A Traveller-centric Approach to Incident Management in Public Transport

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1 Introduction

Incident management in public transport (PT) typically concentrates on service recovery. In general, if there is a disruption of a PT service, the operation control centre (OCC) will give instructions to the PT drivers in order to resolve the disruption. Incidents are defined here as any kind of disruption of the scheduled service by unpredictable events such as an accident, a severe delay, or a vehicle breakdown.

However, a traveller's perspective is the missing piece in the traditional way of handling incidents in PT. This is the focus of the idea introduced here—a traveller-centric incident management (TCIM). It complements the existing methods and is expected to resolve PT service disruptions in a faster and cheaper manner. This will be achieved by rerouting the passengers considering their proximity to the affected area and capacity constraints on the PT services surrounding the affected area. This is enabled by new information communication technology (ICT) applications.

The Section 2 gives an overview of the state-of-the-art on existing measures of incident management in PT. This overview highlights that PT incident management is almost completely done by PT drivers and OCC, whereas the traveller's perspective is indeed missing. The following Section 3 describes the approach by which TCIM is expected to fill the aforementioned gap.

2 State of the art of Incident Management in PT

According to Eberlein (1995), the existing incident management measures can be classified into three categories:

- Station Control
- Inter-station Control
- Other Strategies

Typical station control strategies are 'holding' and 'station-skipping' so that a PT vehicle can extend its 'dwelling time' or 'save time', respectively, in order to readjust the current service status to the planned schedule. These are the commonly applied measures, because they are proven to be very effective (Eberlein 1995; Sáez et al. 2012; Ceder 2016).

Methods such as speed control and traffic signal prioritisation belong to the inter-station control category. When a PT vehicle is in between two stops it can speed up or slowdown in order to stick to the schedule. With traffic signal prioritisation PT vehicles are prioritised at traffic signals which means that the traffic light ideally turns green when a PT vehicle approaches. Thereby, in case of any delay, a PT vehicle can travel faster and be able to reduce its delay (Ceder 2016).

The third category of other strategies includes methods such as dispatching reserved PT vehicles (Eberlein 1995; Schmöcker et al. 2005). This is meant to increase the PT capacity temporarily in case of sudden increase in demand to avoid excessive waiting times.

In addition, several studies have investigated the comparison and combinations of the aforementioned measures to recover from delays and service disturbances more effectively. Eberlein et al. (1999, 2001), for instance, examined the combination of holding with two of the station-skipping strategies namely *deadheading* and *expressing*. Ceder et al. (2013), and Nesheli and Ceder (2014) compared station-skipping in general, with holding and investigated the different effects of skipping a single stop compared to skipping a segment of stops. Delgado et al. (2012) compared holding and holding in combination with boarding limits. Liu et al. (2014) modelled the combination of holding and speed control in the context of available vehicle-to-vehicle communication.

All the above described methods are implemented by the PT drivers according to the instructions given by the OCC. Modern OCCs monitor the status of the PT services and the PT vehicles and get immediately notified when deviations from the schedule are detected. The cause of severe incidents is communicated verbally by the drivers and/or the police. During an interview with a dispatcher of the OCC in the city of Karlsruhe, Germany, it became clear that almost all incidents get detected and are reported by PT drivers. Therefore, the system fully relies on the driver's and dispatcher's experience. In case of the OCC in Karlsruhe all the dispatchers used to be PT drivers and consequently have a profound knowledge of the network and incidents that can happen.

3 Introduction of a new approach

As discussed in the previous section, the traveller's perspective of incidents occurring in PT systems is not considered yet. The dispatching measures, mentioned in the previous section, focus on restoring the functioning of the PT line and thus only indirectly improving the traveller's journey. However, densely meshed PT networks might provide alternatives to restore large parts of the passenger journeys before the dispatching measures of the disturbed line come into effect. New technologies can help introduce this passenger's perspective into the OCC's consideration, which builds the foundation of this new approach introduced in this paper.

This "passenger's perspective" includes considerations of the parts of their exact route affected by the incident, available alternatives tailored to their respective travel demand and usability of those alternatives – all considerations that cannot be done by the individual passengers without any ICT support. This new way of tackling the effect of incidents is expected to improve passenger flow, support today's incident management and thereby to accelerate the recovery of PT systems in case of incidents.

The figure below depicts the flow chart of the basic idea. The OCC monitors the service status and gets notified if an incident occurs. For now, it is assumed that in case of any incident the OCC is able to collect all the relevant information which is needed to feed the TCIM. The first step of the TCIM will be to analyse the situation from the traveller's perspective, which includes questions such as who is affected by the incident, what are the locations, origins and destinations of the travellers, etc. The use of traveller data e.g. through automated fare collecting systems can enable such considerations (Ibarra-Rojas et al. 2015). Once these questions are answered it will be elaborated to if change of

route is beneficial for the affected PT users under the current PT network conditions. Hereby conventional OCC data and the current dispatching decisions are utilised. If viable alternatives have been found, the different routes are rated according to their available capacity – a consideration necessary to prevent secondary incidents which could occur if capacity was exceeded on these alternative routes. This is the reason why, not all the affected PT users might be able to get redirected to their fastest alternative routes, in order to ensure that apart from the affected services rest of the system functions as usual. Therefore, the best combination of alternative routes for different passengers will be examined so that not all the affected travellers are redirected to the same alternative route.

The goal is to develop a TCIM which guides passengers in case their journey is disrupted by an incident whilst considering the PT system's properties and status. Optimum rerouting will be a compromise of the affected traveller's shortest alternative paths and the PT system's capacity constraints.

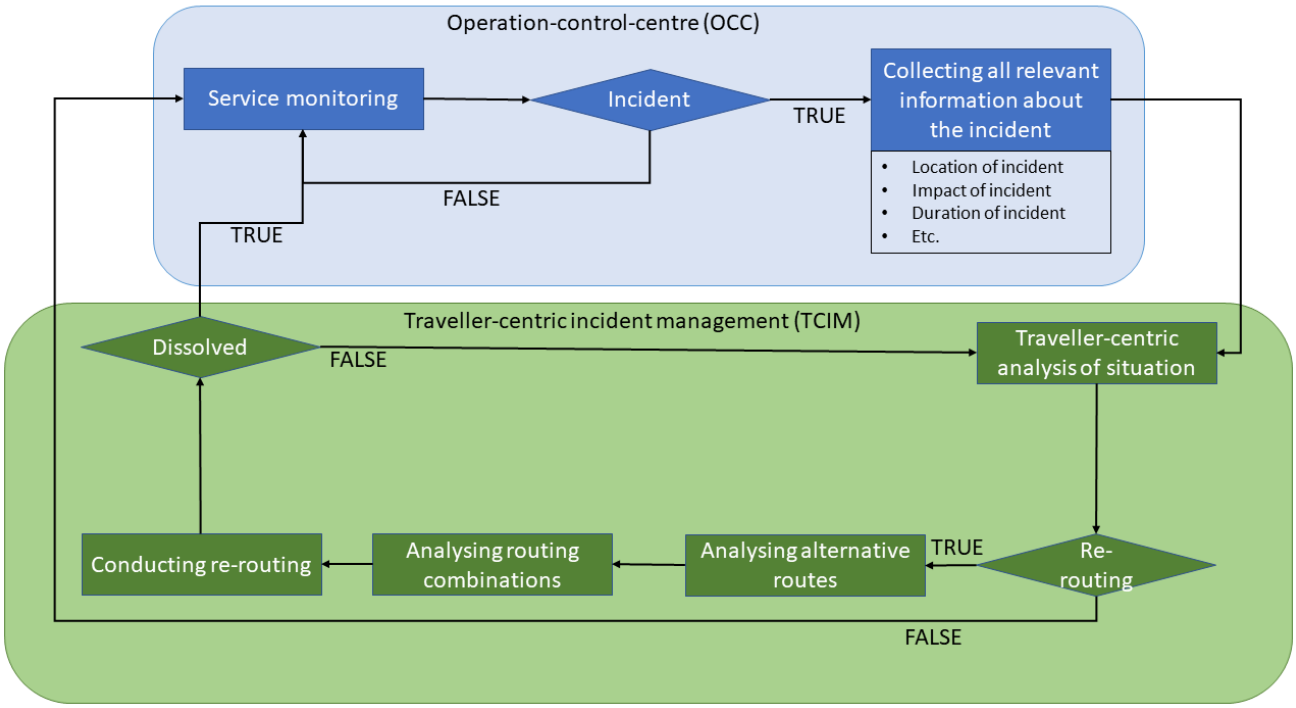

Figure 1: Flow chart describing the traveller-centric incident management concept

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