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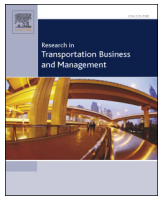

Making hinterland transport more sustainable a multi actor multi criteria analysis

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ABSTRACT

As the key nodes in our global transport system, ports are increasingly pushed to improve the sustainability of their hinterland transport system. In this paper, we use the Multi Actor Multi Criteria Analysis to evaluate four possible measures for improving the sustainability of the ports' hinterland transport systems. This methodology allows explicitly the evaluation of criteria considered relevant by all stakeholders. The analysis shows that additional port handling costs and road pricing are the alternatives that score best overall, while modal split quota are the least preferred option.

1. Introduction

The importance of the environmental friendliness of transport systems continues to increase. The trend towards less-polluting transport solutions and the quest for sustainable transport arose from a combination of customer demand and regulatory frameworks. The transport sector is one of the largest polluters, and the sector's stakeholders, especially its policy-makers, are aiming to construct regulatory frameworks that will facilitate the growth of sustainable transport solutions. The paper focuses on several stakeholders' evaluations of different measures to make ports more sustainable.

Ports are the key nodes in our global transport system. Making these nodes more sustainable will have a huge impact on the sustainability of the whole system. To characterise sustainable ports, the Brundtland report (WCED, 1987), which defines sustainable development from environmental, social, and economic perspectives, can be used as a starting point. Black (1996, p. 1) alters the report's definition and applies it to sustainable transport as 'satisfying current transport and mobility needs without compromising the ability of future generations to meet these needs'. Focusing on sustainable transport systems, Jeon, Amekudzi, and Guensler (2013) add transport system effectiveness to the classic triple bottom line in their framework. Due to the growing recognition of the environmental impact of the transport system, ports have already begun to develop environmental strategies and corporate social responsibility (CSR) strategies (cf. Carter & Jennings, 2002). CSR can take the form of infrastructure investments, such as the Environmental Ship Index (ESI), which addresses on-shore power supply or green port dues that are related to the environmental performance of the vessels, or investments related to hinterland transport, as proposed by Bergqvist and Egels-Zandén (2012). Another possibility is better cooperation between ports, which enables the segmentation and bundling of goods.

This paper explores various environmental strategies related to making ports more sustainable with regard to the hinterland they serve. The term "hinterland" often refers to the effective market or the geo-economic space in which the seaport sells its services (cf. Slack, 1993). A similar definition is presented by van Klink and van den Berg (1998), who define hinterland as the interior region served by the port. The logistics related to the hinterland involve many actors and activities, and require intense collaboration and coordination to work effectively and efficiently. The demand for more environmentally friendly transport solutions has had a great impact on the design of the hinterland transport system, both in terms of the technology used and modes of transport applied. Hence, ports' hinterland strategies have become a crucial part of ensuring efficient and more sustainable supply chains. The increased focus of sustainability in ports calls for environmental strategies and governance mechanisms focusing not only on sea transport but also on the hinterland transport system. One example of this development is the development of concepts such as

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dry ports where port activities are moved inland (cf. Bergqvist, Wilmsmeier, & Cullinane, 2013; Roso & Lumsden, 2010; Roso, Woxenius, & Lumsden, 2009). Governance is here defined as a process of distributing authority, allocating resources, and managing relationships in order to achieve a desired outcome. The complexity of hinterland logistics, in combination with the quest for sustainable and cost-efficient services, highlights the importance for developing hinterland strategies that maximise the combined output in terms of environmental performance, cost-efficiency, and logistics quality.

Implementing these strategies is, however, very difficult, because the numerous stakeholders involved often operate under conflicting objectives. The aim of this paper is to explore different options and the advantages and disadvantages these options might have for the various stakeholders. This exploration will identify the reasons why certain strategies are quite difficult to implement and which implementation paths are most suitable.

2. Literature review

Developing hinterland strategies with the purpose of maximising the combined output in terms of environmental performance, cost-efficiency and logistics quality is complex. Many considerations have to be done because of the many stakeholders involved. Besides the stakeholder perspective, there are different alternatives for achieving hinterland strategies. From previous research we have identified four main alternatives that are then compared to the current business as usual base scenario. In this section we describe and analyse the different alternatives based on previous research. All alternatives should be understood as a bonus–malus system where total costs remain the same but distributed differently between stakeholders based on their performance on goal variables.

The first alternative is labelled *internalisation* of external cost and consists of a hinterland transport index that calculates the external costs of hinterland transportation. This would mean that the societal costs caused by transport through emissions, accidents, noise, infrastructure damage etc. would be calculated for each individual transport chain. In average circumstances the intermodal transport options will generate lower external costs compared to road-only transport (Macharis & Van Mierlo, 2010). This can however not be generalised, as for instance long post-haul post-rail transport distances and low loading capacity utilisation might make the road-only alternative perform better. Macharis, Van Hoeck, Pekin, and van Lier (2010) and Iannone (2012) found that the competitiveness of intermodal transport in solutions hinterland transport increases when externalities are internalised. The external costs of transport can be (partly) internalised using different methods (Gibson et al., 2014). This alternative would push to use each transport alternative where it can bring the greatest societal gains compared to the other modes.

A second alternative relates to the introduction of a system of *road pricing* whereby road transport is charged per kilometre driven. The rationale behind road pricing is to decrease the road traffic volume and finance infrastructure. As such, it is related to fuel taxes, used for covering investment and maintenance costs of road infrastructure but separate environmental taxes can also be levied on fuel and thus it adds to the distance dependent cost. Effects of road pricing on hinterland transport has been analysed by Aronietis et al. (2010) and Meersman et al. (accepted for publication) studied its effect on the competitiveness of Flemish ports. The implementation of road pricing systems can however be hindered by *inter alia* technological, legal, financial and political constraints (Shepherd, 2003; Ubbels, 2006) and often, the public acceptability is very low. The suggested kilometre charge can be differentiated according to the level of pollution of the vehicle, by for example distinguishing between EURO-norm classes. Therefore road pricing can be used to internalise external pollution costs but compared to a system where no differentiation is made in function of time and space, a variable scheme performs better in decreasing congestion. An example of road pricing is the German LKW-MAUT system. In Belgium, an advanced road pricing system for trucks over 3.5 t is planned to be implemented in 2016 to replace the current Eurovignette. In this case, a differentiation will be made according to location and vehicle characteristics (Viapass, 2014). In Sweden, no national road pricing is in place, but in Stockholm and Gothenburg, time-dependent congestion charging schemes exist.

As a third possible alternative, a system of *modal split quota* is defined whereby the ports need to achieve specific levels of modal split to adhere to environmental and air quality legislation or get permissions to expand. As an example, the environmental permit of Stockholm Arlanda Airport considers emissions from aircrafts, from vehicular traffic to, from and within the airport as well as from the terminal buildings (Swedavia, 2014). To increase air traffic, the airport operator Swedavia thus needs to get passengers to and from the airport by rail or bus rather than by own cars. According to Woxenius and Bergqvist (2011), the petrochemical industry in Stenungsund, Sweden, had to adhere to a similar emission cap when extending their production facilities and investigated a 50 km rail shuttle to Port of Gothenburg. These emission caps have been disputed due to rather obvious governance issues since transport to and from facilities are often beyond the control of a terminal operator or industry. A port can, however, influence the modal split by restricting capacity or prolonging handling times at the port-lorry interface or by selective pricing for transshipment services. A certain modal split can also be defined in the port concession agreement as thoroughly investigated by Van den Berg and De Langen (2014). A modal split clause was introduced by Port of Rotterdam as part of the concessions for the Rotterdam World Gateway terminal at Maasvlakte 2 to DP World in 2007 (De Langen, Van den Berg, & Willeumier, 2012). The motives to include modal split requirements included sustainability improvement, curbing congestion on the main access highway and to ensure that port development would not be constrained by future air quality regulations. Also APM Terminals' concession at Maasvlakte 2 includes modal split targets and it has decided to apply equal prices for truck and barge moves (Van den Berg & De Langen, 2014) although transshipment to a barge is likely to incur higher costs.

The fourth and final alternative is labelled *additional port dues*. The fundamental idea of a port dues system related to hinterland transport is to construct a port due scheme based on cost recovery (i.e. IMO, 2000). A differentiated port due system can provide a tool for not only promoting modal shift but also influences inter-mode competition. A differentiated port due system would enable better opportunities for traffic allocation of different modes of transport. Previous research related to port dues have mainly been directed towards areas such as waste, oil pollution (Carpenter & MacGill, 2001), air pollution (Kågeson, 1999; Michaellowa & Krause, 2000; Swahn, 2002), port facilities and charging structures (Bergantino & Coppejans, 2000; Haralambides, Verbeke, & Musso, 2001; Heggie, 1974; Suykens, 1986). Research, such as Gardner, Marlow, and Pettit (2006), show that ports are aware of the externalities related to hinterland traffic for example but chose not the assess it, rather they focus solely on complying to environmental legislations on the local, regional and international levels. Based on existing research it is evident that little research has been directed towards port due systems of port's hinterland activities at the same time it is recognised as an important environmental factor.

3. Methodology

Very few methodologies can include different stakeholders simultaneously in a decision problem. Evaluation studies often use social cost benefit analysis to calculate the impact of a project on society at large, but this type of analysis does not allow researchers to compare explicitly the impact of a decision on a specific stakeholder or stakeholder category. Furthermore, the monetisation of the criteria considered often leads to generalisations and possible loss of information (Damart & Roy, 2009; Scanella & Beuthe, 2003; Tsamboulas, Yiotis, & Panou, 1999). As an

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