PARIS 2 ▸ 7 OCTOBER 2016
INTERNATIONAL RAILWAY SAFETY COUNCIL

RISK MANAGEMENT AT SNCF: FROM LAGGING TO LEADING INDICATORS

Wybo Jean-Luc[1], Delorme Frédéric[2], Anner Franck[3], Auvrèle Patrick[4]

[1] Consultant, [2] Corporate Safety Manager, [3] PRISME Project leader, [4] System Safety Director

[1] JLW Conseil, [2,3,4] SNCF

RESUME

Managing railway safety in high-density areas requires running several organizational processes. These processes follow the evolution of regulations, technologies and organizational practices, which need to set up a global safety excellence initiative that ensures coherence among them and facilitates the tasks of managers and staff.

SNCF launched the PRISME initiative in February 2015 to structure and develop coherence among these processes. PRISME gathers six main goals: proactive behavior, risk-driven management, cooperation between activities, simplification of procedures, individual commitment to safety and investment in innovative equipments. In this paper, we present the organization set up to achieve the second goal: risk-driven management.

Setting up a risk-driven management implies different objectives: getting a strong knowledge of the different risks threatening people and operation, reducing these risks to an acceptable level, monitoring the safety level and anticipating risk-prone situations to prevent accidents.

As part of this process, safety management indicators used by SNCF managers and the executive board are mostly composed of lagging indicators based on accidents' rates and historical data, as requested by authorities. The PRISME initiative aims at providing a strong understanding of risky situations, their causes and the measures to take to control the risks. This knowledge will be used to define relevant leading safety indicators and develop anticipation.

INTRODUCTION

The PRISME Program

PRISME is an initiative created to integrate the different processes contributing to the Safety Management System of SNCF and to promote Safety Excellence through four main objectives:

- Ensure the highest safety level;
- Demonstrate at any time, any hierarchical level, anywhere in the company that safety is the first priority;
- Account for the best practices in the railway domain and other industries and simplify documentation;
- Develop a strong safety culture in the company.

PRISME is composed of six objectives. The first objective is to develop a proactive behavior of managers and staff, by analyzing every gap, incident or accident and sharing lessons learnt. The second objective is to set up a risk-driven management to analyze, control and anticipate risky situations. The third objective is to facilitate cooperation at the interfaces between the different activities that share the same resources and environment. The forth objective is to simplify procedures and documentation and facilitate access to the different users. The fifth objective is to create the managerial context to develop managers and staff's commitment to safety. The sixth objective is to invest in new technologies that contribute to increase the safety level.

PRISME is based on the principle of subsidiarity: each sector, department or activity in SNCF is in charge of choosing its own initiatives and setting up the related projects. The PRISME managing group is a light structure, supporting the projects and proposing methods, tools and training. In each of the six objectives, project leaders share their progress, difficulties and best practices.

THE RISK MANAGEMENT PROCESS

Identification and representation of risks

In the SNCF safety management organization, railway safety and occupational safety are managed the same way, using the same methods and tools. There are four main kinds of information used to identify which risks must be monitored and managed:

- Risks identified during the design phase;
- Risky situations, incidents and accidents that occurred;
- Audits and observation of staff's activity used by managers to identify potential risky situations;
- Risky situations that managers and staff consider as important to address.

In order to represent risky situations and evaluate their criticality, the Bow-Tie method [1] was chosen as it allows an easy knowledge sharing between experts, managers and staff about every risky situation, its potential causes and consequences, and the prevention and protection measures that are used to reduce risk. The Bow-Tie method is used for observed risky situations and accidents and for potential situations that never occurred before. Figure 1 presents an example of Bow-tie resulting from the analysis of an accident involving a test train.

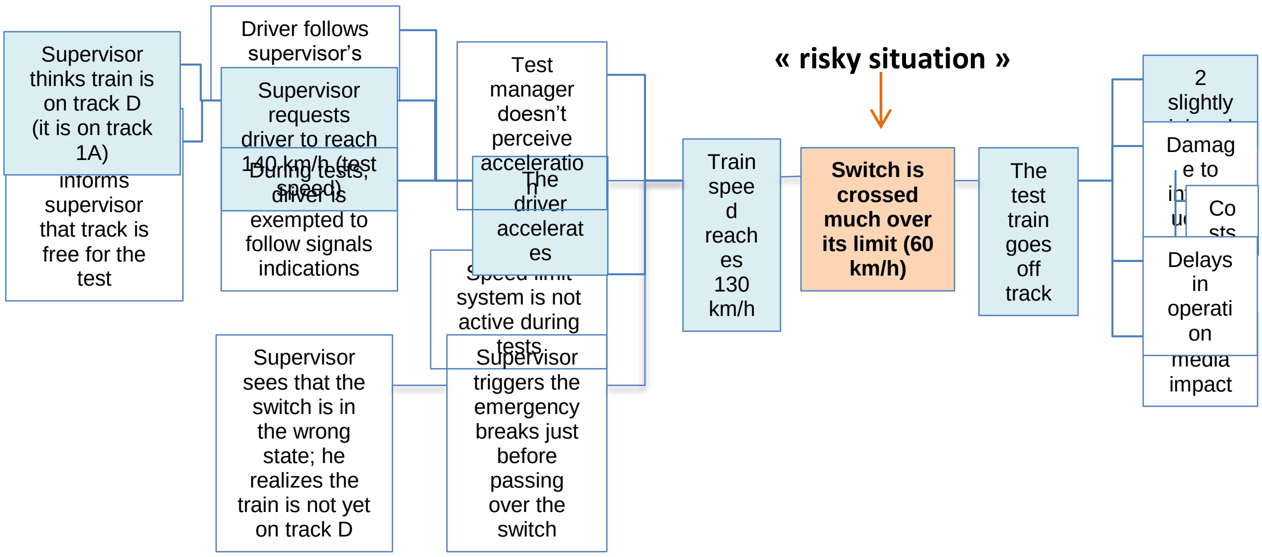

Figure 1: example of Bow-tie representation of a risky situation

This representation of railway risks was developed by Railway Safety in Great Britain in 1997 [2] to describe 110 risky situations ("hazardous events") that have the potential to harm people or the environment. Muttram [2] identifies three main groups: train accidents, movement accidents and static accidents.

Assessing criticality of risks

The process of analyzing risky situations and learning from incidents and accidents, along with the collection of data about technical malfunctions and failures gives access to an objective evaluation of the causes' frequency and consequences' severity of risky situations and of the efficiency of related prevention and protection barriers. This analysis allows assessment of the nominal level of risks (without preventive and protective barriers) and the residual level (with risk-reduction barriers in operation).

The next step of the process is to assess how far risks can be controlled. When setting up a barrier to prevent a cause or reduce the severity of a consequence, the barrier is considered as available and efficient. In order to get the real criticality of risks, this “theoretical” efficiency must be checked along the life of the related process: is that barrier always available? Is it always efficient? Accessing this information at any time for all barriers is not possible, so one needs to use available data: inspections and audits on one side, analysis of incidents, near-misses and accidents on the other side. By assessing the observed levels of availability and efficiency, it is possible to select the most appropriate barriers to use, which combine a good efficiency and availability with a good level of trust based on a large number of observations in real conditions of operation.

At the corporate level, all those data are used to rank the observed and potential risky situations threatening personnel, passengers, the public and the company, based on their frequency, severity and controllability. This risk mapping is used by the executive board to allocate resources for risk reduction measures.

Figure 2 presents the risk management process:

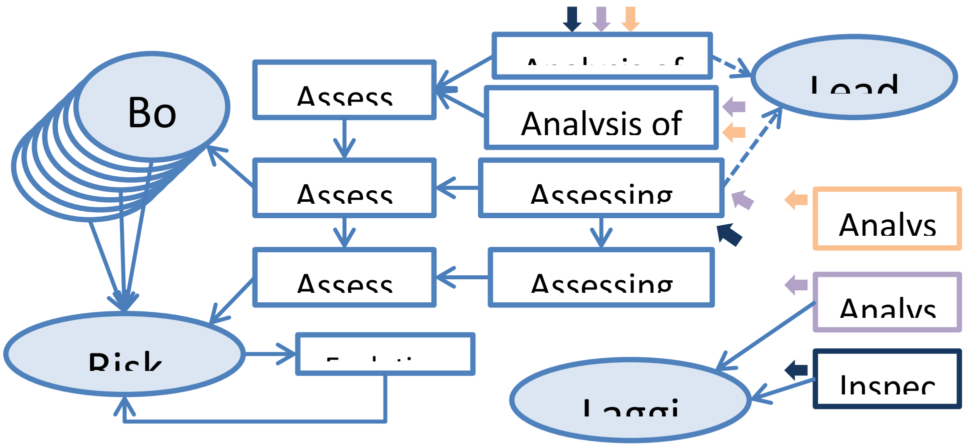

Figure 2: risk management process

MANAGERS‘ RISK PERCEPTION

In July 2016, SNCF organized an important event dedicated to the PRISME Program attended by 700 managers: the SNCF Safety Convention. During this event, each manager had opportunities to meet the different project leaders, to attend interactive sessions and to exchange experiences and practices with peers. One of the interactive sessions was dedicated to risk management; this session was attended by 200 participants. In order to get their perceptions on the most important risks to address and their proposals for safety indicators, a questionnaire was distributed to the participants. 130 completed questionnaires were collected and analyzed.

Risks identified as important by managers

During the design phase of technological and organizational systems, systematic risk analyses are conducted to identify the risks linked to the new systems or to their introduction in existing systems and organizations. These analyses are completed by the selection and integration of appropriate technical, human or organizational measures to control the risks. Although these analyses are done rigorously by experts with appropriate methods (FMECA, HAZOP, …), some unplanned risky situations may appear in operation and must be addressed.

Managers and staff have a key role in detecting, identifying and alerting about such new risky situations, as stated in the first objective of PRISME (develop a proactive behavior). Participants were first requested to list the risks they are the more concerned with in their activity. Here are the categories of risky situations cited:

- 119 are related to work environment and technology;
- 115 correspond to errors in application of procedures;
- 54 are related to human and organizational factors;
- 51 are related to external causes;

- 39 correspond to occupational risks.

A noticeable proportion of these risky situations correspond to situations that were not identified at the design phase, which demonstrates the need to associate managers and staff in the identification of risks they have to deal with.

Assessment of risks' criticality

The second question of the questionnaire proposed a 4x4 severity/frequency matrix and asked participants to assess the priority/criticality of each combination in a 3-level scale: 1=low (no action needed to reduce risk); 2=medium (urgent action); 3=high (immediate action).

Figure 3 presents the mean values of data provided by managers; colors correspond to priority scale: (1.00 to 1.66) = green; (1.66 to 2.33) = yellow; (2.33 to 3.00) = red.

Severity → / Frequency of occurrence	Low	Moderate	High	Very high
Frequent	1.96	2.47	3.00	3.00
Occasional	1.60	2.18	2.95	3.00
Rare	1.03	1.60	2.36	2.89
Almost never	1.00	1.14	2.06	2.64

Figure 3: values and classification of risk priority as a function of frequency of occurrence and severity

These results show a high level of risk aversion (50% high priority, 30% low priority) among managers that corresponds to a strong commitment to address high priority risks.

LAGGING AND LEADING SAFETY INDICATORS

An indicator is a measurable representation of an aspect of reality. Indicators are quite important to ensure safety, as they provide essential information about the past state (lagging indicators) and the future state (leading indicators) of risks.

"One strategy to avoid accidents is to be continuously vigilant through the use of indicators. Often, hindsight has shown that if signals or early warnings had been detected and managed in advance, the unwanted event could have been prevented" [3].

The reason for having indicators of safety performance is, presumably, that they can be used to drive the behavior of managers and workers. Under the adage 'what gets measured gets managed', we can see that having effective indicators can drive required performance. Having ineffective indicators may lead to management of the figures, instead of the issues under consideration, while having no indicators often leads to having no attention paid at all.[4]

There are reasons why lagging indicators are popular. One of these is their incontrovertible character. Once an accident has actually occurred, there is little or no room for maneuver: it has happened; while a near miss can always be shrugged off as just that. [4]

For Oien [3], a "risk indicator" is a measurable representation of a "risk influencing factor". When no risk model is available, Oien uses the term "safety indicator" for indicators based on assumed relations or the use of correlation. This is the case of lagging indicators representing safety performance results (number of accidents for instance).

The difficulty with indicators is that they each represent one measure of one aspect of any situation. This means that there is always room for discussion and even disagreement about what an indicator really represents. [3]

In order to avoid such difficulties in defining a risk indicator, the risk influencing factor must be part of a model; for instance the indicator is the availability of a prevention barrier and the risk model is the bow-tie representation of a risky situation.

Lagging indicators

SNCF uses a series of lagging indicators to monitor the company safety level. These indicators include those requested by the National Railway Safety Authority: EPSF. These indicators represent the number of railway incidents and accidents and the number of occupational accidents.

The severity of railway incidents and accidents is evaluated using the EPSF scale, from 1 (minor event) to 6 (major consequences). Incidents and accidents ranked from 3 to 6 in the EPSF scale form the “ESR” (remarkable safety events); ESRs are analyzed in details and classified by type. The evolution with time of the number of ESR is the main indicator used by SNCF at corporate level to take risk reduction decisions and evaluate their effects.

Occupational accidents are monitored using two main indicators: the monthly numbers of accidents and person-days of absence related to occupational accidents, and the evolution of these figures over time.

Leading indicators

As part of the PRISME initiative, SNCF is looking for leading indicators that could complement existing lagging indicators to better assess the safety level by adding a dimension of anticipation of risky situations.

SNCF safety managers organized working sessions with the RSSB (Rail Safety and Standards Board) in Great Britain and their homologues at RENFE in Spain and RATP in France to know the different types of leading indicators they developed and use.

The European Directive 2004/49/CE, Annex 1, defines a list of 6 leading indicators (“precursors”) related to infrastructure and rolling stock (rail, axle and wheel rupture, track deformation, signaling malfunctions) and to operation (passing close signals). Most of data used for assessing leading safety indicators result from the analysis of accidents and near-misses; they correspond to monitoring potential causes of accidents and failures of safety barriers.

Many kinds of data can be used to build risk indicators; for instance, Walker & Strathie present in a recent paper [5] how black box data from the rail sector can be turned into useful ‘information’ in the form of Human Factors leading indicators of risks by analyzing behavioral sequences of operators.

Indicators or observations are relevant only if they pertain to the same phenomenon as is meant to be controlled. For major accidents these can be entities that influence the consequences and entities that influence the probability [6].

The choice of which causes or barriers to monitor is achieved using two main strategies:

- Causes and barriers related to potentially severe accidents:
- Causes and barriers corresponding to several risky situations.

The risk management process of the PRISME initiative presented above provides relevant information that may be used to select, assess and monitor relevant leading safety indicators, using a combination of these two strategies.

Introducing new indicators in the safety dashboard of managers requires a good understanding of managers’ perceptions and practices in safety management; that’s why we introduced in the questionnaires used during the 2016 SNCF Safety Convention a third question for managers about their proposals for relevant safety indicators in their area of concern.

The analysis of their proposals reveals interesting trends for the selection of leading indicators:

- 80 proposals related to technology (among them, 13 related to infrastructure);
- 64 related to Human and organizational features;
- 44 related to management;
- 20 related to human resources;
- 14 related to safety barriers;
- 10 related to security.

From this survey and the results of the risk assessment process presented above, we'll define a set of leading indicators with the highest relevance, taking in account three parameters:

- The combined criticality of risks related to the indicator;
- The ease/difficulty to collect data needed to assess and monitor the indicator;
- The managers and staff's perception of the indicator's meaning and relevance.

CONCLUSION

The combination of an improved representation of risky situations and the existing lagging and leading indicators provide SNCF managers at local and corporate levels with a set of efficient tools to control the different risks and their evolution over time. The risk management system presented in this paper uses different and complementary sources of information from experts, managers and staff.

As stated by Zwetsloot [7] in the process industry, these inputs are essential for monitoring the safety level and to achieve anticipation of risky situations:

The use of a proper set of process safety indicators implies that there is a regular fact based informational input to the safety management system. It forms a basis for well-informed decision making, and provides feedback on the actual safety performance (lagging indicators) as well as on the functioning of the safety management system (leading indicators). [7]

As quoted by Hudson [4], associating leading and lagging indicators for risk-driven management is probably the best compromise:

"Experience with control of systems suggests that, where possible, a judicious mix of feedback and feed-forward is the most effective way of achieving stable goal-directed behavior". [4]

We argue that using a set of leading risk indicators based on a sound model of risks and a good knowledge of causes and barriers' efficiency, chosen in cooperation with managers and staff, has the potential to improve risk anticipation and contribute to an efficient risk-driven management, in combination with existing lagging indicators.

"It would appear that many of the problems arise because the approaches typically taken are intuitive, not based on any systematic analysis of the hazards and how they are to be managed to achieve safe performance". [4]

REFERENCES

[1] Chevreau FR, Wybo JL, Cauchois D, 2006. Organizing learning processes on risks by using the bow-tie representation, Journal of hazardous materials, 130, pp 276-283

[2] Muttram RI, 2002. Railway Safety's Safety Risk Model, Proc Instn Mech Engrs 216 Part F: J Rail and Rapid Transit

[3] Øien K, Utne IB, Tinmannsvik RK, Massaiu S, 2011, Building Safety indicators: Part 1 – Theoretical foundation, Safety Science 49, 148–161

[4] Hudson PTW, 2009, Process indicators: Managing safety by the numbers, Safety Science 47, 483–485

[5] Walker G, Strathie A, 2015, Leading indicators of operational risk on the railway: A novel use for underutilized data recordings, Safety Science 74, 93–101

[6] Ben Ale, 2009, More thinking about process safety indicators, Safety Science 47, 470–471

[7] Zwetsloot GIJM, 2009, Prospects and limitations of process safety performance indicators, Safety Science 47, 495–497