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Calculating the value of connection conflicts

Anselmo Stelzer [a,*]

[a] *Technische Universität Darmstadt, Railway Engineering, Otto-Berndt-Str. 2, 64285 Darmstadt, Germany*

Abstract

Objectives. In the domain of railway dispatching the handling of connection conflicts is a complex and most of the times intransparent task for the dispatcher. A decision support system is needed to provide relevant objective information regarding a connection conflict. Connection conflicts need to be evaluated from the transportation company's point of view. Hereby not only traveller discomfort is taken into account, but also economic considerations. In this paper, we present possible applications for connection evaluation. One of them is the conflict resolution for which a method for connection conflict evaluation is provided which can be used in decision support systems.

Data and Methodology. To derive and possible contexts for connection evaluation, first, the context of connections in the dispatching process in the railway system is examined. Possible contexts are analysed and described. For each context, the value of a connection is calculated based on multiple influences which can affect each other. In contrast to other literature, the focus is not only on the traveller or train delay but also on other influences. Influence factors relevant to transportation companies are determined. Then a technique is presented to respect all relevant influences and combine them. Thus, the evaluation consists of a function with several evaluation components. For every influence we follow a strict scheme to define the background, the deduction of a function or influence, the placement in the overall evaluation, combinations with other influences and an estimation of feasibility for that influence.

Expected results. This paper shows, how to apply evaluations of connection conflicts in different contexts and for one of them an evaluation function is be defined. The result is a function to measure the (monetary) value of a connection conflict. The function contains all determined influences and combines them. The function can be used for different conflict resolution methods, e.g. for optimization or as an integration in decision support systems. Alternatively, it can be displayed to the dispatcher directly who then can take the so-derived value of a connection into consideration for his dispatching decision.

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1. Introduction

Connection conflicts are a common problem in public transportation and often lead to huge discomfort for the traveller. This makes connection dispatching an important issue as the result of dispatching decisions directly affect

* Corresponding author. Tel.: +49-6151-16-65915; fax: +49-6151-16-6903.
E-mail address: stelzer@verkehr.tu-darmstadt.de

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the passengers' travel chains and their delay at the destination. Furthermore, travellers today expect more sophisticated systems to solve their connection conflicts as well as an individual treatment. Also, traffic authorities begin to dictate rules regarding secured connections which could lead to penalty payments for transportation companies. This development goes along with more complex schedules based on denser networks leading to rising numbers of existing connections and travel possibilities.

A more individual care for each traveller, more sophisticated conflict treatment and regulation by authorities motivate the need for complex decision support systems in connection dispatching. These systems support in decision taking, but also in different contexts as visualization, prioritization, etc. of conflicts and help to deal with a rising number of connections and connection conflicts. In each of the context the order of conflicts can differ. That is why different approaches of evaluating connections are necessary.

The transportation company is responsible for connection planning, communication and the resolution of connection conflicts (in contrast to the infrastructure company which is maintaining the network). Therefore, an evaluation has to be calculated from the transportation company's point of view.

Until today, no systems exist that take into account the complex requirements of travellers, authorities and the transportation company and combine all influences into a general connection value. However, there is a need for evaluation of connections and a general method how to derive the evaluation. In this paper, a universal method will be presented that can be applied in various contexts. The derived evaluation function can be used to measure quality constraints, as e. g. for conflict resolution. Also the functions can be used in existing connection related problems such as the delay management problem.

Subsequently, first possible contexts for connection evaluation in section 3 are outlined. Then we present a general formalized method how to derive a good evaluation procedure for a chosen context in section 4. The method will be exemplarily applied in section 5 to derive an exemplarily evaluation function. This function will be utilized to calculate the connection value on a real world example in section 6. This paper closes with a conclusion in **??** and an outlook in section 8.

2. Related Work

Already in 1995 Martin (1995) developed a method to evaluate train runs and shuntings based on linear optimization. They also investigated the treatment of connection conflicts and mentioned the need to evaluate the dispatching decision.

In connection dispatching often OR-methods are used, such as linear optimization Schöbel (2007); Gatto et al. (2007); Dollevoet et al. (2012, 2014); Corman et al. (2012, 2015) or heuristic approaches Kanai et al. (2011); Kurby (2012), where a conflict evaluation is needed to define the target function. These approaches are limited to waiting/non-waiting strategies and generally use the passenger delay as cost factor (Gatto et al., 2007). In Dollevoet et al. (2012) fixed costs based on the passenger delays are assumed for maintaining connections. Kanai et al. (2011) use the passenger dissatisfaction as evaluation criteria. Ginkel and Schöbel (2007); Corman et al. (2012) consider two target functions, the minimization of delays on one hand and the minimization of missed connections on the other hand. The optimization faces to minimize both functions to find Pareto solutions. In Corman et al. (2015) the objective is to minimize the passenger discomfort. The objective function to reduce the passengers' discomfort is minimizing their time in the railway system.

Although in (Kurby, 2012, 28ff) several approaches for conflict evaluation in the context of connection dispatching are discussed, the chosen evaluation method, as well, is a (clustered) traveller delay. The elaboration of the discussed approaches is still subject to further research. Kurby (2012) use the traveller delay as target function to evaluate simulated conflict resolutions for a given conflict.

Also in the planning phase an optimization using travel times as target function is found in the literature. Klemenz (2008) optimizes the process of planning connections by comparing delays of the travellers using a graph model.

The conflict evaluation in all mentioned approaches is strongly related to the used OR-method.

In a different approach Fay (1999) uses Fuzzy-Logic to decide in case of conflicts. The evaluation function is based on statements of dispatchers and used for specific fuzzy-decisions.