Safety First! Expert Perspectives on Cultural Differences in the Use of Track Warning Systems

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Abstract. Network Rail, who maintains Britain's rail infrastructure, identified that UK track workers may have an increased incident rate associated with use of warning systems, compared to other countries. This study aimed to identify cultural factors that could influence the design, procurement and use of rail safety equipment. Semi-structured interviews with six experts were conducted. Three of these were subject to a thematic analysis, using information from the other interviews and several industry documents for the purpose of verification. Six main themes were identified: "Organisation", "Mentality", "Training", "Kit", "Choice of warning system", and "Product acceptance process". Recommendations for improvements are proposed.

Keywords. Railway, Maintenance, Safety, Culture.

1. Introduction

In the UK, there are 15,777 km of train tracks (Office of Rail Regulation, 2013), which are maintained by Network Rail. In order to ensure the safety of track workers, different measures can be taken, such as blocking the line (green zone working), or leaving the lines open to trains but warning track workers with track warning systems (red zone working). The present study focuses on red zone working, and particularly on the use of Lookout-Operated Warning Systems (LOWS). This is due to Network Rail suspecting that there may be an increased incident rate in the use of LOWS in the UK, as compared to the countries where the system was designed (Germany and Switzerland). For this reason, the aim of this study was to explore how cultural factors can influence the design, procurement and use of rail safety equipment. The findings served to produce recommendations for Network Rail as to what to consider when importing new equipment from another country.

1.1 Culture and Behaviour

Hofstede, Hofstede, and Minkov (2010) describe six dimensions in which cultures differ. Of these, three have been shown to predict safety culture and incident involvement. These are (i) power distance (Helmreich & Merritt, 1998; cited by Casey, Riseborough, & Krauss, 2015), which captures the extent to which people accept an unequal distribution of power, low values reflecting little acceptance (Hofstede et al., 2010); (ii) uncertainty avoidance (Lu, Lai, Lun, & Cheng, 2012), high values of which show a preference to avoid unknown situations (Hofstede et al., 2010); and (iii) individualism (Mearns & Yule, 2009), which reflects the interdependence between members of the society, high values corresponding to a self-image of "I" (vs. "we") (Hofstede et al, 2010). While Germany and the UK both have a very low score of 35 in power distance (Hofstede et al., 2010), they differ on the dimensions of uncertainty avoidance, scoring 65 and 35, respectively (Hofstede et al., 2010), and individualism, on which they score 67 and 89, respectively (Hofstede et al., 2010). These differences suggest that the two countries might have different approaches to risk perception and risk taking, even if their cultures seem very similar at first.

1.2 Organisational Factors and Safety Performance

Mearns and Yule (2009), in their investigation on the role of national culture in determining safety performance, found that their results suggested that organisational factors impacted more on workers' commitment to safety and accident rates than national values. Several organisational factors have been considered in literature.

Managers' safety compliance was found to be positively correlated with workers' commitment to safety (Mearns and Yule, 2009). This is in line with Itoh, Andersen, and Seki's (2004) findings that managerial behaviour had an impact on incident and accident rates in work groups. It is assumed that manager behaviour might vary across companies.

Several studies have identified an influence of training on safety behaviour and incident rates of rail maintenance workers (e.g. Farrington-Darby, Pickup, & Wilson, 2005; Baysari, McIntosh, & Wilson, 2008). Spangenberg et al. (2003) further found that the planning of construction work influenced injury rates of workers. As construction work and railway maintenance are both high-risk domains, planning might also play a role in injury rates of track workers. Both the nature of training and the quality of planning are influenced by organisational regulations.

In their comparison of automated train traffic control between Sweden and the UK, Golightly et al. (2013) identified that role distribution and the organisation of the railway infrastructure differed across the two countries. These differences could also exist between other countries, and might influence track work and the use of safety warning systems.

1.3 Design of the Safety Warning System

Baysari et al. (2008) identified inadequate equipment design to be a problem in 18 out of 23 railway incidents. Design preferences across countries have been found (e.g. German participants differed from others in their preferences of website design, generally prioritising colour choice over general aesthetics [Cyr, Head, & Larios, 2010]), and these can influence interface acceptance and user behaviour (Evers, 1997).

To summarise, as stated by Golightly et al. (2013), *"it is rarely straightforward to transfer an efficient solution from one organisation to another"* (p.368).

2. Methods

Semi-structured interviews were conducted with six experts in the UK, Germany, and Austria. The participants' roles included a rail expert consultant, safety specialists in the UK and Germany, and managing directors of UK subsidiaries of the manufacturers. Interviews outside the UK were conducted by phone. The questions that participants were asked were derived from the factors identified from literature, and participants were only asked questions relevant to their role. In order to ensure this, they were always first asked to quickly describe their current role. Questions to managing directors of manufacturer subsidiaries included, for example, *"Do you think the design and use of the system are affected by users from different cultures or countries?"*, and safety specialists were asked for example *"How do you perform risk assessment?"* and *"How difficult is it to get users to accept a new system?"*. Note that the experimenter let herself be guided by the conversation, sometimes investigating a topic in more detail, so that interview questions were not identical for every participant of a given role.

Three of the interviews (a total of 4h49) were subject to a thematic analysis as described by Braun and Clarke (2006). These interviews were fully transcribed, then coded with a

total of 29 codes. The codes were generated during the coding process, as no clear hypotheses could be derived from literature. The codes were first sorted into clusters, according to their interdependencies, then a first set of themes was produced by finding overarching terms that defined these clusters, and discarding information that was not relevant to the study question. Findings from the remaining interviews (a total of 1h53) were used to corroborate findings from the thematic analysis. The contents from these interviews were summarised and used to add explanatory detail to the first set of themes. A range of industry documents (standards, incident reports, handbooks, incident data) that were collected during the course of the study were also reviewed and used to supplement the findings. A final set of six themes, each containing several sub-themes, was identified.

3. Results

Six main themes and 17 sub-themes were identified. These are displayed in table 1. The last theme reflects the fact that human-triggered warnings (i.e. lookouts and LOWS) are used to a bigger extent in the UK than in other countries, and what a reason for this might be.

Table 1. Main themes, their sub-themes and their content.

Main theme	Sub themes	Explanation
Organisation	Structure	Not all companies are structured in the same way. While Network Rail Maintenance is an in-house company doing maintenance, Deutsche Bahn Fahrwegdienste (Germany) is a private company. Another difference exists between Network Rail and the SBB (Schweizerische Bundesbahnen – Switzerland): SBB integrates train operating and infrastructure companies, while in the UK, these are separated.
	Contract	There are differences in the kind of contracts made. In Germany, two contracts are concluded for bigger worksites (one for the job, one for safety). This leads to one safety procedure being defined for every task over the whole duration of the work, while each task is planned separately in the UK.
	Role distribution	Roles are not exactly equivalent in the UK and Germany. Roles can also slightly vary locally within the UK.
	Contractors	Contractors have been reported to be a source of incidents in the UK. This does not seem to be the case in Germany.
	Incident investigation	No cultural differences confirmed, but the sub-theme was included because a lengthy investigation might influence kit acceptance, as the kit is quarantined during this time.
Mentality	Local	This is not a difference between countries, but points towards differences in kit acceptance and incident rates within the UK that might need to be considered.
	Attribution of blame	Incidents happening with a safety warning system may be reported more reliably, as workers feel that they can blame the kit. Moreover, in the UK, the technology is often said to be at fault for an incident, while other countries seem to focus more on the investigation of incorrect operation by the user.

Training	Pre-qualifications	Differ between the UK and Germany. In the UK, there is a medical test and some guidelines, while in Germany more assessments are needed. Educational level of workers might also be different (pointed out by only one participant).
	Content	Training content is not identical across countries. This is due to the fact that roles are slightly different, and that Network Rail adapted the training to suit their expectations.
Kit	Years of usage	Safety warning systems have been in use for different time frames in the UK and Germany. This might influence incident rates, as staff and organisation have had more time to evolve with the system in Germany.
	Evolution	The kit evolved differently across countries: Network Rail have made a few changed to the LOWS already (in consultancy with the manufacturer), while Germany waited for a new version of the kit to be released.
Product acceptance process	Health and safety regulations	These play a big role in everyday life in the UK, while it is not the case in Germany. Regulations also define the SIL (Safety Integrity Level) the system has to comply to, which, according to one participant, differ between the UK and Germany (not verified).
	Focus of risk assessment	Priorities during risk assessment vary between the UK and Germany.
	Expectations and requirements	Expectations of the system differ, especially concerning the complexity of the system and the amount of functions.
Choice of warning system	Rules and standards	Rules and standards are not the same in all countries. For example, the hierarchy that defines which system to choose differs between the UK and Germany.
	Planning	Influences the choice of safety procedure, as some procedures require less planning than others. One participant felt that track work was better planned and orchestrated in Switzerland, because train operation had a higher priority.
	Infrastructure	The complexity of the rail infrastructure influences the choice of warning system. The high complexity of some junctions in the UK might explain the wider use of LOWS.

4. Discussion and Conclusion

The main themes "kit" and "product acceptance process" reflect the fact that different design aspects are relevant across countries. These differences in design preferences are consistent with the findings of Cyr et al. (2010), who described that Germans prioritised some aspects of design (website design in that study) differently than other cultures (Canada and Japan). The fact that Network Rail upgraded the kit several times while other countries waited for the manufacturer's new version, reveals that British users may have different design expectations. It may therefore be important to develop a process to make a more detailed assessment of the likely design changes that are needed prior to importing the equipment. The types of design changes that might need to be considered could be identified by reflecting on changes made to the current system.

The main theme "product acceptance process" is also very relevant in the procurement process of the system. Even though no major differences were identified, the focus of risk assessment, as well as expectations and regulations that define the requirements of the system, differ slightly. The theme "organisation" further points towards other differences, for example in the railway infrastructure. This type of difference has been identified previously by Golightly et al. (2013), describing differences in the rail infrastructure between the UK and Sweden. The infrastructure influences the choice of safety warning system, and this will need to be considered during the procurement process.

Even though users could not be interviewed, several aspects influencing the use of safety warning systems could be identified. First, and this was considered very relevant by both participants who raised this, the UK have a wider use of human-triggered warnings (i.e. LOWS and lookouts) as compared to any other country. They recommended to reduce the use of LOWS and increase the use of automatic warnings, as it would remove the human element in the warning and reduce the risk of human error, which is higher than the risk of technical failure.

The wider use of LOWS might explain the higher amount of incidents with this system in the UK, as it is used more and therefore provides more opportunities for failure than in other countries. It would be interesting to re-examine the incident rate, taking into account the hours of use for each safety warning system.

Planning has been identified as a factor that influences the choice of warning systems. One participant suggested that track work in Switzerland seems very well orchestrated as compared to the UK. Planning is also known to have an influence on worker safety (Farrington-Darby et al., 2005; Spangenberg et al., 2003). Further work with planners could be conducted to consider how planning activities could be strengthened to set up safe systems of work using this type of technology and encourage users to use them more effectively.

The interviews also revealed a difference in role distribution and the responsibilities of each role. Golightly et al. (2003) identified role distribution and responsibilities as influencing the implementation of train traffic control systems in Sweden as compared to the UK. It might be assumed that it also influences the use of track warning systems. When considering a new safety system to import from another country, it will be necessary to ensure that the system is appropriate for use by the staff. Mismatches might be solved through changes to the system or adapting the training. The current cross-cultural differences in training and the changes made to the kit by Network Rail suggest that the company has already made some progress in this area. The likely success of these changes should be evaluated.

In addition to cultural differences across countries, the researcher was told that workers' attitudes towards safety procedures, their training compliance, and their acceptance of safety warning systems vary greatly within the UK. This would be interesting to explore in more depth and consider when introducing a new system, in order to give greater mentoring and training to the relevant regions.

The research sample consisted of six participants. This sample size might appear small at first, but the researcher obtained a total of almost seven hours of semi-structured interview data with representatives of manufacturers, managers, and safety specialists. The interviewed participants were all experts in the domain and provided the researcher with a large amount of relevant information for the present investigation. A high proportion of this content was subject to a thorough thematic analysis. The remaining content was collected, for practical reasons, close to the conclusion of the project and could not be analysed in the same level of detail. However, content from these interviews was used to provide additional detail and corroborate earlier findings from

the analysis. The six final themes do not represent all the information contained in the interviews, as the researcher focussed on the information that was relevant to cultural differences that can influence the design, procurement and use of safety warning systems, and discarded irrelevant data during the analysis. In this sense, it must be noted that the thematic analysis performed on the interviews was partly driven by subjective judgements made by the researcher, though a rigorous process was used in the coding and analysis of the data.

The detailed contents and descriptions of issues, from the perspective of managers and other stakeholders, provide a useful structure to explore relevant issues with a wider set of users and stakeholders. In this study, it was not possible to collect users' experiences with the safety warning systems. This would be an obvious next step for investigation in future work, including the identification of design issues that might affect users' perceptions of the safety level of the safety equipment, and their trust in this type of device.

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