SAFETY IN RAILWAYS – QUO VADIS?

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SUMMARY

The evolution of railway safety is described from the perspective of the European Union Agency for Railways (ERA). The increasing importance of risk management is emphasized, as well as recent initiatives concerning Common Occurence Reporting in Europe and a “big data” approach. The emphasis of the Agency is on developing a positive safety culture, leading to integrating Safety Management Systems with human and organisational factors. New threats drive our thinking towards the management of both safety and security risks in a consistent manner.

INTRODUCTION

Rail is to play an important role in creating a sustainable future for transport in Europe and world-wide, as rail transport may help to achieve essential policy objectives such as tackling climate change, fighting congestion, and creating economic growth. **But first and foremost, rail transport is safe.** The safety level of rail has improved at impressive pace over the past decade and the railway industry can be proud of its achievements. Most of this has been achieved through advances in technology.

However, although extremely rare, catastrophic, multi-fatality rail accidents still have a heavy impact. As well as the human cost, every accident, whether they result in injuries or not, represents a significant business, in some cases environmental, cost in a highly competitive environment.

We live in a world characterized by rapid change and uncertainty. We are all aware of the incredible developments in e.g. smart phones and increasingly the deployment of drones. We see autonomous vehicle technology on the verge of a breakthrough and more recently we see proposals for new systems of transport like Hyperloop. In Europe we have seen a rapidly changing level of security risk that threatens to supplant the more traditional safety risks. In common with other areas of life we see a digital transformation in rail.

In such a world regulations that take five years to negotiate and then 3 years to implement are often either ineffective or block innovation. To be able to continuously adapt to the challenges we face we need to become masters of risk management. In Europe we see that the set of data we currently collect at a European level simply does not allow us to identify the weak but significant signals that tell us of a growing risk. We have started a programme of work to develop European wide Common Occurrence Reporting and a research study into the potential benefits of a “big data” approach.

For over a decade in Europe we have been migrating towards a system of managing risk through safety management systems but we still have some way to go. For Safety Management Systems to be truly effective we need strong safety leadership and we need to build the management system in an environment that has a positive safety culture.

Human factors appear regularly in the causality chains of major accidents. Therefore, the Agency supports the evolution from solely managing technical risks to integrating Safety Management Systems with human and organisational factors.

The increasing reliance of rail operation on complex networks of computer systems, together with the associated challenges in terms of security, leads to the new concept of “security culture”. It might be interesting for us to elaborate on security aspects with a “cultural perspective” in the future challenge to integrate the management of both safety and security risks.

THE EUROPEAN UNION AGENCY FOR RAILWAYS

Founded in 2004 (as the then “European Railway Agency”), the European Union Agency for Railways based in Valenciennes (FR) has currently 165 staff. Its main objective is to contribute, on technical matters, to the implementation of the European Union legislation aimed at improving the competitive position of the railway sector by (1) enhancing the level of **interoperability** of railway systems, (2) developing a common approach to **safety** on the European railway system, and (3) contributing to creating a **Single European Railway Area** without frontiers, guaranteeing a high level of safety. New legislation in force since 2016, the "4th Railway Package" will transform the Agency from a consultative body to an **Authority** capable of issuing EU-wide Safety Certifications and Vehicle Authorisations by 2019.

Among the deliverables of the Agency is the Biennial Report on Railway Safety Performance in the European Union, with the last such report published in 2016, and a web-only update published in 2017 (it sets out the railway safety performance in the European Union for the year 2015.). The report is based the common safety indicator (CSI) data reported by the Member Staes, plus information on Significant Accidents from the ERAIL system.

DEVELOPMENT OF SIGNIFICANT ACCIDENTS IN THE EU

Over the last years there have been, on average just over 2 000 significant accidents each year on the railways of the EU Member States. Accidents to persons caused by rolling stock in motion and level-crossing accidents constitute more than three quarters of railway accidents, excluding suicides. In these accidents, on average just under 1 100 persons are killed and 900 persons seriously injured each year. There has been a long-term downward trend in all these indicators.

In 2015, all of these common safety indicators (CSIs) continued to improve across Europe, with 1 808 significant accidents resulting in 963 fatalities and 684 seriously injured. The year-to-year reduction between 2014 and 2015 is significant for accidents, fatalities and serious injury numbers. These main outcomes have decreased over the past five years (Figure 1).

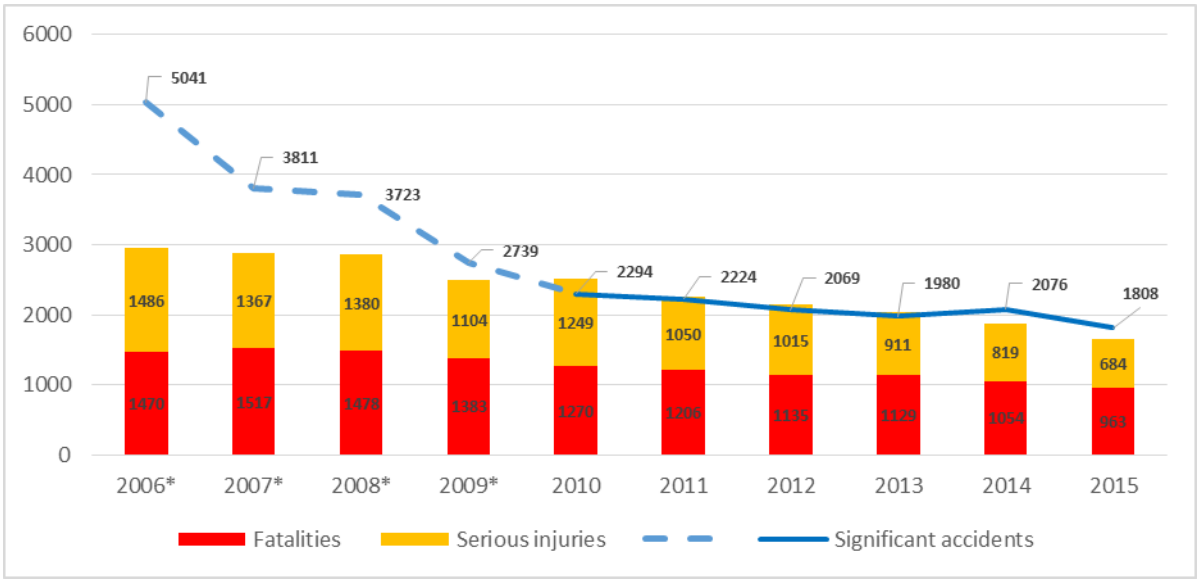

Figure 1: Significant accidents and resulting casualties for the EU-28 (2010–2015)

Figure 2 data come from the historical archive of railway accidents maintained by the Agency; it shows the number of major accidents and resulting fatalities for the 37 years 1980–2016. This historical archive includes not only the train collisions and derailments with five or more fatalities, but also the major level-crossing accidents, train fires, and accidents involving groups of persons struck by rolling stock in motion.

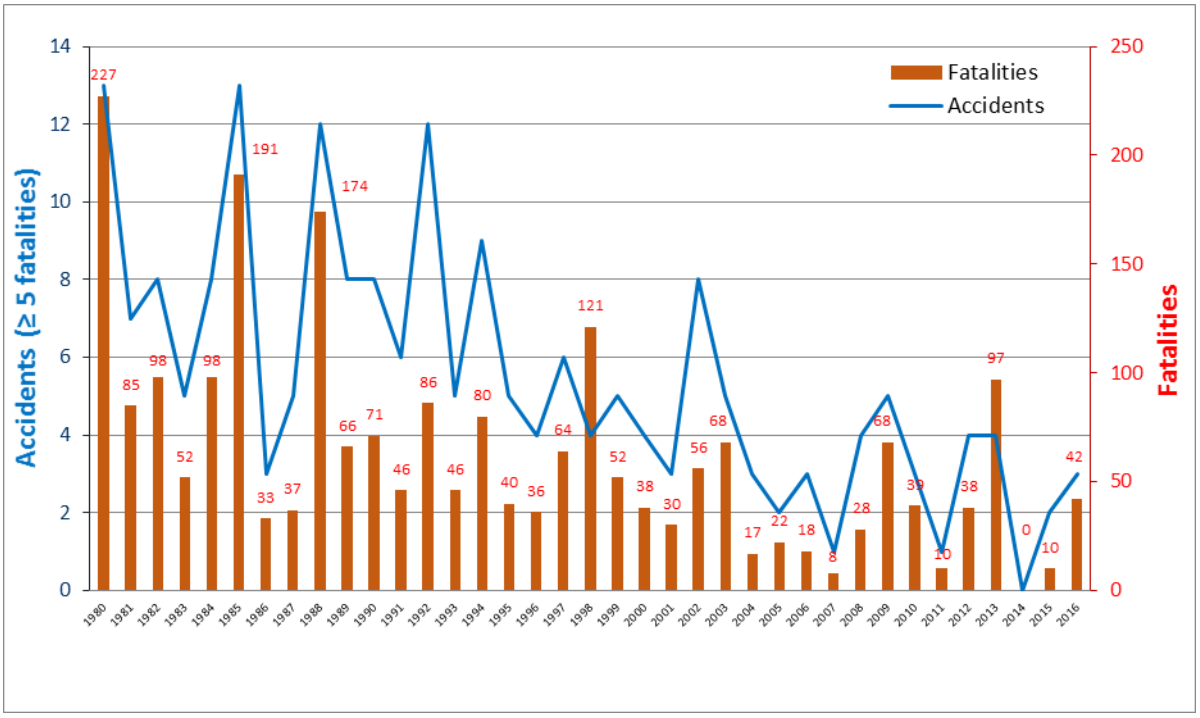

Figure 2: Railway accidents with five or more fatalities (1980–2016) for all EU countries, Norway and Switzerland, excluding Romania for the period 1980–1989.

While the overall level of railway safety in Europe, as measured by fatal train collisions and derailments per billion train-kilometres, has gradually improved since 1990 (although there is considerable scatter from year to year), accidents with multiple fatalities have risen since 2014. This negative trend is of concern to the Agency and others engaged with the oversight of railway safety.

THE COMMON OCCURENCE REPORTING PROGRAMME

Data on railway accidents and incidents are limited and not always enabling risk-based proactive management of safety at national and EU level. The current legislative framework does not require Member States to collect information on **all** railway accidents. Therefore, the available data come mainly from accidents and some other occurrences, investigated by the NIBs and shared through the Agency register of investigated occurrences (ERAIL). In order to improve risk profiling and modelling techniques, and to ensure full visibility of safety performance in EU Member States, following a request from the European Commission, in 2015 the Agency launched a Common Occurence Reporting programme. The goal is to improve learning, exchange and sharing of accident/incident data between all EU actors, so that better risk-based decision making can help to improve railway safety performance.

The new reporting scheme should give early warnings of any deviation from the expected outcome, or assurance that the expected outcome is achieved as planned, give information about unwanted outcomes, and support decision making at both regulatory and operational level, by all the relevant actors. The objectives will be achieved by (1) building awareness and support for sharing at a European level, (2) gathering and disseminating intelligence on state of the art methods, and (3) setting out clearly the cost, benefits and requirements (including legislative, resource and competence, and cultural). Well supported methods and plans will be proposed, following a long term plan for the evolution of risk profiling built on better data.

Different information is shared for different purposes. Safety alerts are designed to share unknown or poorly understood information about hazards and their consequences urgently. Safety management data collected as an output of continual monitoring provide information about the adequacy and improvement of risk management measures.

The completeness and complexity of the internal monitoring process of each railway operator is also linked with the collection of data. Data collection can be automatic or manual. It is automatic when the data acquisition is triggered by a specific event detected by sensors (such as trains traversing the route on a specific point) and then collected and stored by means of technical equipment, without any human intervention. Manual reporting can be done using technical systems or IT equipment (tablets, mobile phones, etc.) but it is always done manually by humans. The decision to report is not triggered by sensors but is made by human beings according to their perception of reality, introducing a subjective element.

To date, automatic and manual reporting are to be considered complementary. Automatic systems allow to detect issues which are not easily detectable by humans. On the other hand, humans are still necessary to detect and report new risks or unexpected occurrences.

Data collection and analytics have changed substantially in the last 10 years. New opportunities are the result of technological progress applied to other industries such as healthcare, road transport and aviation. The big-data technology helps to improve data collection and analytics with more sophisticated tools for data collection, analysis and visualization, but also through the possibility to reduce the human intervention in the reporting systems.

The Agency believes there is room for improving the detection, reporting and analysis of occurrences. This is why the Agency has decided to investigate the potential for big data in the railway industry. Big data is the new frontier for collecting and analysing data and for turning it into usable information. Big data is the evolution of past data analytics techniques and it is a consequence of the increased computational power, the dramatic reduction of price of storage devices and the increased potential for collecting data due to the technological progress.

The step change is significant in terms of speed and possibility to deal with big volumes of data, but the main difference is in the working principle. In fact, while the traditional techniques were based on descriptive statistics, big data uses inferential statistics. The difference is significant because “while the descriptive statistics aim to summarize a sample, the inferential one uses the data to learn about the population that the sample of data is thought to represent”. This is the main change that allows big-data to be a flexible tool, able to handle structured and unstructured data, to learn from “experience” detecting patterns, relationships and dependencies and to predict outcomes and behaviours.

Safety related data can be collected with automatic systems but also through ad-hoc monitoring activities, which can include human observation, audits, manual reporting, etc. This diversity of data sources has to be considered and requires care in order to ensure that data is correctly prepared to be analysed. Thanks to its capability to elaborate quickly big volumes of “low density information” data, coming from various sources, and its ability to infer information from it, big data can speed up the data analysis and consequently the modelling of risks. Moreover, using machine learning, it could be possible to enable a process of self-improvement of the risk models.

TOWARDS A POSITIVE SAFETY CULTURE

After a decade of Safety Management Systems (SMS) and risk management, we still face catastrophic accidents. This highlights the need for strong safety leadership and for a **positive safety culture.** Investigations have shown that Human and Organisational Factors (HOF) play a significant role in all catastrophic railway accidents and occurrences. In order to continually improve safety we need to articulate the two sides of safety - rule based safety (anticipating as much as possible) and Safety Management (managing the unexpected), and migrate from compliance behaviour to proactive behaviour.

Safety culture refers to the interaction between the requirements of the Safety Management System, how people make sense of them based on their attitudes, values and beliefs, and what they actually do, as seen in decisions and behaviours. A **positive** safety culture is characterised by a collective commitment by leaders and individuals to always act safely, in particular when confronted with competing goals. The attributes for a positive railway safety culture are summarized in Figure 3.

Figure 3: Attributes for a positive railway safety culture

SAFETY AND SECURITY

The changing profile of security risks has prompted further debate on the interface between safety and security, and on the impact that any regulation concerning security might have on interoperability.

Both safety and security relate to the protection of people and assets, whereby security is mainly concerned with hazards due to malicious intent/harmful behaviour. From an Agencyperspective, it is on the one hand necessary to assure coherence on policy/regulation level, in relation to both safety and security (e.g. the Safety Management System (SMS) of a Railway Undertaking should address **all** hazards and risks), and, on the other hand, it is necessary to meet the objectives of the Single European Railway Area (open market, international operation, interoperability), by having a common approach to the protection of passengers who might suffer harm as a consequence of hazards arising from intended (malicious) acts, as well as from unintended events.

Mitigation of hazards caused by security events can be in principle considered in the ERA scope, when the undesirable consequences of security hazards are “safety relevant. In a top down risk analysis, starting with hazard identification, all events (random equipment failures, systematic equipment failures, organisational errors, operational errors, intentional attacks, ...) contributing to causing a safety relevant consequence must be appropriately considered.

CONCLUSION

The Agency remains steadfast in its belief that a systematic approach to managing safety risks, supported by organisational and regulatory cultures that are positive about safety improvement, is the only way to maintain progress in railway safety. This cultural commitment to safety is driven by effective leadership, at all levels of all the organizations that influence safety, regulators and operators alike. The three pillars of safety are Technical Safety, Safety Management Systems, and Human and Organisational Factors. These three pillars have to be rooted in a positive Safety Culture, in order to improve safety performance and to build up resilience, also against security threats.

NOTATION

CSI	Common Safety Indicator
ERA	European Union Agency for Railways
ERAIL	European Railway Accident Information Links, accessible through http://erail.era.europa.eu/
EU	European Union
NIB	National Investigation Body
SMS	Safety Management System