s and 12.8 per cent from 2000 to 2006, resulting in global port volumes estimated at more than 400 million TEU[1] in 2006, a significant increase on the 230 million TEU in 2000 (OSC, 2007). Growth rates at British ports were lower but still considerable, at around 5 per cent 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 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.

There is little detailed understanding of the nature of this particular market, particularly in terms of the detailed nature of service provision and operating efficiency. The key trends and characteristics of containerised goods flows and, specifically, their impacts on Britain's rail freight network were analysed in previous research by the author (Woodburn, 2007). The present paper seeks to update and develop this earlier work, particularly through the analysis of original survey data of container train load factors, in the specific context of the growing problems of accommodating growth in freight traffic on the British rail network. The paper has the following objectives:

1. to establish the recent rail freight trends for port hinterland flows

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[1] A TEU is a twenty-foot equivalent unit, meaning a standard 40 foot container is two TEU.

2. to identify the current level of rail freight service provision in this market, 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. the load factor) and evaluate scenarios that would maximise use of existing service provision

4. to discuss the viability of, and policy implications for, increasing train capacity and load factors to assist with making port hinterland flows more efficient and sustainable.

The next section presents a background to the problem and updates the status of rail's activity in the port hinterland market (i.e. the first objective). The survey methods adopted for this research are then discussed and justified. The subsequent sections deal with each of the paper's other objectives in turn, before conclusions are drawn.

BACKGROUND

This section first establishes the trends in container traffic through UK ports and seeks to establish the role that rail plays in the land-based movement to and from the key ports. It then discusses the issues identified in the literature relating specifically to the use of rail for such flows over the British network.

Trends in container traffic through UK ports and rail's role in this market

Table 1 shows the trend in container volumes passing through the UK's ports since the mid-1980s. In tonnage terms, there was an increase of more than 150 per cent between 1985 and 2008. In terms of the number of containers handled, the increase since 1985 (i.e. 147 per cent) has been similar to that of tonnage, but the increase in TEU, at 187 per cent, has been greater, reflecting the trend towards longer containers with 40' containers being increasingly dominant and 20' containers losing some of their market share. As can be seen, the number of TEU per container has increased fairly steadily, from 1.43 in 1985 to 1.66 in 2008. 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, known as high cube containers.

Table 1 – Container traffic through UK ports on lift-on, lift-off and conventional services, 1985 – 2008
(source: based on DfT (2006) and DfT (2009))

	1985	**1990**	**1995**	**2000**	**2005**	**2006**	**2007**	**2008**
Tonnage (millions)	23.7	34.5	47.6	51.6	53.9	54.5	60.7	59.7
Containers (millions)	2.13	2.84	3.64	4.32	4.75	4.88	5.38	5.27
TEU (millions)	3.05	3.97	5.36	6.71	7.79	8.03	8.90	8.76
TEU per container	1.43	1.40	1.47	1.55	1.64	1.65	1.65	1.66

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 almost 50 per cent in the number of tonne kilometres in the decade from 1998/99 to 2008/09, and accounts for 25 per cent of all rail freight moved in Britain (ORR, 2009). Figure 1 reveals the year-on-year trend both for total activity and share of the rail freight market for this time period. Intermodal volumes have continued to increase despite the global economic downturn, albeit at a slower rate, with the latest figures (for the first three quarters of 2009/10) showing a 3 per cent increase over the same period in the previous year at a time when total rail freight activity declined by almost 10 per cent (ORR, 2010). It is clear that intermodal rail freight activity has increased greatly in the last decade, both in terms of the absolute level of activity and in its share of the total rail freight market. The rail freight growth has been faster than either the tonnage or number of TEU handled at British ports (see Table 1); while the units of measurement differ, it appears that rail has gained a greater share of the market for container movements to/from ports. 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), and the recent trends suggest that rail has further increased its share at Felixstowe. More details about the trends in the intermodal market can be found in DfT (2010).

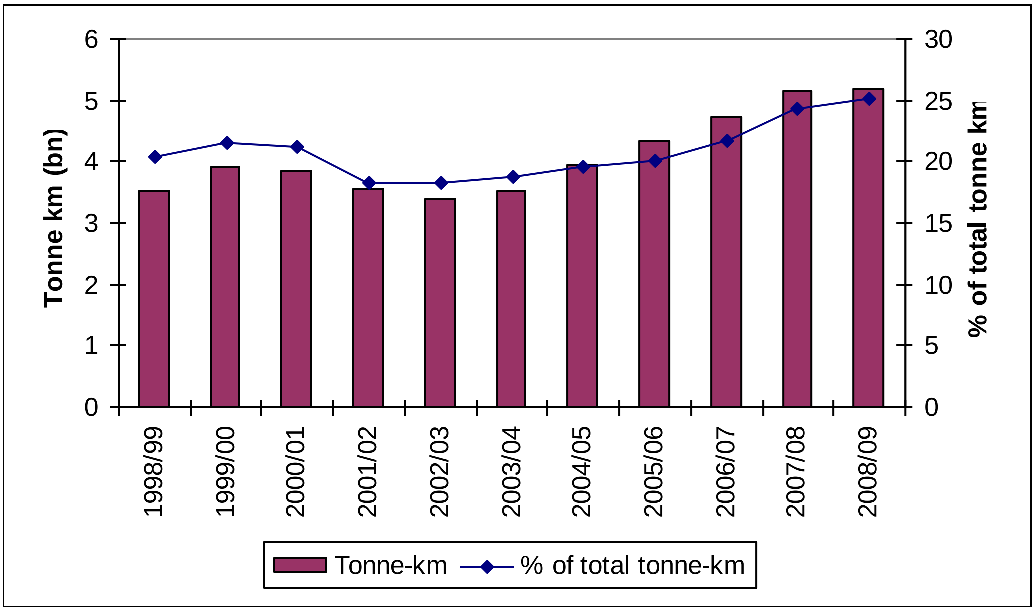

Figure 1 – Intermodal rail freight volumes and share of total rail freight market , 1998/99–2008/09 (Source: ORR, 2009)

The ports served by dedicated container train services are Felixstowe, Southampton, Tilbury and Thamesport. The former two are by far the most significant for both port container throughput and rail freight activity. The locations of the ports, and the services offered in 2007 (the time of the detailed research analysed later in this paper), can be seen in Figure 2; it is evident that Felixstowe and Southampton are each directly linked to the majority of the inland terminals, while a smaller selection is served from each of Tilbury and Thamesport.

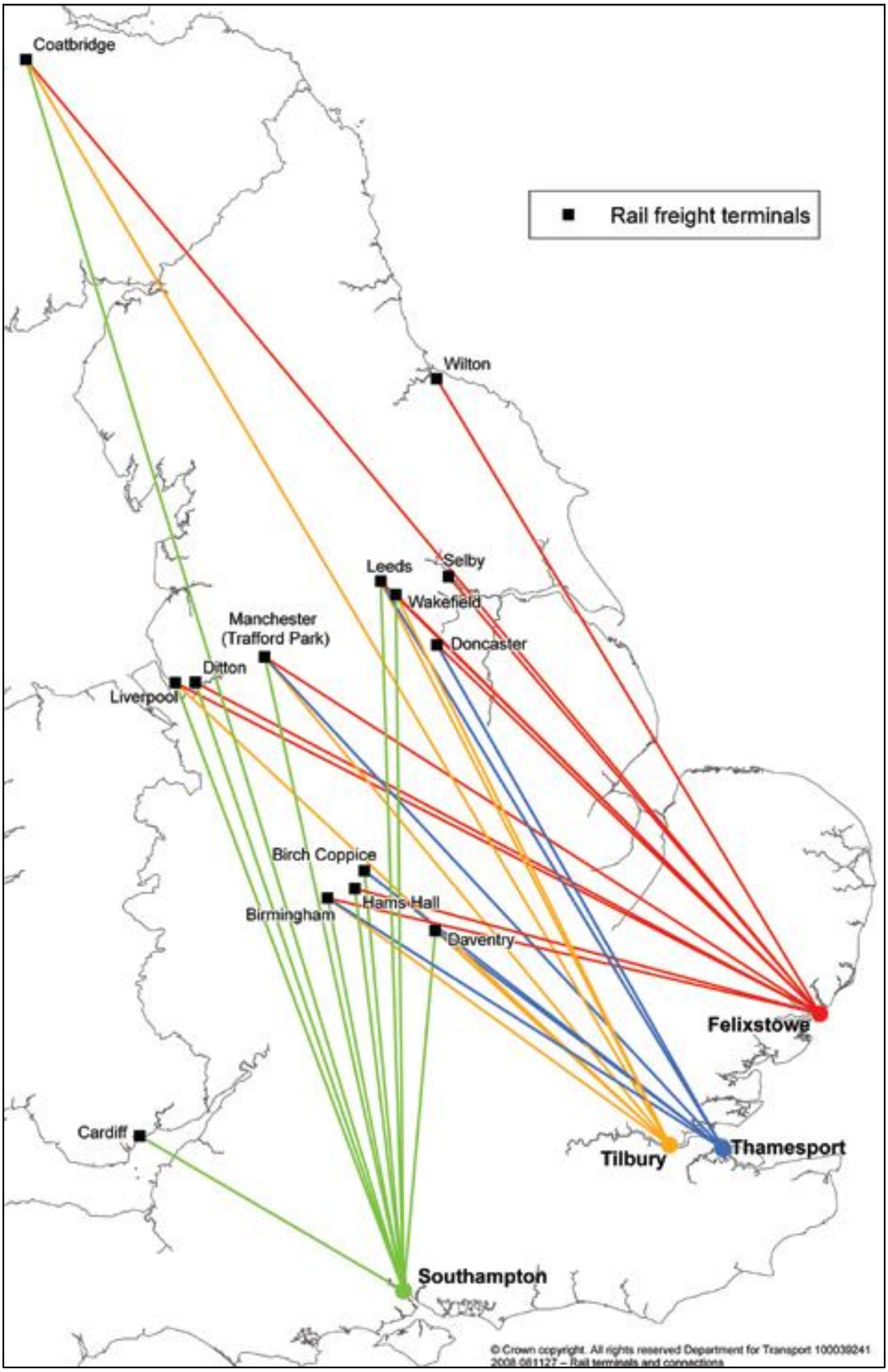

Figure 2 - Indicative map of rail services to/from the four key container ports (Source: DfT (2008), based on author's research)

Further details of this service provision can be found in the analysis later in the paper.

Government and rail industry approach to rail market share and operational efficiency for container traffic in the UK

With the potential for variations in train capacity and 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 these variables 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. 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). These have been supplemented by the identification of a Strategic Freight Network (SFN), where funding is currently being targeted (Network Rail, 2008). Of note is the clear intention to accommodate growing rail freight volumes, especially container flows to and from ports. Particular constraints that are identified are network availability, loading gauge restrictions[2] 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 (2006), 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

[2] Details about the British loading gauges, and their relationship to other European gauges, can be found in Network Rail's Freight Route Utilisation Strategy (Network Rail, 2007), particularly in Section 6 and Appendix A.

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 per cent but would increase to 85 per cent 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. The remainder of the paper will focus on the potential role of improved load factors (and, to some extent, train length) to carry a greater number of containers without recourse to the more expensive infrastructure and rolling stock related solutions.

METHOD

This paper develops earlier research through an assessment of the number and length of container trains operated, together with their load factors, at a disaggregated level. In the context of container train operation, this is a measure of the number (and length) of containers carried on the train as a percentage of its total carrying capacity. The research is based on a survey of all container trains serving the four principal rail-served ports (i.e. Felixstowe, Southampton, Tilbury and Thamesport) shown in Figure 2. 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 per cent of scheduled services to and from these ports during the survey period. For 563 of the sampled services, the entire train was videoed; the remaining 15 were recorded manually due either to them being stationary or because of recording equipment failure. In all cases, a complete record of the train's load was documented. The survey covers more than 97 per cent of all scheduled container trains arriving at and departing from British ports, based on the summer 2007 schedule; the remainder served other ports such as Purfleet and Liverpool, where dedicated services have since ceased in any case.

Considerable attention was paid to ensuring that the sampling framework was as representative of the service provision to and from the four ports as was practicable. As a consequence, the sample is wholly representative with respect to port, freight operating company and direction of flow (i.e. import or export). Table 2 shows the composition of the sample in terms of these three variables, which precisely matched the scheduled service provision at the time of the survey. In addition, efforts were made to make sure that the sample was broadly representative of specific origin-destination pairs. The majority of train services are scheduled to operate on five or six days per week, and these were all surveyed at least four and no more than seven times. Of the 113 services in this category, almost half (48) were surveyed on the exact number of occasions that they operated per week, and only five were over- or under-represented by two survey observations. The few other services that operated less often were surveyed broadly in proportion with their service frequency.

Table 2 - Composition of survey sample by port, freight operating company and direction of flow
(Source: author's survey)

	Import					**Export**					
Port	**FL**	**EWS**	**GBRf**	**Fastl.**	**Total**	**FL**	**EWS**	**GBRf**	**Fastl.**	**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; Fastl. – Fastline

Overall, the combination of the large sample size and its representative nature offers a solid basis for analysis.

DETAILED ANALYSIS OF SERVICE PROVISION

The weekly scheduled service provision at the time the survey was conducted was presented in Table 2. Felixstowe and Southampton between them account for 84 per cent of trains serving the four ports, with 44 per cent and 40 per cent respectively. At 9 per cent of the total, Tilbury has a slightly higher share than Thamesport (7 per cent), 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 per cent of trains. EWS, the second largest provider, has a 17 per cent share of service provision. The other two operators, First GB Railfreight and Fastline, each serve just one port and have small shares at 7 per cent and 2 per cent respectively. Despite growing competition between operators, the port-based container train market remains highly concentrated, with over 60 per cent of trains that operate to or from the four key ports in reality being operated by Freightliner and serving Felixstowe or Southampton.

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 3 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, though capacities greater than 72 TEU were exceptional (occurring on only four occasions in the survey sample), 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 3 - Mean TEU capacity provided per train, by port and direction of flow (Source: author’s survey)

Port	Mean capacity per train (TEU)		
	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**

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 per cent 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 per cent 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 3, and by operator, as shown in Table 4. When considering the ports, Felixstowe has a typical observed capacity 16 per cent 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 4, 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 4 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 4 - Mean TEU capacity provided per train, by port and train operator (Source: author's survey)

	Mean capacity per train (TEU)				
Port	**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**

CAPACITY UTILISATION

Having identified the container carrying capacity of the sampled train services, this section deals with the second 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 5 shows that, in the complete sample, the mean load factor was 72 per cent 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 per cent, while at the other extreme the observed average load factor at Tilbury was only slightly more than 50 per cent. 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 6, 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 per cent full. Freightliner's mean load factor was observed to be 73 per cent, though this ranged from 80 per cent at Felixstowe and Thamesport down to just 58 per cent 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 5 - Mean TEU capacity utilisation per train, by port and direction of flow (Source: author's survey)

	Mean capacity utilisation per train (TEU carried as % of capacity)		
Port	**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**

Table 6 - Mean TEU capacity utilisation per train, by port and train operator (Source: author's survey)

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

SCOPE TO ENHANCE UTILISATION OF EXISTING CAPACITY

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, the findings from this research are of interest since they identify considerable underutilisation of existing capacity. This section considers the additional volume that could be carried by the existing number of services under three different scenarios, as follows:

- Scenario 1: full use of existing service provision, with no change to the number of wagons per train or the mix of wagon types (i.e. 100 per cent load factor for every existing train rather than the surveyed average of 72 per cent)

- Scenario 2: replacement of all non-standard wagons with standard 3 TEU capacity wagons on a one-for-one basis, will all trains having 100 per cent load factors (i.e. assumes gauge enhancement allows replacement of non-standard wagons with standard ones and all wagons are fully loaded)

- Scenario 3: all services operating with 24 standard 3 TEU wagons (i.e. train capacity of 72 TEU), corresponding to the current industry 'standard' maximum for the port-based container market on rail, and with 100 per cent load factors

It should be noted that 100 per cent load factors are neither practical nor sought-after in reality, since they are likely to lead to sub-optimal performance. The findings presented are therefore indicative of what is possible rather than a desirable outcome. Essentially, the analysis here shows the absolute maximum extent to which additional volume can be carried without any increase in capacity provided. Scenario 1 is fully based on the operating patterns pertaining at the time of the survey, while Scenario 2 assumes that gauge enhancement allows high cube containers to be carried on standard wagons rather than requiring specialist rolling stock, and Scenario 3 assumes that all trains are able to operate with a length of 24 standard wagons. For the purposes of analysis, it is assumed that the scenarios are additive. Table 7 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.

Table 7 - Impacts of each scenario on rail volume and mode share (Source: author's survey)

	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

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 per cent, taking rail's share of the existing port throughput of containers from 16 per cent to 22 per cent. Scenario 2 would result in rail volumes rising by 50 per cent over current volumes, with mode share correspondingly rising to 24 per cent. The measures assumed by Scenario 3 would lead to a 65 per cent increase in volumes and result in a 26 per cent mode share for rail. Figure 3 reveals how the various scenarios would affect rail volumes at each of the four ports, shown on a cumulative basis since, as Table 7 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 for 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. 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.

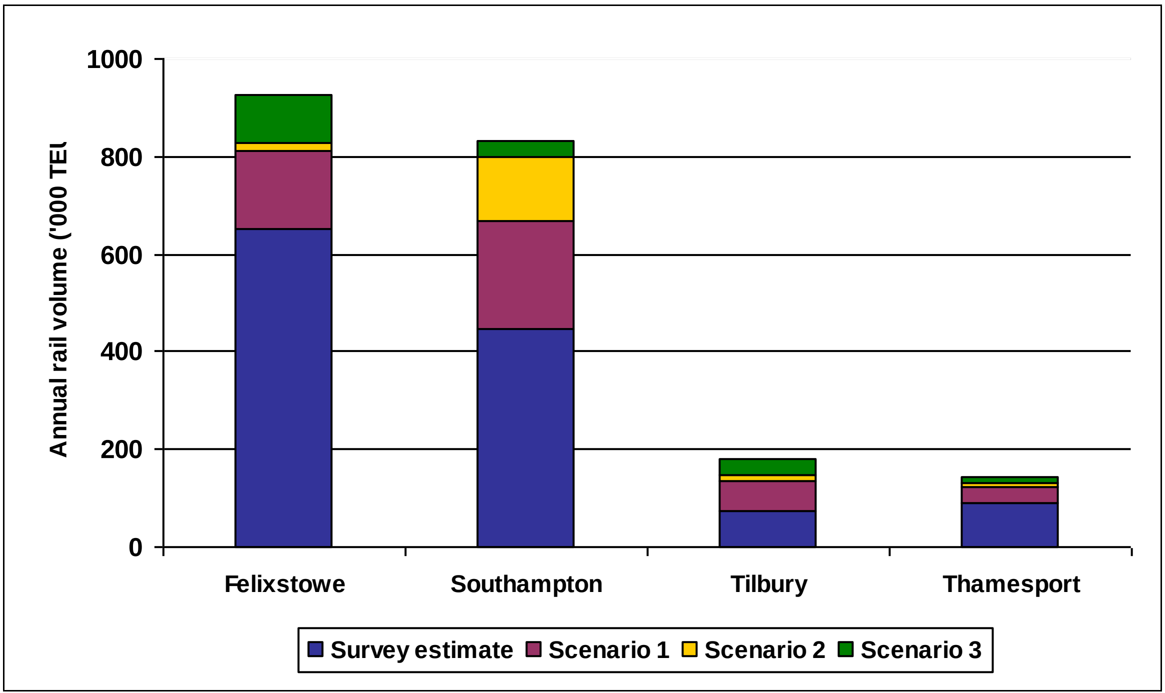

Figure 3 - Annual rail volumes (in thousand TEU) at each port under each scenario (Source: author's survey)

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 per cent to 30 per cent, while Southampton's rail share would rise from 30 per cent to 55 per cent. 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, due to the lack of gauge enhancement on any route serving Southampton; this is why Scenario 2 has a major impact on Southampton's potential volume, although a 55 per cent rail share at Southampton would be a challenge 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.

DISCUSSION OF RESEARCH FINDINGS

Thus far, the analysis has been fairly hypothetical in nature. The fourth objective aims to contextualise the quantified results by setting out arguments relating to the achievability 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 (near to) 100 per cent 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:

- train weight limits
- rail network infrastructure and terminal restrictions
- route capability issues, particularly loading gauge
- availability of sufficient numbers of wagons

In general, these rail-related factors are likely to influence the train capacity through constraints imposed by the infrastructure or the hauling capabilities of the locomotives. In contrast, external influences are likely to influence both load factors and train capacity, and include:

- insufficient demand for full trainloads
- imbalance of flows by direction on specific corridors
- existence of government grants for certain corridors
- daily or seasonal fluctuations in volumes
- variability in customers' demands, particularly at short notice
- lack of strategic planning to maximise rail's strengths
- mix of container lengths (mainly 20' and 40', but also including some 30' and 45' containers)

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. As stated earlier, 100 per cent loading is not desirable in any case since it is unlikely to be the most efficient method of operation. 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 per cent. If the other three operators achieved the same mean load factor, there would be a 23 per cent 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 per cent. 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.

IMPLICATIONS FOR POLICY MAKERS

Perhaps the biggest single issue for the potential market for intermodal rail freight is clearly the rapid increase in the use of high cube containers (Woodburn, 2008), and a number of key routes are currently being upgraded to enable these containers to be carried on standard wagons. By 2006, high cube containers made up 40% of the deep sea market (measured in TEU), and they are expected to increase to 65-70% by 2023 (Network Rail, 2007). The importance of the port-based intermodal market, and its perceived future growth potential, has already been recognised by government with the considerable funding allocation in the first phase (in Control Period 4, from 2009-2014) of the development of the Strategic Freight Network (SFN) on loading gauge enhancement for routes serving the main container ports. Broadly half of the £200 million SFN funding is being used for loading gauge enhancements (Network Rail, 2008), and further funding is coming from other sources such as the Transport Innovation Fund (TIF) – Productivity. As Table 8 shows, there will be an almost doubling of the proportion of port departures able to carry high cube containers on standard wagons, so the impacts of the gauge enhancement programme will be substantial with three quarters of services able to operate over gauge-cleared routes. In terms of the absolute increase in network coverage, Southampton will be the biggest beneficiary since approximately two thirds of services leaving the port will operate over gauge-cleared routes by 2014, serving the terminals in the West Midlands and on the West Coast Main Line (WCML) branches further north. Felixstowe will also benefit greatly, gaining gauge-cleared services to the cluster of terminals in Yorkshire; only its daily service to the North East of England will remain gauge restricted. There will be no increase in Tilbury's capabilities, and Thamesport will still lack any gauge-enhanced routes.

Table 8 - Percentage of services (as at January 2008) in 'before' and 'after' scenarios using gauge-cleared corridors (Source: Woodburn (2008))

Port	% of departures per week with gauge clearance	
	Current	With 'committed' & 'planned' schemes
Felixstowe	73	96
Southampton	0	71
Tilbury	71	71
Thamesport	0	0
Total	39	77

Despite the forthcoming significant growth in the extent of the gauge-enhanced network, a number of important gaps will remain. The most notable routes that will still not have gauge clearance are:

- Southampton – Leeds/Wakefield
- Tilbury – Leeds/Wakefield
- Thamesport – all destinations

In addition, a number of other specific services will still require specialist wagons in order to carry high cube containers. Two specific concerns remain, relating to diversionary routes and the future growth of container services on additional routes. In particular, diversionary routes are an important component of rail network capability and resilience, given the planned and unplanned blockages that occur on core routes. For rail to be as competitive in the market place as possible it is vital that gauge-cleared diversionary routes are available for the main corridors, otherwise rail's ability to reliably carry high cube containers will be compromised. The importance of diversionary routes is increasingly being recognised by policy makers. Plans for the development of additional routes, often involving additional ports, could either benefit from further gauge enhancement schemes or the cascading of specialist wagons from existing routes that are upgraded.

There are other infrastructure enhancement schemes either in progress or planned, and these are intended to allow additional train service provision to/from ports. It is clear from this analysis, however, that considerable spare capacity exists within the existing provision and growth in rail volumes could be achieved without the expense of infrastructure capacity upgrades. This research has had its focus on establishing the capacity provision and utilisation, but it is possible to suggest means by which policy makers may be able to influence these factors:

- Identify existing train length bottlenecks that could be eliminated by relatively small-scale network improvements (e.g. terminal siding lengthening) to allow longer trains to operate

- Investigate the reasons behind the high load factors achieved by the ‘best practice’ operations and try to diffuse these practices more widely

- Evaluate the impacts of grant funding on train capacity and, more specifically, load factors, and identify potential enhancements to the funding regime which could help to maximise load factors

- Continue to encourage on-rail competition within the intermodal port hinterland market, perhaps with incentives to allocate additional train service capacity on the basis of evidence of efficient operation

- Encourage the development of ‘inland ports’ that allow efficient and well utilised rail shuttle operations between the ports and these inland terminals. Rail’s potential to undertake block movements of containers is currently under-exploited, for example in moving containers away from congested ports to inland terminals in advance of customers needing them; this could also benefit port operations, by freeing up space, and customers, by having the consignments on hand

- More widely, use the policy and regulatory framework to encourage better supply chain planning that considers rail use at a more strategic level, so that it becomes more embedded within supply chain operations

These, and other, measures are beyond the scope of the research reported in this paper and require more detailed investigation, but the analysis serves to highlight the current ‘inefficiencies’ in operation that could be reduced to allow higher load factors and, as a consequence, greater rail volumes and a higher mode share.

CONCLUSIONS

This paper has offered 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 per cent 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 per cent. 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. This poses considerable challenges 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.

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