Risk management - an essential process for maintaining and improving railway safety

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SUMMARY

Structural changes in the railway system but also the application of more and more complex technologies influence the duties and activities of national safety authorities. To be effective, the supervision of a national railway system must rely on a risk based approach.

The Federal Office of Transport as national safety authority for the Swiss railway system has implemented a risk management process as basis for the three supervision phases (normative, approval/authorization, operational), to ensure and optimize the transfer of safety relevant data between the phases. The process includes collection and processing of safety relevant data, identification and assessment of risks in case of single events as well as company-specific or net wide topic-specific evaluation, monitoring and mitigation of risks, identification of suitable measures and the controlling of their effectiveness.

The usefulness of a comprehensive risk management process for authorization processes and mitigation of risks is demonstrated by the two examples issues of safety certificates / safety authorisations and risk mitigation of level crossings.

INTRODUCTION

The Federal Office of Transport (FOT) is the national safety authority (NSA) for the Swiss railway system. Its duties are to establish the legal framework, to identify deficiencies of the system and, if necessary, to correct them. In order to have a defined basis for its safety relevant duties, FOT has established a safety concept. In it is fixed the general objective to, at minimum, maintain the current safety level and accept remaining risks only if there are no further possibilities to reduce them with proportionate efforts.

The time series of annual rates of incidents and fatalities for the last 20 years shown in Fig. 1 give an indication of the current safety level of the Swiss railway system. Both, incident and fatality rates show decreasing trends.

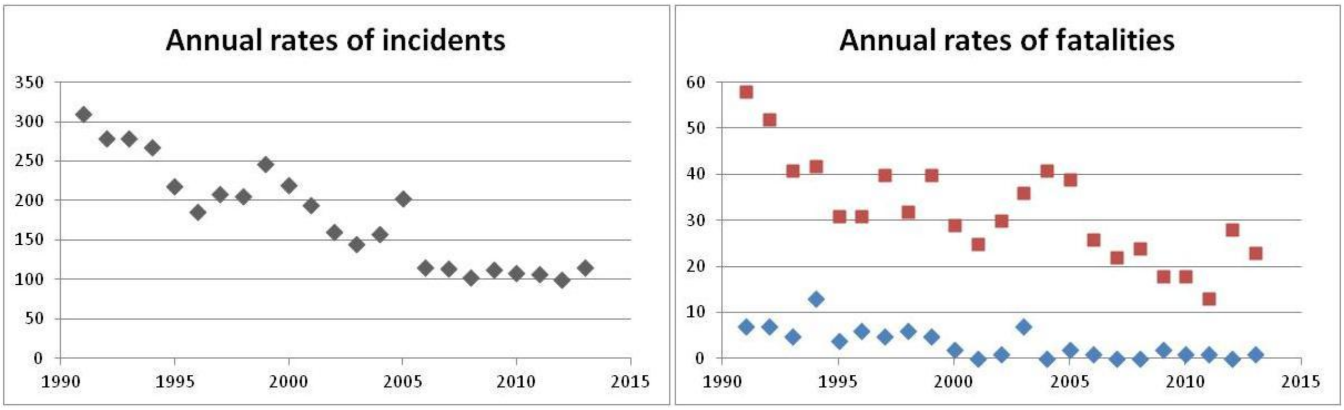

Figure 1: Swiss railway network: annual rates of incidents and annual rates of fatalities. Red squares show annual rates of total fatalities, violet diamonds show annual rates of passenger fatalities only.

With respect to maintenance of the safety level, development of more and more complex technologies and structural changes of the European railway system have to be taken into account. The introduction of conformity assessment, maintenance certification etc. results in significant changes of the competences of NSA and in increased numbers of stakeholders and interfaces. On the one hand, these changes imply that the stakeholders like railway undertakers (RU) or infrastructure managers (ISM) are aware that they are the primarily responsibles for the safety of the railway system. On the other hand, an effective supervision of such a complex system can only be achieved if it is based on a risk approach.

Below, we will present a short introduction into the concept of the risk management process at FOT and some applications.

RISK MANAGEMENT

Safety supervision at FOT includes the normative phase (regulations), the preventive phase (approval, authorization) and the operational phase (surveillance). The corresponding processes to these phases are implemented as a feedback loop. Safety relevant findings from one phase are transferred to the other phases (Fig. 2). The loop is driven by the risk management process.

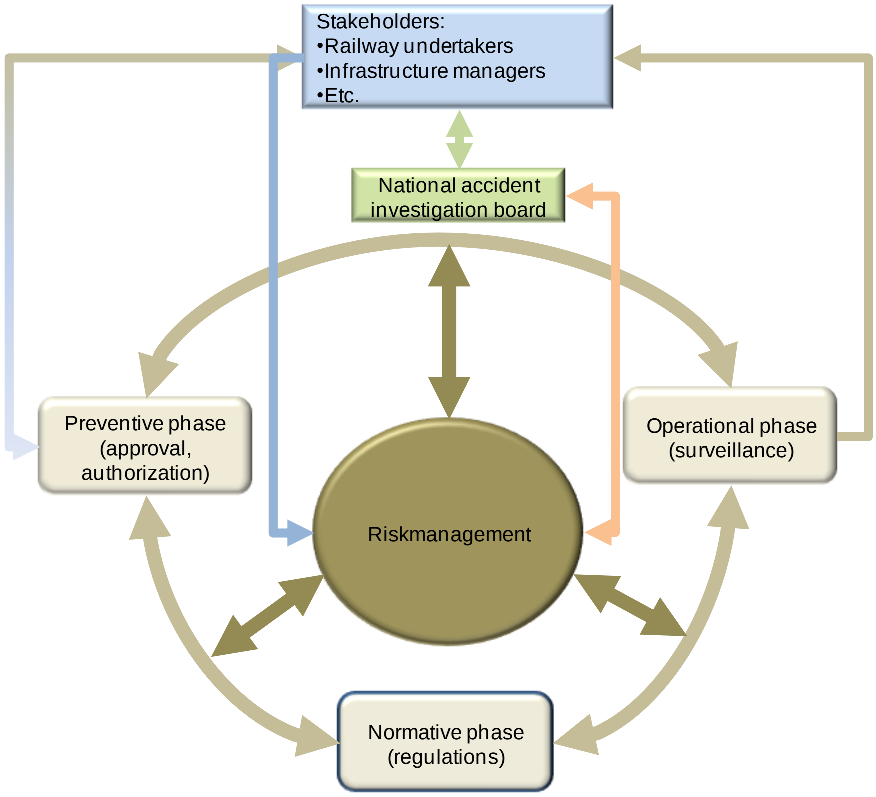

Figure 2: Risk management process: driving wheel for the feedback loop of the three phases of FOT supervision

The process of risk management includes collection and processing of all available safety relevant data, identification and assessment of risks including the evaluation of the need of action in case of single events (e.g. incidents/accidents or reported potentially critical situations) as well as company-specific or net wide topic-specific evaluation, monitoring and mitigation of risks as well as controlling of the implementation of risk reducing measures. (Fig. 3).

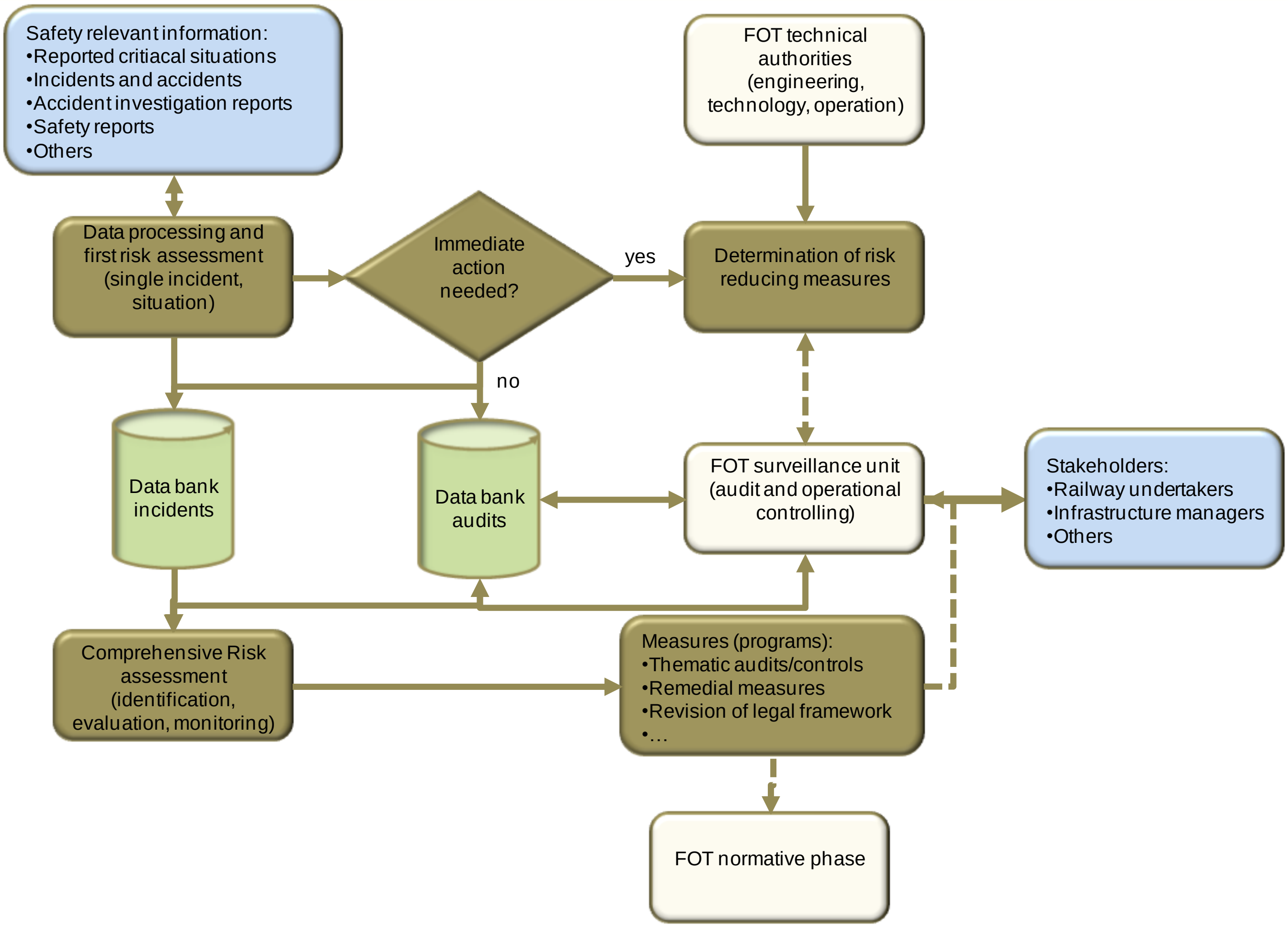

Figure 3: Schematic representation of the FOT risk management process. Brown coloured elements are part of the risk management process. White elements are part of supervision processes. Light blue coloured elements are stakeholders outside FOT.

Safety relevant data are collected form accident and near-accident reports as well as annual safety reports of RU and ISM. Another important data source is potentially critical situations reported by collaborators of FOT or of railway companies or even third persons like e.g. passengers (risk notices). The data are complemented with the results of audits and operational controls (e.g. technical controls of freight wagons or track side train monitoring systems).

In a first step, the data is analysed in terms of quality and safety relevance. Subsequently follows a first risk assessment, including basically the identification of unusual patterns, increased frequencies, etc. with the aim to identify, if required, immediate action. In this case, appropriate measures are determined in collaboration with the FOT technical authorities (engineering, safety technology and railway operation) and the competent unit for surveillance. In most cases, measures include additional topics for already planned audits or specific operational controls on a short term.

Periodical rough risk assessments are performed on the basis of the entire (e.g. net wide risk level) or large parts (e.g. evaluation of specific topics like collisions at level crossings) of the collected data. A major result of these assessments consists of a list of prioritized risks (e.g. collisions, derailments, fire in rolling stock, etc.) including estimation of likelihood and consequences and prognosis of their future development. Based on prioritization, specific risk topics are chosen for further detailed analysis (precursors, relevant causes).

Depending on the results, company-specific or net wide measures (e.g. thematic audits for all concerned companies, remediation programs, operational limitations or interdictions) or even adaption of the legal framework are determined in collaboration with the other three FOT phases. The implementation of imposed measures is controlled on a regular basis according to the nature of the measures.

In contrast to purely reactive action based on the analysis of single incidents or retrospective analysis of statistical incident data, this comprehensive set-up of risk management allows for the identification and prioritization of all relevant risks and a prompt implementation of effective measures with respect to risk reduction an costs (Fig. 4). Changes in the safety level of the railway network, mandatory risk mitigations and needed measures can be systematically and continuously evaluated.

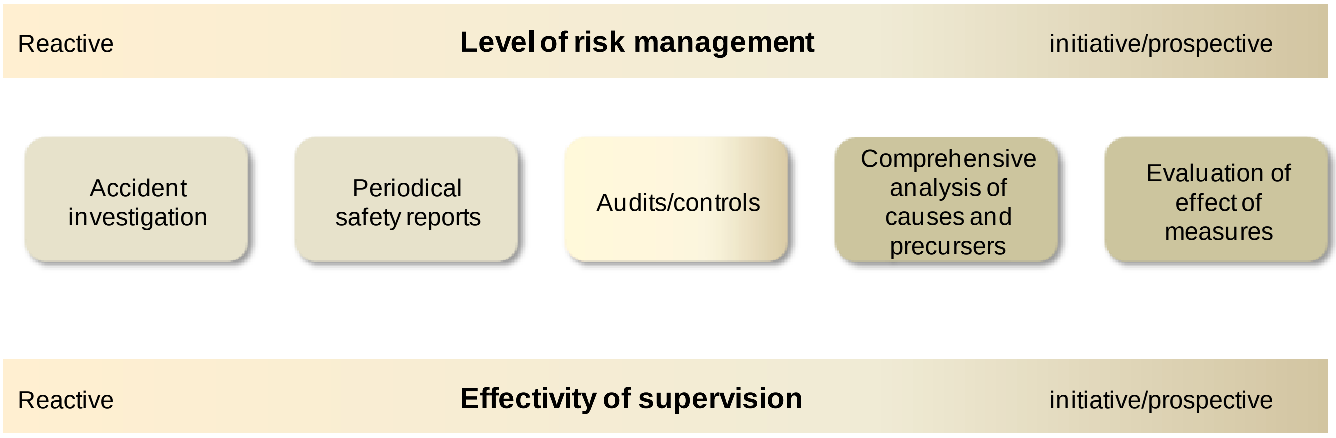

Figure 4: Level of risk management and effectivity of supervision.

Risk management in the process of safety certificate and safety authorization issues

According to directive 2004/49 EC (railway safety), railway undertakers (RU) must hold a safety certificate to receive network access authorization and infrastructure managers (ISM) must obtain a safety authorization in order to be allowed to manage and operate a rail infrastructure. While applying for a certificate or an authorization RU and ISM have to submit their Safety Management System (SMS) to FOT. The plausibility of the SMS is tested by the FOT technical authorities. Analysis and assessment of the available company-specific and safety relevant data is an essential requirement for the ability to test the processes described in the submitted SMS. The data taken into account includes incident reports, risk notices, constraints or requirements from audits and operational controls etc. (Fig. 5). It is analyzed and evaluated with respect to unusual patterns, e.g. unusually high frequencies of (near-) collisions, compared to net wide averages, or repeatedly reported critical situations at construction sites together with requirements from audits about the implementation of the process for contracting construction companies. The conclusions of the assessment can have an influence on the decision whether to issue a certificate / an authorization or not or the duration of it.

The results of the plausibility test are documented in a written statement, which will be used as a basis to formulate the injunction. The plausibility test of the processes described in the SMS may itself give rise to further safety relevant information, e.g. need of short term controls of the implementation of specific processes within the framework of an audit. This information is reintroduced in the risk management process as an element for the planning of future surveillance actions.

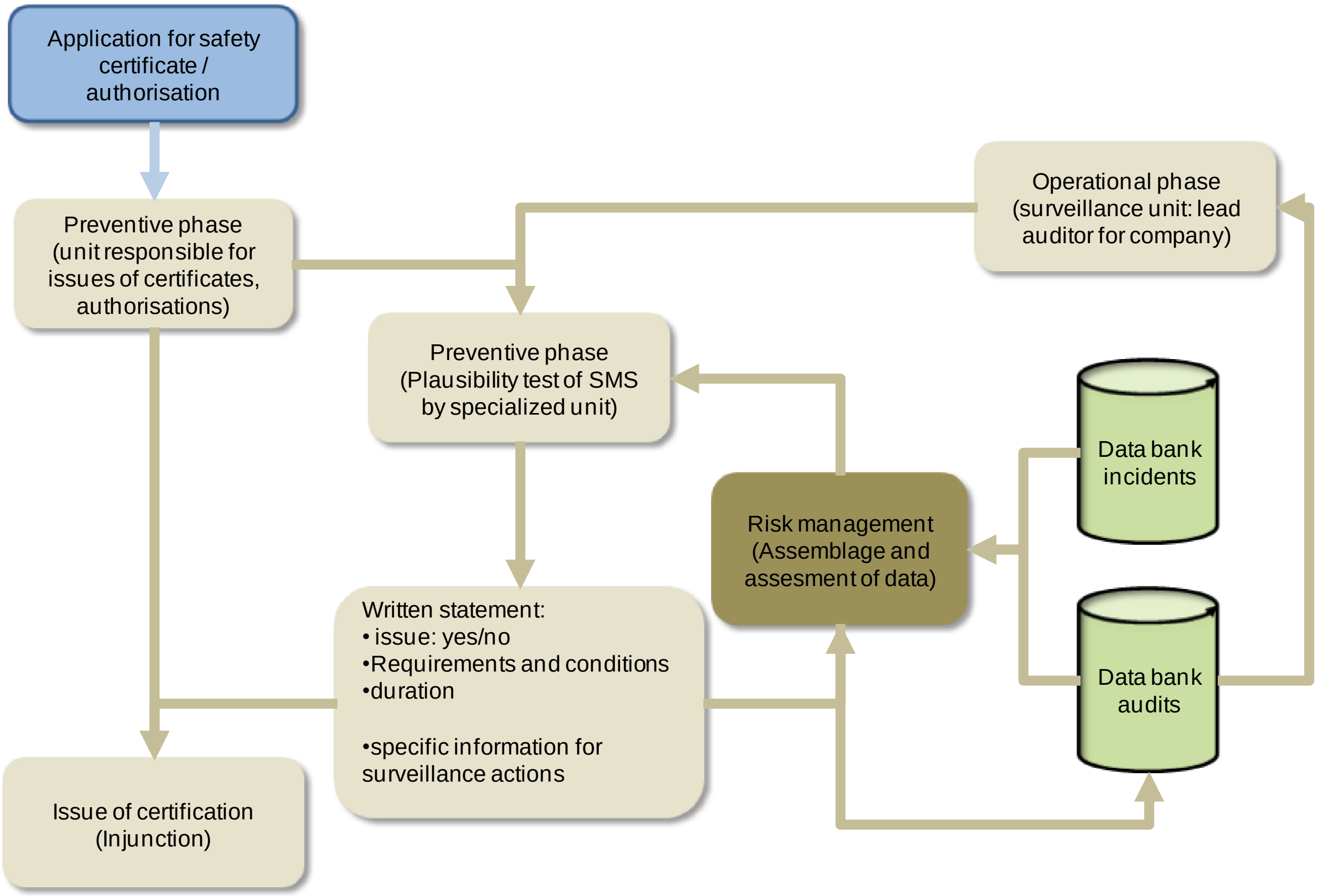

Figure 5: risk management as an important supply for safety relevant information for the process of safety certificate and safety authorization issue.

Mitigation of specific risks: level crossings

In 1999, the FOT requested that railway companies shall take their responsibility with respect to the risks related to level crossings. In a first step, the most dangerous level crossings should be eliminated or otherwise technically upgraded until 2007. In a second step all other level crossings, which do not comply with the regulations, should be eliminated or upgraded until the end of 2014.

Figure 6 presents the time series of accident rates and consequences (fatalities) at level crossings on the Swiss railway net since the year 2000. Accident rates can vary considerably from year to year. Overall, there is no visible trend. This gives rise to the following three assumptions: (1) the remediation program has only a marginal effect, (2) the effect is not yet visible because 1'200 level crossings are still to be remediated, (3) the remediation program has so far, at least prevented a potential increasing trend. Such a trend would be expected since train frequencies on many track lines increased by factors of 2 - 4 and the average 24-hour traffic volume in Switzerland by roughly 15 %.

Annual fatality rates indicate on average lower rates since 2005. Taking into account that the criteria for identification was the sighting time (< 6 seconds), it could be assumed that this pattern is due to the remediation of the 190 most dangerous level crossings, since very low sighting time means that the time for the locomotive driver to break is very short and consequently, collision speeds are on average higher.

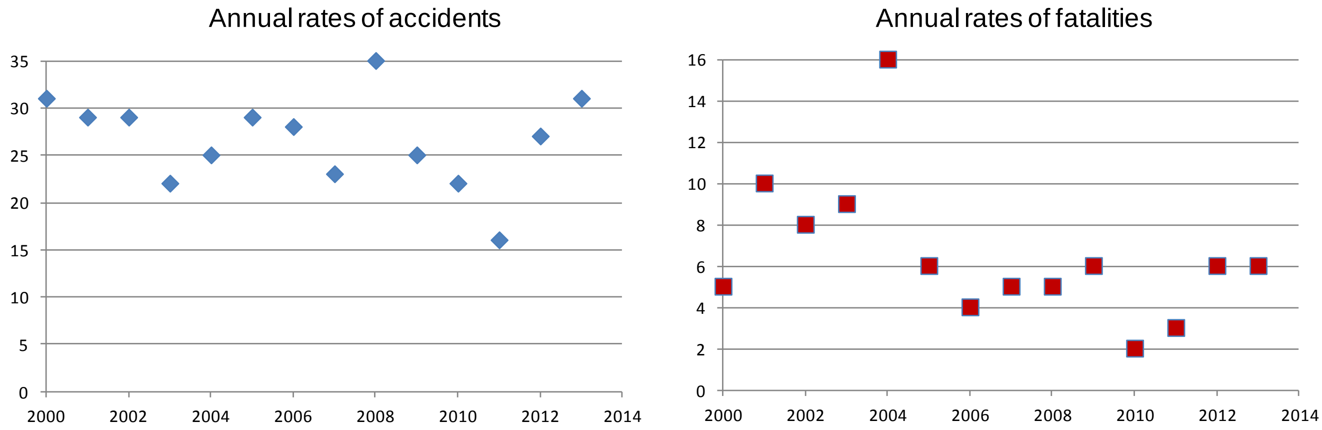

Figure 6: Annual rates of accidents (blue diamonds) and fatalities (red squares) at level crossings of the Swiss railway net.

The table in Fig. 7 presents average accident rates per year divided by the number of level crossings of a certain signaling or installation categories for the period 2000 to 2013. Accident rates at level crossings equipped with flashing light systems or traffic light signals are approximately 5 times and 10 times higher if compared with level crossings equipped with St. Andrew's crosses and (half-) barriers, respectively.

According to the regulations for railways in Switzerland, level crossings have in general to be equipped with barriers or half barriers. The installation of flashing light systems as derogation from this general rule is only allowed, if road traffic is low or the installation of (half-) barriers would represent disproportionate efforts. However, even though less than 10 % of the level crossings of the Swiss railway net are equipped with flashing/traffic light systems, they account for roughly one third of the accidents. In more than 90 % of the cases, disregard of signals by road users caused the accidents.

Categories of level crossing	Average accident rate per year and number of level crossings
(half-) barriers	0.002 ± 0.001
Flashing or traffic light systems	0.023 ± 0.008
St. Andrew's cross or no signaling	0.004 ± 0.001

Figure 7: Average accident rate per year and number of level crossings of a certain signaling or installation categories.

The need of further risk assessment is supported by the analysis of tram level crossings (Fig. 8). Since 2000, accident rates are continuously increasing, even if the increase of the number of level crossings due to the construction of new lines is taken into account.

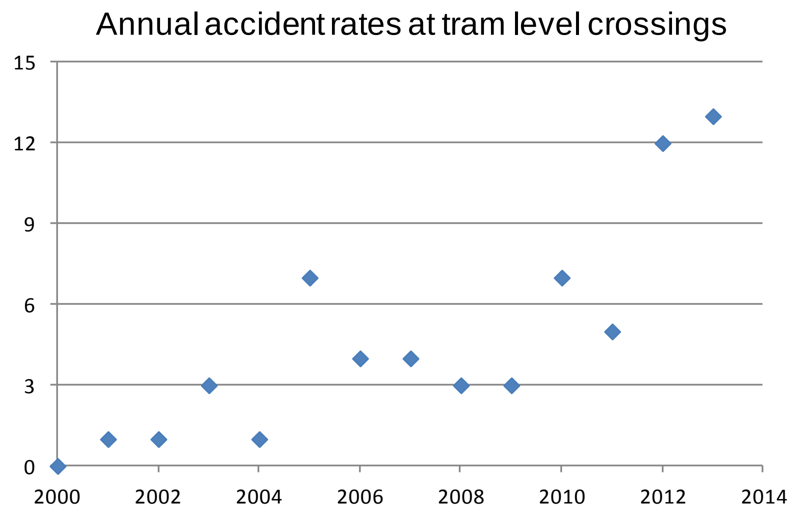

Figure 8: Annual accident rates at tram level crossings equipped with traffic light systems in Switzerland. The accident rates are not normalized with respect to the number of level crossings, which increased over the past years due to the construction of new tram lines.

Average accident rates at level crossings with flashing light systems, the increasing number of level crossings secured by traffic light systems at tram lines and the obvious misconduct ion of road users indicate need of action. However, these results are not sufficient with respect to a decision process. Detailed risk assessment (calculation of probabilities and consequences based on statistical evidence for causes and precursors) has to be performed to be able to discuss acceptance levels and evaluate the effect of potential measures. After implementation of the measures, the development of the risk level has to be monitored to verify the assumed effects. These activities have to be concentrated and structured within a risk management process.

CONCLUSIONS

Structural changes in the railway system but also the application of more and more complex technologies influence the duties and activities of national safety authorities. To be effective, the supervision of a national railway system must rely on a risk based approach.

The implementation of a comprehensive risk management process allows for the identification, assessment and monitoring of the development of net wide or company-specific risks. Moreover, it generates the required basis for the identification of suitable measures, the evaluation and the control of their effectiveness.

By assembling and processing safety relevant data, identifying and assessing risks, the risk management process is a very effective driving wheel for the needed information transfer between different supervision phases of a national safety authority.