ARTICLE IN PRESS

Transportation Research Part D xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Transportation Research Part D

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

Investigating synchromodality from a supply chain perspective

Chuanwen Dong [a,*], Robert Boute [b,c], Alan McKinnon [a], Marc Verelst [d]

[a] Kuehne Logistics University, Hamburg 20457, Germany
[b] Technology and Operations Management, Vlerick Business School, Leuven 3000, Belgium
[c] Research Center for Operations Management, KU Leuven, Leuven 3000, Belgium
[d] Supply Network Innovation Center, Strombeek-bever 1853, Belgium

ARTICLE INFO

Article history:
Received 30 June 2016
Revised 10 May 2017
Accepted 20 May 2017
Available online xxxx

Keywords:
Modal split
Synchromodality
Supply chain
Review
Stochastic model
Application

ABSTRACT

Greater use of multimodal transportation can substantially improve the environmental performance of freight transportation. Despite strenuous efforts by public policy-makers to alter the freight modal split, most companies still rely heavily on road transportation, and modal shifts to rail and water have remained modest at best. In this paper we argue that this is partly the result of a failure to take a holistic supply chain view of the modal shift process. Synchromodality provides a framework within which shippers can manage their supply chains more flexibly to increase the potential for shifting mode. On the basis of a literature review, we broaden the conventional focus of multimodal transportation to give it a supply chain dimension, and propose the concept of 'Synchromodality from a Supply Chain Perspective' (SSCP). Using a case study we show that when the supply chain impacts are taken into account, it is possible to significantly increase the share of intermodal rail transportation within a corridor, without necessarily increasing total logistics cost or reducing the service level. In this way the environmental impact of freight activities can be significantly reduced.

1. Introduction

Between now and 2050 we will have to reduce our greenhouse gas (GHG) emissions dramatically to keep our environment sustainable. According to calculations from the Intergovernmental Panel on Climate Change (IPCC) (2014), annual GHG emissions need to be reduced by 40–70% between 2010 and 2050, for us to have 50% chance of keeping the increase in average global temperature staying within 2 °C by 2100. The Paris Accord, agreed at the COP21 conference in December 2015, committed the 195 participating countries to keeping this average temperature increase 'well below 2 °C by 2100', putting added pressure on them to cut GHG emissions (European Commission, 2015).

All industrial sectors except transportation have been steadily reducing their GHG emissions. In the U.S., GHG emissions linked to transportation have increased by 17% since 1990 (U.S. Environmental Protection Agency, 2014). In the EU-28 (the 28 state members of the European Union), the transportation sector increased its relative share in total GHG emissions from 15% to 22% between 1990 and 2013 (EUROSTAT, 2015a). The freight share of total transportation emissions is expected to rise from 42% in 2010 to 60% in 2050 (OECD/ITF, 2015), making the freight transportation one of the hardest sectors to decarbonize (Guerin et al., 2014).

* Corresponding author.
E-mail addresses: chuanwen.dong@the-klu.org (C. Dong), robert.boute@vlerick.com (R. Boute), alan.mckinnon@the-klu.org (A. McKinnon), marc.verelst@edu.vlerick.com (M. Verelst).

http://dx.doi.org/10.1016/j.trd.2017.05.011
1361-9209/

Please cite this article in press as: Dong, C., et al. Investigating synchromodality from a supply chain perspective. Transport. Res. Part D (2017), http://dx.doi.org/10.1016/j.trd.2017.05.011

Fundamental changes are needed in the transportation sector in order to reverse the growth in GHG emissions. According to Schipper et al. (2000) and IPCC (2014), this will involve the application of a broad range of measures, falling into four categories: (1) activity (reducing the demand for transportation), (2) structure (shifting freight to lower carbon modes), (3) intensity (improving its energy efficiency) and (4) fuel (switching to lower carbon energy sources). By far the most frequently mentioned freight decarbonization measure in the Intended Nationally Determined Contribution (INDC) documents submitted to COP21 was modal shift, i.e. transferring freight to lower carbon transportation modes (Gota, 2016). According to European Environment Agency (2013), CO_2 emissions per tonne-kilometer from railways and inland waterways are about 3.5 and 5.0 times lower than those from road freight transportation. Shifting freight from road to these alternative modes can therefore be one of the most important means of decarbonizing logistics (Holguin-Veras et al. (2008), Winebrake et al. (2008), McKinnon (2008), Hoen et al. (2013))

Modal shift has long been 'seen by policy makers and politicians as the most promising way of easing the environmental and congestion problems associated with goods movement' (McKinnon, 2015). There has been over 50 years of research on the factors influencing companies' choice of freight transportation mode (e.g. Bayliss and Edwards (1970), Jeffs and Hills (1990)), and the use of public policy to alter the allocation of freight between modes. The case for government intervention has been underpinned by the belief that, at a macro-level, the freight modal split is economically and/or environmentally sub-optimal. This sub-optimality has resulted partly from a failure to internalize the environmental costs of freight transportation modes, but also from differences in the regulatory and pricing regimes of the various modes and deficiencies in corporate modal choice behavior. Much emphasis has been placed on the relative pricing of the alternative modes and numerous attempts have been made to quantify cross-modal price elasticities (De Jong et al., 2010; De Jong, 2013). Comparative freight rates, however, are only one of many factors influencing the freight modal split at both micro- and macro-levels. Other criteria, such as transit time, reliability, accessibility, flexibility and security, are also important determinants of modal selection.

In Europe, strenuous efforts over many years by national governments and the EU to shift freight from road to rail and water have been unsuccessful. Between 1995 and 2013, road's share of total tonne-kms increased, rail's share declined and that of inland waterways remained fairly stable (Fig. 1) (EUROSTAT, 2015b). A recent report from the European Court of Auditors (2016) confirms that rail's share of the European freight market has declined since 2011 despite the fact that approximately 28 billion Euros of financial support was injected into railway projects across the EU over the period 2007–2013. Therefore innovations are urgently needed to promote and revive modal shift as a freight policy option.

One of the reasons for the modal split being so difficult to change is that many stakeholders have not been taking adequate account of the overall supply chain impact of multimodal transportation. Trains or barges are in general cheaper and greener, but they lack the flexibility in delivery quantity, frequency and scheduling. As a consequence, logistics managers tend to perceive a straight shift from trucks to trains and barges as likely to have a negative impact on the supply chain. More specifically, in the absence of any associated adjustment to supply chain processes, a shift from trucks to trains and barges often leads to increases in inventory. As rail and inland waterway services are generally slower and less frequent than the equivalent road trips, in-transit inventories and stock levels might be higher at both ends of the journey. Trains and barges also require large and stable shipment volumes in order to be cost-efficient, making it difficult for them to cater for flows that are subject to widely fluctuating demand.

The end-to-end impact of the modal shift requires a change in the logistical decision-making process. Freight modal choice is, after all, a part of the supply chain strategy and needs to be jointly optimized with other supply chain activities, like inventory management and customer service levels. This involves the shipper more directly in the process and puts some onus to alter their schedules to accommodate changes in transportation mode.

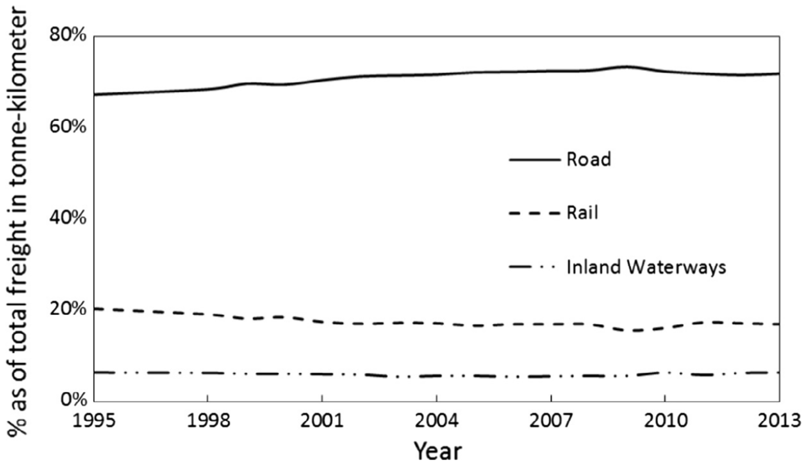

Fig. 1. The freight modal split ratio in EU-28 (EUROSTAT, 2015b).

Please cite this article in press as: Dong, C., et al. Investigating synchromodality from a supply chain perspective. Transport. Res. Part D (2017), http://dx.doi.org/10.1016/j.trd.2017.05.011