EMERGING TRENDS IN RISK MANAGEMENT SYSTEMS IN THE RAIL INDUSTRY

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SUMMARY

This paper discusses three topics that have emerged from recent international work on railway safety management conducted by Arthur D. Little. The themes reflect some of the challenges now faced by the rail industry in managing typically quite low levels of safety risk – and the increased expectations of the safety regulator in demonstrating good safety management.

The first topic discusses improvements in the structuring of risk data using relational methods, an emerging area of activity as industry finds optimal ways to reconcile the numerous data sources now used in safety decision-making.

The paper then goes on to discuss how focus on risk management has turned to risk tolerability, with a particular focus on the treatment of high-consequence events within risk decision-making.

The paper concludes with a discussion of improvements in the management of transient risk and third party risk management, illustrated by some of the recent major infrastructure developments that have been commissioned by MTR Corporation.

Each topic is illustrated from examples provided by MTR Corporation, the operator of a range of public transport services in Hong Kong, Mainland China, London, Stockholm and Melbourne. This paper is co-authored by Arthur D. Little, who has worked with MTR Corporation for over 20 years providing support to a wide range of risk management activities, including review of risk management systems, benchmarking against industry practices, asset integrity management and, most recently, high level corporate safety governance.

INTRODUCTION

Safety risk management is regarded by many as a mature discipline, with numerous codes of good practice published to supplement legislation that describe the obligations to both the rail industry workforce and members of the public that are exposed to risks created by the operation of rail networks.

This paper discusses three topics that have emerged from recent international work on railway safety management conducted by Arthur D. Little. Each topic is illustrated from examples provided by the MTR Corporation (herein also the Corporation).

MTR Corporation operates a range of public transport services in Hong Kong, Mainland China, London, Stockholm and Melbourne, and is committed to being the safest public transport operator in the cities in which it operates. Since 2009, the Corporation has faced a significant increase in patronage resulting in Near-Capacity-Operation in some sections of its Hong Kong lines during the peak hours. Currently, five new lines are being built which will be opened progressively by 2020.

Arthur D. Little has long-term experience working with MTR Corporation, providing support to a wide range of risk management activities, including review of risk management systems, benchmarking against industry practices, asset integrity management and, most recently, high level corporate safety governance.

NOTATIONS

IRSC: International Railway Safety Council

ADL: Arthur D. Little

MTR: MTR Corporation

GB: Great Britain

CIRA: Change Impact Risk Assessment

OSSA: Operations System Safety Assessment

CRI: Composite Reliability Index

1. STRUCTURING RISK DATA HIERARCHICALLY AND IN RELATIONAL DATABASE FORMAT

Safety data collection and management has, historically, been non-hierarchical. Hazard logs and risk registers are commonly-encountered examples of the types of safety data managed by the industry. The data can be considered non-hierarchical given the absence of a 'parent' and 'child' structure and the sharing of parent attributes that might otherwise allow relational structures to be developed. The industry has, in general, been slow to pick up on the benefits of good data structure that are otherwise well-documented (for example within database design). International safety standards such ISO 18001 for Occupational Health and Safety Management Systems do not comment on data hierarchy, leaving this to other standards outside the domain expertise of most safety professionals, such as ANSI/ISA-95 used within manufacturing industries for developing automated interfaces between enterprise and control systems.

Safety professionals have, in ADL's experience, been slow to pick up on the benefits of good risk data structure, although recent years have seen significant work commissioned by a number of operators to restructure the data they have collected into new and more useful forms. This work has tended to focus on how assets can be uniquely identified, and how that identifier can be shared amongst different systems to collate information about a given asset. Interestingly, the views of 'uniqueness' are different depending on the use of the data. For example, Network Rail uses several different unique identifiers for its level crossing assets. A single asset may have several identifiers applied to it, to identify that it has both a footpath and road crossing or to identify its location on a different route. The former might be used for site-based risk assessment and the latter for train drivers to report near misses. This requires safety professionals to work with enterprise system designers to structure the data in a way that supports good risk management.

Case study 1: MTR Corporation

MTR Corporation has a well-established safety management system and a strong safety management organisation for managing risks for its operating railway and projects since the mid-90s. Risk ownerships are clearly defined with continuous efforts at all fronts to identify new risks as well as to review risks and lessons learnt from incidents regularly to ensure that they are properly managed. Asset owners and line managers are empowered with the authority to ensure risks under their ownership are properly managed. Risk review results are subject to the scrutiny of different safety and risk committees depending on the nature and severity of the risks.

The risk management process is clearly documented in the Corporation with a MTR 'home grown' database system, ASRisk, registering all risks facing the Corporation. Risk owners can access the risk information from ASRisk through internet / intranet access easily so that they can update the risk register whenever necessary.

ASRisk, which is a major upgrade to a former hazard registration system, was launched in 2010 and it is a systematic and structured risk management IT solution which allows risk owners to categorise and search risks by different attributes, eg. risk rating, risk owner, risk location and major risk scenario, etc. and record the relevant planned and existing controls with the respective action owners. However, the risk database is linearly structured. The risk elements (e.g. control measures) data are recorded in text format and each risk is registered on its own without a dynamic linkage to other related risks. As such it is not easy to trace the impact of a specific risk control, which can be common to many risks, to the system risk profile during a change.

Before the launch of ASRisk, an asset owner can easily search all risks under his ownership but can hardly tell, for example, the total derailment risk due to bogie failure along a particular line. In 2010, the Corporation took the chance to undertake a major process enhancement to link the risk records in ASRisk in a hierarchical structure, categorising risks into 12 Major Risk Scenarios (e.g. derailment, collision, fire, platform-train-interface, etc) and contributory causes like train failure and bogie failure for a derailment. This structure has given the Risk Owners and the risk committees the capability of viewing the risk profile for each Major Risk Scenario as well as commissioning risk identification and focused risk reviews more effectively.

With the opening of a new extension line in 2014 and the progressive opening of another 4 new lines in the coming few years, the Corporation recognises that there will be new localised or line specific risks arising from the new system and operational features. In addition, with the expanded and more interconnected network, the patronage will grow and the travel pattern will change. These could make some fundamental assumptions in the original risk assessments invalid. These changes are expected to pose significant challenges in managing risks in the near future.

To enable a more holistic view in risk profile and early flag-up of any adverse trend in risks, the Corporation is embarking a further improvement in the risk data structure by building the linkages between attributes such as risk controls, assumptions, and references to important information for supporting risk assessments. This would provide a platform for the Corporation to further develop over time a more flexible and powerful means of analysing risk at system level, by line or station, by cause and even by a change in a common risk control or assumption.

For example, the provision for broken rail detection is different for different lines based on the specific signalling system design of each line. It can be achieved by track circuit detection, trainborne detection or by appropriate maintenance regime. The overall risk of broken rail for each line thus has to be assessed based on the different design and operational arrangements to reduce risk to ALARP.

2. FOCUSING RISK MANAGEMENT EFFORT ON HIGH CONSEQUENCE ITEMS WITH TOLERABLE RISK RATINGS

Risks rated as “tolerable” often account for a substantial proportion of the total risk owned by a company. It is increasingly considered good practice to pay greater attention to these risks, often low frequency, high consequence events (such as those leading to multiple fatalities), which can have a catastrophic effect on corporate reputation and business.

Historically, absolute levels of risk have not been calculated for all assets. The calculation is often difficult to complete without significant uncertainty and difficult to calibrate in the absence of data on total reported safety loss attributed to a given asset type. So risk management has relied (often very successfully) on the proxies for asset failure and the factors influencing the consequence of that failure if it occurs. For example, in the case of track hazards undertaking inspections based on line speed and train tonnage.

Greater collection of risk data (see Section 1) has provided the impetus for more informed business investment decision-making that requires directly comparative results for different hazard types and their level of risk. This had led to the development of risk models calibrated against available industry data – a relatively recent advancement within the GB rail industry that has been supported by publication of the Risk Profile Bulletin by the Rail Safety and Standards Board (RSSB).

The output of the risk models – typically a risk matrix – reports on categories of risk typically classified as ‘high’ and ‘other’ (‘medium’ and ‘low’ category risks are for many intents and purposes treated collectively). Historically, risk tolerability on these matrices has been defined by an overall risk threshold. Risks rated as ‘high’ are treated differently from those below the threshold – for example, by increased frequency of risk assessment or different inspection regimes. However, challenges are faced by industry in managing high consequence risks that may sit below this threshold and therefore traditionally ‘miss out’ out on enhanced risk management processes. It is not practicable to treat all risks as ‘high risk’ – and so industry has developed different ways of classifying risk that tends increasingly to concentrate on greatest uncertainty. Finding ways of incorporating a measure of uncertainty into a risk score and industry can better safeguard against catastrophic risk and the subsequent impacts on the business.

Network Rail’s emerging work on key performance indices provides a very good example of one approach to managing uncertainty. For Network Rail’s current Control Period (a period of five years starting April 2015), a Composite Reliability Index (CRI) has been developed to calculate a total monetised cost per asset failure. This total cost includes both the costs related to train performance (train delays attributed to Network Rai) and the number of fatalities and weighted injuries (FWI) that is converted into a monetised Value to Prevent a Fatality (VPF) from UK government data. Interestingly, the CRI includes a high weighting for safety loss that reflects the potential impact on Network Rail’s reputation in the event of a catastrophic risk occurring. During the development of the CRI it was noted that the low estimated risk of the great majority of Network Rail’s recorded safety hazards made the CRI insensitive to high-consequence events. The CRI’s weighting for safety loss corrects for this, preventing high-consequence hazards from being missed within Network Rail’s broader safety management strategy[i].

Case study 2: MTR Corporation

The Corporation assigns a specific risk rating from R1 to R4 to each identified risk with R1 being the highest risk and R4 being the lowest. A risk with higher risk rating (i.e. R1 and R2) requires more attention with frequent reviews by the risk owners. Most of these risks are low consequence high frequency risks such as slip, trip and fall. Arguably, these are system background risks which cannot be eliminated and difficult to be further mitigated and they will continue to increase as the system continues to expand.

The Corporation acknowledges that the ongoing mitigation efforts on these high frequency, low consequence R1/R2 risks often does not necessarily lead to a tangible risk reduction and may also dilute the relative attention on those R3 risks which are high consequence / low risk events and could have a catastrophic effect on the Corporation. Therefore, there is a need to strike a balance between risk management effort and level of attention on high consequence low frequency risks. Although the calculated frequency of these events is very unlikely, the realisation of such an event would have a major impact on the Corporation’s reputation and business.

An enhanced risk review framework, namely Operations System Safety Assessment (OSSA), has been developed since 2011 to provide a structured process for reviewing the adequacy and robustness of key risk controls for events which could result in high consequence events (e.g. Train derailment, train collision, etc.). By following the OSSA framework, the Corporation can highlight the strengths and weaknesses of existing risk controls for management attention which serves as a basis to prioritise risk management resources, and to provide further assurance that risks are reduced to ALARP on an ongoing basis.

As a Safety-first company, we cannot be complacent and never assume that all risks have been identified. Whatever is meant to go wrong will go wrong and a weak point will eventually manifest itself as a failure as time goes by.

OSSA has emerged in the past few years as an effective and practical process in our risk management journey which enables us to challenge the status quo in a systematic manner and bring in new ideas on risk controls to mitigate risks effectively to ALARP. We have carried out specific OSSA studies on Platform Train Interface (PTI), escalator maintenance, derailment due to bogie failure. Some successful outcomes from the OSSA study are installation of Fallen Object Detection System to detect passengers fallen onto track at curved platform, acceleration of the plan to retrofit older generation of escalators with latest safety devices, driving the study on the use of a standalone radio communication system between Platform Supervisor staff and Train Captain in the event of an emergency.

We found that the OSSA process naturally flags up those relatively weak procedural controls and then tests out their degree of robustness. Typical example is the procedure for a platform staff to monitor and respond to a PTI incident.

3. IMPROVING TRANSIENT RISK AND THIRD PARTY RISK MANAGEMENT

Management of transient and third party risk is of increasing importance when, as is often case, construction works by third parties are frequently underway close to the operating railway. Furthermore, while construction-related risks are often well-understood, the same is not always true of many non-construction risks – for example, the use of heavy equipment in the close proximity of a railway line.

Transient risks are those causing occasional heightened risk. Historically, transient risk has tended to be missed from risk assessment, which can represent a ‘snapshot’ only of the hazards at a particular location. Transient risks may be absent during the risk assessment and therefore not accounted for by the safety management activities. Weather is a particularly good example of acute transient risk. Low sun creates the risk of signal washout and of vehicle drivers missing warning signs on the approach to level crossings. Rain can increase the risk of embankment collapse.

Some of the established good practice in transient risk management include the modelling of transient risks to identify when (and where) these are likely to occur. Network Rail has commissioned a number of such models in recent years, for example to account for the occurrence of low sun at level crossings. Areas likely to encounter these transient risks are marked for further investigation.

Transient risk management can be further strengthened by encouraging relevant company risk owners and staff to identify and log third party risks, achieved through guidance notes and training. ADL has noted a gradual expansion in the definition of ‘near miss’ within incident reporting used by train operators, with greater interest in the activities of third parties working close to the operating railway.

Case study 3: MTR Corporation

Apart from the risks arising from day-to-day railway operations, the Corporation has also been dedicating a lot of efforts in managing the risks arising from works of external parties, interfacing works arising from the construction of new railways and asset replacement works in the operating railway, as their consequence to safety and train service could be very severe.

Top down and bottom up hazard analyses are conducted to identify the major hazardous scenarios, review the detail design and working sequence, assess the risks and propose the safeguard measures. Dedicated safety organizations (including safety working groups and safety committees) have been established to steer and manage the process.

Cost-effective measures are deployed to manage the transient risks. For instance, in the recent years there have been large scale work activities involving heavy piling machinery for new extension projects alongside the existing running lines. In addition to typical safeguard measures like clear site segregation, specially-designed safeguard measures have been developed and imposed to control the risks such as machinery toppling or infringement of the gauge of the running line. A trip wire system has been installed and arranged at critical locations so that in the event that the machinery or other structure infringed the railway, the trip wire system will trigger the alarm to the operators to help prevent trains from entering the affected zone. To balance the risk to train service due to this additional provision, redundancy features have been built-in to minimise nuisance alarms. Another example of risk control is the installation of an Automatic Deformation Monitoring System (ADMS) to detect track settlement on the operating railway which may be caused by the adjacent excavation or tunnelling works and the establishment of an alert, alarm and action triggering system to the project team and operators according to the level of vibration.

The transient risk arising from multiple major engineering and operational changes especially those which are happening concurrently at one location / one system could pose significant and compounded risks to railway safety and service. It is important but challenging to address the "additionality" effect of concurrent risks, which is one of the key elements in the latest Common Safety Method in risk evaluation and assessment, as it cannot be easily assessed using the normal quantitative risk method. For example, a low risk of power lost during the station power supply replacement work coupled with a signalling system upgrade work at that station signalling equipment room could result in a far more complicated recovery process and longer-than-expected service disruption. In this multiple-risk dimension, the transient risks when entangled together will give rise to new risks or escalate the risk severity to a level which is higher-than-expected. On the operational control side, during the transient period with many concurrent changes, the new information and additional demands on the operators could easily exceed their attention span and the capability of existing organisation establishment thereby inevitably creating work stress and inducing higher chance of human error during critical operations.

To manage the challenges during this unprecedented period with large-scale concurrent works, the whole safety management organisation, system and processes have been enhanced. Systematic and comprehensive planning of the work methods and the assessment of transient risks including the interfaces among systems, mixed system operating modes and the impacts on operating environment and human factors are fundamental and crucial to protect the workforce and maintain a safe and reliable train service throughout the period. In addition, the competence and safety awareness of contractor workers especially the subcontractors and the less experienced workforce have to be addressed through tightening of supervision and establishing systems to pay extra attention and care to the workforce.

To strengthen on-site supervision, a risk-based approach, called the Change Impact and Risk Analysis (CIRA), is also adopted to enhance the supervision of site activities in the brown field railway. During the CIRA process, the consequence of the transient implementation risks will be assessed in the context of severity and work complexity. It provides additional assurance through consequence based work programming, planning and site supervision.

Overall, the proper execution of the established method statements and risk controls on site is the most critical challenge in this transient period and the safety vigilance and safety culture of all parties really matter.

CONCLUSION

This paper has presented three areas of interest from recent studies on the management of safety risks. Anecdotal observations made by safety professionals talk of a 'sea of data but a desert of information'. The availability of more sophisticated methods of risk mitigation – such as the rollout of radar-based obstacle detection at GB level crossings – and the gathering of an increasingly broad range of data to support mitigation assessment does little to help this scenario. Much of ADL's recent work has reflected the need to make better use of available information in ways that do not cause indigestion to its consumers, with employee training and competence of paramount importance in supporting these aims. Likewise MTR Corporation has recognised these challenges across recent safety initiatives instigated by the Corporation to reduce complexity and improve decision-making.

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[i] For further information about the CRI please contact Andy Kirwan, Head of Whole Lifecycle Costing, Network Rail, Quadrant MK, 500 Eldergate, Milton Keynes, MK9 1EN, UK. Switchboard +44 (0)207 557 8000