Transportation Research Part A 61 (2014) 53–67

Contents lists available at ScienceDirect

Transportation Research Part A

journal homepage: www.elsevier.com/locate/tra

Assessing the cost and CO_2e impacts of rerouteing UK import containers

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ARTICLE INFO

Article history:
Received 19 June 2012
Received in revised form 28 November 2013
Accepted 3 December 2013

Keywords:
UK port capacity
Northern gateway
Economic and environmental cost

ABSTRACT

Among the most important trade-related issues currently confronting the UK are the environmental implications of very large volumes of containerised freight being handled at a small number of ports while there appears to be significant potential for using other ports and water-rail intermodal connections. Six UK ports are selected for the analysis: Hull/Immingham, Liverpool, Felixstowe, Southampton, Dover and Bristol. Through an origin-destination analysis, the cost and CO_2e impacts of UK port trade patterns are compared using the actual situation against three proposed Scenarios: (1) the re-direction of containers by a combined expansion of Hull and Immingham; Liverpool; and Bristol, (2) moving containers by rail facilitated via expanded capacity at Southampton, and (3) moving containers by rail through expanded capacity at Felixstowe. The research found that transporting containers from Felixstowe and Southampton to the northern regions by rail has the lowest CO_2e impact, and is the most feasible option, although constraints exist in terms of infrastructure provision, water depth and rail network capacity.

1. Introduction

The development of ideas about how commodity chains and inter-organisational networks ultimately link regions and countries together has, over time, extended to include the breadth of supply chains from product development to final consumption (Leslie and Riemer, 1999; Hopkins and Wallerstein, 1986; Gereffi, 1994). As Oro and Pritchard (2011) suggest, the principal concern of such research is how such chains are 'coordinated across space, and how economic value is distributed among participants'. Further, they propose that governance, whereby forward and backward chain linkages are coordinated, establishes how economic factors within the chain operate. Earlier work by Gereffi et al. (2005) categorised such governance into five variants: market based, modular, relational, captive and hierarchical. The conceptual development in understanding how commodity chains and networks work has thus focused primarily on the underpinning logic of relationships. Product and commodity systems have been further defined in a relational spatial context as how economic actors operate in, for example, network arenas (Yeung, 2005; Bathelt, 2006).

Ports are often key contributors to economic development and key facilitators of international trade. As such they can be used to promote the economic cohesion of different regions. Ports are also important nodes in logistics chains and the location and efficiency of ports contributes significantly to economic competitiveness, and there has therefore been a continuous focus on the efficiency of ports in the academic literature (Suykens and Van de Voorde, 1998; Tongzon, 2001; Gonzalez and Trujillo,

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http://dx.doi.org/10.1016/j.tra.2013.12.002

2008). Further, over time competition between ports has intensified, port hinterlands have expanded and port intermodal facilities have been improved, thus allowing carriers to focus their activities on fewer and larger ports. Shipping lines make decisions both about the deployment of vessels to routes and ports, and the assignment of shipments to vessels. The combination of these two activities determines in part which ports will be used on any particular route (Malchow and Kanafani, 2004). What has not been taken into consideration by shipping lines in their port selection criteria however has been the overall environmental impact of the port choice decision, although Emission Control Areas (ECA) specified under MARPOL Annex VI have led to some operational changes by shipping lines in order to comply with legislative imperatives (Fathom Shipping, 2013).

One of the key aspects of improving the environmental performance of supply chains is the transfer of freight from road to less carbon intensive freight transport modes such as water-borne transport and rail. Closely linked to the transfer to water modes is the requirement to select ports which are close to the market under consideration, thereby providing the shortest land route possible: essentially following the 'sea-maximising-land minimising' principle. One of the first studies undertaken in the area of port traffic volumes in relation to location was that of Chisholm (1985) who looked, in particular, at the accessibility of trade generating regions and the level of economic development in Britain. However, no detailed analysis of origin – destination flows through the ports was presented. Further, no reference to the carbon footprint of particular freight routeings was incorporated into the study. Although freight transport corridors were highlighted in the Chisholm (1985) study, the approach taken left considerable room for a more disaggregated analysis. Another early study by O'Connor (1987) examined the way in which related services accrete onto large port cities where there are synergies between the cargoes and regional trades. More recently, Notteboom (2009) considered the complementarity and substitutability of container ports across a range of port regions. Again, however, these studies did not extend to include the broader aspects of how consignment routeings through alternative ports could contribute to improvements in the performance of supply chains in the area of CO_2 reduction.

This paper therefore endeavours to address the issue of whether re-engineered supply chains, using alternative port gateways, can contribute significantly to an overall reduction in freight transport-related CO_2 emissions. In terms of the impact of economic activity on the environment, evidence from the Mauna Loa observatory in Hawaii indicates that CO_2 levels in the atmosphere now stand at 387 parts per million (ppm), up almost 40% since the industrial revolution and the highest for at least the last 650,000 years (NOAA, 2012). At a national level, according to the Department for the Environment, Food and Rural Affairs (DEFRA) (DEFRA, 2006), in the UK freight transport contributes 6% of the total annual CO_2 emissions of the UK. Within the transport sector, road freight transport typically represents around 22% of the total UK annual CO_2 emissions. Additionally, in regards to UK domestic tonne-km, rail transport contributes 9% of total CO_2 emissions and shipping 20% (Department for Transport - DFT, 2007). Hence, freight transport has become an extremely important supply-chain function not least because of its impact on the environment.

A major cause for concern is that CO_2 emissions derived from road freight transport are increasing at a faster pace than the emissions generated by cars and buses. CO_2 emissions from truck movements are anticipated to exceed those derived from passenger transport by the beginning of the 2020s (ECDG Tren, 2007). Considerable efforts are being made by governments, and by the European Union (EU), to decouple the growth in carbon emissions from growth in Gross Domestic Product (GDP). To support these efforts, it is essential to evaluate in detail how supply chains can meet the challenge of more successfully managing their emissions performance. Woodburn and Whiteing (2010) recommend modal shift as one of the most effective strategies to reduce the carbon footprint of freight transport networks within supply chains. This paper aims to explore how the redistribution of freight handled by the main UK ports of entry combined with a shift of freight from road to rail for inland movements could reduce the total carbon footprint of the UK freight transport sector. The approach taken in this study is similar to that of Liao et al. (2010): an activity-based CO_2 emission model is used to estimate the cost and CO_2e impacts of four Scenarios, which are described in the paper as the "current situation" and three "proposed Scenarios". However, in order to run the model, a more disaggregated analysis than that implemented by Liao et al. (2010) has been undertaken. While there is likely to be considerable scope for emissions reduction, the study that follows clearly has boundaries in terms of the assumptions used. Changes to the throughputs at different ports will have repercussions along the supply chain and could negatively influence the savings that could be made, and therefore it could be more difficult to realise the total overall potential reductions than suggested. In this paper, it is hypothesised that the rerouting of containers away from traditional large ports in southeast England and into northern/north-western ports would significantly reduce the overall carbon footprint of marine-based container transport for British trade.

In order to keep the modelling exercise manageable, the flows of empty containers and exported freight are excluded from the analysis. Export volumes are lower and empty container flows do not drive the logistics system in the way that loaded containers do; empties also follow a wide variety of paths through the system with the result that their patterns of movement have less coherence. Thus, the Scenarios presented in this paper only include loaded import containers through the ports moved via rail or road. In practice, however, the logistics of container movements is further complicated by indirect routeing of a significant proportion of containers via Inland Container Depots which act as sinks for rail-hauled containers to/from, for example, Leeds, Glasgow, Manchester and outer London. Local distribution and collection is performed by truck, hence these movements are already 'intermodal'. In Scenarios 2 and 3, three main locations have been selected for the transfer of containers from road to rail, being Derby, Glasgow and Manchester. In the case of Derby and Manchester recent distribution centre developments have improved the intermodal links with the provision of Rail Terminals. One such example is the Daventry International Rail-Freight Terminal which consists of about 2 million sq ft of rail-connected distribution facilities (PROGIS RFI, 2013). This provides the option for users of the terminal to expand