EUROPEAN UNION AGENCY FOR RAILWAYS

Making the railway system
work better for society.

Full Impact Assessment

COMMON OCCURRENCE[1] REPORTING PROJECT

	Elaborated by	*Validated by*	*Approved by*
Name	Antanas Dubikaitis Torben Holvad Marian Marculet Martin Schroeder	Antonio D'Agostino & Oana Gherghinescu	Christopher Carr
Position	Project officers	HoS of Safety Strategy & Performance / HoS of Economic Evaluation	HoU Safety
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Signature			

Document History

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1.0	23/11/2017	First draft proposal for external consultation
1.1	31/05/2018	Updated IA following external consultation

[1] Occurrence means any safety-related event which endangers or which, if not corrected or addressed, could endanger a train or any rolling stock, its passengers, staff or any other person, and includes in particular an accident and incident.

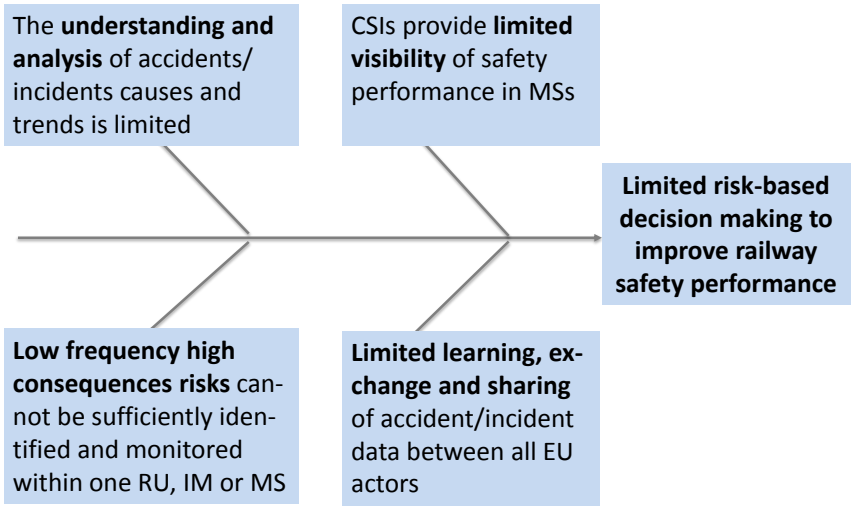
Contents

1. Context and problem definition

1.1. Problem and problem drivers

EU experiences **a concerning persisting number of multi-fatal train accidents**[2] (involving passenger trains or TDG freight trains) as well as **other accidents and incidents** (see Agency's Railway Safety Performance Report). This is driven by multiple factors, such as infrastructure-related, rolling stock and operations related, as well as the *weak information management of accident and incident causes, precursors, risks and trends*.

In particular, weak information management of accident and incident allows only **limited risk-based decision-making** to improve railway safety performance. Four main drivers of this problem have been identified, as displayed below:



1. *The understanding and analysis of accidents / incidents causes and trends is limited*

Lack of indications regarding accident causes is limiting the extent to which appropriate preventative and mitigating measures are introduced by the relevant stakeholders, notably RUs and IMs (as otherwise provided for in the CSM for Monitoring[3]).

2. *CSIs provide limited visibility of safety performance in MSs*

Currently, the harmonised safety reporting measures for the EU consist of the CSIs and the annual safety reporting requirements of the Safety Directive. While they provide only a basic level of information about safety performance, in some Member States they are the only safety data that are collected on EU and sometimes on the Member State level.

[2] For example, six multi-fatality accidents occurred in 2016 in the EU (Bad Aibling – Kolbermoor (DE), Serres (EL), Hermallesous-Huy (BE), on the Bari – Barletta line (IT), O Porrino (ES) and Hitrino (BG)). Please also refer to the last 2016 biennial report on railway safety performance in the European Union for more information about current safety trends.
[3] Regulation No 1078/2012 on the Common Safety Method for Monitoring.

	3. *Low frequency high consequences risks cannot be sufficiently identified and monitored within one RU, IM or MS* Low frequency-high consequences accident risks can be very difficult to predict and therefore manage and avoid (e.g. collisions and derailments[4]) especially for single companies / countries due to the limited number of observations. 4. *Limited learning, exchange and sharing of accident/incident data between all EU actors* For the Member States which do collect greater levels of safety data compared to the EU requirements, their systems and tools for doing so are diverse. There is not a strong, consistent practice of sharing data and working collaboratively at cross-industry and international level to learn lessons from accidents and incidents. It should be noted that the order of magnitude of the problem and the associated problem drivers experienced by Member States will vary. In particular, for MSs already having comprehensive occurrence reporting systems the extent of the problem would be more limited. However, especially for problem drivers no. 3 and 4 there is a European-wide issue at stake.
1.2. Main assumptions	The current impact assessment uses assumptions of the DNV study on occurrence reporting, in particular Report on Task 3 – Impact Assessment (2015)[5] related to the costs of reporting occurrences as well the existing situation of occurrence reporting in each Member State. Furthermore, Task 1 of the same DNV study provided an overview of the current situation with regard to existing National Occurrence Reporting Regimes and Systems[6]. Concerning the evaluation of expected benefits, a potential impact of COR to safety improvements in the railway sector is acknowledged. However, this impact is not assessed in more detail in Section 4 as it can be very misleading to make estimates of how many accidents would be avoided by the use of COR as part of an efficient proactive and evidence based safety system.[7] This choice of approach makes the impact assessment credible by avoiding the inclusion of quantitative estimates of safety benefits based on uncertain assumptions.
1.3. Stakeholders affected	The relevance of the problem is scored from 1-low to 5-high for each of the categories of relevant stakeholders. Based on the information

[4] The CSI data from 2015 shows that only 6 countries with more than 5 collisions.

[5] See Task 3 of DNV study – Impact Assessment: http://www.era.europa.eu/Document-Register/Pages/Impact-Assessment.aspx

[6] See Task 1 of DNV study – 'An assessment of existing National Occurrence Reporting Regimes and Systems'; http://www.era.europa.eu/Document-Register/Pages/Assessment-of-Existing-National-Occurrence-Reporting-Regimes-and-Systems.aspx

[7] For the same reason, the European Commission Impact Assessment on occurrence reporting in civil aviation (2012) does not quantify benefits from potential safety improvements.

provided in the Roles paper, the following stakeholders are most impacted.

Stakeholders	*Importance of the problem*
Railway Undertakings (RUs) / Infrastructure Managers (IMs)	5
Railway National Safety Authorities (NSAs)	5
EU Member State governments	4
European Commission - DG MOVE	3
European Union Agency for Railways (ERA)	3

In addition, the Roles paper identifies other stakeholders likely to be positively impacted by COR:

- Entities in charge of maintenance (ECMs)
- National Investigation Bodies (NIBs)
- Transport of Dangerous Goods (and its Competent Authorities)

As the impact for these stakeholders is considered to be significantly lower compared to the main impacted stakeholders, this impact assessment does not take into account their impacts in more detail.

1.4. Evidence and magnitude of the problem

Several information sources provide evidence concerning the problem and the magnitude of the problem:

› *DNV study on occurrence reporting, in particular Report on Task 3 – Impact Assessment (2015)*
› *European Commission Impact Assessment on occurrence reporting in civil aviation (2012)*
› *Inputs from Common Occurrence Reporting Workshop participants*
› *Other inputs from sector and authority stakeholders*
› *Studies undertaken for railway systems outside Europe and / or other transport modes / other economic sectors*

The main conclusions depicted from these sources are:

1. There are currently **a variety of approaches between the EU Member States concerning the scope and extent of national reporting.** According to the DNV study:

› *11 Member States had a basic occurrence reporting regime[8],*
› *8 Member States had intermediate occurrence reporting regime[9],*

[8] National Occurrence Reporting is largely confined in scope to the reporting requirements of the Common Safety Indicators and the need to notify the NIB of significant accidents.
[9] National Occurrence Reporting goes beyond EU legal minimum requirements of the Common Safety Indicators and the need to notify the NIB of significant accidents, but is either not fully comprehensive or not clearly part of a wider process to turn occurrence reporting into information and then mitigating action.

	› *while 10 Member States had comprehensive occurrence reporting regime*[10] 2. The available CSI information shows that **the ratio between the total number of precursors and total number of significant accidents is not stable, but strongly growing** over the period from 2006 to 2015 at EU level (although this trend is not uniform among the considered countries). 3. The **investigated occurrences represent a fraction of the total number of significant accidents and accident precursors**. In the Agency's Safety Performance Report from 2016 it is mentioned that for each investigated occurrence by the NIB there are 10 significant accidents and 55 accident precursors as defined under the CSIs. The extent of RU/IM investigation into significant accidents and into accident precursors at the EU level is not known. The results of these RU and IM investigations are not systematically shared with other actors or authorities. 4. **Efficient safety management is likely to be significantly enhanced by the analysis of data collected from occurrences reporting schemes,** in particular for low frequency-high consequences accident risks (e.g. collisions and derailments) where individual countries, railway undertakings or infrastructure managers often would have too few observations to undertake any robust analysis. Evidence from **other sectors** was also analysed: › ***Aviation**: Available evidence points to the possibility that an integrated data-driven strategy for improving safety performance can lead to lower safety-related costs of more than 70% as mentioned in the European Commission's Impact Assessment on occurrence reporting in civil aviation from 2012.* › ***Nuclear:** IAEA (2005)[11] concluded that '…nuclear power plants increase the use of feedback from low level events in their day-to-day activities, as this is an important contributor in improving safety performance'.* › ***Mining:** Ekevall, Gillespie and Riege (2008)[12] highlighted that '…safety performance in the Australian mining industry has now stabilised above the target of zero harm. Further progress will require tools that are adapted to contemporary decision-making needs that greater excellence in safety reporting is the first step on this journey'.*

[10] The national occurrence system extends into a comprehensive system for reporting accidents, incidents, and near misses. It is a part of a defined process for turning data into information and then subsequent mitigating action as part of a holistic approach to the management of railway safety at the Member State level.

[11] International Atomic Energy Agency (2005) Trending of low level events and near misses to enhance safety performance in nuclear power plants, IAEA report: IAEA-TECDOC-1477.
http://www-pub.iaea.org/MTCD/publications/PDF/te_1477_web.pdf

[12] Ekevall, E., Gillespie, B. and Riege, L. (2008) Improving safety performance in the Australian mining industry through enhanced reporting, PWC report,
(https://www.pwc.com/gx/en/energy-utilities-mining/pdf/safetypaper_english_final.pdf).

	› ***Health care:*** *Simon, Lee, Cooke and Lorenzetti (2005)[13] concluded that '…Incident reporting (including near misses) can provide valuable qualitative and quantitative data relevant to incidents and adverse events, which in turn can potentially guide organizational and clinical interventions to decrease risks'*
1.5. Baseline scenario	The likelihood that the problem would persist if no action is taken is high. In particular, if no action is taken there could be a missed opportunity to use the common occurrence data for better informed decision making in the safety field.
1.6. Subsidiarity and proportionality	The identified problems would be cumbersome to address efficiently and effectively **by Member States alone** since this would require each Member State to conclude bilateral agreements with all other Member States leading to increased complexity and administrative burden. **Self-regulation** would neither be a feasible approach due to the potential significant administrative burden linked to the required coordination effort as well as reluctance regarding sharing information between different (commercial) entities in the railway sector. **EU action** is likely to address better the identified problems by reducing the burden of coordination (multilateral rather than bilateral arrangements) as well as minimizing the problem linked to lack of willingness to share information by bringing in an independent party. The **Agency** in cooperation with the railway sector is well positioned to address the problem in view of developing a common approach to safety in accordance with the Agency Regulation and the Safety Directive. The problem will be addressed in full respect of the **proportionality principle**, attempting to identify the optimal level of information which is subject to common reporting, as well as the optimal setting/architecture for exchanging the information.

[13] Simon, A., Lee, R.C., Cooke, D.L. and Lorenzetti, D. (2005) Institutional Medical Incident Medical Reporting Systems: A Review, Health Technology Assessment Unit, Alberta Heritage Foundation for Medical Research, HTA report series no. 17. http://www.ihe.ca/documents/HTA-FR17.pdf

2. Objectives

2.1. Strategic and specific objectives

The strategic objective(s) of the Agency with which this initiative is coherent are:

- ☒ Europe becoming the world leader in railway safety
- ☐ Promoting rail transport to enhance its market share
- ☐ Improving the efficiency and coherence of the railway legal framework
- ☐ Optimising the Agency's capabilities
- ☒ Transparency, monitoring and evaluation
- ☒ Improve economic efficiency and societal benefits in railways
- ☐ Fostering the Agency's reputation in the world

General objective:

Contribute towards **better risk-based decision making to improve railway safety performance**

Specific objectives:

SO1 Improve **risk profiling and modelling techniques** regarding accidents and incidents

SO2 Ensure **broader visibility** of safety performance in Member States

SO3 Enable **identifying and monitoring** low frequency high consequence risks

SO4 Improve **learning, exchange and sharing** of accident / incident data between all EU actors

The following **stakeholder specific objectives** were identified:

European Commission:

- *Support impact assessments and decision making regarding proposals for new railway legislation and railway projects funding (contributing to SOs 2-4)*

The Agency:

- *Facilitate the development of risk based regulation (contributing to SOs 2-4)*
  e.g. to support the revision of the technical/ operational/ geographical scope of the TSIs including referenced standards on a risk informed basis so that they are not overly prescriptive in areas of low risk and insufficiently prescriptive for areas of high risk.
- *Enable early identification of emerging safety issues and target appropriate proactive interventions and measures (contributing to SOs 2-4)*
  e.g. to be able to collectively analyse occurrences and precursor data across the EU Member States with the view to receive an

	enhanced picture of emerging catastrophic risks that require actions on EU level • *Support Agency operational tasks relating to railway safety or interoperability, e.g. system authority for ERTMS, NSA monitoring, safety certification or vehicle authorisation (contributing to SOs 2-4)* **National Safety Authority:** • *Improve risk based supervisory activities (CSM supervision) (contributing to SOs 1-4)* e.g. increase efficiency of supervision by focusing supervision on those areas or actors at greatest risk, support better coordination between NSAs regarding supervision strategy for RUs operating in several Member States • *Improve the NSA's understanding of the national risk profile when approving the SMS of RUs/IMs during certification of RU/IM (contributing to SOs 1-3)* • *Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework (contributing to SOs 1-4)* **Member state:** • *Support the Member State for setting up the national safety plan as required by the Safety Directive and help achieve at least CSTs (contributing to SOs 2 and 4)* e.g. by benchmarking between Member States, ensure that the current safety level is maintained or improved • *Develop better national legal framework, including national rules (contributing to SOs 2-4)* • *Improve risk based decision making and prioritisation of investments decided by the Member State (contributing to SOs 2 and 4)* **RUs or IMs:** • *Support SMS development and monitoring (CSM on SMS) (contributing to SOs 1-3)* e.g. to facilitate the adaptation of their SMS. Particularly if area of operation is extended (RUs only), support prioritization of risks and allocate resources accordingly for risk control measures • *Support monitoring of low frequency high consequence risks and establish proper monitoring systems (CSM on monitoring) (contributing to SO3)* • *Support decision making on significance or not of a change (CSM Risk Assessment) (contributing to SO1-3)* • *Reduce administrative burdens for International RUs operating in several MSs, e.g. they have to comply with different reporting requirements from one MS to another (contributing to SOs 3-4)* • *Improve collaboration on identifying and managing shared risks, share experience and good practices between the railway operators (contributing to SOs 1,3-4)* e.g. to support creating, sharing hazard and risks log identified from accidents and incidents between operational actors and provide the ability for benchmarking and sharing taken safety measures

	Specific objectives for other impacted actors are specified more in details in the Roles[14] paper.
2.2. Link with Railway Indicators	The following railway indicators are relevant for this initiative: • *RI 1.2 Improvement of safety maturity level in MS' authorities,* • *RI 1.3 Improvement of safety maturity level of sector, and* • *RI 1.4 Improvement of Railway Safety Performance* Note: it is possible that improved data collection could result in changes regarding how safety performance is measured (RI 1.4) More information about the complete set of indicators is available in the Agency's Railway System Report from 2016: www.era.europa.eu/Document-Register/Documents/Railway%20System%20Report%202016.pdf).

3. Options

3.1. List of options

Options for data content

Description	Baseline (Option 0)	Minimum (Option 1)	Medium (Option 2)	Maximum (Option 3)
Reportable occurrences and taxonomy	CSIs reported in aggregated numbers only (2K reports / year)	CSIs + taxonomy (15K reports / year)	CSIs + a sub-set of the additional incidents + taxonomy (126K reports / year)	CSIs + all incidents + taxonomy (280K reports / year)
Reporting scheme	Mandatory	Mandatory	Reporting CSIs – mandatory Reporting additional incidents – voluntary	Mandatory
Scope		RUs/IMs operations		
Entry and quality of data on EU level		Ensured by the National Reporting Authority (NRA) (e.g. NSA/NIB/Sector assoc., etc.) appointed by MS		

14 https://extranet.era.europa.eu/safety/COR/Deliverables/Roles%20use%20of%20data%20and%20governance%20for%20the%20COR%20SMD.pdf

The building blocks were defined in the 'Phasing the COR Safety Management Data system'[15] , Taxonomy [16] and Roles papers, which were consulted with all relevant stakeholders:

1. *Reportable occurrences and taxonomy – options of the future scope of reportable occurrences in the COR with reporting taxonomy (metadata).*
2. *Reporting scheme – options on mandatory (through legislation) or mandatory and voluntary (through MoU) reporting regime.*
3. *Scope – future COR reportable occurrences have to be reported from RUs/IMs operations in all EU MSs, plus Switzerland, Norway, Channel Tunnel. Shunting operations are also in the scope. For any option, the scope will remain the same.*
4. *Entry and quality of data on EU level – Developed national occurrence reporting systems will remain. Each Member state will be obliged to appoint the National Reporting Authority (NRA) which could be the NSA, NIB or sector association or etc. The National reporting Authority will ensure quality of national data and provide data on EU level, i.e. to the Agency. For any option, entry and quality of COR data on EU level will be done by appointed NRA.*

IT options

IT building block which varies with Min, Med, Max options			
Reporting system	No IT system	EU IT system & national IT systems are not connected	EU IT system & national IT systems are connected
Functionality for data visualization and analytics[17]	No	Optional	Yes

3.2. Description of options

Options on data content will be analysed and compared, including the possible associated IT features.

Option 0 - Baseline[18]

Building block	**Description**
Reportable occurrences	› Accidents and a few precursors are reportable occurrences (Directive 2016/798, Annex I) and reported in aggregated numbers. Global

[15] https://extranet.era.europa.eu/safety/COR/ERA-Working-documents/COR%20-%20Phasing.docx
[16] COR paper on Designing the common occurrences and taxonomy for COR
[17] see Annex I – section 1.5.
[18] More information on the baseline system is included in section 5.1. of the paper on phasing the COR Safety Management Data System.

	consequences are reported per type of accident, causes are not reported at all. › Approx. 2000 occurrences per year are reported based on the assumption, that each European RU / IM establishes one report per year.
Taxonomy	Depends on national reporting schemes. Mandatory taxonomy is provided in Annex I of the Railway safety Directive (CSIs).
Reporting scheme	The reporting scheme (CSIs) is fully mandatory.
Scope	RUs/IMs operations
Entry and quality of data on EU level	› CSIs are reported once per year by RUs and IMs to NSAs within the annual safety report › The NSA prepares the data and makes processed data available to the Agency via NSAs annual report. The data sent to the Agency is aggregated, therefore with a lower level of detail.
IT infrastructure	No specific requirements at NRA (National reporting authority)/RU/IM, MS level. The CSIs data is provided by the NSAs to the Agency via the ERAIL system (manual entry or uploading of the excel file)

Option 1 – Minimum

Building block	**Description**
Reportable occurrences	› 7 Accident categories limited to CSIs as defined in the Directive 2016/798): see Annex I, section 1.1; › 7 Incident categories limited to indicators for precursors as defined in the Directive 2016/798): see Annex I, section 1.1. › We estimate that about 15.000 occurrence reports per year would be reported in COR.
Taxonomy	Each report will include: › Descriptive information: see Annex I – section 1.2; (no difference within all options) › Causes: see Annex I – section **Error! Reference ource not found.**; (no difference within all options) › Consequences: see Annex I - section **Error! eference source not found.**; (no difference within all options)
Reporting scheme	The reporting scheme is fully mandatory
Scope	RUs/IMs operations

Entry and quality of data on EU level	› Occurrences will be reported by the RUs/IMs to the NRA. › The NRA is responsible to verify the quality of data collected in each Member State. › The data will be used by each actor to fulfil its legal obligations as it was defined in the Roles paper.
IT infrastructure	› No specific requirements at NRA/RU/IM level. They can still use existing IT systems or manage the data manually (e.g. excel tables). Data exchange could take place either via existing interfaces or via E-Mail › The Agency could keep the current ERAIL running, modify it or develop a new tool › This latter option allows for more sophisticated IT solutions as well as where all actors manage and exchange data via specific IT solutions (if they provide more benefits than the resulting IT Life cycle costs). Then IT infrastructure could be established as described in option 2.

Option 2 – Medium

Building block	Description
Reportable occurrences	In addition to option 1, the following occurrences have to be reported (highlighted in annex 1, section 1.1): › Accidents related ○ *to all types of collisions (and extended by more detailed sub-categories allowing a more detailed investigation of all types of collisions)* › Incidents related to ○ *Trains operations failures extended to more detailed sub-categories (addition of 7 sub-categories)* ○ *Technical failures of the vehicles extended to more detailed sub-categories (addition of 10 sub-categories)* ○ *Technical failure of fixed installations to more detailed sub-categories (addition of 10 sub-categories)* ○ *Near misses*

	Reportable scope is also extended to collect non-significant [19]accidents. We estimate that about 126.000 occurrence reports per year would be reported to COR of which 120.000 are already available in national systems.
Taxonomy	Each report will include: › Descriptive information: see Annex I – section 1.2 (no difference within all options) › Causes: see Annex I – section **Error! Reference ource not found.** (no difference within all options) › Consequences: see Annex I, section **Error! eference source not found.** (no difference within all options)
Reporting scheme	The reporting scheme is fully mandatory for CSIs and voluntary for reporting of additional incidents (MoU)
Scope	RUs/IMs operations
Entry and quality of data on EU level	› Occurrences will be reported by the RUs/IMs to the NRA. › The NRA is responsible to verify the quality of data collected in each Member State. › The data will be used by each actor to fulfil its legal obligations as it was defined in the Roles paper
IT infrastructure	› Due to the amount of reported occurrences, data needs to be recorded in IT systems. Existing national IT systems might need to be modified to support the proposed taxonomy. › The Agency will implement an EU IT tool (potential successor of ERAIL). › If no IT tools are in place, the NRA can use the EU IT tool – however the NRA is responsible for data quality check. › Data exchange between the national IT systems and the EU IT tool is based on manual integration (with some IT support) or on a fully developed IT interface. › This option allows for more sophisticated IT solutions as well as where all actors manage and exchange data via specific IT solutions (if they provide more benefits than the resulting IT Life Cycle Costs)

[19] 'non-significant accident' means any accident involving at least one rail vehicle in motion, resulting in at least one minor injured person, or in any damage (less than 150 000 EUR) to stock, track, other installations or environment, or any disruptions to traffic (less than 6 hours), excluding accidents in workshops, warehouses and depots.

Option 3 – Maximum

Building block	Description
Reportable occurrences	the same as in option 2
Taxonomy	Each report will include: › Descriptive information ○ *see Annex I, section 1.2 (no difference within all options)* › Causes ○ *see Annex I, section* ***Error! Reference ource not found.*** *(no difference within all options)* › Consequences ○ *See Annex I, section* **Error! Reference ource not found.** *(no difference within all options*) We estimate, that 280.000 occurrence reports per year would be included in COR (in accordance with the DNV study on occurrence reporting from 2015, see the Task 3 report involving an impact assessment).
Reporting scheme	The reporting scheme is fully mandatory
Scope	RUs/IMs operations
Entry and quality of data on EU level	› Occurrences will be reported by the RUs/IMs to the NRA. › The NRA is responsible to verify the quality of data collected in particular MSs. › The data will be used by each actor to fulfil its legal obligations as it was defined in roles paper.
IT infrastructure	› Same as for option 2

3.3. Uncertainties/ Risks	› National reporting systems based on IT solutions might require **specific adaptation to be compliant with the extended taxonomy** – these specific impacts are not taken into account in this impact assessment as generic IT related costs and labour costs/occurrence are used. › Concerning **IT related costs**, the Impact Assessment assumes averaged Hardware and Software costs at EUR 10,65 per occurrence based on the DNV study. After having performed a more detailed analysis of non-functional system characteristics, these costs can increase by about 20% if the most advanced IT solution (EU IT for COR and national OR systems are interconnected) is implemented. The cost impact estimation does not include the costs for evaluating the COR data from the different stakeholders so that they can achieve their specific objectives (outlined in Section 2.1). Especially in case of a high amount of COR data and the lack of automated evaluation tools, the costs of such evaluations may reduce any COR benefits. This is especially relevant for options 2 and 3. › The cost impact estimation assumes that the **information related to the taxonomy of an occurrence can be retrieved easily by the RU or IM** requiring the access to different internal sources/databases. However, in bilateral meetings some NSAs as well as RUs and IMs expressed concerns to retrieve this information and expected a significant higher workload for the retrieval of information (more than 2h which was considered for data retrieval and generation of report in total). They advised to adapt the taxonomy based on the occurrences to be reported and the needs of the IMs or RUs. › **Geographical, cultural and technical differences might limit the possibility to draw conclusions** based on the comparison of COR related data (e.g. when monitoring low frequency high consequence risks). However, these specific limitations are currently not taken into account in this impact assessment as they are not quantifiable at this stage. › The number of occurrence reports – especially for option 3, is based on an estimate of the DNV study. NSA NO expressed in a bilateral meeting with the Agency their concerns that **the number of occurrence reports could be significantly higher at EU level** (up to 10 times – based on experience from their NOR). This would have a major cost impact for option 3. › We assume that the data in COR can be shared without specific restrictions for the different actors, so that their specific objectives can be addressed. However, when refining the taxonomy of COR during the implementation of COR, there might be necessary changes in the taxonomy, as well as specific provisions for the access to COR data in order to meet **data protection requirements as well as business confidentiality issues**. These might limit the achievement of some objectives for specific stakeholders. › **Poorly resourced NRAs, especially NRAs** without any IT support might be more seriously impacted – however they could use the European tool instead of initiating their own IT development (mainly relevant for option 2 and option 3). › Due to the big volume of data and the complexity of data, the Agency and the NRAs might not be able to exploit the data gathered by the industry

	due to a **lack of analytical capability**; this could limit the expected benefits from COR (mainly relevant for option 2 and 3)

4. Impacts of the options

4.1. Impacts of the options (qualitative analysis)

A qualitative assessment of the impacts of four options (incl. the Baseline) is made based on the extent to which an option contributes to the achievement of a stakeholder-specific objective (outlined in Section 2 of this document). It should be noted that the assessment is focussed on how each of the four options perform with respect to the stakeholder-specific objectives. As such this concerns the level of achievement of these objectives with reference to the options as regards to European-wide collection of occurrences.

Option 0 (Baseline)

Impacted Stakeholder: **European Commission**

Stakeholder Specific Objective	*Contribution*
Support impact assessments and decision making	The currently available CSI data would not facilitate Commission impact assessments or decision-making relating to railway legislation / railway projects funding.

Impacted Stakeholder: **The Agency**

Stakeholder Specific Objective	*Contribution*
Facilitate the development of risk based regulation railway legislation	In the baseline the Agency would not have access to data on causes / precursors and still rely only on aggregated CSIs numbers.
Enable early identification of emerging safety issues and target appropriate proactive interventions and measures.	In the baseline the data available to the Agency are too high level to permit the identification of emerging safety issues.
Support Agency tasks relating to railway safety or interoperability	Although, no changes will be introduced for reporting occurrences compared to the present situation, it is noted that on the basis of the current framework Agency outputs have been provided (e.g. advice in relation to priority countries).

Impacted Stakeholder: **NSA**

Stakeholder Specific Objective	*Contribution*
Improve risk based supervisory activities (CSM supervision)	Countries without national occurrence reporting schemes would not be supported by current CSI data only. Moreover, even for countries with NOR information on causes / consequences details could be missing. Overall the baseline would therefore not assist the NSA to any

	improvements in their risk based supervisory activities.
Improve the NSA's understanding of the national risk profile when approving the SMS of a RUs/IMs	For those countries without national occurrence reporting schemes there would not be support with only current CSI data only. Moreover, even in countries with NOR information on causes / consequences details could be missing. Overall the baseline would therefore not assist the NSAs further. As a result, it is unlikely that the baseline would bring any improvements to the NSAs understanding of the national risk profile. It should be noted that for countries with well-developed NOR the NSA's understanding of the risk profile may already be relative mature.
Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework	Overall, the NSAs would not be assisted for this objective by the baseline. Countries without national occurrence reporting schemes would not be supported by current CSI data only. Moreover, even in countries with NOR information on causes / consequences details could be missing.

Impacted Stakeholder: **Member State**

Stakeholder Specific Objective	*Contribution*
Support MS for setting up the national safety plan	For those Member States without national occurrence reporting schemes there would be no support for the setting up of the national safety plan. For the other Member States the possible lack of data on causes could be an important constraint.
Develop better national legal framework, including national rules	Member States without national occurrence reporting schemes there would not be supported regarding their development of the national legal framework. For the other Member States the possible lack of data on causes could be an important constraint.
Improve risk based decision making and prioritisation of investments decided by the MS	This objective may be supported to a certain extent in those Member States with occurrence reporting schemes. However, the contribution would be limited by the lack of data on the causes. For countries without NOR there would be no contribution.

Impacted Stakeholder: **RU or/and IM**

Stakeholder Specific Objective	*Contribution*
Support SMS development and monitoring (CSM on SMS)	Given the extent of reporting varies between Member States as well as between railway undertakings / infrastructure managers there is likely to be limited or no contribution to this objective under the baseline.

Support monitoring of low frequency high consequence risks (CSM on Monitoring)	For some large companies existing reporting may offer limited contribution. However, for most companies there would be insufficient data internally to ensure effective monitoring for this objective. Lack of sharing amplifies this issue.
Support decision making on significance or not of a change (CSM Risk Assessment)	For established companies operating within their domestic market their existing reporting systems could be of some assistance (depending on the amount of internally available data). However, for newcomers or existing companies changing geographical scope there would be very limited assistance.
Reduce administrative burden for International RUs operating in several MSs	The current baseline does not offer the possibility to reduce administrative burden for international railway companies, e.g. having to face different reporting schemes in different countries.
Improve collaboration on identifying and managing shared risks, share experience and good practices between the railway operators	A key problem with the baseline is the implied lack of sharing among the different stakeholders with respect to occurrence reports.

Option 1

Impacted Stakeholder: **European Commission**

Stakeholder Specific Objective	*Contribution*
Support impact assessments and decision making	From an accident outcome perspective more information would be available per accident / incident (notably regarding causes, consequences). This may in some cases support Commission Impact Assessments and related activities.

Impacted Stakeholder: **The Agency**

Stakeholder Specific Objective	*Contribution*
Facilitate the development of risk based regulation railway legislation	The more detailed information per CSI accident / incident would be of relevance for facilitating the development of risk based regulation. However, given that no additional precursors are introduced only a limited positive contribution is expected.
Enable early identification of emerging safety issues and target appropriate	The provision of accident data and especially causes will support the Agency's work. In particular, it would allow the Agency to intervene earlier and undertake analyses of the underlying problem. However, the lack of

proactive interventions and measures.	reporting on incidents is likely to prevent this option to address the objective fully.
Support Agency tasks relating to railway safety or interoperability	For the Agency's tasks on vehicle authorisation / safety certification and NSA monitoring it is likely that this option provides a limited contribution (for example, to decide in which NRA to check the quality of data or in which MS to check the reporting). Also, if under this option there will be collected info on vehicle type it will be an input for the VA. For SC, the information available in this option could contribute to drafting strategic objectives for supervision for NSAs, which then will provide input for SMS assessment for the Agency. In addition, weaknesses of SMS could be reported as causes of the occurrences.

Impacted Stakeholder: **NSA**

Stakeholder Specific Objective	*Contribution*
Improve risk based supervisory activities (CSM supervision)	The option would provide all NSAs with additional information per CSI accident / incident (notably in terms of description, causes and consequences). However, the lack of precursor information may limit the extent to which the supervision activities will be supported, especially for those MSs without NORs.
Improve the NSA's understanding of the national risk profile when approving the SMS of a RUs/IMs	A better view of the national risk profile would be achieved with this option. However, it may not be sufficient to assist significantly the process of SMS approval with particular reference to MSs with limited occurrence reporting.
Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework	This option will allow NSAs to have more information per CSI accident / incident and within a faster framework. This will allow quicker response and on a more robust basis (information on causes). However, the lack of improvement of precursor reporting is likely to prevent this option to contribute strongly to this objective. This is particular, the case for the MSs without comprehensive reporting schemes in place.

Impacted Stakeholder: **Member State**

Stakeholder Specific Objective	*Contribution*
Support MS for setting up the national safety plan	More detailed data for accidents / incidents would facilitate the task of setting up the national safety plan. However, this can only be relatively limited given that the safety plan cannot only rely on the CSI categories but should have wider basis.

Develop better national legal framework, including national rules	This option could have a positive influence through information on causes per CSI accident / incident, which in turn could lead Member States to adjust the legal framework, e.g. changes to national safety rules or technical rules. However, it is unlikely that the setting of national rules or the overall national legal framework could be strongly supported by the reporting improvements under option 1.
Improve risk based decision making and prioritisation of investments decided by the MS	Given a somewhat more detailed picture of risks, there could be some (limited) progress on this objective.

Impacted Stakeholder: **RU or/and IM**

Stakeholder Specific Objective	*Contribution*
Support SMS development and monitoring (CSM on SMS)	The improved reporting of CSI accidents / incidents could be of some help to RUs extending area of operation. However, this is likely to be of only limited importance given the lack of information on additional incidents. It should be noticed that the contribution would come from being able to have access to data from other MSs.
Support monitoring of low frequency high consequence risks (CSM on Monitoring)	For this option railway undertakings and infrastructure managers will not themselves collect more information on low frequency - high consequence risks. However, through the data available on a European level of these risks some contribution for this objective can be expected. However, given that no additional incident data are to be reported it is unlikely that this objective will be fully achieved.
Support decision making on significance or not of a change (CSM Risk Assessment)	The additional data per CSI accident / incident could be of some relevance for the decision-making regarding significance of change.
Reduce administrative burden for International RUs operating in several MSs	It could be the case that the additional data would assist on a limited scale to reduced administrative burden for international operators.
Improve collaboration on identifying and managing shared risks, share experience and good practices between the railway operators	Some contribution towards identifying risks as well as exchanging experiences and best-practices could be envisaged.

Option 2

Impacted Stakeholder: **European Commission**

Stakeholder Specific Objective	*Contribution*
Support impact assessments and decision making	More detailed occurrence reporting per CSI accident / incident category + voluntary provision of additional incident information would support Commission impact assessments in this field. The precise contribution will be determined by the extent of voluntary reporting of additional incidents.

Impacted Stakeholder: **The Agency**

Stakeholder Specific Objective	*Contribution*
Facilitate the development of risk based regulation railway legislation	The more detailed information per CSI accident / incident would be of relevance for facilitating the development of risk based regulation. Moreover, with additional (voluntary) reporting on additional incidents, according to a common taxonomy progress on this objective would be achieved albeit not fully.
Enable early identification of emerging safety issues and target appropriate proactive interventions and measures.	The contribution of this option with respect to this objective will be dependent on the extent of voluntary reporting for additional incidents. If the level of reporting is reaching the one obtained with mandatory reporting of additional incidents (option 3) then a similar achievement result could be reached.
Support Agency tasks relating to railway safety or interoperability	For the Agency's tasks on vehicle authorisation / safety certification and NSA monitoring it is likely that this option would contribute towards this objective sufficiently albeit to a lower extent compared to option 3.

Impacted Stakeholder: **NSA**

Stakeholder Specific Objective	*Contribution*
Improve risk based supervisory activities (CSM supervision)	The option would provide NSAs with additional information per CSI accident / incident. Furthermore, each NSA could receive up to 20-fold more information on additional incidents (precursors) which could be reported on a voluntary basis. This should facilitate their supervision activities, albeit to a lower extent compared to option 3 given that most precursors would be voluntarily reported. Moreover the NSAs may be supported through the enhanced availability of information concerning the precursors (though the contribution would then be dependent on the extent of voluntary reporting of precursors). Hovewer, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.

Improve the NSA's understanding of the national risk profile when approving the SMS of a RUs/IMs	NSAs should obtain a better view of the national risk profile with this option, particularly with respect to causes, consequences and to the somewhat less extent regarding precursors. This would have a positive contribution in relation to the information available to the NSA during the process of SMS approval depending on the extent voluntary reporting. However, contribution is expected to be lower than for option 3 given that most precursors are only to be reported on a voluntary basis. Moreover, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.
Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework	The option should have a positive contribution to helping NSAs in monitoring, promoting and where appropriate enforcing the safety regulatory framework. However, contribution is expected to be lower than for option 3 given that most precursors are only to be reported on a voluntary basis. Moreover, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.

Impacted Stakeholder: **Member State**

Stakeholder Specific Objective	*Contribution*
Support MS for setting up the national safety plan	Given the in-depth overview of the safety performance per Member state this option would provide a stronger basis for establishing safety plans. However, the in-depth overview may be less comprehensive compared to the case for option 3 as it can be expected that fewer precursors would be reported. Moreover, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.
Develop better national legal framework, including national rules	The provision of precursor information would be of importance for the achievement of this objective. Therefore, it can be expected that this option would contribute less than for option 3 due to precursors being mostly reported voluntarily. Moreover, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.
Improve risk based decision making and prioritisation of investments decided by the MS	Given a more detailed picture of risks, there could be progress on this objective, albeit to a more limited extent than for option 3. However, for MSs with comprehensive reporting schemes the possible gains are likely to be more modest.

Impacted Stakeholder: **RU or/and IM**

Stakeholder Specific Objective	*Contribution*

Support SMS development and monitoring (CSM on SMS)	The improved reporting of CSI accidents / incidents and in particular precursors could be of help to RUs extending area of operation. Given the importance of precursor information the option is expected to contribute less than option 3. This option would enable a more comprehensive perspective on risks achieved through the opportunity for sharing. However, the benefits of sharing may be lower due to less reports available on precursors.
Support monitoring of low frequency high consequence risks (CSM on Monitoring)	The contribution of this option with respect to this objective will be dependent on the extent of voluntary reporting for additional incidents. If the level of reporting is reaching the one obtained with mandatory reporting of additional incidents (option 3) then a similar achievement result could be reached.
Support decision making on significance or not of a change (CSM Risk Assessment)	It is likely that decision-making for significance of changes would be facilitated. However, less reporting on precursors would limit the contribution being strongly dependent on the sharing of occurrence reports.
Reduce administrative burden for International RUs operating in several MSs	The availability of detailed accident / incident data on a European level should alleviate the administrative burden for RUs operating in several MSs. Possibly somewhat lower contribution compared to option 3.
Improve collaboration on identifying and managing shared risks, share experience and good practices between the railway operators	The option ensures that comprehensive information on accidents and incidents according to a common taxonomy is available at a European level. This is a precondition for sharing experience and good practice between operators. It can be expected that the contribution would be lower than for option 3 due to less reports on precursors being available for sharing.

Option 3

Impacted Stakeholder: **European Commission**

Stakeholder Specific Objective	*Contribution*
Support impact assessments and decision making	More detailed occurrence reporting per CSI accident / incident category + mandatory provision of additional incident information would support Commission impact assessments in this field.

Impacted Stakeholder: **The Agency**

Stakeholder Specific Objective	*Contribution*

Facilitate the development of risk based regulation railway legislation	The more detailed information per CSI accident / incident would be of relevance for facilitating the development of risk based regulation. Moreover, with comprehensive reporting on additional incidents, according to a common taxonomy, progress on this objective would be achieved.
Enable early identification of emerging safety issues and target appropriate proactive interventions and measures.	A comprehensive picture of risks covering causes of accident / incidents + details regarding precursors should facilitate this objective being fulfilled.
Support Agency tasks relating to railway safety or interoperability	For the Agency's tasks on vehicle authorisation / safety certification and NSA monitoring it is likely that this option would contribute towards this objective sufficiently.

Impacted Stakeholder: **NSA**

Stakeholder Specific Objective	*Contribution*
Improve risk based supervisory activities (CSM supervision)	The option would provide NSAs with additional information per CSI accident / incident. Furthermore, each NSA will receive up to 20-fold more info on additional incidents (precursors). This should facilitate their supervision activities. However, the contribution would be more limited for those MSs with comprehensive reporting schemes in place.
Improve the NSA's understanding of the national risk profile when approving the SMS of a RUs/IMs	A better view of the national risk profile would be achieved with this option, particular with respect to causes, consequences and precursors. This should have a positive contribution in relation to the information available to the NSA during the process of SMS approval. However, the contribution would be more limited for those MSs with comprehensive reporting schemes in place.
Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework	The availability of occurrence reports covering details on accident / incident outcomes as well as precursors should facilitate the monitoring, promotion and enforcement of the safety regulatory framework. However, the contribution would be more limited for those MSs with comprehensive reporting schemes in place.

Impacted Stakeholder: **Member State**

Stakeholder Specific Objective	*Contribution*
Support MS for setting up the national safety plan	Given the in-depth overview of the safety performance per Member state this option would provide a stronger basis for establishing

	safety plans (with the gains varying depending on extent of current reporting schemes in place).
Develop better national legal framework, including national rules	The provision of precursor information would be of importance for the achievement of this objective. With this information it is possible that the development of the national legal framework could be facilitated. The extent of contribution towards the objective would vary between Member States.
Improve risk based decision making and prioritisation of investments decided by the MS	Given a more detailed picture of risks, there could be progress on this objective. The extent of contribution towards the objective would vary between Member States.

Impacted Stakeholder: **RU or/and IM**

Stakeholder Specific Objective	*Contribution*
Support SMS development and monitoring (CSM on SMS)	The improved reporting of CSI accidents / incidents and in particular precursors could be of help to RUs extending area of operation. The option would provide a comprehensive perspective on risks covering both accidents and incidents with detailed information per occurrence. This should enable improvements for the prioritisation of risk areas and allocation of resources, though the contribution would be dependent on extent of existing reporting schemes.
Support monitoring of low frequency high consequence risks (CSM on Monitoring)	As this option provides for reporting on precursors to a much larger extent than under Options 1, 2 and in the baseline an improved view of the monitoring underlying risks for low frequency high consequence accidents would be achieved (although there would be variations between RUs and IMs concerning the gains).
Support decision making on significance or not of a change (CSM Risk Assessment)	With the provision of a comprehensive view of safety performance and underlying risks, including of quantitative data it is likely that decision-making for significance of changes would be facilitated (although there would be variations between RUs and IMs concerning the gains).
Reduce administrative burden for International RUs operating in several MSs	The availability of detailed accident / incident data on a European level should alleviate the administrative burden for RUs operating in several MSs.
Improve collaboration on identifying and managing	The option ensures that comprehensive information on accidents and incidents

	shared risks, share experience and good practices between the railway operators	according to a common taxonomy is available at a European level. This is a precondition for sharing experience and good practice between operators.
4.2. Impacts of the options (quantitative analysis)	**(a) Costs per occurrence** The following cost figures per occurrence covering are estimated based on DNV GL[20] assumptions and complementary information from stakeholders during the COR project: › ***IT hardware and software costs per occurrence*** *- mean IT cost (hardware and software) per occurrence was calculated at €10.65 for baseline and option 1 and approx. €13 for option 2 and 3 assuming more complex IT* › *Full time equivalent (FTE) employees required to collate, input, validate and analyse the data (per occurrence) - working time is estimated at 0.00126 FTE per occurrence; this equated to one FTE processing 800 occurrence reports per annum (or about 4 reports per day such that the average time per report would be approximately 2 hours). Based on an hourly rate of approx. €25, this results in €50/ occurrence.* **(b) Annual costs** (based on unitary cost and FTE values together with information about the expected number of occurrences). The detailed cost calculations are included in Annex II of this IA report. It should be noted that these calculations focus on the costs associated with the options linked to data content. Any one-off costs incurred by the Agency in relation to the implementation of an EU COR IT tool are not considered. These costs would vary depending on the precise details of IT system specification but are likely to involve up to 0,5 **M€** (in accordance with experience from similar IT systems of the Agency). This issue will be considered in details as part of impact assessment work within the context of a **Mandate from the EC to the Agency** in order to assess the specific options for a COR system under consideration by a Working Party. **Baseline -** Occurrences are reported at an aggregated level. Currently, each European railway undertaking produces one report per year, resulting in approx. 2000 reports. In addition, each NSA produces a summarizing report. The costs resulting from the current legal provisions are **0,14 M€ /year**	

[20] DNV GL (2015) Review of Data Quality and Approach of the Agency Annual Report on Safety, Report on Task 3 – Impact Assessment.

	Option 1 - All CSI accidents are reported. Contrary to the baseline scenario, a report is produced for each occurrence. We assume that this would lead to 15.000 occurrences reported to COR. However, according to the DNV study some Member States already operate a comprehensive occurrence reporting system at national level where 120.000 occurrences are already captured. We assume the following ○ *About 62% (18Ms from 29Ms have the NOR electronic database) of above 15.000 occurrences are already kept in NOR, only additional IT costs have to be added to make them available to COR* ○ *For about 38% (11 Ms from 29Ms do not have a NOR electronic database) of above 15.000 occurrences, the reports have to be generated as they are not currently captured in the NOR of some Member States.* This would result in the following additional yearly costs (compared to baseline): ○ *0,16 M €/year IT related costs (if a more complex IT tool would be adopted, the costs would be 0,19 M €/year)* ○ *0,33 M €/year labour costs* The total additional annual costs (compared to baseline) are about **0,50 M€.** **Option 2 -** we assume about 126.000 (125.700 precisely) yearly reported occurrences to COR for the following reasoning: ○ *15.000 occurrences would be reported due to the mandatory reporting obligation (where 5.700 occurrences are not covered by the existing NOR systems – see the assumption of option 1)* ○ *About 120.000 occurrences are already captured today in existing NOR at voluntary base (according to DNV study)* ○ *Additional 110.000 occurrences would be reported at a voluntary level to COR (only involving IT costs)* This would result in the following additional yearly costs (compared to the baseline): ○ *1,34 M €/year IT related costs (1,61 M €/year if more complex IT solution is adopted)* ○ *0,33 M €/year labour costs* The total additional annual costs (compared to baseline) are about 1,67 M€ (in case a more complex IT solution is adopted the total costs would be **1,93 M€ /year**). **Option 3 -** we assume that 280.000 yearly reported occurrences to COR for the following reasoning:

	○ *The DNV study estimated 280.000 occurrences if a comprehensive COR would be applied in all Member States (see option 2)* ○ *120.000 occurrences - already reported in existing NOR - are reported to COR* ○ *160.000 additional occurrences will be captured and reported to COR* ○ *However, NSA NO estimated that the resulting number could be up to 10 times higher at EU level, based on the experience of their NOR.* This would result in the following additional yearly costs (compared to baseline): ○ *2,98 M €/year IT related costs (in case a more complex IT solution is adopted the annual costs would be 3,58 M €/year)* ○ *9,20 M €/year labour costs* The total additional annual costs (compared to baseline) are about **12,2 M€** based on DNV estimates (in case a more complex IT solution is adopted, the annual costs are estimated to **12,8 M€**). Obviously, if the number of occurrences to be reported would be higher than 280.000 as expected by the NSA NO the costs would also then be higher than the above estimated figure. **Break-even analysis** In order to demonstrate the implications for required benefits to match the above estimated costs (taking into account the change in costs only compared to the baseline) several break-even tests were undertaken as regards: • *Number of required avoided fatalities* • *Number of required avoided accidents* For number of required avoided fatalities this would range from 0.2 (Option 1) to 4.9 (Option 3). In proportion of the number of current fatalities these figures would represent from 0.02% (Option 1) to 0.46% (Option 3). These calculations utilised available information concerning the Value of Preventable Fatalities (VPF), in particular a VPF value of 2,49 M€ was used (source: WHO: HEAT - Health Economic Assessment Tool). Similar results are obtained in the case of a number of required avoided accidents. The estimated annual costs for the 3 Do-Something options represent between 0.03% (Option 1) and 0.74% (Option 3) of the reported (CSI) annual accident costs (of some 1,645 billion Euros) covering costs linked to fatalities, injuries, material damage, costs of delays and environmental damage. The break-even results should not be added up to determine a total required improvement (achieving the required improvement in one dimension would be sufficient for break-even).

	Benefits The quantification of the qualitatively identified advantages is challenging. If the number of fatalities is reduced by more than 0,5% as a result of improved occurrences reporting / analysis all options incl. Option 3 (Do-Maximum) would result in positive net-benefits. A series of in-depth interviews with stakeholders have been undertaken to confirm the order of magnitude of the expected benefits linked to the stakeholder-specific objectives. However, although the interview findings were broadly consistent with the qualitative assessment of impacts no robust quantitative estimates of benefits could be determined so far.

5. Comparison of options and preferred option

5.1. Effectiveness criterion (options' response to specific objectives)

Based on a score between 0-5 the options are assessed how they address the stakeholder specific objectives taking into account the analysis in Section 4.1).

	BL	*O1*	*O2*	*O3*
European Commission				
Support impact assessments and decision making	0	2	3	5
Average	***0***	***2,0***	***3,0***	***5,0***
The Agency				
Facilitate the development of risk based regulation railway legislation	0	2	3	5
Enable early identification of emerging safety issues and target appropriate proactive interventions and measures.	0	2	3	5
Support Agency tasks relating to railway safety or interoperability	1	2	3	4
Average	**0,3**	**2,0**	**3,0**	**4,7**
National Safety Authority				
Improve risk based supervisory activities (CSM supervision)	1	2	3	4
Improve the NSA's understanding of the national risk profile when approving the SMS of a RUs/IMs	1	2	3	4
Help to monitor, promote, and, where appropriate, enforce the safety regulatory framework	1	2	3	4

	Average	***1,0***	***2,0***	***3,0***	***4,0***
	Member State				
	Support MS for setting up the national safety plan	1	2	3	4
	Develop better national legal framework, including national rules	1	2	3	4
	Improve risk based decision making and prioritisation of investments decided by the MS	1	2	3	4
	Average	***1,0***	***2,0***	***3,0***	***4,0***
	RUs/IMs				
	Support SMS development and monitoring (CSM on SMS)	0	1	3	4
	Support monitoring of low frequency high consequence risks (CSM on Monitoring)	0	1	3	4
	Support decision making on significance or not of a change (CSM Risk Assessment)	1	2	3	4
	Reduce administrative burden for International RUs operating in several MSs	0	1	3	4
	Improve collaboration on identifying and managing shared risks, share experience and good practices between the railway operators	0	2	3	5
	Average	***0,2***	***1,4***	***3,0***	***4,2***
	Effectiveness (total score)	**8**	**27**	**45**	**64**
	Average total score (calculated as the average of the scores per stakeholder category)	**0,5**	**1,9**	**3,0**	**4,4**

Further validation from external stakeholders has been undertaken and integrated into this version of the impact assessment.

5.2. Efficiency (NPV and B/C ratio) criterion

As the benefits are currently not quantified in monetary terms, no NPV or B/C can be calculated at this stage.

As a proxy, the **efficiency** of an option is calculated as follows:

$$Efficiency\ (Option) = \frac{Effectiveness(Option) - Effectiveness\ (Baseline)}{Annual\ Costs(Option) - Annual\ Costs\ (Baseline)}$$

	Option 0 (baseline)	*Option 1*	*Option 2*	*Option 3*
Efficiency	N/A	38,0	22,2	4,6
Score	N/A	5,0	2,9	0,6

<table>
<tr><td></td><td>The scores between 0 and 5 are then derived by fixing the maximum value obtained, 38, to the score 5 and then determine the scores for the other options relative to that value.</td></tr>
<tr><td>5.3. Summary of the comparison</td><td>The following table summarises the outcomes of Section 5.1 (effectiveness) and Section 5.2 (efficiency)
<table>
<tr><td></td><td>Option 0 (baseline)</td><td>Option 1</td><td>Option 2</td><td>Option 3</td></tr>
<tr><td>Effectiveness</td><td>0,5</td><td>1,9</td><td>3,0</td><td>4,4</td></tr>
<tr><td>Efficiency</td><td>N/A</td><td>5,0</td><td>2,9</td><td>0,6</td></tr>
<tr><td>Overall</td><td>N/A</td><td>3,4</td><td>3,0</td><td>2,5</td></tr>
</table>
The assessment of Option 2 is relatively uncertain as the benefits would depend on the extent of voluntary reporting.</td></tr>
<tr><td>5.4. Preferred option(s)</td><td>The overall assessment indicates that Option 1 as preferred option given the relative low costs involved as well as the relative high likelihood that this option could generate benefits to the concerned stakeholders.

Indeed, given the incremental nature of the options, a gradual approach towards expansion of the scope of occurrence reporting starting with Option 1 towards Option 3 would add additional benefits in the future. On the basis of return of experience further extensions could then be considered over a time period provided an impact assessment at that point would demonstrate added value.</td></tr>
<tr><td>5.5. Further work required</td><td>Further impact assessment work would be required within the context of a Mandate from the EC to the Agency in order to assess the specific options for a COR system under consideration by a Working Party.</td></tr>
</table>

6. Monitoring and evaluation

6.1. Monitoring indicators	Initial proposal for monitoring indicators: • *Number and types of occurrences reported at company level* • *Number and types of occurrences available at national level* • *Number and types of occurrences available at European level* • *Extent of sharing of occurrences reported between companies* • *Extent of sharing of occurrences reported between countries* • *Extent of sharing of occurrences reported at European level* • *Member States assessment of the collection level of occurrences* • *Number of processes established for data quality checking* • *Level of data quality improvement* • *Number of occurrences analysed at the company, national and European level* • *Number of actions adopted linked to occurrences reported*

	• *Railway accident rate by type of accident* • *Possible determination of key risk areas in Europe* • *Perceptions among companies, national authorities and European actors concerning the collection, sharing and analysis of occurrences* Precise details concerning the frequency and data sources for these monitoring indicators will be dependent on the system proposal and the specifications of the system architecture. In particular, the IT framework would have implications on the data sources to be used (e.g. the extent to which the monitoring indicators could be provided electronically). Similarly, there would be implications of the system proposal on the frequency level considered.
6.2. Future evaluations	N.a.

I. Annex I

Note: Future COR reportable occurrences and the taxonomy will be finalised by the WP of CSM on COR. Proposed reportable occurrences and the taxonomy will be considered as a starting point for the discussion in the WP. Links with the RINF and ECCVR will be explored by the WP as well.

1. Reportable occurrences and taxonomy

1.1. Reportable Occurrences

		(Option 1)	Option 2	Option 3
A	**Accidents**			
A1	**Collision**	(X)	X	X
A1.1	**Collision of train with rail vehicle**	X	X	X
A1.1.1	• *Front to Front*	X	X	X
A1.1.2	• *Front to End*	X	X	X
A1.1.3	• *Side*	X	X	X
A1.2	**Collision of train with obstacle within the clearance gauge**	X	X	X
A1.2.1	• *with objects fixed on or near the track*	X	X	X
A1.2.1.1	○ *with buffer stops*	X	X	X
A1.2.1.2	○ *with (part of) infrastructure (equipment) within clearance gauge*	X	X	X
A1.2.1.3	○ *with other fixed objects*	X	X	X
A1.2.2	• *with objects temporarily present on or near track*	X	X	X
A1.2.2.1	○ *with animals (excluding birds)*	X	X	X
A1.2.2.2	○ *with rocks*	X	X	X
A1.2.2.3	○ *with landslides*	X	X	X
A1.2.2.4	○ *with trees*	X	X	X
A1.2.2.5	○ *with lost parts of railway vehicles*	X	X	X
A1.2.2.6	○ *with lost or displaced loads*	X	X	X
A1.2.2.7	○ *with vehicles and machines or equipment for track maintenance*	X	X	X
A1.2.2.8	○ *with road vehicles*	X	X	X

A1.2.2.9	○ *with other temporary objects*	X	X	X
A1.2.3	• *with overhead contact lines*	X	X	X
A2	**Derailment of train**	X	X	X
A3	**Level Crossing Accident**	X	X	X
A3.1	• *with one or more crossing vehicles*	X	X	X
A3.2	• *with crossing users (e.g. pedestrians)*	X	X	X
A3.3	• *with other objects temporarily present on or near track if lost by a crossing vehicle or user*	X	X	X
A4	**Accidents to persons involving rolling stock in motion**	X	X	X
A4.1	• *person hit by a railway vehicle (or by an object attached to, or that has become detached from, the vehicle)*	X	X	X
A4.2	• *person fall from railway vehicle*	X	X	X
A4.3	• *person fall or are hit by loose objects when travelling on board vehicles*	X	X	X
A5	**Fire in Rolling Stock**	X	X	X
A5.1	• *Fire in Rolling Stock*	X	X	X
A5.2	• *Explosion in Rolling Stock*	X	X	X
A6	**Other accident**	X	X	X
A6.1	*Collision of rail vehicle not forming a train*	X	X	X
A6.2	*Derailment of rail vehicle not forming a train*	X	X	X
A6.3	• *Electrocution*	X	X	X
A6.4	• *Other accident*	X	X	X
A7	*Suicides and attempted suicides*	X	X	X
A7.1	• *Suicide*	X	X	X
A7.2	• *Attempted suicide*	X	X	X
I	**Incidents**			
	Indicators relating to precursors of accidents			
I1	**Train Operations Failure**	(X)	X	X
I1.1	• *Signal passed at danger when passing a danger point*	X	X	X
I1.2	• *Signal passed at danger without passing a danger point*	X	X	X
I1.3	• *Runaway train*		X	X

I1.4	• *Wrong routing*		X	X
I1.5	• *Train over-speeding*		X	X
I1.6	• *Loading irregularity*		X	X
I1.6.1	○ *Overweight*		X	X
I1.6.2	○ *Oversized loading*		X	X
I1.6.3	○ *Imbalanced loading*		X	X
I1.6.4	○ *Insecure loading*		X	X
I1.6.5	○ *Open door*		X	X
I1.7	• *Train Composition Failure*		X	X
I1.8	• *Train available for boarding or alignment outside platform*		X	X
I1.9	• *Other (train operation failures)*		X	X
I2	**Technical Failure of the vehicles**	(X)	X	X
I2.1	• *Broken wheel on rolling stock in service*	X	X	X
I2.2	• *Broken axle on rolling stock in service*	X	X	X
I2.3	• *Wrong side signalling (vehicle) failure*	X	X	X
I2.4	• *Braking system failure*		X	X
I2.5	• *Losing of vehicle parts*		X	X
I2.6	• *Traction Motor failure (electrical)*		X	x
I2.7	• *Diesel engine failure*		X	X
I2.8	• *Hot axle box*		X	X
I2.9	• *Coupling failure*		X	X
I2.10	• *Doors failure*		X	X
I2.11	• *Suspension system failure*		X	X
I2.12	• *Other (technical failure of the vehicle)*		X	X
I3	**Technical Failure of fixed installations**	(X)	X	X
I3.1	• *Broken rail*	X	X	X
I3.2	• *Track buckle and other track misalignment*	X	X	X
I3.3	• *Wrong side signalling (infrastructure) failure*	X	X	X
I3.4	• *Switch and crossing failure*		X	X
I3.5	• *Failure of the level crossing equipment*		X	X
I3.6	• *Disorder of earthworks/embankment failure*		X	X

I3.7	• *Structures failure*		X	X
I3.7.1	○ *Tunnel failure*		X	X
I3.7.2	○ *Viaduct failure*		X	X
I3.7.3	○ *Culvert failures*		X	X
I3.7.4	○ *Rail bridge structural failure*		X	X
I3.7.5	○ *Over line bridge (e.g. pedestrian) failure*		X	X
I3.7.6	○ *Station structure failure*		X	X
I3.7.8	○ *Platform failure*		X	X
I3.8	• *Power supply equipment failure*		X	X
I3.9	• *Train detection equipment failure*		X	X
I3.10	• *Overhead contact line failure*		X	X
I3.11	• *Fire of fixed installations*		X	X
I3.12	• *Other (technical failure of fixed installations)*		X	X
I4	**Near Misses**		X	X
I4.1	• *with rail vehicle*		X	X
I4.2	• *with road vehicle*		X	X
I4.3	• *with person*		X	X
I4.4	• *with other object*		X	X

(highlighted in yellow: additional element of option n compared to option n-1 – in order to indicate the incremental change between options)

1.2. Occurrence taxonomy

This proposal is valid for all the options:

		Option 1	Option 2	Option 3
1.	**Occurrence reference number**	X	X	X
2.	**Reporting Entity**	X	X	X
2.1	• *Company reference number*	X	X	X
2.2	• *Reporter reference number*	X	X	X
3.	**Occurrence notification status**	X	X	X
3.1	• *Initial notification*	X	X	X
3.2	• *Updated notification*	X	X	X
3.3	• *Final notification*	X	X	X

4.	**Occurrence identification**	X	X	X
4.1	• *Date*	X	X	X
4.2	• *Local Time*	X	X	X
4.3	• *RUs involved*	X	X	X
4.4	• *IM involved*	X	X	X
5.	**Occurrence category**	X	X	X
5.1	• *Accident*	X	X	X
5.1.1	○ *Serious accident*	X	X	X
5.1.2	○ *Significant accident*	X	X	X
5.1.3	○ *Non-significant accident*		X	X
5.2	• *Incident*	X	X	X
6.	**Occurrence description (free text)**	X	X	X
7.	**Vehicle characteristics**	X	X	X
7.1	• *Train type*	X	X	X
7.1.1	○ *Freight train*	X	X	X
7.1.2	○ *Passenger train*	X	X	X
7.1.2.1	▪ *High-speed train*	X	X	X
7.1.2.2	▪ *Conventional train*	X	X	X
7.1.3	○ *Engineering train/Maintenance rolling stock*	X	X	X
7.2	• *Composition*	X	X	X
7.2.1	○ *Locomotive*	X	X	X
7.2.1.1	▪ *Diesel*	X	X	X
7.2.1.2	▪ *Electric*	X	X	X
7.2.1.3	▪ *Hybrid*	X	X	X
7.2.2	○ *DMU*	X	X	X
7.2.3	○ *EMU*	X	X	X
7.2.4	○ *Wagons*	X	X	X
7.2.5	○ *Coaches*	X	X	X
7.3	• *ECM*	X	X	X
8	**Infrastructure characteristics**			
8.1	• *Location*[21]	X	X	X

[21] The location details aim to provide a description of the infrastructure equipment. In order to facilitate the reporting, the parameters above (country, National line ID, Operational points, track number and railway

8.2	• *Country*	X	X	X
8.3	• *National Line ID*	X	X	X
8.4	• *For occurrence located on a section of line: Operational Points IDs Start and End* • *For occurrence located in an operational point (stations, sidings, switches, etc): Operational Point ID*	X	X	X
8.5	• *Track or platform number (when relevant)*	X	X	X
8.6	• *Railway location (distance from the origin of the line – for occurrence located on a section of line only)*	X	X	X
8.7	• *Geographical coordinates (latitude / longitude)*[22]	X	X	X
8.8	• *Type of level crossing involved*	X	X	X
8.8.1	• *Passive level crossing*	X	X	X
8.8.2	• *Active level crossing*	X	X	X
8.8.2.1	• *manual*	X	X	X
8.8.2.2	• *automatic with user-side warning*	X	X	X
8.8.2.3	• *automatic with user-side protection*	X	X	X
8.8.2.4	• *rail-side protected*	X	X	X
9.	**Transport of Dangerous Goods**	X	X	X
9.1	• *Yes*	X	X	X
9.1.1	○ *Dangerous goods are released*	X	X	X
9.1.1.1	▪ *Yes*	X	X	X
9.1.1.2	▪ *No*	X	X	X
9.2	• *No*	X	X	X
10.	**Signalling system characteristics**	X	X	X
10.1	• *ERTMS*	X	X	X
10.2	• *Lineside signalling*	X	X	X
10.3	• *Cab signalling*	X	X	X
10.4	• *Other*	X	X	X

location) correspond to existing RINF parameters. These allow then to retrieve all the information related to technical details of the infrastructure already reported in the RINF and will prevent additional reporting of the same information in the future COR system. If some data is not yet available while the implementation phase of the RINF is still on-going, necessary fields could be temporarily added to the taxonomy.

[22] The report of geographical coordinates will allow, in addition with information already included in the RINF, to provide precise geographic visualisation and mapping of occurrences (e.g. mapping of black spots).

11.	**Environmental relevant factor**	X	X	X
11.1	• *Meteorology/Weather*	X	X	X
11.1.1	○ *Fog*	X	X	X
11.1.2	○ *Flooding*	X	X	X
11.1.3	○ *Frost*	X	X	X
11.1.4	○ *Ice*	X	X	X
11.1.5	○ *High winds*	X	X	X
11.1.6	○ *Storm*	X	X	X
11.1.7	○ *Snow*	X	X	X
11.1.8	○ *Heat*	X	X	X
11.1.9	○ *Other*	X	X	X
11.2	• *Landslide*	X	X	X
11.3	• *Rock/stone fall*	X	X	X
11.4	• *Earthquake*	X	X	X
11.5	• *Vegetation*	X	X	X
11.6	• *Light conditions*	X	X	X
11.7	• *Other*	X	X	X
12.	**Associated occurrences/ occurrences**[23] Occurrence reference number	X	X	X
13.	**Occurrence consequences** See 1.3 Occurrence consequences	X	X	X
14.	**Occurrence causes** See 1.4 Occurrence causes	X	X	X
15.	**Actions/Measures taken (free text)**	X	X	X
16.	**Link to NIB report (if relevant)**	X	X	X
17.	**Additional relevant information/documents/pictures**	X	X	X
18.	**Shunting Operations**	X	X	X
18.1	• *Yes*	X	X	X
18.2	• *No*	X	X	X

[23] Each occurrence shall be reported under the type of the primary occurrence listed in the Annex I, even if the consequences of the secondary occurrence are more severe. It is however required to report here the full list of occurrence, when relevant, in order to be able to set the chain of occurrences, using the categories listed in Annex I.

1.3. Occurrence Consequences

This proposal is valid for all the options:

1.	**Casualties**	X	X	X
1.1	• *Passenger*	X	X	X
1.1.1	○ *Deaths*	X	X	X
1.1.2	○ *Serious Injuries*	X	X	X
1.1.3	○ *Light injuries*	X	X	X
1.2	• *Employee or Contractor*	X	X	X
1.2.1	○ *Deaths*	X	X	X
1.2.2	○ *Serious Injuries*	X	X	X
1.2.3	○ *Light injuries*	X	X	X
1.2	• *Level Crossing User*	X	X	X
1.2.1	○ *Deaths*	X	X	X
1.2.2	○ *Serious Injuries*	X	X	X
1.2.3	○ *Light injuries*	X	X	X
1.3	• *Trespasser*	X	X	X
1.3.1	○ *Deaths*	X	X	X
1.3.2	○ *Serious Injuries*	X	X	X
1.3.3	○ *Light injuries*	X	X	X
1.4	• *Other person at a platform*	X	X	X
1.4.1	○ *Deaths*	X	X	X
1.4.2	○ *Serious Injuries*	X	X	X
1.4.3	○ *Light injuries*	X	X	X
1.5	• *Other person not at a platform*	X	X	X
1.5.1	○ *Deaths*	X	X	X
1.5.2	○ *Serious Injuries*	X	X	X
1.5.3	○ *Light injuries*	X	X	X
2.	**Damage to Environment**	X	X	X
2.1	• *Yes*	X	X	X
2.1.1	○ *Costs*	X	X	X
2.1.2	○ *Description (free text)*	X	X	X
2.2	• *No*	X	X	X

3.	**Material damages to rolling stock**	X	X	X
3.1	• *Yes*	X	X	X
3.1.1	○ *Costs*	X	X	X
3.1.2	○ *Description (free text)*	X	X	X
3.2	• *No*	X	X	X
4.	**Material damages to infrastructure**	X	X	X
3.1	• *Yes*	X	X	X
3.1.1	○ *Costs*	X	X	X
3.1.2	○ *Description (free text)*	X	X	X
3.2	• *No*	X	X	X
5.	**Other Damages**	X	X	X
5.1	• *Yes*	X	X	X
5.1.1	○ *Type*	X	X	X
5.1.1.1	▪ *Structures/Buildings*	X	X	X
5.1.1.2	▪ *Objects*	X	X	X
5.1.1.3	▪ *Cargo*	X	X	X
5.1.1.4	▪ *Other*	X	X	X
5.1.2	○ *Description (free text)*	X	X	X
5.1.3	○ *Costs*	X	X	X
5.2	• *No*	X	X	X
6.	**Delays**	X	X	X
6.1	• *Passenger Trains*	X	X	X
6.1.1	○ *Number of trains*	X	X	X
6.1.2	○ *Number of total minutes*	X	X	X
6.2	• *Freight Trains*	X	X	X
6.2.1	○ *Number of trains*	X	X	X
6.2.2	○ *Number of total minutes*	X	X	X
6.3	• *Overall (sum of passenger and freight trains calculated automatically)*	X	X	X
6.3.1	○ *Number of trains*	X	X	X
6.3.2	○ *Number of total minutes*	X	X	X
6.4	• *Extensive disruption to traffic (Yes/No)*	X	X	X
7.	**Economic Impact of Occurrence** (sum in euro calculated automatically)	X	X	X

1.4. Occurrences causes

This proposal is valid for all the options:

1.	**Accident** (see 1.1 Reportable occurrences)	X	X	X
2.	**Incident** (see 1.1 Reportable occurrences)	X	X	X
3.	**Human and Organisational Performance**	X	X	X
3.1	***Human function(s)*** [24] ***involved***	X	X	X
3.1.1	• *To provide power for train operations in normal operations, or situations where there are disruptions or engineering work*	X	X	X
3.1.1.1	○ *Take up power control duties*	X	X	X
3.1.1.2	○ *Monitor power*	X	X	X
3.1.1.3	○ *Provision of traction supply*	X	X	X
3.1.1.4	○ *Detect irregularity*	X	X	X
3.1.1.5	○ *Agreement of isolation*	X	X	X
3.1.1.6	○ *Formal agreement for control of the line*	X	X	X
3.1.1.7	○ *Apply isolation*	X	X	X
3.1.1.8	○ *Return of power / remove isolation*	X	X	X
3.1.2	• *To respond to incidents and occurrences, including arrangements for safety and initiation of remedial actions*	X	X	X
3.1.2.1	○ *Detect irregularity*	X	X	X
3.1.2.2	○ *Conduct immediate mitigation, containment*	X	X	X
3.1.2.3	○ *Gather and communicate incident information*	X	X	X
3.1.2.4	○ *Protect work area*	X	X	X
3.1.2.5	○ *Verify work arrangements*	X	X	X

[24] The list of human function has been established following the study on human functions of University of Nottingham made for the Agency in 2013. The report of the human functions involved in an occurrence intends to classify and provide a view of the railway functions involved in the occurrences, in order to better highlight the areas where improvements/actions/measures might be necessary. This should be considered as a first attempt to enhance focus of investigation and report on those areas. Usually, it appears that such information are collected (either directly or indirectly in existing occurrence reporting system – mainly through free text) but rarely classified, undermining the focus of investigation of those areas.
The different human functions listed here are defined in the study and available on Agency's website.
However, in order to be more comprehensive, we recognize that this classification would need to be extended to other functions that might be involved in an occurrence, such as, for instance, technical functions (of equipment) or regulatory functions (from NSAs, the Agency).

3.1.2.6	○ *Ensure status of infrastructure*	X	X	X
3.1.2.7	○ *Formal agreement for control of the line*	X	X	X
3.1.2.8	○ *Coordinating failure and incident response*	X	X	X
3.1.2.9	○ *Anticipate delay*	X	X	X
3.1.2.10	○ *Re-planning train service*	X	X	X
3.1.2.11	○ *Ensure passenger and personnel safety*	X	X	X
3.1.2.12	○ *Rectifying the incident*	X	X	X
3.1.2.13	○ *Protect evidence*	X	X	X
3.1.3	• *To maintain, repair and extend the infrastructure*	X	X	X
3.1.3.1	○ *Identify engineering work requirements*	X	X	X
3.1.3.2	○ *Establish network access*	X	X	X
3.1.3.3	○ *Formulate work plans*	X	X	X
3.1.3.4	○ *Allocate resources*	X	X	X
3.1.3.5	○ *Formal agreement for control of the line*	X	X	X
3.1.3.6	○ *Verify work arrangements*	X	X	X
3.1.3.7	○ *Protect work area*	X	X	X
3.1.3.8	○ *Supply of resources to site work*	X	X	X
3.1.3.9	○ *Establish safe working environment*	X	X	X
3.1.3.10	○ *Using trains, plant and machinery for engineering work*	X	X	X
3.1.3.11	○ *Close down site on completion of work*	X	X	X
3.1.3.12	○ *Supervision of teams and individuals*	X	X	X
3.1.3.13	○ *Carrying out trackside work*	X	X	X
3.1.4	• *To operate a train in normal operational situations and situations where disruption or problems occur*	X	X	X
3.1.4.1	○ *Ensure authority*	X	X	X
3.1.4.2	○ *Maintain appropriate speed*	X	X	X
3.1.4.3	○ *Ensure train integrity and load integrity on journey*	X	X	X

3.1.4.4	○ *Stopping train*	X	X	X
3.1.4.5	○ *Management of train control systems*	X	X	X
3.1.4.6	○ *Ensure status of infrastructure*	X	X	X
3.1.4.7	○ *Operate level crossing*	X	X	X
3.1.4.8	○ *Warnings to other rail users*	X	X	X
3.1.4.9	○ *Stabling of vehicles*	X	X	X
3.1.4.10	○ *Provide information and support to passengers*	X	X	X
3.1.5	• *To control train movements in all operational circumstances*	X	X	X
3.1.5.1	○ *Take up control of train movement duties*	X	X	X
3.1.5.2	○ *Handover of responsibility*	X	X	X
3.1.5.3	○ *Monitor rail network*	X	X	X
3.1.5.4	○ *Authorise train movements*	X	X	X
3.1.5.5	○ *Route / re-route passenger or freight service*	X	X	X
3.1.5.6	○ *Record train movements*	X	X	X
3.1.5.7	○ *Anticipate delays or poor traffic flow*	X	X	X
3.1.5.8	○ Deal with irregular train movements	X	X	X
3.1.5.9	○ Provide train identification	X	X	X
3.1.5.10	○ Manage implementation of emergency / temporary speed restrictions	X	X	X
3.1.5.11	○ Gather and communicate information	X	X	X
3.1.5.12	○ Control level crossing	X	X	X
3.1.5.13	○ Despatch train	X	X	X
3.1.5.14	○ Supervision of teams and individuals	X	X	X
3.1.6	• To prepare trains for service	X	X	X
3.1.6.1	○ Assembling vehicle formation	X	X	X
3.1.6.2	○ Preparation of vehicles	X	X	X
3.1.6.3	○ Take up driving duties	X	X	X

3.1.6.4	○ Loading of freight	X	X	X
3.1.7	• Support passenger movements and well-being at stations	X	X	X
3.1.7.1	○ Preparing stations for use by passengers	X	X	X
3.1.7.2	○ Assisting passengers	X	X	X
3.1.7.3	○ Control of crowds	X	X	X
3.1.8	• To check, inspect maintain and repair rolling stock for service	X	X	X
3.1.8.1	○ Identify rolling stock maintenance requirements	X	X	X
3.1.8.2	○ Allocate resources	X	X	X
3.1.8.3	○ Prepare rolling stock for inspection	X	X	X
3.1.8.4	○ Inspect rolling stock	X	X	X
3.1.8.5	○ Handover of responsibility	X	X	X
3.1.8.6	○ Installation of components onto vehicles normally in service	X	X	X
3.1.8.7	○ Maintenance of components on vehicles normally in service	X	X	X
3.1.8.8	○ Servicing of rolling stock	X	X	X
3.2	▪ **Human and organisational factors**[25]	X	X	X
3.2.1	• Dynamic staff factors	X	X	X
3.2.1.1	○ *Expectation / Intention while acting / Decision model / Error type*	X	X	X
3.2.1.2	○ *Vigilance/ concentration*	X	X	X
3.2.1.3	○ *Fatigue*	X	X	X
3.2.1.4	○ *Stress (incl. emotions & psychosocial factors)*	X	X	X

[25] Human and organisational factors aim to identify possible sources of variability that can be considered as part of the causes of an occurrence and which can be considered at all levels of the operational and management processes. This approach is inspired by the research study from Kyriakidis M., on Understanding human performance in sociotechnical systems – Steps towards a generic framework. Safety Sci. (2017), http://dx.doi.org/10.1016/j.ssci.2017.07.008
The approach introduced in the above mentioned study has been adapted to the COR taxonomy needs and taking into account the others parts of the taxonomy (e.g. the section 4 covers the Safety Management System). The need to cover further the "growing conditions" of a safety culture as well as the interactional elements related to it has also led to additional elements compared to the approach taken as reference.
The terms used here are not further defined in this paper as they are mainly based on standard words and concept. Some explanations are also provided in the article about the research mentioned above. However, if the need for further definition appears necessary, more work can be carried out at a later stage to provide more details.

3.2.1.5	○ *Situational awareness (incl. self awareness - situational self knowledge)*	X	X	X
3.2.2	• *Dynamic tasks factors*	X	X	X
3.2.2.1	○ *Uncertainty-Volatility / Time pressure / Time to respond*	X	X	X
3.2.2.2	○ *Complexity-Ambiguity / Autonomy*	X	X	X
3.2.2.3	○ *Shift pattern (working hours, breaks, manning)*	X	X	X
3.2.2.4	○ *Working environment (visibility, noise, vibrations, weather,…)*	X	X	X
3.2.3	• *Static Staff Factors*	X	X	X
3.2.3.1	○ *Familiarity / Individual experiences - job history*	X	X	X
3.2.3.2	○ *Individual characteristics (incl. self trust, openess (and others aspects of personality,...))*	X	X	X
3.2.3.3	○ *Motivation / Commitment (to goal (priorities, risks), to organisation, to rules)*	X	X	X
3.2.3.4	○ *Fit to work (matching to the requirements of the tasks/activities, health)*	X	X	X
3.2.3.5	○ *Decision making skills*	X	X	X
3.2.4	• *Static Task Factors*	X	X	X
3.2.4.1	○ *Technical Communication Means*	X	X	X
3.2.4.2	○ *Task instructions - Quality of procedures and rules*	X	X	X
3.2.4.3	○ *User-centered design / Human Machine Interfaces / Levels of automation*	X	X	X
3.2.4.4	○ *Preventive dispositions and devices*	X	X	X
3.2.4.5	○ *Societal & Institutional ontext (regulation, economy, politics, medias, trespassing, sabotage, terrorism…)*	X	X	X
3.2.5	• *Interactional Factors*	X	X	X
3.2.5.1	○ *Communication (between employees, within organisation)*	X	X	X
3.2.5.2	○ *Relations (within team, with teamleader, within organisation) - power issues*	X	X	X
3.2.5.3	○ *Trust in information - in others (management, colleagues, technical means,…)*	X	X	X
3.2.5.4	○ *Positive - negative reinforcement*	X	X	X
3.2.5.5	○ *Involvement in decision making*	X	X	X

4.	• **Safety Management System**[26]	X	X	X
4.1	• *Leadership*	X	X	X
4.1.1	○ *Leadership and commitment*	X	X	X
4.1.2	○ *Safety Policy*	X	X	X
4.1.3	○ *Organisational roles, responsibilities, accountabilities and authorities*	X	X	X
4.1.4	○ *Consultation of staff and other parties*	X	X	X
4.2	• *Planning*	X	X	X
4.2.1	○ *Actions to address risks*	X	X	X
4.2.2	○ *Safety objectives and planning*	X	X	X
4.3	• *Support*	X	X	X
4.3.1	○ *Resources*	X	X	X
4.3.2	○ *Competence*	X	X	X
4.3.3	○ *Awareness*	X	X	X
4.3.4	○ *Information and communication*	X	X	X
4.3.5	○ *Documented information*	X	X	X
4.3.6	○ *Integration of human and organisational factors*	X	X	X
4.4	• *Operation*	X	X	X
4.4.1	○ *Operational planning and control*	X	X	X
4.4.2	○ *Asset Management*	X	X	X
4.4.3	○ *Contractors, partners and suppliers*	X	X	X
4.4.4	○ *Management of change*	X	X	X
4.4.5	○ *Emergency management*	X	X	X
4.5	• *Performance evaluation*	X	X	X
4.5.1	○ *Monitoring*	X	X	X
4.5.2	○ *Internal auditing*	X	X	X
4.5.3	○ *Management review*	X	X	X
4.6	• *Improvement*	X	X	X
4.6.1	○ *Learning from accidents and incidents*	X	X	X
4.6.2	○ *Continual improvement*	X	X	X

[26] Following the Commission Delegated Regulation establishing common safety methods on safety management system requirements

5.	**Regulatory Framework**	X	X	X
6.	**Security**	X	X	X
6.1	○ *Terrorism*	X	X	X
6.2	○ *Assault*	X	X	X
6.3	○ *Theft*	X	X	X
6.4	○ *Arson*	X	X	X
6.5	○ *Vandalism*	X	X	X
6.6	○ *Cyber attack*	X	X	X
6.7	○ *Other (security causes)*	X	X	X
7.	**Other causes**	X	X	X
7.1	○ *Design of vehicle*	X	X	X
7.2	○ *Design of fixed infrastructure*	X	X	X
7.3	○ *Other*	X	X	X

1.5. Extra functionalities for the EU IT system

1.5.1. Web user interface for data reporting

The web interface for data reporting is necessary in case of countries without National Occurrence Reporting system or of countries which system will not be interfaced with the EU IT System.

1.5.2. APIs for data sharing

The data sharing interface is necessary to allow users to get access to the EU data warehouse (conditions are to be defined). By using the APIs, all the players can get easy access to the necessary data using different software but using a standard interface.

1.5.3. Web-based data analytics tool

This functionality should be considered to support the safety analysis done by the reporters, the National Reporting Authority and the Agency. The functionality should rely on the use of statistics and visualisation tools (charts, maps, dashboards, etc.).

II. Annex II – Cost calculation details & Break-Even Analysis

Input factors for cost calculations - Option 0				**Calculation of annual costs (EUR)**												
Hardware cost per occurrence (EUR)	1.569231															
Software cost per occurrence (EUR)	9.084406															
IT system cost per occurrence (EUR)	10.65															
People to report per occurrence	0.000451															
People to validate per occurrence	0.000526															
People to analyse per occurrence	0.000285															
FTE / occurrence	0.001262															
Estimated number occurences / year	2000			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average
Estimated worked hours per year	1686		Average hourly cost for FTE (EUR)	25.420763	25.70039	25.9831	26.26891	26.55787	26.85	27.14535	27.44395	27.74584	28.05104	28.3596	28.67156	
Adjusting factor for MS not connected	1		Annual cost (IT and FTE) - (EUR)	129462.46	130652.2	131855.1	133071.2	134300.7	135543.7	136800.4	138070.9	139355.4	140654	141966.9	143294.2	136252.3
Adjusting factor for EU not connected	1															
Adjusting factor for MS connected	1															
Adjusting factor for EU connected	1.2															

Input factors for cost calculations - Option 1				**Calculation of annual costs (EUR)**														
Hardware cost per occurrence (EUR)	1.56923077																	
Software cost per occurrence (EUR)	9.08440629																	
IT system cost per occurrence (EUR)	10.65																	
People to report per occurrence	0.0004509																	
People to validate per occurrence	0.00052601																	
People to analyse per occurrence	0.00028493																	
FTE / occurrence	0.00126183																	
Estimated number occurences / year	15000			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average	Average FTE costs	IT costs
Estimated worked hours per year	1686		Average hourly cost for FTE (EUR)	25.4207625	25.7003909	25.9830952	26.2689093	26.5578673	26.8500038	27.1453539	27.4439528	27.7458362	28.0510404	28.3596019	28.6715575			
Adjusting factor for MS not connected	1		Annual cost (IT and FTE) - (EUR)	468013.004	471403.897	474832.09	478297.993	481802.021	485344.593	488926.134	492547.071	496207.839	499908.875	503650.623	507433.53	487363.972		
Adjusting factor for EU not connected	1																327613.9724	159750
Adjusting factor for MS connected	1		Annual cost with 1,2 upgrade for IT	499963.004	503353.897	506782.09	510247.993	513752.021	517294.593	520876.134	524497.071	528157.839	531858.875	535600.623	539383.53	519313.972		
Adjusting factor for EU connected	1.2																327613.9724	191700

Input factors for cost calculations - Option 2				**Calculation of annual costs (EUR)**														
Hardware cost per occurrence (EUR)	1.569231																	
Software cost per occurrence (EUR)	9.084406																	
IT system cost per occurrence (EUR)	10.65																	
People to report per occurrence	0.000451																	
People to validate per occurrence	0.000526																	
People to analyse per occurrence	0.000285																	
FTE / occurrence	0.001262																	
Estimated number occurences / year	125700	120000		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average	Average FT	IT costs
Estimated worked hours per year	1686		Average hourly cost for FTE (EUR)	25.42076	25.70039	25.9831	26.26891	26.55787	26.85	27.14535	27.44395	27.74584	28.05104	28.3596	28.67156			
Adjusting factor for MS not connected	1		Annual cost (IT and FTE) - (EUR)	1646968	1650359	1653787	1657253	1660757	1664300	1667881	1671502	1675163	1678864	1682606	1686389	1666319		
Adjusting factor for EU not connected	1															1800189	327614	1338705
Adjusting factor for MS connected	1		Annual cost with 1,2 upgrade for IT	1914709	1918100	1921528	1924994	1928498	1932041	1935622	1939243	1942904	1946605	1950347	1954130	1934060		
Adjusting factor for EU connected	1.2																327614	1606446

Input factors for cost calculations - Option 3				**Calculation of annual costs (EUR)**														
Hardware cost per occurrence (EUR)	1.569231																	
Software cost per occurrence (EUR)	9.084406																	
IT system cost per occurrence (EUR)	10.65																	
People to report per occurrence	0.000451																	
People to validate per occurrence	0.000526																	
People to analyse per occurrence	0.000285																	
FTE / occurrence	0.001262																	
Estimated number occurences / year	280000	120000		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Average	Average FTE	IT costs
Estimated worked hours per year	1686		Average hourly cost for FTE (EUR)	25.42076	25.7003909	25.9831	26.26891	26.55787	26.85	27.14535	27.44395	27.74584	28.05104	28.3596	28.67156			
Adjusting factor for MS not connected	1		Annual cost (IT and FTE) - (EUR)	11634997	11730179.6	11826410	11923698	12022057	12121497	12222032	12323672	12426431	12530319	12635351	12741538	12178182		
Adjusting factor for EU not connected	1				1.01												9196182	2982000
Adjusting factor for MS connected	1		Annual cost with 1,2 upgrade for IT	12231397	12326579.6	12422810	12520098	12618457	12717897	12818432	12920072	13022831	13126719	13231751	13337938	12774582		
Adjusting factor for EU connected	1.2																9196182	3578400

Break-even analysis								
		Option 1	**Option 2**	**Option 3**		**Option 1**	**Option 2**	**Option 3**
	Annual costs	487363.9724	1666319.0	12178181.7		519314	1934060	12774582
1. BE	VPF (mln EUR)	2487000	2487000	2487000		2487000	2487000	2487000
	Required Avoided Fatalities for Break-Even	**0.2**	**0.7**	**4.9**		**0.2**	**0.8**	**5.1**
	Proportion of required avoided fatalities of total fatalities	**0.02%**	**0.06%**	**0.46%**		**0.02%**	**0.07%**	**0.49%**
	Required Avoided accidents for Break-even	**0.6**	**2.1**	**15.4**		**0.7**	**2.4**	**16.1**
	Proportion of required avoided accidents of total accidents	**0.0%**	**0.1%**	**0.7%**		**0.0%**	**0.1%**	**0.8%**
	Average cost per accident	792771	792771	792771		792771	792771	792771
	Proportion of COR cost relative to total annual accident costs (based on economic CSI data)	***0.03%***	***0.10%***	***0.74%***		***0.03%***	***0.12%***	***0.78%***
	Proportion of COR cost relative to total annual accident costs (fatalities and serious injuries)	*0.0%*	*0.1%*	*0.9%*		*0.0%*	*0.1%*	*0.9%*
	Proportion of COR cost relative to total annual accident costs (excl. costs linked to fatalities and serious injuries)	***0.2%***	***0.7%***	***5.0%***		***0.2%***	***0.8%***	***5.2%***
	Total annual accident costs (mln EUR)	1645	1645	1645		1645	1645	1645
	Total annual accident costs (mln EUR casualties only, fatalities and serious injured)	1400	1400	1400		1400	1400	1400
2. BE	Cost of labour	27.0	27.0	27.0		27.0	27.0	27.0
	Required Hours saved for BE	18039.5	61677.8	450767.8		19222.1	71588.0	472843.2
	Required FTE's saved for BE	10.7	36.6	267.4		11.4	42.5	280.5
	Proportion of EU rail employment	0.0019%	0.0065%	0.0478%	0.0000%	0.0020%	0.0076%	0.0501%
	Number of Entities	84.0	84.0	84.0		84.0	84.0	84.0
	Required Hours saved per entity for BE	214.8	734.3	5366.3		228.8	852.2	5629.1
	Required FTE s saved per entity for BE	0.1	0.4	3.2		0.1	0.5	3.3