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The challenge of appropriate hub terminal and hub-and-spoke network development for seaports and intermodal rail transport in Europe

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ABSTRACT

To achieve the modal shift projected by public transport policies, intermodal rail transport needs to improve its performance in order to become more attractive. Hub-and-spoke (HS) bundling is an option to improve its performance. It potentially increases the attractiveness of intermodal rail freight services, also for flows that are too small to fill a direct train on the required frequency level. HS bundling can be carried out in different ways (types of hubs, trains and operations). Only some of them lead to competitive transport services. This paper argues that – in many situations – the best HS network employs terminal hubs and shuttle trains, and that the hub terminal should be a real hub terminal. A real hub terminal is designed to fulfil its main function, rail-rail transhipment, effectively and efficiently.

Despite their apparent advantages HS networks with real hub terminals are penetrating the market at a very slow pace. The paper discusses major barriers for a faster implementation, and advocates a change of perception of rail operators, and also of public transport policies. It is recommended that the development of hub terminals is supported by public vision-making and cooperative or more centralised network design within the sector.

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1. Introduction

Intermodal rail transport is to play an important role in future freight transport in Europe. The main background is that society (e.g. EU, seaports Antwerp and Rotterdam) is striving for a shift to more sustainable transport modes. Rail is such a mode. And intermodal rail transport is a key opportunity for growth within the European rail sector (CER, 2013).

However, a real breakthrough of intermodal rail transport, measured in terms of modal shift, is hardly visible. Decades after the introduction of the container, the share of intermodal rail transport still lies below the 9% of the total road traffic in the European Union (Kombiconsult, Intermodality, Planco, Gruppo Clas, 2015), despite the large success on some large flow corridors such as between the Antwerp/Rotterdam and northern Italy. On many transport relations unimodal road transport keeps growing faster.

The modest modal shift is largely due to modest performances. Intermodal rail transport is not attractive enough in comparison to reference modes. The conclusions of the European project Intermodal Quality that intermodal transport in Europe in general performs poorly except in some large flow corridors, to and from a few large nodes and in some well-organised regions (Cardebring et al., 2000a), still is rather valid (CER, 2013). The European Technology Platform ALICE (Alliance for Logistics Innovation through Collaboration in Europe) with reference to Shift2Rail mentions “dissatisfaction among customers causing potential customers to consider rail as incapable of meeting their logistic needs” (ALICE, 2013a, p. 17).

Symptoms of a poor quality are low frequencies (practitioners often consider less than three services per week to be poor) or the absence of connections (even in the “own” hinterland of a seaport many inland terminals are not accessed from the seaport). In addition there is also the cost problem. Often the costs of rail transport are not competitive to road transport.The low road costs lead to a downwards price pressure in the rail system. The rail firms regularly report having problems to cover their costs. A feature of high costs is the small size of trainloads. Incidental observations, but also structural observations for an entire country (Woodburn, 2011, for the UK) indicate that there are still many 400–500 m long trains running, while 600–700 m long trains would be technically possible on many corridors.

To change this reality and perception of performances intermodal rail transport needs to be innovated. An important innovation field is the bundling of rail flows, especially finding new ways of directional bundling. This is the process of transporting flows of different rail relations[1] in joint trains during part of their journeys. Directional bundling is needed when flows are too small to fill a direct train on the required frequency level, and this is the case for many relations, also from

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[1] We define a rail relation as the rail flow between a begin terminal (or station or private siding) and an end terminal (or station or private siding).

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and to large transport nodes like large seaports. If such flows would nevertheless go by direct trains, trainloads would be (too) small, and service frequency and network connectivity (too) low.

The potential imbalance between train capacity and flow size is an evergreen issue in the rail sector. The classical solution to the challenge to artificially increase the scale of transport was the so-called wagonload network as described by Beisler, Kettler and Molle (1995) or Dobeschinsky and Bitter (2004). In the post-war period these networks were streamlined, given the emerging competition by road transport and the increase of labour and other costs. The streamlining led to (for an overview of this evolution see Kreutzberger 2008b) 1) the introduction of dedicated intermodal trains, hence trains only carrying intermodal load units, 2) the large scale substitution of capillary local rail networks by road pre- and post-haulage (PPH), and 3) the large scale employment of wagon group trains[2] becoming the backbone of intermodal rail transport during the 1990s, also for intermodal transport (Kombiconsult & K + P Transport Consultants, 2007). The streamlining was partly conducted top-down, as the "Reshaping of British Railways" in the 1960s (Stone, 2008), partly bottom-up, organised by different rail actors.

Visionary transport experts (mainly in Germany, France, The Netherlands and Sweden) in the 1980s and 1990s anticipated that the streamlining would not be sufficient. They launched innovative rail concepts in the field of networks, vehicles, terminals and load units, together representing a true innovation wave. Notable is a memorandum of the platform of German rail and logistic experts (KV-Technologieplattform 2000+, 1995) and the initiative of Deutsche Bahn to develop a Megahub at Lehrte (near Hannover). This new-generation terminal was designed for the large-scale exchange of continental load units between trains simultaneously visiting the hub. The terminal and its French pendant, the Commutor new-generation hub terminal(s) and rail network of the French railways, were two exponents of the innovation wave. The two hub terminals were to serve intermodal rail hub-and-spoke (HS) networks and would respond to the aim of covering large areas (France or northern Germany) by day A/B train services, despite of visiting a hub in between (Jalard, 1993a; Gaidzik et al., 1994). In favour of high performances the operations were robotised, and the terminals would have a terminal internal transport and sorting system (TITSS) to their disposal. This system serves to move load units between different crane segments, for instance from the front position of one train to the back position of another train. It minimises longitudinal movements and cycle times of cranes and paralyses operations, hence accelerates operations and increases the terminal capacity.

The robotisation and the TITSS were the common features of these hub terminals distinguishing them from a rail-road terminal. There have been numerous studies pointing out the effectivity of these new-generation hub terminals, especially in terms of handling time (Jalard, 1993a; Gaidzik et al., 1994; Simet, 1995; TERMINET, 2000; Bontekoning and Kreutzberger, 2001b; Ballis and Golias, 2002).

So far only a few dedicated intermodal HS networks and terminals proposed for rail-rail transhipment have been built. None of them has the distinguishing TITSS. The slow market penetration gives rise for doubt, whether this direction of innovation really was and is promising or instead actually has some hindering disadvantages. The doubt could even become larger as the first terminal really designed as a hub terminal, the Mainhub in Antwerp, and its main customer, the domestic (Belgian) NARCON network, have been shut down end of 2013.

One answer to the doubt is that some of the new concepts were characterised by heavy conceptual mistakes. This was the case for Commutor. Its overhead crane construction implied the need of standardised wagons which most likely would have prevented many, certainly foreign rail operators to run trains through the French rail network.

On the other side, confirming the value of hub terminals, some new hub terminals have been built and others have been announced, two of them including a TITSS, namely Lehrte and Duisburg.

The relevance of the bundling innovation has recently been underlined by policy statements. One is by the European Intermodal Research Advisory Council (EIRAC; 2010) pointing out that "…a higher consolidation [authors: = bundling] of goods per equipment move (bundling of freight) has to be achieved to use the resource more efficiently." The report provides a plea for "research on intermodal hub equipment and easy cross-docking technology to increase productivity and modal shift capability" and "research on best practices and additional possibilities to bundle freight". Another confirmation comes from transport and logistic experts contributing to ALICE workshops. We cite from the report Corridors, hubs and synchromodality. Research and Innovation Roadmap (ALICE, 2013a): "In the coming decade, a number of trends driving the need for innovations in hubs, corridors and synchromodality will be seen" (page 18). The term hub therefore here is used in a broad sense (like urban industrial node) and narrow sense (like rail hub): "Consolidating creates the volume needed to sustain regular new services and regular services will in turn attract higher cargo volumes" (page 19).

Given this background it is desirable to structure the bundling and hub innovation challenge, pointing out the requirements, solutions, development conditions, the innovation having taken place already, and which research is needed to boost the innovation. The paper addresses these issues in a rather explorative instead of exhaustive way, highlighting areas that are of special importance for the central questions of this paper: 1) Why are terminal-based HS networks important to improve the performances of intermodal rail transport? 2) What is the state-of-the-art of HS networks and terminals in Europe? 3) What are the reasons for the slow market penetration of terminal-based HS networks and how could this change?

2. Methodology in and structure of the paper

The mentioned explorative character of the paper is to say that we give orientation by providing conclusions on the basis of conceptual structuring and quantitative indications. The paper does not present a systematic comparison of performances of hub alternatives. Instead it aims at creating a holistic picture from studies and practitioners' statements (in interviews or working environments like research projects).

The paper has a design and an analytical dimension, discussing challenges (e.g. performance aims) and solutions in layers. An aim can require several solutions, while a solution may respond to several aims. Also, the solutions of one layer can be the aim for the next layer. Some layers refer to the transport chain, others to the network or to the hub. This complex interaction is visualised in Table 1, underlining the relevance of a holistic approach. The starting point are the (door-to-door) performance requirements of customers (layer 1 of Table 1). The table includes the performance requirements considered to be the most important for customers of rail transport (Section 3).[3] The rail operator then chooses operational configurations which provide the required performances, on the level of chains (layer 2) and networks (layer 3). From this level the operator decides on what the contribution of nodes, in particular the hub, must be to the required network and chain performances (layer 4). These functional and sometimes geographical descriptions are the framework from where to decide on the physical means to be employed like terminal equipment on the hub (layer 5). This layer approach essentially resembles the value chain

[2] Wagon group trains only have a small number of directional groups, contrary to the long-haul trains in the wagonload networks. This allowed to carry out rail-rail exchange at flat instead of gravity shunting yards, leading to rather competitive exchange times and costs.

[3] Without the performance type "information" mentioned by CER (2011) because this serves all operations and innovation, without train capacity which is an operational challenge on a another level, and without ecological performances which derive from all decisions in Table 1.

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