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Improving railway performance in Norway

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A B S T R A C T

As in many countries, railway performance in Norway is not as high as management would wish. This paper describes 'forensic' work undertaken to understand the reasons for, and durations of, delays at stations in the Oslo area. These delays are often small in nature, and poorly-recorded, so are not well-understood. Detailed analysis of over 1000 departures identified many reasons for delay, of which data on six (train stopping position, despatch delay, staff position relative to the critical door, excess customer service, passenger door forcing, and knock-on delays) are presented here. It is hoped that this data may be of use to those developing rail simulations or more widely trying to understand railway performance in more detail. Actions being taken in Norway designed to address these issues are expected to improve punctuality by about 3%.

1. Introduction

1.1. Railway performance in Norway

As with many railways, the performance of services operated by Norwegian State Railways (NSB) in recent years has not been as high as management would have wished. Figures on the % of trains arriving on time (defined as within 3 min 59 s) are set out in Table 1.

Variations by line are significant, with the best-performing route in the busy Øst area Porsgrunn-Notodden (achieving 94.4%) whilst the worst routes Oslo-Lillehammer and Oslo-Skien achieve only 79.3% and 80.8% respectively, against a target of 90%. The NSB network has some important features, not least the merging of a range of lines (some of them single-track) into a core route between Lillestrøm and Drammen. Of this, the key short (3-km) city-centre section between Oslo S and Skøyen is underground. The core route is entirely double-track, although in recent years new higher-quality line sections have been constructed between Lillestrøm and Oslo S, and between Lysaker and Asker, thereby effectively creating 4-track railways over these sections (see Fig. 1). A maximum of 18tph was operated through the central core until the December 2012 timetable, at which point an improved timetable increased train service frequencies to 20tph. Further service improvements are expected in December 2014.

This paper describes a range of 'forensic' service planning activities which were undertaken during 2012 to understand the types and durations of delays to train services, especially during station stops. This is because the key success factor for punctuality on urban and regional services was identified by Olsson and Haugland (2004) as the management of boarding and alighting passengers. Our core focus is on understanding the variability of processes undertaken during dwells, and an identification and quantification of the types of specific delay which occur during station stops.

A huge amount of research has been expended in recent decades into optimising train running times, signalling systems and track infrastructure. Key outputs from this have been syntheses of best practice (e.g. Hansen and Pachl, 2008) and simulations such as Opentrack (Nash and Huerlimann, 2004). However, there is less information about smaller delays, some of which are not even recorded fully (Gisby, 2013). In particular, the area of station stops has been less well-researched, with many simulations merely using booked dwell times, subject to random variations fitting some form of Weibull or gamma distribution (Yuan et al., 2006; Yuan and Hansen, 2008) which can be calibrated to observed performance. There are a number of reasons for this. First, some automatic systems (such as those driven by signalling equipment) do not measure the time during which trains are stationary. Secondly, many of the reasons for delays at stations involve the behaviour of people (passengers and staff), not equipment which might be directly monitored. Thirdly, railways do not generally record the reasons for delays of <1 min (a category into which the vast majority of station stop problems fall), and hence data for input into operational simulations is also lacking from the public domain. Indeed, it is

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Table 1
NSB performance, 2011 and 2012.

Line	Punctuality		
	2012 (%)	2011 (%)	Change (%)
Porsgrunn-Notodden	94.4	91.1	3.3
Skøyen-Mysen-Rakkestad	91.3	83.9	7.4
Asker/Skøyen-Årnes-Kongsvinger	90.7	88.9	1.9
Skøyen-Ski	90.3	87.9	2.4
Oslo-Halden	90.2	86.2	4.0
Drammen-Dal	89.5	86.8	2.7
Skøyen/Spikkestad-Moss	89.1	83.6	5.5
Spikkestad/Drammen-Asker-Lillestrøm	85.1	84.8	0.3
Kongsberg-Eidsvoll	84.5	82.0	2.6
Oslo-Lillehammer	80.8	65.6	15.2
Oslo-Skien	79.3	82.6	−3.3
Total NSB Øst	87.4	84.1	3.4

the lack of causal explanation which led this work to use experienced observers, rather than methods used by other researchers (e.g. Buchmüller et al., 2006) involving automatic equipment.

The work reported here aimed to fill in this knowledge gap whilst simultaneously providing information of real value to NSB, enabling it progressively to address the issues found and hence to improve its train service performance. Work concentrated on peak periods, since this is the period in which the number of trains is greatest (and the largest number of passengers is affected), and also in which the potential for service recovery is smallest.

1.2. Station stop data collection

The Railway Consultancy has been undertaking a series of station stop surveys for almost 20 years using a standard format. Data collection is focussed at the critical (busiest) door, and a database of over 100 other measurements enables comparisons and best practice to be discerned, as has been occurring through the application of this method to Imperial College's metro and suburban railway benchmarking groups (Harris and Anderson, 2007). The approach (which requires two observers) includes counts of passenger movements, and the timing of these and the other tasks that railway staff have to undertake e.g. door opening and closing, train despatch etc. The work in Harris and Anderson (2007) and elsewhere forms the backdrop to this study, against which any perturbations can be examined.

The overall process of a train stopping at a station includes within it a range of more detailed functions which occur almost on every occasion:

- Wheel stop.
- Doors open (after traction interlock disabled).
- Passengers alight.
- Passengers board (sometimes before the completion of alighting).
- If time to depart is reached and signal is green, despatch process is initiated.
- Doors close.
- Wheel start (after traction interlock enabled).

Typical values for the duration of these were set out in Harris and Anderson (2007), but this paper is designed to provide evidence of variability in processes (as well as averages), so Table 2 below sets out coefficients of variation (cv) as well as means for a group of suburban rail locations within that dataset typically having 15tph. The consistency in cvs is remarkable, except for the delay-related elements of adverse signals and awaiting time. It is also worth noting that the despatch element is the most variable of the remainder, even though this should be within management control.

Source: Harris and Anderson (2007).

In addition to these 'normal' stop time elements, however, things inevitably go wrong and delays do occur. These problems can generally be categorised as resulting from:

- Infrastructure design.
- Rolling stock (design and operation).
- Traincrew.
- Timetabling.
- Train control.
- Station operation.
- Passenger behaviour.

All of these are commonly-recognised as sources of railway delay, but usually only at an aggregate level; their contribution to delays at stations is less well-understood.

1.3. Structure of this paper

The remainder of this paper is structured as follows. Section 2 briefly describes the method, whilst a more substantial Section 3 discusses the results found. Section 4 provides some indication of actions taken to manage the problems found, with Section 5 containing our conclusions and recommendations.

2. Method and immediate observations

2.1. Methods

As with previous work, this project used skilled railway operators to watch and enumerate the delays observed, in addition to the times taken for 'normal' functions. At the time of writing, c. 1000 trains had been observed across 30 surveys, some of which had been undertaken simultaneously, in order to understand knock-on effects, and delays in run-times between stations. The number of departures represented in this analysis (primarily of 2012 data) is shown by station in Table 3, and concentrates on stations where larger sample sizes give greater confidence in the results.

As can be seen, there is, of course, considerable variation around the mean values of stops at the different stations, determined principally by passenger movement times and any unplanned delays, from whatever cause. The extent of variability is of concern to management. However, it should be noted that trains are booked to stand at Oslo S for two minutes (sometimes more) to enable both crew changes and service recovery, so Goverde's results (Goverde et al., 2001) about late trains having longer dwells do not apply there. An example plot of Sandvika dwell times is shown in Fig. 2, which not only demonstrates the expected distribution but also the inadequacy of the schedule in allowing sufficient time for even expected deviations; this is part of a wider problem which NSB has been addressing in recent timetables.

None of the stations had any particular characteristics which were felt likely to influence the timings of technical processes, except possibly at Lysaker where curved platforms might make staff unduly cautious in despatch. Issues such as platform:train gaps are, of course, much more important in determining passenger alighting and boarding rates.

2.2. Immediate observations

Although a wide range of issues were unearthed during the survey programme, two quickly established themselves as the key determinants of primary station stop delays in Eastern Norway by duration (if not by frequency, see Fig. 3).