The Role of Human Factors in Supporting Safety Learning from Railway Incidents

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Summary

Human factors as a discipline has a key focus on human performance and the influence that organisational systems have on that human performance. A human factors approach is key to understanding railway incidents, which are dominated by operational human performance issues and underlying causes related to safety management systems. This paper considers some of the multi-faceted ways in which the human factors discipline has supported incident investigation methods and strategies in the GB rail context.

In particular the paper will describe the development of this work through the research programme funded by the UK Department for Transport and managed for industry by RSSB. Through RSSB, the GB rail industry invests about £10m each year in a varied research and development programme. The programme supports a broad range of short- and long-term engineering, operations, and management activities that no one company or sector could solve on its own.

Developing an understanding of the role of human factors in incident investigations

A key starting point for the development of the role of human factors in safety learning was an analysis of a sample of 280 GB railway incident reports from 2005-2008[1]. This analysis was undertaken by human factors specialists at RSSB with support from operations specialists, and provided insights in to the benefits of collecting human factors data on the underlying causes of incidents for the industry.

Based on this initial research it was identified that this work should be carried on and delivered into national application as part of the national incident reporting database in the GB rail industry. This database is called the Safety Management Intelligence System (SMIS). SMIS began operating in 1997, and organisations such as Network Rail and the passenger/freight train operators enter about 75,000 events into it each year. Incidents reported include fatalities and injuries to people while they are on the rail network, whether they are a passenger, a

[1] RSSB (2009) **An analysis of formal inquiries and investigations to identify human factors issues** (T635) RSSB: London.

member of the public or part of the workforce, as well as events which pose a risk such as signals passed at danger and derailments.

Through a user-centred development process, a national classification system which captures information on human performance and wider safety management causes was developed as part of SMIS[2]. This part of SMIS is termed the Incident Factor Classification System (Gibson et al, 2012)[3]. A key feature of the classification is that it goes beyond the individual factors that led to an incident and looks at human performance, the equipment, and safety management systems in an organisation that did not work correctly or made it more likely for a person to make an error.

Figure 1 shows how investigation findings can be broken down into human performance failures or system failures (known at the 10 Incident Factors).

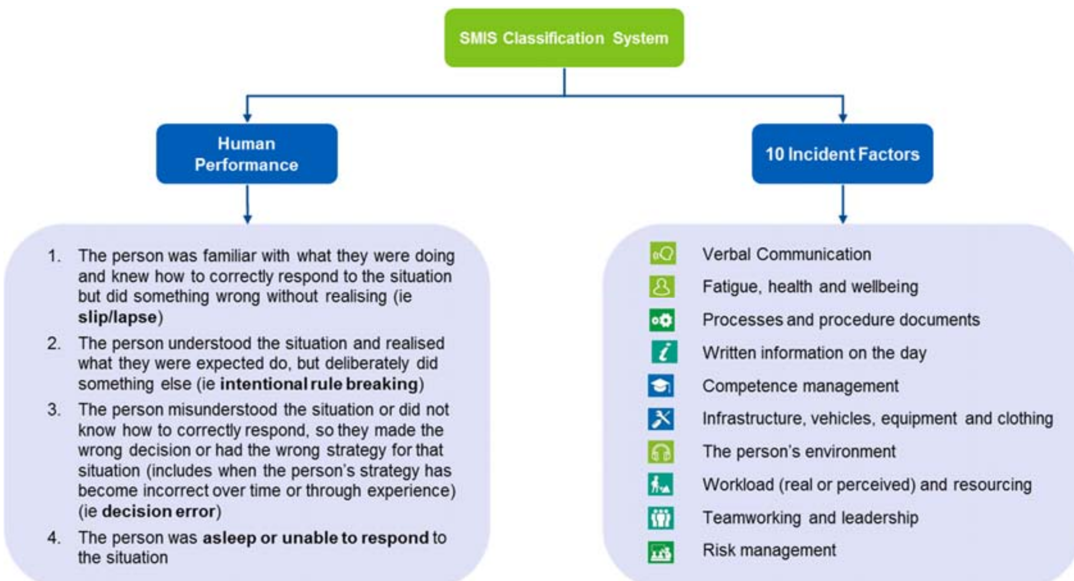

Figure 1. The Incident Factor Classification System

Since its development and implementation, the Incident Factor Classification System has been used to develop strategy and learning in a number of areas for the GB rail industry, including:

- **Safety Critical Communications.** A sample of 95 industry incidents where human performance verbal communications issues contributed were

[2] RSSB (2015) **Development of an incident factor classification system module for SMIS** (T994) RSSB: London.

[3] Gibson, W.H., Smith, S.A., Lowe, E., Mills, A.M., Morse, G., & Carpenter, S. (2012). **Incident Factor Classification System**. In N. Dadashi, A. Scott, J.R. Wilson, and A. Mills (Eds), Rail Human Factors: Supporting Reliability, Safety and Cost Reduction. London: Taylor and Francis.

identified. The incident reports were supplied by industry and analysed at RSSB using the Incident Factor Classification System. These data have been fed in to a national training programme on safety critical communications for front line staff developed as part of the research programme[4].

- **Fatigue** A key driver for the initial development of the incident classification system was to generate better data on fatigue for the industry. These data were delivered in a special topic report to industry on fatigue and its contribution to railway incidents[5].
- **Route Knowledge.** For research in to train driver route knowledge a human factors review of train incidents where driver route knowledge played a part was undertaken using the Incident Factor Classification System[6].
- **Signals Passed at Danger** (SPAD). The Incident Factor Classification System was used to analyse a sample of 250 SPAD incidents for industry. The analysis was supported by field work, including human factors support to industry SPAD investigations and workshops with managers and front line staff including signallers and drivers. The study data and recommendations have been used to inform national SPAD strategy. They have also been fed in to the UIC working group on SPADs. Further research work is ongoing using the IFCS classifications of SPAD incidents[7], supported by a cross-industry steering group including both Freight and Passenger train operators, Network Rail and the Rail Delivery Group.

To provide examples of outputs, some key data are presented from the study on commnications[4] and fair culture for SPADs in the next two sections.

Example results on verbal communication issues

95 railway incident reports from 2012 to 2015 which involved communication factors were analysed. The types of incident involved in the analysis are presented in Table 1. From 95 incident reports, 541 incident factors were identified. 383 of these were verbal communication incident factors, with the remaining 158 being broader systems issues (eg competence or workload) which contributed to the communications issues. The data highlight that there are frequently a number communications issues in a single incident. This is because

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[4] RSSB (2017) **Developing a safety critical communications training programme** (T1078). RSSB: London.

[5] Bowler, N. and Gibson, H. (2015). **Fatigue and its contribution to railway incidents.** Retrieved 31 July 2017 from https://www.rssb.co.uk/Library/risk-analysis-and-safety-reporting/2015-02-str-fatigue-contribution-to-railway-incidents.pdf

[6] RSSB (Ongoing) **Route Knowledge** (T1108)

[7] RSSB (Ongoing) **Human Factors Causes of SPADs** (T1128)

communications can involve multiple parties, equipment issues, issues with how information is communicated and issues with the accuracy of the content of the communication.

Table 1 - Communication incidents by incident type

Event type	Total
SPAD	35
Operating irregularity	18
Near miss	13
Possession irregularity	11
Derailment	6
Infrastructure damage	4
Collision with object	2
Runaway	1
Workforce harm (non-movement)	1
Collision	1
Passenger harm (movement)	1
Fire	1
Infrastructure failure	1
Total	*95*

266 of the verbal communications incident factors were identified as causal/ contributory to the incident and are summarised in Figure 2.

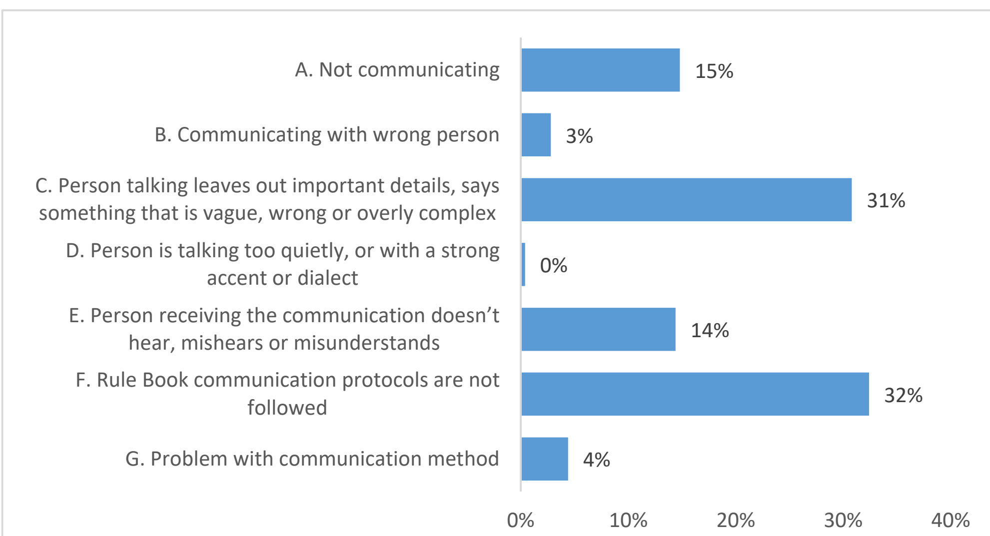

Figure 2- Communication causal/contributory factors

In addition to causal/contributory factors, the analysis has highlighted the importance of post-event communications, for which 70 factors were identified from the 95 reports.

A key learning point is that the top 3 communication issues, accounting for 78% of the causal/contributory factors identified, relate to the 'sender' of the information. The sender is the person with information which they need to communicate to another party. Misunderstandings of the information by the 'receiver' of a communication only account for 11% of the issues identified. This highlights the key role of the sender who has information to communicate to other people. In this role of 'sender' the key failure types identified are:

- Not using the communication protocols (eg using the phonetic alphabet and using repeat backs) (32%)
- Leaving out important details, says something that is vague, wrong or overly complex (31%)
- Not starting a communication at all (15%).

As the most frequently occurring factor, protocol issues were investigated further. A lack of repeat back was identified as the most common protocol failure, with other issues such as a failure to confirm location and lack of challenge also commonly occurring. This finding highlights the need for developments in the quality of communication protocol training and assessment to ensure safety critical communications match the requirements of nationally agreed protocols.

It is also important to recognise that communication failures are frequently underpinned by broader system factors, such as fatigue, workload, being provided with inaccurate information and communication equipment issues. This illustrated by the data in Table 2 which presents deeper underlying causes which underpin the communication issues identified. The 10 incident factor 'verbal communication' is excluded from the table, as it was a component in all 95 of the incidents analysed. The prominence of competence management (15% of underlying factors) provides support for the other element of this research project, which was development of national competence development materials for industry.

Table 2- Underlying factors contributing to communications issue

10 incident factors	Total	%age
Workload and resourcing	22	18%
Infrastructure, vehicles, equipment and clothing	22	18%
Fatigue, health and wellbeing	21	17%
Competence management	19	15%
Processes and procedure documents	16	13%
Written information on the day	15	12%
Teamworking and leadership	4	3%
Risk management	3	2%
The person's environment	3	2%
Total	**125**	**100%**

Fair Culture

The work on SPADs also aimed to address some of the challenges related to developing a fair culture for incident investigations. A fair culture around incident reporting is one facet of the wider safety culture at a company. A fair culture is key to ensuring that staff talk as openly as possible about factors surrounding an incident and can help to ensure safety learning is optimised. The work included a survey undertaken on perceptions of responsibility for incidents which has been shared across the industry. In addition, guidance has been developed as part of the research programme to support fair culture development at railway companies through creating appropriate plans (eg competence development) after incidents for the staff involved. This has been delivered as a good practice guide to the GB rail industry and has been supported by the train driver union ASLEF[8].

Human Reliability

Another key human factors developments as part of the research programme has been the delivery of support to industry for considering human reliability in incident investigations and as part of risk assessments. This work has involved interworking between human factors and risk specialists at RSSB.

One tool which has been developed to support industry is Railway Action Reliability Assessment, which is used for the quantification of human reliability and provides generic estimates of human performance reliability[9]. In addition,

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[8] RSSB (2016) **Supporting a Fair Culture: Creating Appropriate Plans After Incidents - Good practice guide** (T1068) RSSB: London.

[9] RSSB (2012) **Railway Action Reliability Assessment user manual, A technique for the quantification of human error in the rail industry** (T270) RSSB: London.

the Red Aspect Approaches To Signals (RAATS) toolkit has been developed for the GB rail industry by risk specialists from RSSB with support from the University of Huddersfield as part of the research programme[10]. The tool provides data on red aspect approaches to signals and has been used to develop driver reliability estimates for SPADs and to inform thinking on SPADs within the GB rail industry.

Understanding performance reliability of front line staff can support our understanding of human performance in accidents and incidents. For example, for train drivers, train cab design, signalling design and train operations can impact on human performance. More generally, human reliability cannot be assumed to be perfect, even for very simple tasks, due to natural human variability. As examples of factors which can impact on human performance:

- Placing two buttons next to each other on a control panel or two railway signals next to each other on the railway lineside reduces human reliability through increasing the opportunity for confusion[8].
- When a driver routinely carries out a task in one way (eg opening train doors on the left side of a train for station duties) train driver reliability is reduced when the opposite action is occasionally required (i.e. opening train doors on the right hand side of a train)[11].

Railway Action Reliability Assessment, has been used in a variety of practical applications within the GB rail industry, for which examples are:

- **Supporting incident investigations.** Used to understand signaller performance reliability for an incident investigation undertaken by the GB Rail Accident Investigation Branch[12].
- **Support to the development of standards.** Used to understand driver performance in a risk assessment to support decision making for a standard on Driver Only Operated (Passenger) DOO(P) On-train Camera Monitor Systems (RIS-2703-RST)[13]. It has also been used to support a review of the industry guidance for defective on-train equipment (GO/GN3637).

Gibson et al (2011) **Tailoring the HEART technique for application in the rail industry** ESREL 2011, Troyes, France.

[10] Stow et al (2016) "Estimating the Frequency of Trains Approaching Red Signals – a Key to Improved Understanding of SPAD Risk" **IET Intelligent Transport Systems** Volume 10, Issue 9, November 2016.

[11] Basacik, D. and Gibson, H. (2015) **Where is the platform? Wrong side door release at stations.** In: Sharples, S., Shorrock, S. and Waterson, P. (Eds) Contemporary Ergonomics and Human Factors 2015, Proceedings of the International Conference on Ergonomics & Human Factors 2015, Daventry, Northamptonshire, UK, 13-16 April 2015. London: Taylor and Francis

[12] RAIB (2017) **Near miss between a train and a level crossing user at Dock Lane**, 14 June 2016. RAIB: Derby.

[13] RSSB (2016) **Evaluating the use of on-train driver only operation (passenger) monitors during station departures** (T1059) RSSB: London.

- **To underpin research.** It has been used to understand the impacts on driver performance on the number and frequency of transitions to/from ERTMS operation[14].
- **To support operational decision makers at companies.** A paper is currently in press which provides two examples of train companies using performance reliability data related to stopping at stations. These company data have been compared with generic performance estimates provided in Railway Action Reliability Assessment[15].

Summary

This paper has described the development of the role of human factors in supporting safety learning from railway incidents. The paper describes the Incident Factor Classification System, Railway Action Reliability Assessment and Red Aspect Approaches To Signals tools. These projects were funded under the research programme managed by RSSB for the UK Department of Transport. The paper also demonstrates how these research projects have been used to support safety decision making in the industry on a range of topics.

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[14] RSSB (2016) **Number and frequency of transitions to/from ERTMS operation - impact on railway operations** (T1091) RSSB: London.

[15] Gibson et al (In press) **Exploring the limits of train driver reliability** 6th International Rail Human Factors Conference