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An empirical study of the variability in the composition of British freight trains

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ABSTRACT

As part of the broader sustainability and economic efficiency agenda, European transport policy places considerable emphasis on improving rail's competitiveness to increase its share of the freight market. Much attention is devoted to infrastructure characteristics which determine the number of freight trains which can operate and influence the operating characteristics of these trains. However, little attention has been devoted to the composition of the freight trains themselves, with scant published data relating to the practicalities of this important component of system utilisation and its impacts on rail freight viability and sustainability. This paper develops a better understanding of the extent to which freight train composition varies, through a large-scale empirical study of the composition of British freight trains. The investigation is based on a survey of almost 3000 individual freight trains, with analysis at four levels of disaggregation, from the commodity groupings used in official statistics down to individual services. This provides considerable insight into rail freight operations with particular relevance to the efficiency of utilisation of trains using the available network paths. The results demonstrate the limitations of generalising about freight train formations since, within certain commodity groupings, considerable variability was identified even at fairly high levels of disaggregation.

1. Introduction

European transport policy favours a much increased role for rail in meeting the growing requirement for both freight and passenger movement (European Commission, 2011). In Britain, rail's share of the domestic freight market (measured in tonne kilometres) reached a low of 6 per cent in 1995 before rising to 9 per cent in 2010 and national rail's share of passenger kilometres increased from 5 per cent to 7 per cent in the same period (DfT, 2014). The growth in network activity is exacerbating the conflicts that arise from the operation of a mixed traffic railway (i.e. one that caters for both passenger and freight traffic). While there is a considerable body of literature relating to rail capacity utilisation, the emphasis has tended to be on analysis of train path provision and, to a lesser extent, path characteristics or path utilisation so as to maximise rail freight activity on a route or network. There is surprisingly little consideration of how well the freight trains themselves are utilised and how this varies, for example between and within flow types.

The timetabling process for freight trains tends only to crudely reflect variations in planned train capacity and actual on-train utilisation, if indeed any variability is included at all. In the British context, for example, Network Rail (2014a) plans train

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paths using timing loads which take account of factors such as train trailing weight, traction type, train length and maximum permissible speed. However, these are greatly simplified for ease of planning and to ensure that timetabled paths provide schedules which are usable by a range of different freight train types, even where the path is used by only one flow type. Given the increasingly competitive rail freight market in Britain and elsewhere in Europe, standardised train paths for freight trains of a designated maximum speed and trailing weight are becoming more common, particularly on international rail freight corridors. For example, pre-arranged paths with standard parameters to encompass access requests for most types of freight flow have been introduced on the Corridor Rhine-Alpine (2015). This high degree of standardisation in the scheduling of freight trains is logical from a planning perspective, but typically ignores the actual on-train utilisation of the train filling the path. No literature comprehensively assessing on-train utilisation across an entire country's network has been identified but Leyds (2012) found that, in the Netherlands, there was considerable variability in freight train operating speeds and tonnages along the studied Dutch rail corridors but that freight train paths were timetabled using a single standard. However, on-train capacity utilisation, and the extent to which it varies (e.g. by flow or by time), plays an important role in determining:

- The extent to which rail system capacity is being utilised: this is an important issue in countries such as Britain which have experienced considerable growth in rail freight activity and where network capacity concerns are emerging more frequently
- Rail freight viability, given the high fixed costs involved in running freight trains and the challenges of reducing unit payload costs to make rail freight more competitive
- Rail freight sustainability, since the quantification of sustainability impacts typically relies on the use of average factors based on top-down data and does not account for operational variability at a more disaggregated level.

These issues are discussed in more depth in Section 2. In the absence of published operational data for variables such as tonnage or number of unit loads at an individual train level across the entire British rail freight industry, this paper is based on a large-scale empirical study of the composition of British freight trains using the number of wagons per train as a proxy variable. While this measure has some shortcomings, identified in Section 3, it does permit an evidence-led approach to better understanding the nature of freight train composition across a country's entire rail freight market. Specifically, the twin research objectives are to understand the extent to which there is variability in freight train composition on the British rail network and to determine the level of disaggregation of rail freight activity that is required in order to find a high degree of homogeneity in composition. Essentially, the paper seeks to establish the level of granularity needed to be able to reasonably understand or predict the capacity provided on a freight train and to identify whether this differs by rail freight market segment: in other words at what level, if any, can one talk about a 'typical' freight train in terms of its composition? The objectives are satisfied through a large-scale empirical study of the composition of British freight trains.

The paper is structured as follows. The next section sets out the detailed study context, summarising the key issues from the academic and policy-based literature. Section 3 provides details of the materials and methods used for the primary research on British rail freight train composition, followed in Section 4 by analysis and discussion of the survey results. Section 5 discusses the paper's contribution by considering the practical implications of the research findings for understanding the impacts of the variability in freight train composition.

2. Study context

This section begins with a discussion of the categorisation of rail freight operations. It then considers the key aspects of the literature relating to the role of freight train composition in the use of rail system capacity and the viability and sustainability of rail freight.

2.1. Conceptual categorisation of freight train operations

It is possible to categorise the method of freight train working, with a caveat that the reality is generally not as straightforward as the conceptual frameworks in the literature suggest. From the literature base, Table 1 provides a range of examples of the categorisation of the types of rail freight operations.

For the core rail freight market, excluding mail/express freight and infrastructure traffic, the following categorisation summarises the key operational differences, although the precise terminology adopted varies depending on the source:

1. Trainload – an entire train, usually of a single commodity (e.g. coal, steel), running from origin to destination without intermediate marshalling
2. Wagonload – trunk trains operating between hub marshalling yards made up of single wagons (or small groups of wagons), generally with a mix of commodities and/or customers and with feeder trains between hubs and individual customers' terminals; this type of operation typically involves a wagon being re-marshalled several times en route from origin to destination

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