Common Safety Indicators and Common Safety Targets of European Railways

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Abstract

The process of creating an internal European rail market is in progress. The introduction of the first railway package of European Directives in 1995 created a common framework for access to railway infrastructure, for licensing and safety certification and for allocation of railway infrastructure capacity.

The second railway package of European Directives in 2001 concerning rail transport aspects expanded on this approach by adding the safety aspects, extending the work on interoperability to new areas and putting it all into a comprehensive, clear and consistent context.

The Safety Directive (2004/49EC) is aiming for a position whereby a set of Common Safety Targets (CSTs) for monitoring safety performance and an agreed set of Common Safety Indicators (CSIs) be used to ensure that measured safety performance (the effectiveness of Safety Management System) of different organisations are comparable and are related to CSTs.

Common Safety Targets (CSTs) and Common Safety Indicators (CSIs) are to measure the safety performance and the effectiveness of the SMS therefore they are key-characters of the railway system.

This paper addresses the main process on how Common Safety Indicators and Common Safety Targets should be identified and how the Common Safety Indicators should be measured. However, the discussions on this topic identified some gaps and led to the additional setting up of Specific Safety Indicators and Specific Safety Targets.

Common Safety Targets are the reference for the whole system Specific Safety Targets should be derived for different parts of the railway system in addition to common safety targets. This would suggest an apportionment of the common safety target to specific parts.

The main question concerns the level at which the Specific Safety Targets should be defined.

Deriving acceptable risk levels for the various parts of the railway system requires first a classification of all the risks into various categories, and then the assignment of a target or acceptable risk level to each category, with respect to each group(s) exposed to the risk. Such a process is also called risk apportionment.

Nevertheless Safety Targets could be quantitative and qualitative as well and should be derived by analysis of different level of the system or part of the system.

The paper is to give an overview on the state of the art (based on the results of EU SAMNET project) of development of Common Safety Targets and Indicators including the results of justifying the setting up of Specific Safety Targets and Indicators for European railway undertakings and infrastructure managers.

1 Introduction

The introduction of the first railway package of European Directives created a common

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framework for access to railway infrastructure, for licensing and safety certification and for allocation of railway infrastructure capacity. The European Directives on interoperability concern the global approach to all rail transport aspects, the second railway package published in 2001 (Directive [8]) expanded upon this approach by adding the safety aspects, extending the work on interoperability to new areas and putting it all into a comprehensive, clear and consistent context.

SAMNET "SAfety Management and interoperability thematic NETwork for railways system" [6] was a project launched by the European Commission in 2003 to investigate and to propose the approaches to specify and to implement the requirements identified in the Safety Directives. In particular, issues concerning policies on Safety Management System, Common Safety Indicators, Common Safety Targets and Common Safety Methods were addressed by this project. The aim was to promote knowledge, experiences and best practices collected during the projects to various types of audience including Regulatory Authorities, Transport Authorities, Transport Operators, Managers of Infrastructure, Standardisation Bodies, Notified Bodies, Universities and Research Centres, Passenger Organisations, Manufacturers and Engineering Companies. The main results of the SAMNET project that ended its activities on December 2005 are summarised in the SAMNET synthesis report [13].

2 European Safety Directive

The European Safety Directive (2004/49EC) aims at harmonising the regulatory structure that enforces railway operation and to ensure the development and improvement of safety on the Community’s railways by:

- Maintaining the overall level of railway safety in each Member State,
- Harmonising the regulatory structure in the Member States,
- Defining responsibilities between the actors (IM, RU,..)
- Developing common safety methods, common safety indicators and common safety targets,
- Requiring the establishment, in every Member State, of national safety authorities and national bodies for accident investigation,
- Defining common principles for the management, regulation and supervision of railway safety.

The Directive describes the actors involved in railway safety management, a harmonised structure of safety management and the roles and responsibilities of each actor within it:

- European Infrastructure Managers
- European Railways Undertakings
- European Member States Railway Safety Authorities
- European Member States Investigating Bodies
- European Members States
- European Railways Agency
- European Commission
3 Main structure of CSTs and CSIs in the EU Safety Directive

Directive 2004/49/EC (Safety Directive) states:

Article 3:

“CSTs means the safety levels that must be reached by the different parts of the rail system (such as the conventional rail system, high speed rail system, long railway tunnels or lines solely used for freight transport) and the system as a whole, expressed in risk acceptance criteria”.

CSTs can refer to different “at risk groups” such as passengers, staff, track workers etc. Besides these groups a distinction can be made between individual risk and collective or societal risk.

Individual risk defines the chance of a person dying due to a certain activity. This is most often expressed globally in the probability of “fatalities per year”. Individual risk is measured in terms of the probability of a “fatality per individual per year”. Societal risk deals with the consequences of a railway accident on the environment (in terms of harm and damage). For instance, accidents with several fatalities have a greater impact on society than accidents with one or two fatalities. Societal risk can be expressed in group risk which refers to the society’s acceptability of accidents with several fatalities. It should be noted: a definition of societal risks is still to be agreed meanwhile the UIC Safety Platform have proposed a description as a basis “total number of deaths and of injuries (per year) due to railway accidents affecting large groups of population outside the boundaries of the railway”.

Article 5:

In order to facilitate the assessment of the achievement of the [Common Safety Targets] and to provide for the monitoring of the general development of railway safety, Member States shall collect information on Common Safety Indicators (CSI) through the annual reports of the safety authorities as referred to in Article 18.

Article 7.3:

The first set of draft CSTs shall be based on an examination of existing targets and safety performance in the Member States… All proposals for draft and revised CSTs shall reflect the obligations on Member States...

Article 7.4:

CSTs shall define the safety levels that must at least be reached by different parts of the railway system and by the system as a whole in each Member State, expressed in risk acceptance criteria for:

a/ individual risks relating to:

- passengers
- staff including the staff of contractors
- level crossing users and others,

and, without prejudice to existing national and international liability rules, individual risks relating to unauthorised persons on railway premises

b/ societal risks
According to the Art 7.4 the Directive requires at least five different Common Safety Targets that must be reached in each Member State.

These correspond to:
- Global individual risk for passengers
- Global individual risk for staff
- Global individual risk for level crossing users and others
- Global individual risk for unauthorised persons on railway premises
- Global societal risk

As the Safety Directive is aiming to set Common Safety Targets (CSTs) for monitoring safety performance, it is essential that an agreed set of Common Safety Indicators (CSIs) be used to ensure that measured safety performance (the effectiveness of Safety Management System) of different organisations are comparable and are related to CSTs. CST should be defined on the basis of Common Safety Indicators (CSIs) that could reveal areas where progress appears to be possible or needed.

It is absolutely vital that CSIs are be reliable. They will be used to determine future investment policy. They will be inevitably used by the news media and politicians to judge the relative performance of national railways. Rail safety performance is a politically sensitive topic, attracting extensive coverage in the news media in all countries, especially after serious rail accidents.

The Safety Directive gives very little information about the content of the CSTs. What is certain is that they should define a safety level and must take the form of risk acceptance criteria, i.e. they must detail the risks that are considered acceptable for individuals or society. The questions as to whether they should be qualitative or quantitative targets or both and how the concept of societal risks is to be understood, remain unanswered.

- Possible qualitative targets can be defined
  - To ensure safe operation through sufficient legal requirements
  - To implement proactive measures for risk reduction where necessary for ethical, social, legal or economic reasons
  - To use suitable methods applied in other safety-critical industries, e.g. selection tests

- Possible quantitative targets can be defined
  - Numerically quantifiable individually and socially acceptable existing risks at various system levels, e.g. annual reduction of shunting accidents
  - Subsystem dependent risk acceptability criteria, e.g. through comparison with the existing risk level
  - Safety performance of other modes of transport, e.g. fewer deaths per passenger

4 Relationship between CSTs and CSIs

Safety Targets are to be expressed in acceptance risk criteria. This does not pose any problem for individual risk as it relates to the probability for an individual to have an accident.

There is as yet no common understanding of societal risk and it has been difficult to
understand the usefulness of the concept. This risk is expressed as a collective risk and not an individual risk, and is meant to essentially include risks of catastrophic accidents involving people and the environment, for example the release of dangerous goods. Since these events ought to be extremely rare, it is considered that a factor for scaling would not be necessary therefore a unit per year for each country is suggested.

Societal risk including possible large societal effect proposed by SAMNET should contain:

- Risks that affect society as a whole, such as environmental harm. This is in addition to the total risk of harm to groups such as individual passengers, staff, level crossing users and unauthorised persons,
- Risks to persons living near the railway (railway neighbours),
- Risks of collective accidents, that is of accidents causing multiple fatalities,
- Intermodal effects, for example the fact that passengers will transfer to road because they perceive the railway to be unsafe,
- The risk that the public will lose trust in the institutions of the State.

As the Safety Directive is aiming to set Common Safety target (CST) for monitoring safety performance, it is essential that an agreed set of Common Safety Indicators (CSIs) be used to ensure that measured safety performance (the effectiveness of Safety Management System) of different organizations are comparable and are related to CSTs. Each of these safety targets would need to be defined with adequate Common Safety Indicators (CSIs).

An example is shown below.

<table>
<thead>
<tr>
<th>Common Safety Targets</th>
<th>Common Safety Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of death or injury to passengers from any causes</td>
<td>Total number of deaths and of injuries on railway premises from any causes (per passenger km) including falls on station platforms, accidents due to passenger behaviour etc</td>
</tr>
<tr>
<td>Risk of death or injury to railway employees</td>
<td>Total number of deaths and of injuries (per track km); includes staff employed by contractors</td>
</tr>
<tr>
<td>Risk of death or injury to innocent third parties</td>
<td>Total number of deaths and of injuries (per train km); includes harm to persons correctly using level crossings or living near the railway</td>
</tr>
<tr>
<td>Risk of death or injury to illegitimately present third parties</td>
<td>Total number of deaths and of injuries (per train km); includes trespassers and persons using level crossings incorrectly and cause the accident</td>
</tr>
</tbody>
</table>

Table 1: Global Safety Targets and Indicators.
Commonality for targets could therefore be considered only as applicable to objects which are the same in all of the Member States such as generic functions, sub-systems, operations or part thereof which are characteristic of all area of the European rail system. Safety targets applied to requirements in TSIs, sub systems or Interoperability Constituents are good examples of such Specific Safety Targets. Deriving acceptable risk levels for the various parts of the railway system requires first a classification of all the risks into various categories and then the assignment of a target or acceptable risk level to each category with respect to each group(s) exposed to the risk. Such a process is also called risk apportionment. There are several ways of classifying risks depending on their various characteristics. We can identify roughly 5 distinct approaches for the classification of risks [13] and derivation of acceptable risk levels for parts of the railway system:

- System breakdown approach (drivers, rules, onboard control, trackside control)
- Breakdown by categories of hazard causes (technical faults, human error, operational failure)
- Functional breakdown approach (route setting, train driving, train control, train regulation)
- Breakdown by hazard types (over-speed, SPAD, wrong signal transmission)
- Breakdown by accident types (fire, collisions, derailments)

These 5 approaches (5 possible structures for Specific STs) correspond in fact to different levels of detail that can be focused on when analysing safety of a railway system. This can be illustrated by the following figure showing the hierarchy in a typical safety requirement allocation process [4]:

![Figure1: Proposed apportionment of safety targets](image)

SAMNET project proposed to use CSTs and if necessary Specific (Common) STs related to identified parts of the railway system. Specific STs could be considered together with related Specific Safety Indicators (SSIs) as the latter could provide feedback on the effectiveness of the barriers.

It is not obvious that Specific Safety Targets need to be Common – that is, they may not need to be harmonised and indeed could be different from MS to MS but these stakeholders will need to take any CSTs set at national level into account.
CSTs should be defined within an overall goal that provides a framework for safety decisions. One or more corresponding Common Safety Indicators (CSIs) can measure the level to be achieved by Member States. It should be noted that SAMNET suggested using the name of Global (system-wide) Safety Target instead of Common Safety Targets.

Common (Global) Safety Indicators: measure the overall level of safety of the railway within a Member State.
Specific Safety Indicators: measure the effectiveness of the SMS e.g. of individual companies (RU & IM) or probability of critical events e.g. SPADs, human faults, external causes.

Stakeholders such as RUs, IM and the manufacturers, would have to set their own specific safety targets in coordination with the principle players. These stakeholders will still be required to take any Common (Global) STs set at national level into account.

The safety level of the whole system must be reached by different parts of the system. Firstly the performance of the whole system and the effectiveness of Safety Management System should be measured.

6 Functional breakdown approach for CST apportionment

The railway system is decomposed in six sub-systems that are:

- energy,
- infrastructure,
- control command and signalling,
- rolling stock,
- operation and
- telematic.

Maintenance is specific in every sub-system. These subsystems are performed by a number of functions, which are implemented by a number of resources and programmes. All these elements constitute the Representative Architecture of the conventional rail system ([10] and [5]). This approach showed that if some functions can clearly be allocated to the IM or to the RU, responsibilities within other functions are shared. The shared responsibility aspect of some functions may derive from the goal of the function that involves both the IM and the RU or from the way it is implemented.

Ensuring safe railway operations can also be expressed in a qualitative way. Both qualitative and quantitative safety targets can be allocated from a bottom-up approach as well as a top-down approach. A CST is expressed as a risk [4] (i.e. a combination of frequency and severity of harmful events). It is important to stress that whichever way the risks might be apportioned for defining CSTs, there will still be some rather complicated safety allocation process necessary behind in order to derive (qualitative and quantitative) safety requirements.

CSTs are the reference to derive CSTs for the various parts of the railway system because the specific acceptable risk levels should be derived for these different parts of the railway system as well as for the global safety targets.

The AEIF breakdown structure to set up targets at Member State seems to be a tool to share the responsibilities between RUs and IMs in an adequate way.
All deliberations on the definition of targets must be based on an analysis of the ratio between cost and benefits taking into account political, social and economic commensurability.

7 Conclusions

7.1 Common Safety Targets

• Use global CSTs to meet more closely the requirements of the safety directive for CSTs.

• Specific CSTs could be considered together with related specific CSIs as the latter could provide feedback on the effectiveness of the barriers. The specific targets development should start from Specific Safety Targets existing in some member states, which could be harmonised to become Specific Common Safety Targets. (Common does not necessarily mean harmonised but rather more accepted or recognised).

• The common safety targets are for the NSA to supervise the system safety level. Targets are also necessary at TSI level to facilitate acceptance of innovative product.

7.2 Common Safety Indicators

• Definition of separate sets of CSIs for general and specific part of the railway

• The societal risk should have a defined definition and common agreement before using it.

• Concerning suicide, it is proposed to treat this category separately out of the safety indicators. Moreover, imposing a common indicator for suicide seems outside the scope of the Safety Directive, although were this to change, an indicator for suicide could be easily accommodated.

• The harmonisation of terminologies of different parameters and examination of data consistency using for CSIs is unavoidable. Especially a common agreement needed for the definition of serious injuries

• It is suggested to use fatality data until there is a consensus on how to define and measure injuries. Serious injuries have a great importance in measuring safety performance and therefore should be included into the safety measuring process

• Specific targets and specific indicators should be based on frequency of occurrence of critical events that might have resulted in an accident. They should apply to the more frequent and serious critical events (e.g. SPAD). The Specific CSIs should be monitor the effectiveness of SMS.

• Need of Global Indicators first then see if there is a need of Specific Indicators

• Indicators should be aligned with targets, we should be developing the indicators that we have

• Indicators about direct financial costs of accidents are of no use for the purpose
• Indicators of management of safety should be done by external audits that are comparable and consistent, e.g. ERA to supervise the accreditation and standards for the auditors.

7.3 Final proposal of SAMNET project for Common (Global) STs and Common (Global) Safety Indicators

The final conclusions and proposal is shown below:

<table>
<thead>
<tr>
<th>Common (Global) Safety Target</th>
<th>Indicator (for one Member State, per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk of death or injury to passengers as a result of train operations or who are harmed by any other means</td>
<td>Total number of deaths and of serious injuries on railway premises as a result of train operations or who are harmed by any other means (possibly scaled as “per passenger km”) - this would include falls on station platforms, accidents due to passenger behavior etc</td>
</tr>
<tr>
<td>Risk of death or serious injury to railway employees</td>
<td>Total number of deaths and of serious injuries (per track km); includes staff employed by contractors</td>
</tr>
<tr>
<td>Risk of death or injury to innocent third parties</td>
<td>Total number of deaths and of injuries (per train km); includes harm to persons correctly using level crossings or living near the railway includes trespassers and persons using level crossings incorrectly and contributing to the cause the accident</td>
</tr>
</tbody>
</table>

*It may be effective to separate track workers and on-train staffs. “Track km” may be the correct scaling parameter for track workers but it is unlikely to be correct for on-board workers*

*It should be noted that in practice it is often not possible to identify innocent and culpable third parties. Care will need to be exercised by Member State to ensure a satisfactory way is developed for determining into which category each victim should be placed*

Table 2: Proposal for Common (Global) Safety Targets and Indicators

The Common (Global) SI related to the total number of deaths and of injuries (per train km); including harm to persons correctly using level crossings or living near the railway takes into account the trespassers and persons using level crossings incorrectly and cause the accident. This position merges the safety targets related to the risk of death or injury to innocent third parties and the risk of death or injury to illegitimately present third parties.
References