DEVELOPING GB RAIL'S SAFETY MANAGEMENT INTELLIGENCE SYSTEM

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Summary

The SMIS+ programme aims to develop a world leading enterprise health and safety management system for the GB rail industry as the key enabler for delivering its vision of "the risk intelligence that a world class railway needs, efficiently provided to the right people, in the right format, and at the right time." This has involved:

- Designing and building a new risk-based data model for capturing information on safety incidents
- Designing an integrated investigation process
- Developing new self-service business intelligence functionality
- Industry wide business change involving multiple organisations transitioning to a new system and supporting the programme
- Development of new safety management system functionality, including business process workflows, predictive analytics, and integrated risk management

This paper will cover the development of the first phase of the Safety Management Intelligence System (SMIS), the longer-term vision for the programme and the benefits it is trying to realise, and how it supports the wider health and safety strategy for GB rail.

Key topics include how the new risk-based data model was developed, and how this can be used to support risk identification and management. An overview of how the system was developed, including data migration, business change and developing new software functionality. And how this links into the GB rail industry's Taking Safe Decisions framework to better support decision makers and duty holders manage risk on the railway.

Introduction

The overriding goal of the SMIS+ programme is to achieve the next step change in reduction of safety risk in the context of an ever-sharper focus on value for money. Following significant improvement in safety performance over the 2000's this is now starting to plateau at a level of residual risk, which requires new intelligence and risk management approaches to effectively target timely interventions.

Background

Figure 1 shows the modelled risk from train accidents on the GB mainline railway as calculated by the precursor indicator model (PIM). Following significant improvement in safety performance over the 2000's this has now started to plateau at a level of residual risk.

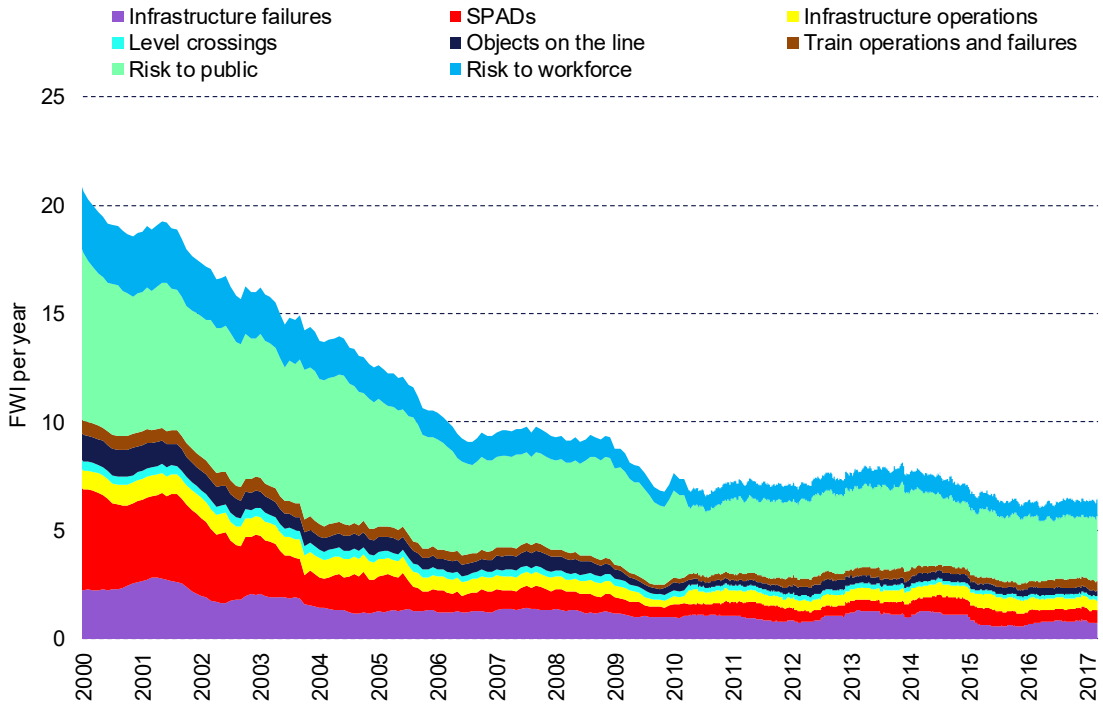

Figure 1: Train accident risk, GB mainline railway[1]

In response to this plateauing level of risk, and the continuing growth in both passenger numbers and fright volumes, the rail health and safety strategy, Leading Health and Safety on Britain's railway, has been developed.[2] The SMIS+ programme is one the mechanisms of delivering this strategy, by developing next generation reporting systems and risk models, exploiting new technology and designing for health and safety change management.

[1] Source: Precursor Indicator Model, RSSB
The risk is expressed in fatality weighted injuries (FWI). The railway industry agreed that the following ratios should be applied from April 2008: 1 Fatality: 10 Major injuries: 200 Reportable minor Injuries: 1000 Non-reportable minor injuries: 200 Class 1 shock/trauma cases: 1000 Class 2 shock/trauma cases.

[2] https://www.rssb.co.uk/improving-industry-performance/leading-health-and-safety-on-britains-railway

Safety Management Intelligence System

The SMIS system replaced the Safety Management Information system at the beginning of March 2017. The primary functions of both system are to;

- Records safety incidents
- Track investigations and recommendations
- Provide automated regulatory reporting to the ORR
- Deliver business intelligence

The new SMIS system aims to enhance upon this by;

- Creating a platform on which future developments can more easily be developed
- Providing better monitoring of safety performance and risk through development of a new data model, and enhanced business intelligence functionality
- Include SMS functionality, for example routing tasks and integrated risk management

New Data Model

Our ability to understand safety risk is dependent upon the information we are able to collect and analyze. The data model used in the previous system was originally developed almost 20 years ago; and while it has been enhanced over the intermediate period, there was some inconsistency in how different types of incident were captured. In addition to this the risk profile has changed, with some events becoming less prevalent, and new areas of risk emerging. A new data model was required to better capture information on the safety incidents.

The data model which has been developed comprises of 33 sub-events, which cover the types of safety incidents which we are trying to record in the system, these are shown in figure 2 and detailed in appendix 1. Multiple sub-events can be combined in an event chain for more complex events; for example there may be an event consisting of a damaged fence, leading to an animal being on the line, leading to a train striking the animal, leading to a train derailment.

Figure 2: Train accident risk, GB mainline railway

Against each sub-event there are a number of data fields to capture the details of what occurred and the possible causes and outcomes; additionally any 'objects' which were involved in the event can be added; such as trains or people, and details of their involvement recorded, such as any injuries a person sustained as a result of the event. In total, the data model consists of approximately 2000 fields spread over approximately 170 sections.

The data model was developed using a risk based approach to identify the information which would be useful to capture for each safety event. For each area of risk that was identified, a workshop was carried out with technical experts from industry. This involved identifying the possible causes, barriers and outcomes for the event; which could then be used to develop a set of fields to capture this information.

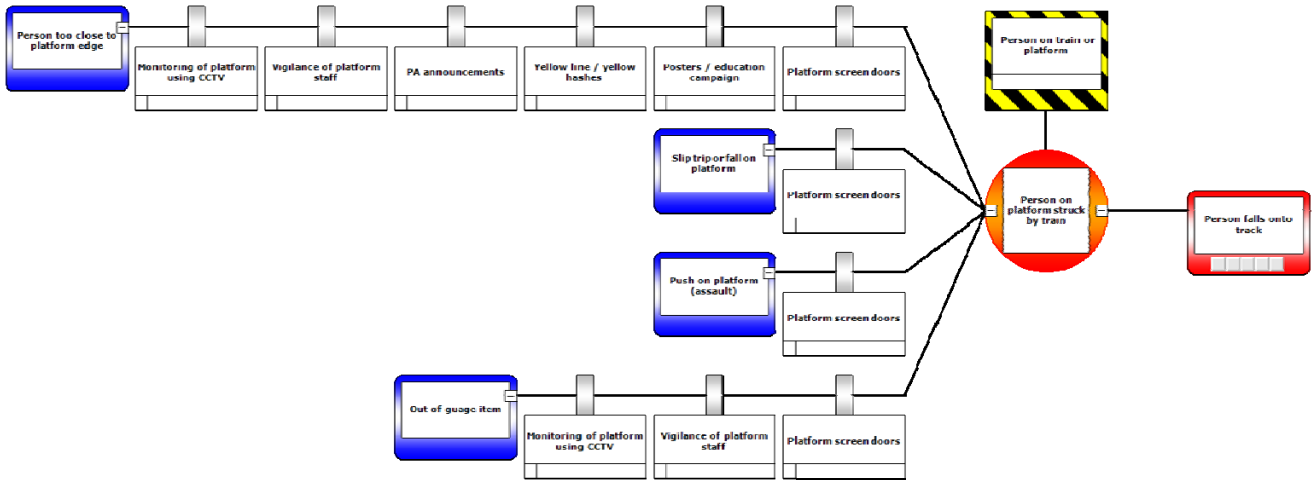

Figure 3: Example 'bow-tie' used in data specification workshops

Following these workshops, further 'theme discovered' workshops were undertaking to refine the data requirements. Taking into account what information it is possible to capture and that it would be clear to a data inputter what was being asked for.

Data Migration

In order to enable long term trend reporting and business intelligence, it was necessary to migrate all the records entered into the previous system; and where possible map these to the new data model.

2.2 million records

75k records per year

30-40 organisations

250-300 users

This was a substantial tasks, involving a team of analysts going through each field and value in the legacy data model and attempting to identify a suitable map to the new data model.

Business Intelligence

Currently the majority of safety reporting consists of static outputs that are distributed each period, monthly or at less frequent intervals. Generally, an analyst will produce a report with the same format and content as previously.

If there is further information the consumer of the information is interested in, this will need to be fed back to the team who create it; and this will generally be included in the next report, which can take a while to reach the consumer.

There has also been the challenge that in order to correctly analyze and interpret the data; a user needed to have a good understanding of the underlying data model and how the information is entered into the system.

A major goal of the new self-service business intelligence functionality of the system is to allow the consumer of the information to ask questions of the data immediately; rather than having to wait for the reporting cycle. The consumer should then become more familiar with the data that is available and therefore what might be of interest to them.

This also allows intelligence from the system to reach a larger number of users; as people can extract information that is of specific interest to them rather than relying on general reporting.

In order to achieve this, it is important that it is clear what the outputs from the system mean; so that consumers don't misinterpret what they are pulling out, and so that it is simple to explore the data without having a thorough understanding of the data model.

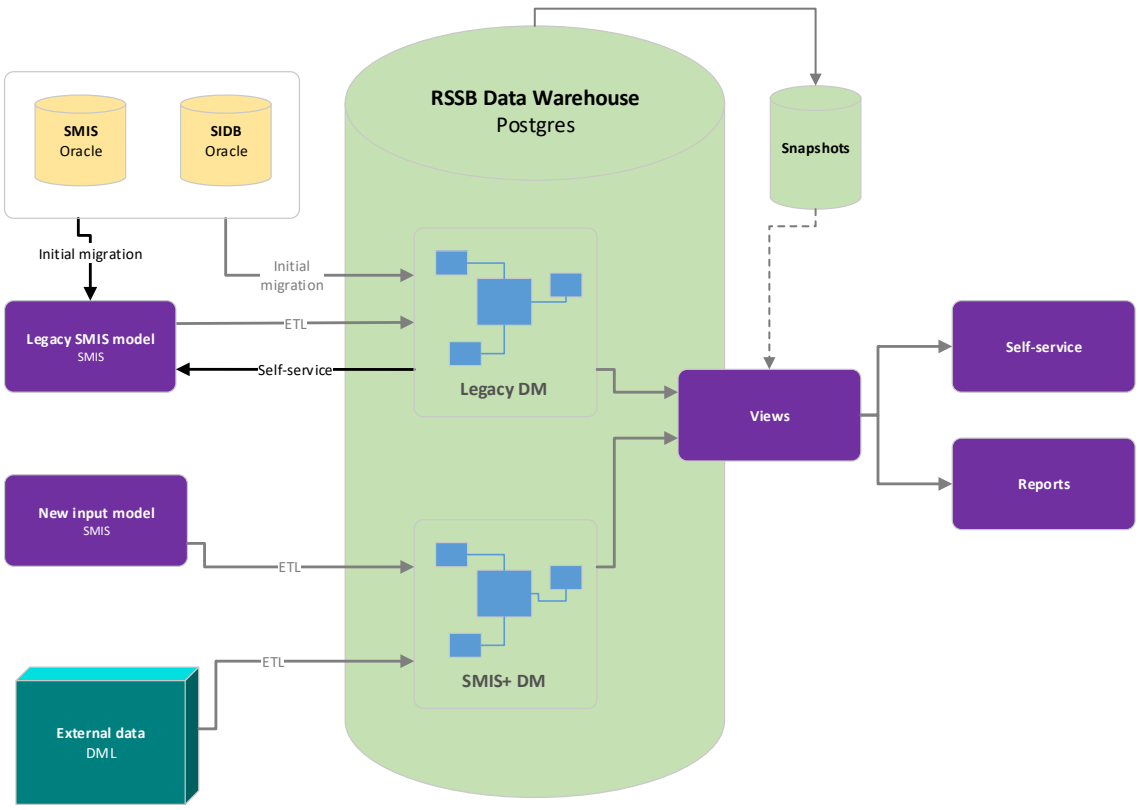

Figure 4: Business Intelligence end-to-end diagram

The reporting model comprises of around 70 reporting views, covering general reporting and specific topics. These combine the new and legacy data models, as well as external datasets such as normalizers or asset data.

Benefits and applications

One function of the system is to provide greater automated monitoring and altering of trends in safety performance. Currently there is generally a lot of manual effort involved in identify emerging trends and deviations in safety performance; and similarly, re-investigating areas where there is has been no change in the level of safety performance. There are also emerging areas of risk which are not immediately identified as they are not being actively monitored.

With the new SMIS the goal is for the system to be far more proactive in this area; alerting the relevant teams of where there has been a change that warrants investigation, and avoiding unnecessary analysis where a measure is within what would be expected from what has historically been observed.

One of the techniques we are using to achieve this is passing a large number of metrics through control chart algorithms, as shown in figure 5. There are a number of tests which are applied to each data point to identify behavior that is unlikely to occur randomly in a stable process. These tests will then trigger an alert to a relevant user to investigate.

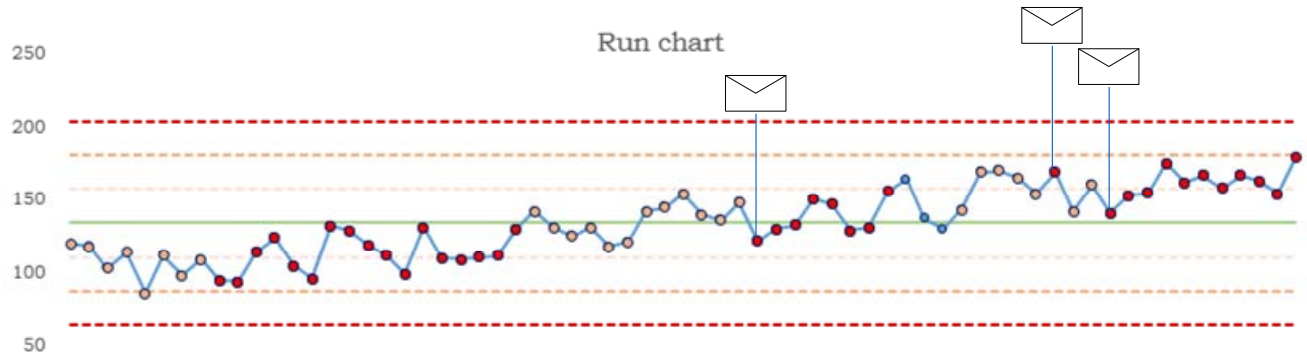

Figure 5: Run chart analysis

It is worth emphasizing that monitoring and investigating for changes and emerging trends in a process is only one tool in the kit: as technology and use of the railway changes, levels of risk that the industry were previously able to accept may have business cases for improvement emerge; which should be monitored separately from understanding changes to the level of safety performance when making decisions on whether to tackle a given risk area.

Conclusion and Future Roadmap

Ultimately the goal is for the system to drive safety management activities, focusing resources on the highest risk areas; through monitoring the status of controls and how often they are preventing threats escalating coupled with tracking of how recently they have been audited or had a risk assessment undertaken; by monitoring emerging risks. There are a number of scenarios where we can make the system trigger an action for someone to perform

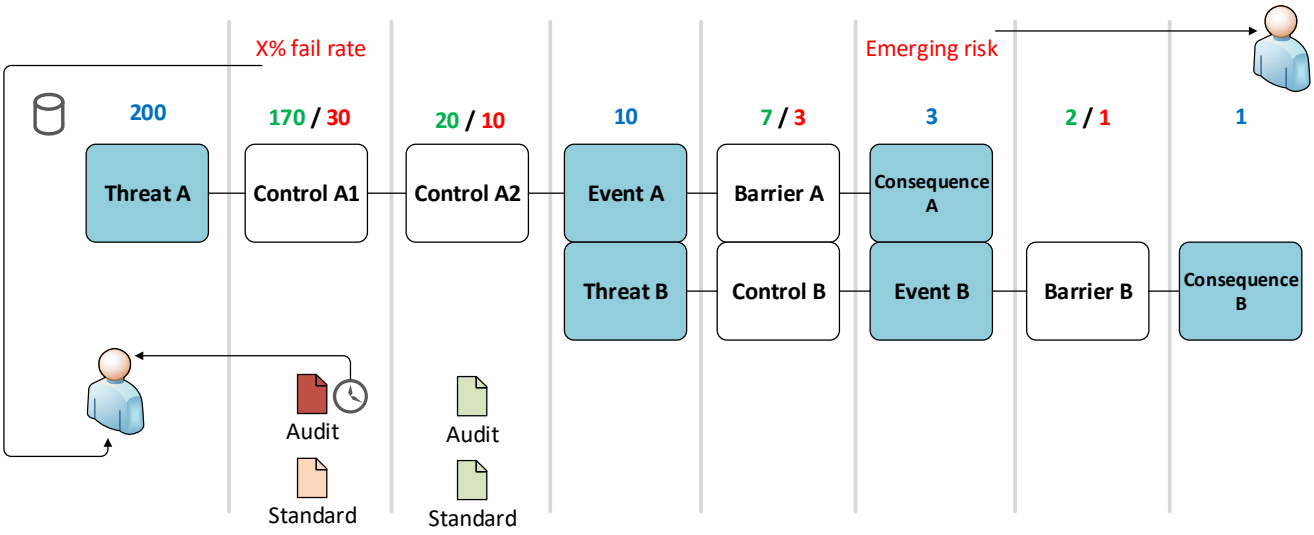

Figure 6: Using the SMIS system to drive safety management

As the system is developed further it is the intention to make greater use of the business process workflow functionality to enable this

Appendix 1: Sub-events

List of sub-events in the SMIS data model.

- Machine plant equipment or tool failure
- Train-track control system brake application or fault
- Train Fault
- Vandalism
- Person in a prohibited area
- Assault and abuse
- Loss of load from a road vehicle
- Slip trip or fall
- Railway infrastructure fault
- Workforce ill health record
- Environmental contamination
- Electric shock
- Train striking or struck by animal, object or road vehicle
- Irregular signal aspect sequence
- Intervening in a suicide or self-harm event
- Non-rail vehicle colliding with animal, object or another road vehicle
- Person exposed to a hazardous condition
- Signal passed at danger
- Flooding of the line
- Train colliding with another train
- Person interacting with animal, object, vehicle or another person
- Object, road vehicle or animal on or near the line
- Train axle or wheel loading fault detection
- Incorrect usage of level crossing
- Awkward Body Movement
- Train derailment
- Lifesaving rule breach
- Person exposed to a hazardous substance
- Other event resulting in injury or fatality
- Fire or explosion
- Congestion or crowding
- Railway operating incident
- Speed restriction warning board fault or irregularity