Distraction and the Use of Modern Communication Devices in the Train Driver’s Cab

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Abstract

Swiss railway companies provide their train drivers with modern communication devices like cell phones and tablets to perform their tasks. However, the use of these devices can distract the drivers to an extent that is not to be underestimated. Increasing irregularities or unsafe actions, including signals passed at danger, can be attributed at least to a certain extent to the distraction by these mobile and other digital devices in the cab. The goal of this study was to identify appropriate measures to reduce distraction without restricting the scope of action of the train drivers. Based on the results of observations and interviews, we suggested how to address distraction in the driver’s cab from a work psychology and design perspective by considering the individual driver as well as design technology and the organizational processes. In close collaboration with experts of several railway companies we developed a set of 26 preventive and protective measures. Preventive measures aim to avoid distraction, while protective measures aim to reduce the negative consequences of distraction. By carefully selecting and implementing these measures, the railway companies can ultimately support their train drivers to use modern communication devices in the driver’s cab safely and sensibly.

1. Introduction

Travelling by train in Switzerland is one of the safest forms of transport according to a safety report of 2021 published by the Swiss federal office of transport. The probability of a fatal accident on a train is 55 times lower per person-kilometre than in a car. In a European comparison, Switzerland ranks second after the United Kingdom in terms of safety in rail transport (Bundesamt für Verkehr 2021). Nevertheless, unsafe acts or irregular incidences are happening more often (e.g. reports of increased incidents of signals passed at danger), and could be at least partly caused by distraction due to smartphone use or other interactions with displays. This applies not only to the railway sector, but also to road traffic to the same extent. In Switzerland the main causes of serious road accidents have remained unchanged for years: inattention and distraction rank first, followed by failure to yield the right of way, speed, and alcohol (Allenbach et al. 2021). Swiss road accident statistics for the year 2020 show that inattention and distraction were most frequently recorded by the police as the causes for serious accidents: 28% of the victims of serious personal injuries had suffered an accident due to inattention and distraction (Allenbach et al. 2021). The risk of accidents increases by 3.6 times due to mobile phone use and by 2.5 times due to the operation of other devices (e.g. the radio) (Bächler 2018). Worldwide, the figures are at a similar level. Thus, about 25% of all accidents are due to inattention, and 7–9% of all accidents are due to distraction (Cavegn et al. 2008).

The primary task of a train driver is the safe transport of passengers or goods and the shunting of trains. Secondary tasks can be communication with the control centre, informing passengers, and troubleshooting among others. For train drivers, communication devices such as smartphones and tablets are state-of-the-art work equipment that are provided by many train operating companies. While the mobile phone is mainly used for professional communication via e-mail and telephone, the tablet is used, among other things, as a display for the route plan that guides the train driver through the journey
This means that these mobile devices, as well as other communication and information displays in the driver's cab, are on the one hand needed to perform the work tasks, but on the other hand represent a potential for distraction that should not be underestimated. In collaboration with one of the leading Swiss railway companies, we analysed the use of these communication devices and other displays in the driver's cab, as well as their potential for distraction. We also investigated the situations and working conditions in which this distraction is particularly noticeable, and how it can be dealt with from an occupational psychology perspective.

The aim of the study was to develop preventive and protective measures to eliminate or reduce irregularities and unsafe actions due to distraction by communication devices in the future. These measures should not restrict the train driver's scope of action, and should not hinder them in the execution of their primary tasks.

2. Theoretical Background

Several studies show that distraction and inattention while driving are important causes of accidents involving passenger cars and trucks (Allenbach et al. 2021; Horberry et al. 2006; Klauer et al. 2006; Olson et al. 2009). In particular, the distraction factor caused by typing on the mobile phone, reaching for objects, and talking on the mobile phone have been identified as potential sources of danger (Dingus et al. 2016).

The results, previously mentioned, of the road traffic research can be transferred to rail transport, as accidents in recent years have shown (BBC News 2021; CNN News 2013). Train drivers are increasingly using electronic means of communication to perform their tasks. The use of a mobile phone or a tablet (which provides the train drivers with a route overview with all necessary information, such as departure and arrival times, speeds, etc.) is necessary for the performance of work, but also represents a potential for distraction. For example, interaction with a mobile device can lead to visual, cognitive, physical, and also auditory distraction, resulting in more unsafe actions and irregularities, such as departing when the signal indicates a stop.

2.1 Attention and distraction

The job of a train driver requires a lot of attention to perform the driving task. Attention describes a mental function that allows us to consciously process sensory stimuli and prioritise information (Kluwe 2006; Wickens 2013). It involves several processes: the focussing of attention on a particular stimulus, the maintenance of attention over time, and the allocation of attention to different stimuli. Attention can be focussed, divided, and sustained, and it can be object or space related. However, attention is a limited resource that can also be distracted, and it can switch between different foci (involuntarily or intentionally).

The task of driving a vehicle requires a large amount of visual, cognitive, physical, and auditory resource (Peters et al. 2001). While performing the main activity – driving – not all the required resources are
always used exclusively for the driving task, but, depending on the person's expertise, can also be used for secondary activities, like communicating, for example. This results in a reduction of the resources available for the driving task. The diversion of resources to other tasks is called distraction (Sheridan 2004).

In the specific context of driving tasks, distraction is the diversion of attention away from activities critical for safe driving towards competing activities, which may result in insufficient, or no attention being paid to safe driving activities (Regan et al. 2011; World Health Organization 2011). Distraction, thus, refers to a partial or complete shift of attention from the primary task of safe driving to other activities.

Distraction and inattention are often considered related concepts, and they are not consistently defined in the literature. Reagan et al. (2011) refer to driver inattention as insufficient attention to activities critical for safe driving, and also describe driver distraction as diverted attention, which is thus a possible form of driver inattention.

### 2.2 The technical support systems of train drivers

To perform their work tasks, train drivers are usually located in the driver’s cab of the traction unit, which is equipped with various technical systems to support the drivers in carrying out their tasks. Tablet and mobile phones are placed on the available fixtures or free surfaces, depending on the type of train (Fig. 2).

These systems must be used during driving or when driving off and stopping, but not all functions are task-relevant in every work phase. In addition, the systems provide the train drivers with a variety of information, of which they only use parts for the current work task. Furthermore, for train drivers there are phases during the journey that are perceived as monotonous and unchallenging, and in which the devices are deliberately used by the train drivers for non-work-related distraction. Table 1 contains some examples of work-related and non-work-related sources of distraction for train drivers that can occur during their primary task of driving.

<table>
<thead>
<tr>
<th>Type of distraction</th>
<th>work-related distractions</th>
<th>non-work-related distractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>visual</td>
<td>Focussing on situationally irrelevant visual signals</td>
<td>Reading a private text message</td>
</tr>
<tr>
<td>cognitive</td>
<td>Being mentally preoccupied with the duty roster</td>
<td>Being mentally preoccupied with private concerns</td>
</tr>
<tr>
<td>physical</td>
<td>Trying to eliminate a situationally irrelevant signal</td>
<td>Dialling a mobile phone for a private call</td>
</tr>
<tr>
<td>auditory</td>
<td>Focussing on a situationally irrelevant acoustic alarm</td>
<td>Making private calls on the mobile phone</td>
</tr>
</tbody>
</table>
3. Methods

Our investigation focused on the working activities of train drivers in the area of passenger transport in a Swiss railway company.

To collect data, we used the following methods: document analysis, observational interviews, interviews, and expert workshops. The document analysis included a total of 44 safety reports from the participating railway company from 2014 to 2018 on the topic of irregularities, unsafe acts, and events. The focus of the analysis was on distractions in the driver's cab caused by means of communication and information, which were – or could have been – the cause of the respective event. During the observational interviews we observed 14 regular working shifts in the field of passenger transport, experienced rides in the driver's cab, and subsequently conducted structured interviews of train drivers and examination experts, by means of an interview guide. To gather different perspectives of the various functions of the mobile and other digital devices, we also interviewed six experts (train drivers, an examination expert, a practical trainer, a locomotive crew leader). And finally, we held two workshops with 10 experts each from two railway companies (train drivers, examination experts, planners, etc.). In the workshops we jointly developed suitable measures for dealing with distraction.

4. Results And Discussion

4.1. Sources and types of distraction for train drivers while driving

During driving, train drivers mainly use the following potentially distracting communication tools: mobile phone, tablet, radio telephone, passenger information system and diagnostic display (to indicate faults in the vehicle). Table 2 contains the most frequently identified work-related and non-work-related distractions caused by these communication tools.
Table 2
Most frequently identified work- and non-work-related distraction sources.

<table>
<thead>
<tr>
<th>work-related distractions</th>
<th>non-work-related distractions</th>
</tr>
</thead>
<tbody>
<tr>
<td>mobile phone</td>
<td></td>
</tr>
<tr>
<td>- telephone calls with the control centre, whereby not all calls are relevant to the train drivers in their current driving situation</td>
<td>- private telephone calls</td>
</tr>
<tr>
<td>- reading and/or writing private text messages (SMS, Whatsapp, etc.)</td>
<td>- reading and/or writing private text messages (SMS, Whatsapp, etc.)</td>
</tr>
<tr>
<td>- listening to music</td>
<td>- listening to music</td>
</tr>
<tr>
<td>tablet</td>
<td></td>
</tr>
<tr>
<td>- retrieving information about the route and the current speed of the train</td>
<td>- reading and/or writing private text messages (SMS, Whatsapp, etc.)</td>
</tr>
<tr>
<td>- listening to music</td>
<td></td>
</tr>
<tr>
<td>radio telephone</td>
<td></td>
</tr>
<tr>
<td>- telephone calls with the control centre, whereby not all calls are relevant to the train drivers in their current driving situation</td>
<td>(not applicable)</td>
</tr>
<tr>
<td>passenger information system</td>
<td></td>
</tr>
<tr>
<td>- input of information for passengers</td>
<td>(not applicable)</td>
</tr>
<tr>
<td>- troubleshooting of the passenger information system</td>
<td></td>
</tr>
<tr>
<td>diagnostic display</td>
<td></td>
</tr>
<tr>
<td>- reading and processing of fault messages, whereby not all messages are relevant for the train drivers in their current driving situation</td>
<td>(not applicable)</td>
</tr>
</tbody>
</table>

4.2 Preventive and protective measures at the levels of human–technology–organisation

In the framework of our investigation, we elaborated a set of 26 preventive and protective measures. The preventive measures can eliminate (or mitigate) a source of distraction, and thus prevent people from being distracted; these have a preventive effect. If sources of distraction cannot be eliminated, protective measures can help to mitigate or even compensate for the consequences of distraction. Accordingly, they have a protective effect (Fig. 3).

A sustainable reduction of distraction in the driver’s cab can only be achieved if (preventive and protective) measures include all three levels, namely human, technological, and organisational, according to the socio-technical approach by Hacker et al. (2018; see also Ulich 1997). Each level is important and must be included in a systematic consideration when planning measures. During the expert workshops, various measures were developed, or measures that are used in other sectors were examined and adapted. Table 3 shows some examples of such measures at the different levels.
Table 3
Examples of preventive and protective measures at the levels of human–technology–organization.

<table>
<thead>
<tr>
<th>human</th>
<th>technology</th>
<th>organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>preventive measure</strong></td>
<td><strong>preventive measure</strong></td>
<td><strong>preventive measure</strong></td>
</tr>
<tr>
<td>Train drivers should be</td>
<td>Functions and information that are not</td>
<td>Critical areas should be</td>
</tr>
<tr>
<td>sensitised to the issue of</td>
<td>currently relevant should be suppressed</td>
<td>defined when the distraction</td>
</tr>
<tr>
<td>monotony and trained in</td>
<td>automatically and situationally by the</td>
<td>of the train drivers must</td>
</tr>
<tr>
<td>dealing with it.</td>
<td>technology.</td>
<td>remain minimal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>protective measure</strong></td>
<td><strong>protective measure</strong></td>
<td><strong>protective measure</strong></td>
</tr>
<tr>
<td>Train drivers should be</td>
<td>Possibility of manually suppressing</td>
<td>Messages should be</td>
</tr>
<tr>
<td>trained for the recovery of</td>
<td>incoming messages and postponing them for</td>
<td>transmitted from a single</td>
</tr>
<tr>
<td>situational awareness after</td>
<td>later processing.</td>
<td>point of contact to the</td>
</tr>
<tr>
<td>a distraction.</td>
<td></td>
<td>driver's cab.</td>
</tr>
</tbody>
</table>

We supplemented each of the 26 measures with assistance for its implementation, potential risks, and side effects that need to be considered. The criteria for assessing the suitability of a measure were:

- anticipated effectiveness
- sustainability
- operational feasibility
- lowest possible risk of negative side effects

An example of the latter could be the manual suppression of incoming messages and postponement of them for later processing, whereby in the worst case the train driver might tend to simply click away (even important) messages, or forget about them. In case of clicking certain messages away, this could lead to difficulties in building up a mental model of the driving situation, or to a loss of situational awareness. Therefore, when implementing these measures, it is important to carefully anticipate, evaluate and, if necessary, compensate for these risks.

5. Conclusions

Modern means of communication, such as smartphones and tablets, have become an indispensable part of everyday working life. As they are to a large extent not only necessary, but also helpful for the execution of work, there is no supposedly simple solution prohibiting them during work. Therefore, it is important to investigate where possible distractions caused by modern means of communication can be prevented at the levels of people, technology, and organisation through good training, engineering, and process design. In addition, as sources of distraction cannot be completely eliminated, we need to minimise or compensate for negative effects of distraction wherever necessary. In any case, it is important for the acceptance of these measures that their concretisation and implementation are developed in a participatory manner with the professional groups concerned (see Fig. 4). It is they who have the expert knowledge and experience to design the measures in such a way that they can be implemented in everyday working life.
Recommendations for the effective implementation of measures to support safety

- Enable participation
- Use preventive and protective measures
- Implement measures on all three levels: human – technology – organization
- Assess risks and side effects
- Determine responsibilities
- Check the effectiveness of the measures.

Declarations

Ethics approval and consent to participate

Informed consents were obtained from the participants. No names or other personal data were collected during the data collection process. All procedures performed in the study were in accordance with the Swiss law, the "Ethical Principles of Psychologists and Code of Conduct" of the American Psychological Association (APA) and the "Ethical Guidelines for Psychologists of the Swiss Society of Psychology (SGP)".

Consent for publication

Not applicable.

Availability of data and material

Data sharing not applicable to this article as no (quantitative) datasets were generated or analysed during the current study. Qualitative raw data that led to the development of the findings and recommendations are not publicly available.

Competing interests

The authors declare no competing interests.

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Authors' contributions

N.S. and K.F. wrote the main manuscript text. K.F. designed the analysis. N.S., J.B., S.W., M.D., K.H. collected and analysed the data. All authors reviewed the manuscript.

Authors' information (optional)
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None

References


Figures
Figure 1

Driver’s tablet with route plan (symbolic photo).
Figure 2

Support systems including tablet and mobile phone in the driver’s cab of a modern traction unit (symbolic photo).
Figure 3

Preventive and protective measures to deal with distraction.