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INCIDENT MANAGEMENT IN PUBLIC TRANSPORT - SURVEYING DISPATCHERS' ACTIONS

Lars Briem
H. Sebastian Buck
Miriam Magdolen
Laura Lange
Peter Vortisch
Institute for Transport Studies, Karlsruhe Institute of Technology

1 ABSTRACT

Incident management in local public transport is the basic element to improve information flow and robustness for passengers in public transport. Dispatchers in an operations control centre continuously monitor the operations and intervene if the deviation from the schedule is critical or unexpected events happen. To understand the robustness of a public transport network, one must therefore understand the decisions taken by dispatchers. In the paper at hand a qualitative interview study is conducted providing first insights into the dispatching process. The study was conducted as a basis for a quantitative survey, which is essential for formalizing dispatching processes.

2 INTRODUCTION

Public transport can contribute to many transport policy objectives. The attractiveness of public transport can be increased if, for example, punctuality, information flow, or robustness are improved. This is one of the tasks of incident management. Incident management in local public transport is operated by a group of professional dispatchers in an operations control centre (OCC). The incident management is carried out in order to maintain operation in a specific incident situation. Dispatchers adjust their selected dispatching measure to this incident situation. On the one hand, there are national and international regulations as well as instructions on possible dispatching measures (Association of German Transport Companies 2015). These are partly extended or reduced by the local transport agencies. They form the scope of action for the dispatchers. In daily practice, on the other hand, decisions are often made quickly and individually by an individual dispatcher. Their scope of action is thereby also determined by the timetable. Planning a timetable with more possibilities for dispatchers would improve the whole system. For this, planners need an option to evaluate the punctuality and robustness of timetables before it is implemented in a real system. Friedrich et al. (2017) show an approach to measure robustness by introducing artificial disturbances into a simulation framework. However, dispatchers deal with incidents and disruptions and change the robustness of the whole system. Therefore, it is necessary to

consider the decisions done by the OCC staff in a robustness test. A formalization of the behaviour of dispatchers is unavoidable to improve such tests.

The long-term goal of our research is to figure out the scope of actions and the decisions of dispatchers in an OCC in public transport. We aim to understand the interdependence between the current situation in the network and the decisions of the dispatchers. The heterogeneity of such decisions is the most relevant aspect for formalization. Therefore, the aim of this paper is to analyse the extent to which the influencing factors and freedom of choice in the incident management can be surveyed. For this, we conducted a qualitative study with dispatchers of the public transport authority of Karlsruhe (KVV). This provides initial insights to create a survey concept applicable in many transport agencies.

3 LITERATURE REVIEW

In literature, there is little information about the factors influencing dispatchers or research methods to figure them out. Carrel et al. (2010) show that most of the current literature tries to develop new optimal decision strategies but does not consider many endogenous factors influencing the decisions. They further develop a framework to understand the decisions by observing the dispatchers in the OCC. Strathman et al. (2000) give an overview of the development of dispatching measures over several generations. They focus on the techniques and do not survey the decision process of dispatchers. Pangilinan et al. (2008) show the value of real-time automatic vehicle location for dispatching. Due to this technology, the scope of action of dispatchers is widely increased.

Widening the field to other areas of transportation research shows that formalizations are often based on quantitative surveys. However, a quantitative survey can only be conducted, if the phenomenon itself can be sufficiently described. To gather this knowledge qualitative research has proven to be a sufficient tool. One of the first examples where qualitative studies changed the way we model travel demand is the HATS technique. It is a widely acknowledged milestone in the development of activity-based travel analysis (Jones et al. 1983). Clifton and Handy (2003) describe how the outcome of a qualitative study with a few participants shaped a quantitative study resulting in the first Household Activity-Travel Simulator (HATS).

4 METHODOLOGY

To gain insights into the circumstances that influence the behaviour and actions of dispatchers, an overview on the relevant aspects is necessary. As there are only a few studies about the behaviour of human dispatchers in public transport, no established methodology to survey such a behaviour exists. For this reason, we conducted qualitative interviews with dispatchers to understand their working environment and scope of action. Since it is unclear to what extent the

answers of the individual dispatchers differ, a semi-structured interview with the help of a previously developed guideline was performed. The guideline has two tasks: First, it serves as support for the interviewer during the actual interview situation. The guideline lists both main questions and useful side questions to ensure that all relevant topics are covered. The main questions aim towards our research focus while the side questions serve as a suggestion for thematic deepening that does not result from the course of the conversation. Second, the guideline helps to check if the interview partner has already addressed the relevant aspects of interest. The structure used should avoid abrupt changes of topic during the interview but is flexible, if necessary, in order to reorder the questions during the conversation with the dispatcher. The interviewer could include new or additional questions that arise during the course of the interview. The guideline is structured in five sections as shown in Figure 1.

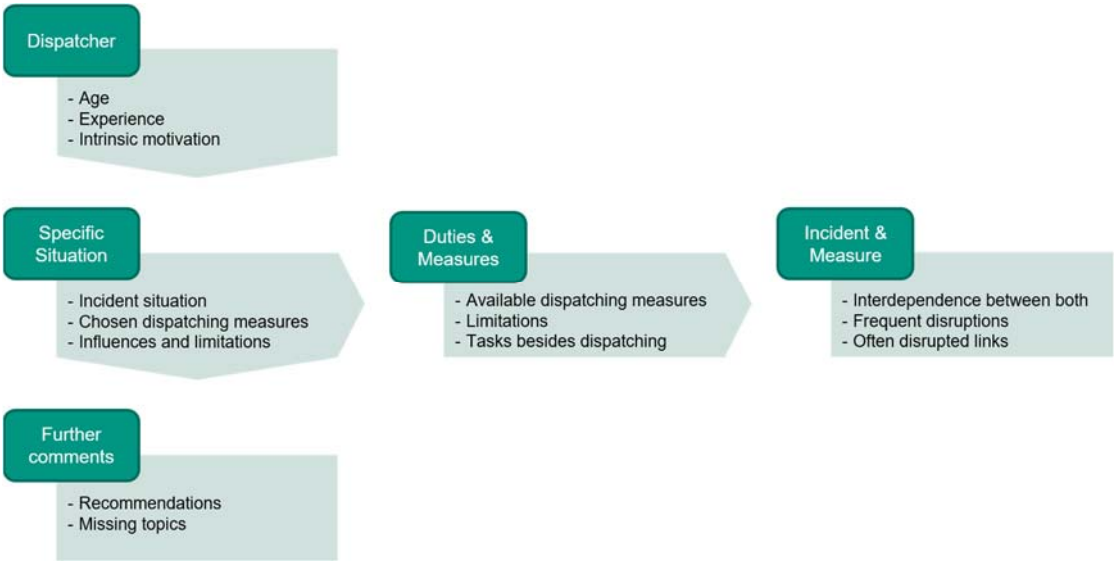

Figure 1: Structure of the interview guideline

4.1 Study Design

Dispatchers are usually not used to be interviewed. Therefore, the first section allows an easy start into the interview with questions that they are definitely able to answer. Further on, we assume that various characteristics influence the dispatchers' decisions. Therefore, this block covers the age, the experience as a driver as well as a dispatcher, the lines and courses they regularly drive, and why they became a dispatcher.

In the second section, the dispatcher is asked to describe the dispatching process at a currently occurred disruption. This focusses on the process of selecting a dispatching measure and targets the following questions:

- Which measures were available?
- What were the reasons of selecting this measure and not another one?
- Which factors influenced the choice of the measure?
- Which factors were considered?
- How often does this disruption occur?

The dispatchers were asked to describe the situation and their reactions as detailed and accurate as possible.

In the third section, the dispatchers are asked about their duties as a dispatcher and the dispatching measures they are able and allowed to use in general. It focusses on the scope of action together with limitations and factors they consider during their daily work. The deepening questions were as follows:

- Which challenges are they faced with daily?
- Which dispatching measures are frequently used and why?
- When and why do they consult other dispatchers?
- How long does it take to get back to normal operations?
- How limited are they in their decisions?

The last content related section deals with the interdependency of the types of disruptions and the dispatching measures chosen. This is based on the disruptions which happen often as well as the links which are often disrupted. Further, this section deals with the factors influencing the choice of the dispatchers in such situations. Situations, which often occur, might lead to standardised strategies to solve them. Therefore, it is also asked whether predefined dispatching strategies for such situations exist.

In the last section dispatchers were asked to name important skills for their job, further recommendations as well as improvements for the next interviews. In this section, the dispatchers could also give suggestions which questions and issues are relevant from their point of view for capturing dispatchers' actions in case of incidents and which were not already discussed in the previous sections.

4.2 Study Area

Our study took place in the OCC of KVV in Karlsruhe. The OCC has 35 dispatchers employed which control the public transport vehicles in the city of Karlsruhe around-the-clock. During rush hour, four dispatchers are in duty. Two of them handle the operations of vehicles in service, one is responsible for the handling of vehicles in the depot, and one dispatcher informs the passengers via dynamic passenger information systems (monitors at stops, websites and

social media). During rush hour, about 200 trams and 60 busses are in service. Karlsruhe, as the inventing city of the tram-train concept, has the additional characteristic that trains from the outer region drive as trams in the city. Therefore, dispatchers have to hand over the tram-trains at the exchange locations to dispatchers of other OCCs. Dispatchers at KVV are required to drive at least 20 hours per year either bus or tram. In Karlsruhe, most of the dispatcher drive even more. This gives them the necessary knowledge about the network and the limitations for dispatching measures in various parts of the city.

We conducted five interviews with dispatchers selected by the shift leader. The dispatchers had different levels of experience ranging from only a few years to several decades. Three of the dispatchers work mainly in the OCC, while the other two work close to the OCC to be available as a replacement if another dispatcher is unavailable, e.g. if one dispatcher is ill. The interviews took place directly after the morning shift of the dispatchers. Therefore, there was no pressure for the dispatchers to get back to work. The replacement dispatchers were asked during their normal work. The interviews with the dispatchers working in the OCC on a daily basis took 50 to 60 minutes while the interviews with the replacement dispatchers took about 30 and 70 minutes.

During the whole interview it was important that dispatchers answered the questions as detailed as possible. This allows us to better understand the situations. By comparing the results of section two with section three and four, we determine how dispatchers adapt the general procedure and possibilities to specific situations.

4.3 Evaluation

The interviews were transcribed and analysed using the methods of Kuckartz (2014). We determined three main categories of interest: ‘influences and limitations’, ‘described dispatching procedure’, and ‘other topics besides disruption management’. The first two categories are of main interest because they cover information about the dispatching procedure in disrupted situations. The last category is to collect information about duties of dispatchers which are not directly linked to disrupted situations, such as supporting drivers with route information.

The main categories are further split into subcategories as shown in Table 1. The category ’influences and limitations’ distinguishes between internal and external influences and limitations, e.g. a missing driver is internal, while an emergency vehicle on the tracks is external. Further on, this category covers the characteristics of disruptions, e.g. length or location in the network. One important part in this category is the effect of the dispatching measure itself, meaning the influences and limitations on other transport users. Finally, it contains the communication between dispatchers. The second category

'described dispatching procedure' deals with the situation which is described by the dispatcher. It contains the description of the situation as well as the chosen dispatching measure. Additionally, it covers the particularities of the situation, e.g. why this situation is different from other situations. The third category contains other tasks a dispatcher has to do in the OCC and the skill set that is necessary for a dispatcher.

Table 1: Categories and subcategories to classify information given by dispatchers.

Influences and limitations	**Described dispatching procedure**	**Other topics besides disruption management**
Internal factors and limitations	Description of the disruption	Other tasks
External factors and limitations	Chosen dispatching measure	Necessary skill set
Characteristics of disruptions	Particularities	
Influences and limitations due to dispatching measures		
Communication		

5 RESULTS

The interviews show that all dispatchers describe the general procedure similarly. However, dispatchers consider a different number of influencing factors depending on their experience. When describing certain situations and specific dispatching measures, two types of dispatchers can be distinguished: Dispatchers who work daily in the OCC, and dispatchers whose last shift was longer ago or who only fill in on call, for example if someone else is absent. Dispatchers who work in the control centre daily, describe the specific situations in much more detail. The dispatchers who work as stand-ins were also asked about specific situations. However, they describe less a particular situation rather than the general procedure.

Given the categorization in Table 1, the answers of the dispatchers were assigned to one of the categories. The most important *internal influences and limitations* are legal constraints for drivers. A dispatcher must ensure that drivers comply their driving and rest periods. Dispatching measures are not

allowed to violate those periods, even if this means a worse service for passengers. Another critical limitation is the exchange of drivers. It should not happen that a vehicle must wait for a new driver. If the exchange of drivers has to be moved to another location, it might influence exchanges later on the day. Therefore, dispatchers must consider the shifts of drivers. Changing the time or location of a driver exchange can be much simpler if replacement drivers are available. However, as the driver situation is currently tense at KVV, replacement drivers are not always available. In contrast, replacement vehicles are not mentioned as an issue. Therefore, we assume that there are enough vehicles available. Further, the infrastructure is also a limitation for dispatching measures. It defines the scope of possible dispatching measures. However, the dispatchers know the infrastructure and its characteristics well. They subconsciously take limitations of the infrastructure into account. The last internal influence is the one of the dispatching measures itself on other lines. The dispatchers have to consider the effect of measures, for example a short turn, on the remaining untouched lines.

Passengers are one of the largest *external influences and limitations* on operations. Dispatchers always prioritize passengers over minimizing operational costs. This is stated by all dispatchers especially in the examples where one branch of the network is the only available connection for passengers to or from a given location, e.g. a branch to city parts or communities with no alternative links. In such a situation, the dispatchers do not short turn all vehicles even if they are heavily delayed and they could get them back on time by such a dispatching measure. It is more important to pick up and drop off the passengers. However, this passenger-oriented dispatching strategy is seldomly recognized by passengers. They only see their delay or train cancelation. Providing information to the passengers in such situations is crucial. Incoming information is another external limitation for dispatchers. Dispatchers are not at the scene of the incident. Therefore, drivers must provide information to the dispatchers as accurate as possible. If drivers do not oversee the whole situation or are unable to cope with the situation, they might provide inconsistent information. In such a scenario, dispatchers send out traffic managers to support the driver and get a better overview about the situation. Another major external influence is the private (motorized) vehicle transport. Most parts of the tram network in Karlsruhe are on independent tracks and most bus lines do not use independent lanes. Therefore, as soon as the tram shares its tracks with the lanes of private transport, it is much more vulnerable to disruptions. Because this has a huge impact on the source of disruptions, all dispatchers know the critical road sections in the network well.

Given a certain disruption, its characteristics are another influencing and limiting factor. First of all, the type and severity of the disruption has logically a huge influence on the duration of the disruption and thus on the time dispatching measures are active. For example, accidents involving injuries of people take

longer than disruptions which can be solved by the drivers themselves. Besides the type and severity, the location of the disruption is also a huge limitation, especially in rail-based systems. If the disruption occurs in the city, it is typically more critical than in the outskirts. This is mainly because the frequency and number of lines on a link in the city are often higher as on a link in the outskirts. Thus, in the outskirts the solving of disruptions is not as stressful as in the city. As already mentioned, the connection to the outskirts is important for the passengers and thus not all dispatching measures are considered.

Dispatching measures itself are another limiting and influencing factor. The most commonly used dispatching measure is the detour. In detours, most of the dispatcher favour to leave the planned route as late as possible and return to it as soon as possible. The advantages for the passengers together with the smallest deviation for the operations are the reasons named by the dispatchers. Nevertheless, the dispatchers also consider the detour time and try to fit it into the timetable to prevent detoured vehicles to overtake regular vehicles, e.g. if the detour is a shortcut. Such situations are problematic, as one of the drivers might be too late or early at their next exchange point. Further on, in the city centre, with lots of lines on the same links, falling out of the frequency might hinder vehicles of other lines spreading the delay to originally uninvolved lines.

The last influencing and limiting category is the communication dispatchers do during their work. Dispatchers consult drivers, other departments or the city hall, and other dispatchers. The drivers are questioned and informed about current delays or early arrivals. In such cases, the drivers are asked to adapt their driving styles to be back on time, if possible. The communication to other departments and the city hall is used to reduce deficits in the operation. The consultations between dispatchers are first used to spread knowledge about dispatching in various situations, second to find better solutions in complex scenarios, and third to find optimal solutions for situations that nobody has thought of in the past.

Taking a look at the described disruption scenarios reveals that the most common dispatching measure is the detour of vehicles followed by short- and long-turn measures. While the detour is typically used as a measure early in the dispatching process, short- and long-turn measures are used to get back to normal operation and to reorder the vehicles according to the vehicle schedule. The described situations also reveal that there are a lot of small differences between similar looking scenarios. Most of those differences affect the additional tasks a dispatcher has to do, e.g. calling the police or other emergency forces. Thus, it is necessary to get as many real situations to better distinguish between the general process and particularities in single situations.

In the first interview, the questions about the general process and behaviour were asked first and afterwards the questions about the specific disruption

situation. It turned out that the order was inconvenient. We therefore asked the questions about the specific disruption situation first. We assume that it is easier for dispatchers coming out of the OCC to start with a topic they have been faced with the last couple of hours before reflecting their work in general. Most dispatchers were surprised that the interview was so short and convenient. Therefore, we assume that the methodology can be used to conduct an interview study as described in this paper.

6 CONCLUSION

In this study, we analyse the dispatching process of staff in an OCC. The methodology provided us first insights into this process. We developed a semi-structured interview based on a guideline and interviewed dispatchers of a public transport authority. The guideline used in this study contains questions dealing with diverse aspects of incident management. The first section of the guideline was on the question why the interviewee became a dispatcher. This question revealed as an opener for the further questions. The interviewees not being used to give interviews were reserved in the beginning but opened up during this question. Thus, we recommend using similar opening questions to ease the interview situation and to gather more insights in later questions. The further questions in the guideline are ordered from specific situations to more general information. Comparing these results with the questions targeting the general dispatching processes reveals that the dispatchers describe the general process more or less the same way. The differences are in the specific situations the dispatchers describe and in the dispatching measures taken in those situations. Dispatchers working daily in the OCC describe the situation in much more detail compared to dispatchers working as a replacement. For dispatchers working as a replacement, the more general process was much easier to describe as certain situations. We assume the reason is that those dispatchers are not faced with disruption situations often and thus stay with the general process instead of adapting the process to every situation. Our sample size in this interview study is small in absolute but high in relative measures. Nevertheless, the number of participants is too low to formalize the results. Hence, we aim to use the outcomes of the semi-structured interviews of this study as a basis to extend our research with a quantitative survey.

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