Available online at www.sciencedirect.com

ScienceDirect

Transportation Research Procedia 27 (2017) 538–544

Transportation Research Procedia

www.elsevier.com/locate/procedia

20th EURO Working Group on Transportation Meeting, EWGT 2017, 4-6 September 2017, Budapest, Hungary

Discussions of the reschedule process of passengers, train operators and infrastructure managers in railway disruptions

Nuannuan Leng*, Ulrich Weidmann

Institute for Transport Planning and Systems, ETH Zurich, Stefano-Franscini-Platz 5, 8093 Zurich, Switzerland

Abstract

In case of railway disruptions, the whole railway traffic will be impacted in a large area and for a long time. There are three stakeholders in railway disruption management process that cannot be neglected: passengers, train operators and infrastructure managers. Infrastructure managers are mainly responsible for operational feasibility of the rescheduled timetable. Train operators aim at minimizing operation costs and maximizing the services offered to passengers. Passengers' needs are an important evaluation for rescheduled timetable in railway disruptions. Since the three stakeholders have diverse and even conflicting objectives in the disruption management process, how to handle the trade-offs of these objectives deserves further discussion. This paper summarizes the possible methods to solve the holistic rescheduling process including passengers, train operators and infrastructure managers in railway disruptions. Specifically, this paper discusses two reschedule process and compare their pros and cons. This research links passengers, train operators and infrastructure managers in the rescheduling process of disruption management. It is the base for solving the trade-offs of different objectives of stakeholders.

Peer-review under responsibility of the scientific committee of the 20th EURO Working Group on Transportation Meeting.

Keywords: Disruption management; passenger satisfaction; timetable reshceduling; rolling stock reshceduling

1. Introduction

There are three main sub problems in railway disruption management (Jespersen-Groth et al., 2009): timetable adjustment, and rolling stock and crew rescheduling and summarise the roles and objectives of infrastructure managers

* Corresponding author. Tel.: +41-44-633-2478.
E-mail address: nuannuan.leng@ivt.baug.ethz.ch

2352-1465 © 2017 The Authors. Published by Elsevier B.V.
Peer-review under responsibility of the scientific committee of the 20th EURO Working Group on Transportation Meeting.
10.1016/j.trpro.2017.12.034

and train operators. From the network viewpoint, infrastructure managers are responsible for network traffic control while train operators are for rolling stock schedule and crew schedule. From station viewpoint, infrastructure managers are responsible for train routing and platform assignment while train operators are for shunt planning. As described in Cacchiani et al. (2014), there are papers dealing with the integration of different phases of real-time railway rescheduling, with the aim of determining a good new schedule for the timetable, and the rolling stock and crew duties when a disruption occurs. In this paper, we omit the quotes of the literatures according to crew rescheduling.

Current research with regard to disruption management is mainly from operations-centric views. The main problem in railway disruption is to reschedule the timetable, which is generally obligated by infrastructure managers. The most popular objective is to minimise train delays (e.g. Brucker et al., 2002). There are also some extending variations to describe train delays more precisely. For instance, Albrecht et al. (2013) propose two criteria to measure the rescheduling objectives. The one is the minimum total delay, consisting of train delays and the maintenance delay, while the other is to minimise the maximum train delay, avoiding largely attributed delay to one single train. Narayanaswami and Rangaraj (2013) minimise the weighted sum of the difference between the actual and scheduled arrival time at the destination for all trains on both directions of a single track. The second wide-applied objective is to minimise the deviations from original timetable. For example, Hirai et al. (2009) aim at minimising the number of stops outside stations and the deviations from original timetable. To avoid the modifications of scheduled timetable, some papers propose minimising the number of cancelled trains as one objective. Zhan et al. (2015) and Veelenturf et al. (2016) minimise the number of cancelled trains and the total weighted delay. Except minimising the delays of the operated trains and the number of cancelled trains, Louwerse and Huisman (2014) include another two objectives from the operation viewpoint: balancing the number of trains in both directions, and distributing the operated trains evenly over time. The former objective is specified by the absolute difference between the numbers of cancelled train sub series in each direction while the latter one is demonstrated by the maximum time between two operated trains in the same direction.

In addition to timetable rescheduling, the train operating companies need to reschedule the rolling stock at reasonable cost, and then to adjust the crew schedules. The literature review in this section mainly focuses on rolling stock rescheduling. The prime objective of train operating companies is to minimise the operation cost. Sato and Fukumura (2012) seek to minimise the total sum of the costs of selected paths. Budai et al. (2010) not only use carriage-kilometres, seat shortage kilometres and the number of composition changes as additional objective, but also propose to resolve as many off-balances as possible in the rescheduling process. Besides, Nielsen et al. (2012) measure the deviation of the rescheduled circulation from the original circulation by employing three objective criteria: cancelled trips, changes to the shunting processes, and off-balances.

Jespersen-Groth et al. (2009) proposed that one important objective of the operators in the disruption management process is to minimize the number of passengers affected by the disruption, and to minimize the inconvenience for the affected passengers. However, literatures are from passenger-centric views to deal with disruption management are much scarcer than that from operations-centric views. Binder et al. (2016) focus on passenger oriented timetable rescheduling in railway disruptions and integrate three objectives: passenger satisfaction, operational costs and the deviation from the original timetable. The passenger dissatisfaction is given by the generalised travel time including in-vehicle time, waiting time, numbers of transfers, early arrival and late arrival. The operational costs refer to the running cost of original trains as well as emergency trains. The deviation from the original schedule is a weighted sum of the different rescheduling possibilities: cancellations, re-routings, delays and the cost of adding an emergency train. Almodóvar and García-Ródenas (2013) study the rolling stock rescheduling for passenger railways in case of emergencies and minimise the total in-system time of the passengers. The objective function in Kroon et al. (2015) consists of two parts: the system-related costs and the service-related costs. The system-related costs refer to three penalties: modifications in rolling stock compositions, modifications in the shunting operations and end-of-day off-balances. The service-related costs refer to the sum of the individual inconveniences, considering the increase of passenger delay under the limits of train capacity. Cadarso et al. (2013) integrate the timetable and rolling stock rescheduling in disruption management and propose an integrated objective consisted of seven terms: operating costs of planned and emergency services, operating costs of empty movements, composition changes, cancellation of services, denied passengers, deviation from the schedule of commercial services, deviation from the schedule of the empty movements. Especially, the last two terms hint to minimise the length of the recovery period. The objective