



Report on  
**Railway Safety and  
Interoperability  
in the EU**

2022

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# Abbreviations

CAPEX	Capital expenditure
CEF	Connecting Europe Facility
CCS	Control Command and Signalling
CINEA	European Climate, Infrastructure and Environment Executive Agency
CNC	Core Network Corridor
CSI	Common Safety Indicator
CT	Channel Tunnel
DMT	ERTMS Deployment Management Team
ECM	Entity in charge of maintenance
ERA	European Union Agency for Railways
ERADIS	European Railway Agency Database of Interoperability and Safety
ERAIL	European Railway Accident Information Links
ERTMS	European Rail Traffic Management System
ETCS	European Train Control System
EU	European Union
FWSI	Fatality and weighted serious injury
GSM-R	Global System for Mobile Communications – Railway
IM	Infrastructure manager
NIB	National investigation body
NoBo	Notified body
NSA	National safety authority
OBU	On-board unit
OP	Operational point
OTIF	The Intergovernmental Organisation for International Carriage by Rail
PRM	Persons with reduced mobility
RFC	Rail Freight Corridor
RID	Regulation concerning the international carriage of dangerous goods by rail
RINF	Register of Railway Infrastructure
RNE	RailNetEurope
RSD	Railway Safety Directive
RU	Railway undertaking
SC	Safety certificate
SERA	Single European Railway Area
SoL	Section of lines
SPAD	Signal passed at danger
SSC	Single Safety Certificate
TAF	Telematics Applications for Freight services
TAP	Telematics Applications for Passenger services
TDD	Train Drivers Directive
TDG	Transport of Dangerous Goods
TENtec	The European Commission's Information System to coordinate and support the Trans-European Transport Network Policy
TIS	Train Information System
TPS	Train Protection System
TSI	Technical Specification for Interoperability
UNECE	The United Nations Economic Commission for Europe

# Country codes

AT	Austria
BE	Belgium
BG	Bulgaria
CH	Switzerland
CY	Cyprus
CZ	Czechia
DE	Germany
DK	Denmark
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
MT	Malta
NL	Netherlands
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia
UK	United Kingdom

# Foreword by the Executive Director

Dear reader,

I am very pleased to introduce the 2022 edition of the European Union Agency for Railways (ERA) report monitoring progress on the safety and interoperability of the European Union (EU) railway system. This report is a key element in our continuous effort to better understand the situation of European railways and its evolution over time in terms of safety and interoperability. The data contained in this report can be used to identify areas for improvement towards reaching a more efficient and effective railway system for all citizens of Europe: the Single European Railway Area. The report is also an important source of information for decision-making at EU and Member State levels.

The recent worldwide health crisis has resulted in a slowdown in economic and railway activities across Europe, but at the same time it has created an opportunity to thoroughly reflect on how to move Europe towards a sustainable and safe railway system without barriers after the pandemic restrictions. The COVID-19 pandemic has had a major impact on the transport sector, particularly the aviation sector but also the railway sector, especially in terms of railway passenger volumes. The pandemic could also potentially permanently change travel behaviour and traffic patterns. Let us all make the best of this period by carefully analysing the data in this report in order to align and improve our future actions.

The methodology used for this report, as explained in detail in Annex I, proposes indicators for outcomes, as well as outputs and underlying processes and conditions. Those indicators are primarily drawn from the data reported to ERA under the European legal framework. However, several indicators rely on non-statutory data provided voluntarily by national bodies and other stakeholders. We warmly thank the national safety authorities, RailNetEurope, the European Climate, Infrastructure and Environment Executive Agency and other data providers for their active contribution to this report.

## Progress with railway safety

European railways remain among the safest in the world, with major accidents (with five or more fatalities) becoming increasingly rare and significant accidents decreasing in recent years. However, the overall cost of railway accidents remains high, and progress has also been very uneven across the EU Member States, with a significant variation in safety levels. The railway community must continue to work relentlessly and tirelessly to improve railway safety. We can never afford to be complacent.

Unlike the European aviation and maritime industries, railways still have not implemented a systematic and comprehensive EU-wide safety occurrence reporting scheme, which would enable us to learn effectively not only from major accidents, but also from incidents without victims. Several areas in which safety has been stagnating recently, such as level crossing and railway workers' safety, or rolling stock fires, would particularly benefit from wider reporting and information sharing across countries. However, we should not only count accidents and incidents. ERA has received the mandate to draft common safety methods for assessing the safety levels and the safety performance of railway operators at national and EU levels. The common safety methods for assessing safety level and safety performance introduce two new important elements: (1) the obligation to report on the occurrence scenarios, to better understand the underlying mechanisms that (could) lead to accidents; and (2) the concept of safety performance, that is the level of maturity of a railway operator to manage the risk control measures put in place to control the risks of



**Josef Doppelbauer**

its operations. When implemented, this should provide an additional angle to assess how safety is managed. Similarly to aviation, a common IT reporting platform should be set up to support the collection and analysis of these new safety data.

I invite all railway parties to be strongly committed to enhancing railway safety by rigorously applying a robust safety management system and by implementing a positive railway safety culture. ERA is actively fostering a common positive European railway safety culture. Safety is not only about regulations, rules and procedures. Safety is about a continuous and collective commitment. By developing useful instruments to support the sector, ERA is demonstrating its engagement in developing a positive safety culture. However, we need the commitment of all players to achieve sustainable and safe performance across the Single European Railway Area. You can find more information about safety culture on our website <sup>(1)</sup>.

## Progress with railway interoperability

Our records confirm that we have already come far in terms of improving the interoperability of railways in Europe. However, we are still a long way from reaching our targets in many areas. Although sound progress can be seen in aligning operational frameworks in terms of rules, only modest improvements are visible in making the railway assets interoperable. As a consequence, railways have been unable to increase their modal share in the transportation mix in the past decade, despite being the most sustainable mode of transport.

In this edition of the report, for the first time, thanks to our valuable collaboration with RailNetEurope, we present new indicators for monitoring cross-border rail traffic volumes, transfer time and punctuality at border sections, which may provide an indication on the seamlessness of international rail connections. We plan to assess the evolution of these new indicators in the coming years in order to further monitor the development of rail interoperability across Europe. At border crossings the weaknesses in railway interoperability are most visible; even the core corridors in Europe suffer from a lack of technical interoperability due to patchy European Rail Traffic Management System deployment, national rules and non-conformity with technical specifications for interoperability (TSIs). In many areas, delays in the implementation of legal requirements in a few Member States have delayed the interoperable deployment of railways in other countries, preventing the EU from fully benefiting from the harmonised system. For example, the delayed implementation of TAP/TAF TSIs and PRM TSIs and the lack of cross-border agreements in some Member States negatively affect railway customers' daily experiences and the reputation of European railways as a whole. In most cases, the implementation of TSIs does not entail large costs for the sector and there are no excuses for further delays in the implementation of requirements for which the deadline has already passed. The 2022 TSI revision package proposes a fair migration and transition framework to allow the railway sector to adapt to new regulatory requirements.

We all need to enhance our efforts in particular in the area of railway data interoperability. High-quality interoperable and open railway data are essential in connecting the rail business across borders and with other modes of transport. After years of building single-purpose databases, our focus must now shift towards synergies enabled by connected data and underlying IT systems, which can improve rail competitiveness. To significantly improve the current incompleteness and inaccuracy of data in certain ERA registers, I invite all parties involved to boost their efforts towards achieving better data quality.

The ongoing digital revolution offers both inspiration and potential solutions. The European Commission's strategy on sustainable and smart mobility sets out the direction to be taken to make all modes of transport greener. Therefore, we would like to emphasise the importance of a modal shift towards green transport and logistic chains. Rail is the most sustainable, affordable and effective transport mode to meet the goal of decarbonisation, and it could be the backbone of European transport. However, trains need to run

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<sup>(1)</sup> [https://www.era.europa.eu/activities/safety-culture\\_en](https://www.era.europa.eu/activities/safety-culture_en)

alongside other modes of transport in order to carry goods and people in the most effective way. Such a multimodal approach requires the seamless integration of the transport modes, facilitated by digital technologies.

In addition, our new approach to the revisions of TSIs should enable ERA and the railway sector to allocate expert resources more efficiently, to enhance international standardisation and to react rapidly to emerging technologies to considerably shorten their time to market.

Finally, as part of its mandate under the fourth railway package, since 2019 ERA has been issuing vehicle authorisations, granting single safety certificates and deciding on European Rail Traffic Management System trackside approvals across the whole of the EU through entirely paperless procedures. Our experience with this new role is overall positive and promising for the future.

I hope that you will find this report interesting and a valuable point of reference. Enjoy reading!



# Introduction

This report is one of the visible results of the activities of the European Union Agency for Railways (ERA) in monitoring safety performance. It is also part of the agency's effort to provide to its stakeholders with a comprehensive overview of the development of railway safety and interoperability in the European Union (EU). In accordance with EU legislation <sup>(?)</sup>, the report has been published by ERA biennially since 2006.

Specifically, this publication represents the third edition of the report on progress on safety and interoperability in the Single European Railway Area (SERA), a joint statutory report mandated by the recast agency regulation. It follows the two thematic reports that have been produced by ERA since 2006.

Monitoring the safety and interoperability of the EU railway system is one of the key tasks of ERA. The agency collects, processes and analyses different sets of data in order to support recommendations on actions to be taken. In this way, ERA facilitates evidence-based policymaking at EU level. By continuously monitoring and analysing the safety and interoperability performance of the EU railway system, the agency provides assurance that the common goals are achieved.

## Report scope

This report is based on data up to the 2020 reporting period, and, where available, up to 2021. As Cyprus and Malta do not have railway systems that are covered by EU legislation, the EU railway system is composed of the railway systems of 25 Member States. Data are also provided for Norway, Switzerland and the United Kingdom. The Channel Tunnel is a separate reporting entity, with relevant data provided separately by both France and the United Kingdom. Therefore, there were, in total, 29 reporting entities in 2020, referred to in this report as 'ERA countries'.

## Information sources

This report is based on data available in various EU databases and registers as provided by national authorities, such as national safety authorities (NSAs) and national investigation bodies (NIBs), operators and other actors.

In the area of safety, the national bodies have a legal obligation to report to ERA a set of defined information that can be used to assess the development of railway safety in the EU. Notably, the NSAs gather common safety indicators (CSIs), defined in legislation, from the railway undertakings (RUs) and infrastructure managers (IMs), which show safety performance in Member States and the EU.

In the area of interoperability, the report draws on data available in the databases and registers hosted by ERA, complemented by an annual data survey among NSAs. Furthermore, the official data available from the European Commission are used. Finally, data from industry associations add to the picture.

## Report and chapter overview

This report consists of two main parts: progress with safety (Part A) and progress with interoperability (Part B). To monitor the progress in these two aspects of the EU railway system, a series of standard indicators are used. A comprehensive methodological framework outlined in Annex II governs their selection. Indicators are based on the logical framework for

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<sup>(?)</sup> This report is published in accordance with Art. 35(4) of Regulation (EU) 2016/796.

evaluation, assessing three main areas: inputs, outputs and outcomes. For each indicator, further details are provided in the following sections:

the **purpose** section describes the reason for the indicator, its importance in the quest for safety and interoperability, its goal, or official target if available, and its expected use;

the **indicators** section describes the measures of quantitative assessments used to track and compare performance;

the **findings** section provides the main observations along with the results of the data analysis;

the **sources and limitations** section provides additional information on the data source, data production and other aspects influencing the metric and its quality.

Metrics for each indicator are shown with the help of figures. Where available, two figures are used: the first provides an overview, while the second provides further insight.

## A. Progress with safety



## Summary

The safety level of the EU railway system remains high; it is in fact one of the safest railway systems in the world. In a multimodal comparison, rail appears the safest mode of land transport in the EU, with the fatality rate for passengers similar to that for aircraft passengers.

Significant accidents and resulting casualties have decreased steadily since 2010; the safety levels registered for 2020 are historically the highest.

Major accidents resulting in five or more fatalities have become rare: no such accidents have occurred in the past 2 years, and only two have been registered in the past four years. The number of fatal train collisions and derailments has decreased continuously since 1990. In 2020, though, a peak (of eight such accidents) was registered.

The rates of significant accidents, fatalities, and fatalities and weighted serious injuries (FWSIs) per million train-km have decreased substantially since 2010. Despite the reduction in passenger fatalities, taking into account the significant drop in passenger-km (due to the COVID-19 pandemic), passenger fatality rate has increased compared with 2019, showing a slightly rising trend since 2017.

The results of the latest assessment of the achievement of safety targets (carried out annually by ERA) indicate that safety performance remains acceptable at EU level, although possible deterioration in safety performance was identified in eight instances. Such a result is in line with the 10 previous assessments, which typically identified possible deterioration in safety performance in a few countries and categories.

Behind the overall positive trends are the realities requiring the attention of both the railway sector and policymakers. Despite an overall decrease in the number of significant accidents since 2010, the number of 'internal' accidents (collisions, derailments, fires in rolling stock and other accidents) is stagnating and the overall toll of railway accidents remains high: the economic cost of significant accidents alone was estimated at about EUR 3.2 billion in 2020. Progress has also been very uneven across the EU Member states, with variation in safety levels remaining high.

High variation in the number of accidents involving the transport of dangerous goods (TDG) was recorded in 2018–2020, but it cannot currently be established with certainty if this actually is the result of a decrease in safety or a variation in the interpretation of the applicable legislation.

Good results achieved in reducing third-party fatalities (trespassers and suicides) came with a similar reduction in overall suicide mortality rates and cannot therefore be fully attributed to the work done by the railway IMs.

No clear progress has been seen in reducing railway worker casualties since 2014, if looking at absolute figures. Each year (except in 2019), close to 30 fatalities were reported among railway workers. In addition, more than 40 employees were seriously injured annually. After a significant decrease until 2018, both the railway passenger fatality rate and the railway employee fatality rate show a slightly increasing trend in the past 2 years.

Safety at level crossings has been improving in the past decade, despite the stagnating trend in recent years (since 2016). In 2020, there was a significant decrease in the number of level crossing accidents and related fatalities compared with 2019; however, this reduction should be interpreted with caution, as it could be partially linked to the lockdown measures (and the related travel restrictions) imposed during the COVID-19 pandemic. However, level crossing accident rates still vary considerably across EU Member States.

One of the main drivers of disparities in safety levels seems to be the level of safety of the railway infrastructure: the deployment of advanced train protection systems (TPSs) and raiiside protected level crossing devices varies greatly across Europe.

The accident investigation reports and a high number of reported precursors highlight the potential for further safety improvements through learning from experience. This potential can be fully exploited only if the information and knowledge is shared across the EU.

Although the trend over the last 3 years confirms the gradual transition towards single safety certificates (SSCs), the number of part A safety certificates remains quite stable. This can be explained by, among other reasons, the renewal of these safety certificates before the transposition date of the fourth railway package and by specific measures taken by some Member States to extend their validity.

At the end of 2021, even though they were not yet mandatory, 223 entity in charge of maintenance (ECM) certificates for vehicles other than freight wagons were reported in the European Railway Agency Database of Interoperability and Safety (ERADIS).

# Overview of indicators and figures

## Part A: Progress with safety

Indicator	Figure	Indicator/Figure(s)	Category	Area
<b>1</b>	1	<b>Cost of railway accidents</b> Estimated costs of railway accidents, million EUR (EU-27, 2020)	Impacts	Economic costs
	2	Estimated costs of railway accidents per country, million EUR (EU-27 + CH + NO + UK, 2020)		
<b>2</b>	3	<b>Accidents and their outcomes</b> Main safety outcomes (EU-27, 2010-2020)		
	4	Significance of changes in annual counts of significant accidents (EU-27, 2016-2020)		
<b>3</b>	5	<b>Major accidents and fatal train collisions and derailments</b> Major accidents in Europe (EU-27 + CH + NO + UK, 1980-2021)		
	6	Fatal train collisions and derailments in Europe (EU-27 + CH + NO + UK, 1990-2020)		
<b>4</b>	7	<b>Trends in accident and casualty rates and their variations</b> Trends in accident and fatality rates (EU-27, 2010-2020)		
	8	Fatalities and weighted serious injuries rates (EU-27, 2010-2020)		
<b>5</b>	9	<b>Railway and passenger fatality rates</b> Railway fatality rates (2018-2020)		
	10	Railway passenger fatality rates (2010-2020)		
<b>6</b>	11	<b>Safety of different transport modes</b> Passenger and driver fatality rates for different transport modes (EU-27, 2015-2019)		
	12	<b>Worldwide railway safety</b> Railway fatality rates for different countries worldwide (2016-2020)		
<b>7</b>	13	Passenger fatality rates for different countries worldwide (2016-2020)		
	14	<b>Achievement of safety targets</b> Instances of possible/probable deterioration in safety performance by risk category (EU-27 + NO, 2008-2020)		
<b>8</b>	15	Instances of possible/probable deterioration in safety performance by country (EU-27 + NO, 2008-2020)	Final outcomes	Accidents, casualties and rates
	16	<b>Significant accidents</b> Significant accidents per type (EU-27, 2016-2020)		
<b>9</b>	17	Railway 'internal' and 'external' significant accidents (EU-27, 2010-2020)		
	18	<b>Accidents and incidents involving transport of dangerous goods</b> Accidents involving the transport of dangerous goods (EU-27, 2010-2020)		
<b>10</b>	19	<b>Casualties from significant accidents</b> Fatalities per victim category, excluding suicides (EU-27, 2016-2020)		
	20	Fatalities per type of significant accident (EU-27, 2016-2020)		
<b>11</b>	21	<b>Suicides and trespasser fatalities</b> Railway suicides and trespasser fatalities (EU-27, 2007-2020)		
	22	Suicide and trespasser fatality rates (EU-27 + CH + NO + UK, 2018-2020)		
<b>12</b>	23	<b>Railway suicides versus overall suicides</b> Railway suicide rate (EU-27, 2011-2020) and suicide mortality (EU-27, 2011-2017)		
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<b>13</b>	25	<b>Railway workers safety</b> Railway employee casualties (EU-27, 2010-2020)		Railway workers
	26	Railway passenger and employee fatality rates (EU-27, 2006-2020)		
<b>14</b>	27	<b>Level crossing safety</b> Level crossing accidents and resulting casualties (EU-27, 2010-2020)		Level crossings
	28	Level crossing accident rates (EU-27 + CH + NO + UK, 2018-2020)		
<b>15</b>	29	<b>Precursors to accidents</b> Precursors to accidents (EU-27, 2016-2020)	Intermediate outcomes	Accident precursors
	30	Accident precursor to accident ratio per country (EU-27 + CH + NO + UK, 2016-2020)		

Indicator	Figure	Indicator/Figure(s)	Category	Area
<b>17</b>		<b>Accidents investigations</b>	Outputs	Accident investigations
	31	Accidents and incidents subject to independent investigation (EU-27+CH+NO+UK, 2006-2021)		
	32	Accident types of NIB-investigated accidents (EU-27 + CH + NO + UK, 2006–2021)		
<b>18</b>		<b>NSAs monitoring</b>		NSAs monitoring
	33	Findings issued during the monitoring of NSAs (EU-27, excluding Cyprus and Malta, plus Switzerland, end 2021)		
<b>19</b>		<b>Deployment of train protection systems on railway lines</b>	Inputs	Infrastructure safety
	34	Share of tracks equipped with train protection systems, % (EU-27 + NO, 2020)		
	35	Share of railway lines equipped with ERTMS, % (EU-27, end 2021)		
<b>20</b>		<b>Deployment of level crossing protection systems</b>		
	36	Level crossings per type of protection (EU-27, 2011–2020)		
	37	Number of level crossing accidents and number of passive level crossings per country (EU-27 + CH + NO + UK, 2018–2020)		
<b>21</b>		<b>Safety certification</b>		Certifications
	38	Number of safety certificates (part A) and SSCs valid at the end of 2019, 2020 and 2021 by issuing country / ERA (EU-27 + CH + NO)		
	39	Number of safety certificates and SSCs valid at the end of 2021 by type of service (EU-27 + CH + NO)		
<b>22</b>		<b>ECM certificates</b>		
	40	Number of ECM certificates active at the end of 2021 per country of the certified entity (EU-27 + CH + NO)		
	41	Number of ECM certificates for wagons and other types of vehicles (end 2021)		

## A-1 Costs of railway accidents

### Purpose

An unsafe railway system has direct and indirect impacts on society. Economic theory allows the expression of those impacts in monetary terms. This gives an idea of the costs of unsafe railway operation to both industry and society. Although the monetisation of costs to business is relatively straightforward, the evaluation of socioeconomic costs is based on per-unit cost estimates from economic studies, which evolve with time along with more empirical evidence.

### Indicators

In the application of the railway safety directive (RSD) (Directive (EU) 2016/798), the economic impact of accidents is measured by the economic impact of fatalities and serious injuries, the costs of delays, the costs of material damage to rolling stock or infrastructure and the costs to the environment. Other types of costs have been recognised, but they represent a minor addition to the statutory costs.

### Findings

The total cost of significant railway accidents <sup>(?)</sup> in 2020 is estimated at about EUR 3.2 billion (in the EU-27), lower than the figures published in the previous 2 years but still high. In recent years, an update to the casualty unit costs resulted in a significant increase in these costs. Fatalities account for 70 % of total costs. The costs reported and estimated for individual Member States reflect both the accident outcomes and the economic situation, as per unit cost estimates for casualties.

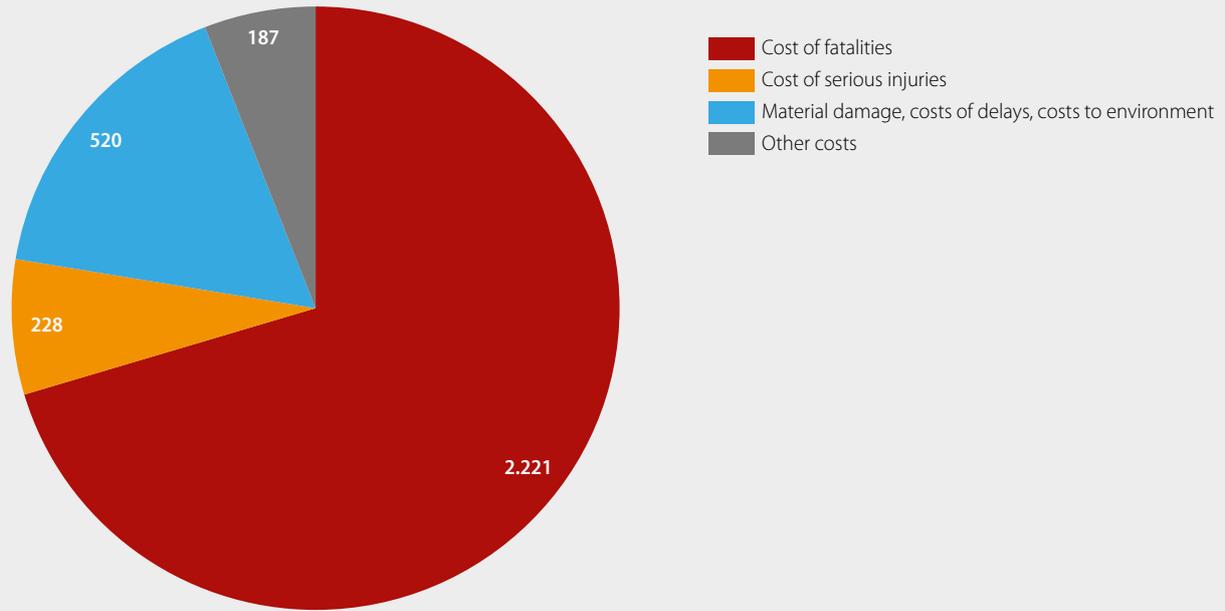
### Sources and limitations

While the economic impact of casualties can be estimated for all countries thanks to EU-wide studies on the unit costs, the costs of delays are available for 22 (out of 25) EU countries. A few Member States were not able to monetise the total material damage of significant accidents in 2020, and only seven countries recorded environmental damage related to those accidents. Data have been reported by NSAs for more than 10 years, under Annex I to the RSD (CSIs), and detailed guidance material, which also contains fallback values, is available. In addition, some countries fail to report some types of costs, so the reliability of cost data should be considered on a case-by-case basis.

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<sup>(?)</sup> The railway safety directive (Directive (EU) 2016/798) defines a 'significant accident' as 'any accident involving at least one rail vehicle in motion, resulting in at least one killed or seriously injured person, or in significant damage to stock, track, other installations or environment, or extensive disruptions to traffic, excluding accidents in workshops, warehouses and depots'. The directive explains that "[s]ignificant damage to stock, track, other installations or environment" means damage that is equivalent to EUR 150 000 or more, and that "[e]xtensive disruptions to traffic" means that train services on a main railway line are suspended for six hours or more.

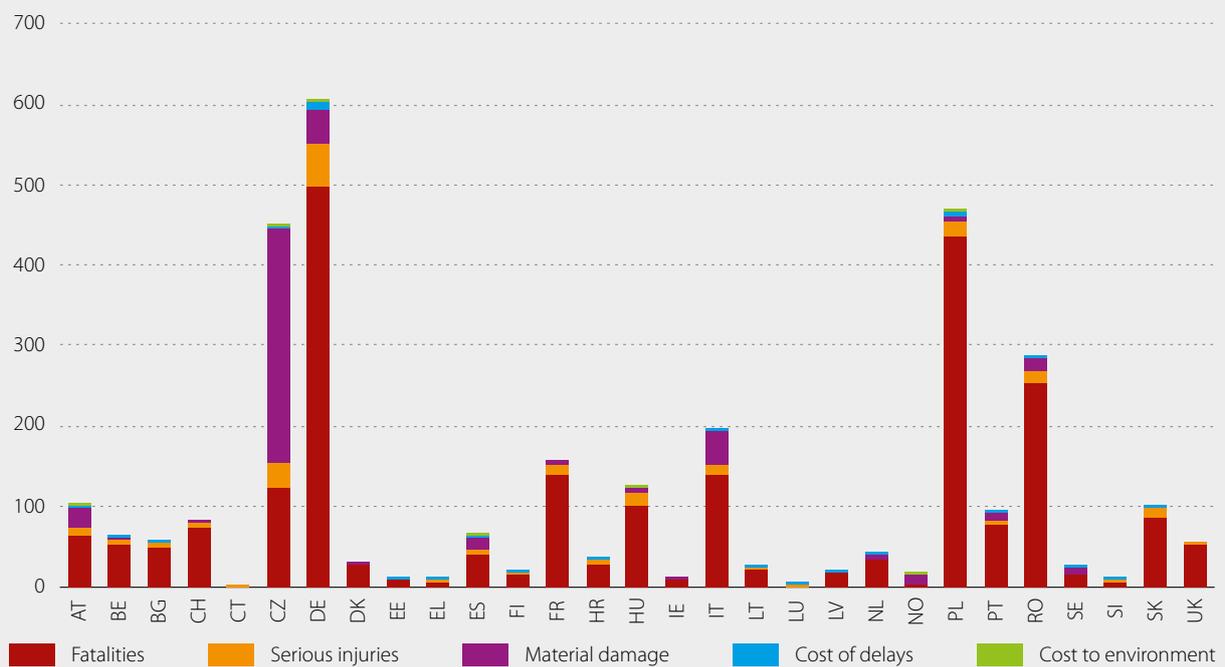
**Figure A-1:** Estimated costs of railway accidents, million EUR (EU-27, 2020)



Note: Other costs are those associated with modal shift, air pollution, administration, rerouting, reputational damage and productivity losses, and are estimated from unit costs developed by a consultant for ERA.

Source: CSIs as reported by NSAs to ERA.

**Figure A-2:** Estimated costs of railway accidents per country, million EUR (EU-27 + CH + NO + UK, 2020)



Source: CSIs as reported by NSAs to ERA.

## A-2 Accidents and their outcomes

### Purpose

Significant accidents and the resulting casualties provide the ultimate insight into the safety level of railway systems. European legislation sets the goal to maintain or, where possible, improve railway safety in SERA. The monitoring and assessment of this goal is assured by the use of rates (casualties normalised by transport volume).

### Indicators

The absolute numbers of significant accidents and resulting serious and fatal injuries are recorded.

### Findings

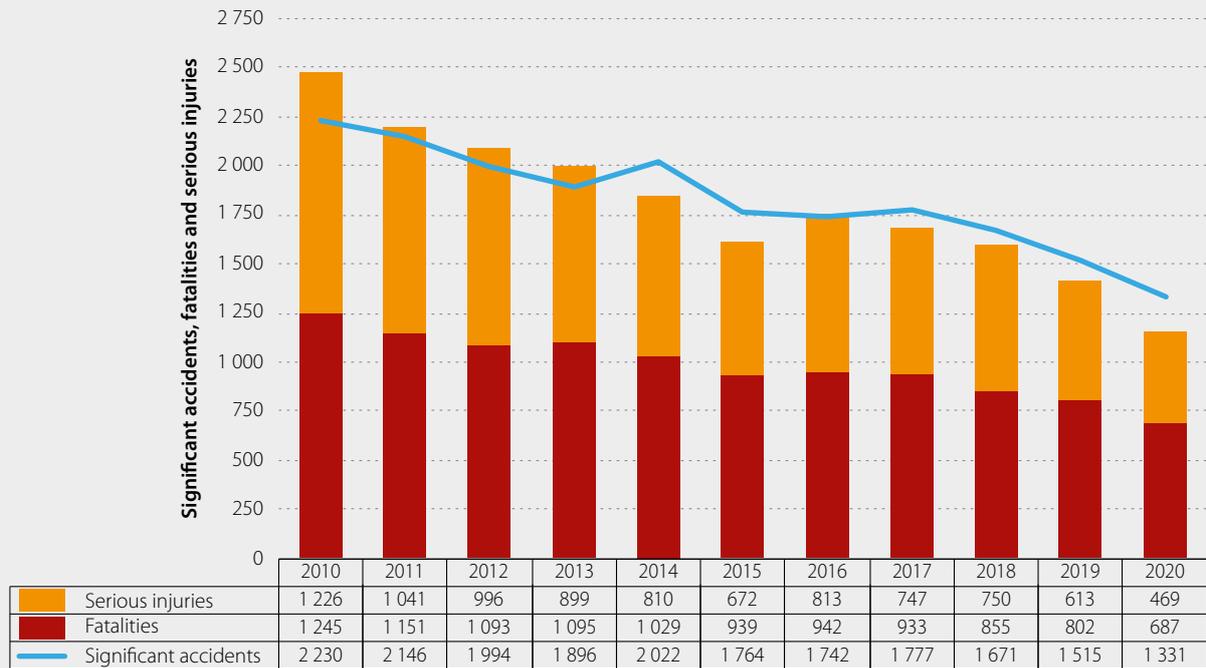
Both the number of significant rail accidents and the number of resulting casualties, for which harmonised data are available across the EU, declined steadily over the period 2010–2020. In total, 1 331 significant accidents, 687 fatalities and 469 serious injuries were reported in the EU-27 countries in 2020, the lowest values ever recorded. The 12 % decrease in significant accidents between 2019 and 2020 is statistically significant; the difference between the 2020 figure and the average of the four preceding years is also significant. The decrease occurred across all accident categories except collisions and other accidents; statistically significant reductions in serious injuries, fatalities and suicides have also been observed. However, collisions of trains and other accidents increased in 2020 compared with 2019 and with the average for 2016–2019.

### Sources and limitations

The data used to monitor progress with safety outcomes are part of the CSIs as supplied by the NSAs to ERA. More than 10 years of continuous work on improving data quality in Member States and at the agency provides assurance on the accuracy of the data.

**Figure A-3: Main safety outcomes (EU-27, 2010–2020)**

Significant accidents, fatalities and serious injuries



Source: CSIs as reported by NSAs to ERA.

**Figure A-4: Significance of changes in annual counts of significant accidents (EU-27, 2016–2020)**

Significance of change in outcomes	2020/2019	2020/(2016-2019)
Collisions of trains	7 %	7 %
Derailments of trains	-5 %	-7 %
Level-crossing accidents	-19 %	-20 %
Accidents to persons	-14 %	-28 %
Fires in rolling stock	-41 %	-63 %
Other accidents	11 %	32 %
All significant accidents	-12 %	-21 %
Fatalities	-14 %	-22 %
Serious injuries	-23 %	-36 %
Suicides	-5 %	-10 %

Note: A Poisson statistical significance test was performed at a significance level of 95 %. Statistically significant changes are highlighted in orange.

Source: CSIs as reported by NSAs to ERA.

## A-3 Major accidents and fatal train collisions and derailments

### Purpose

As past accident records may not always be complete in all EU countries, narrowing the scope to railway accidents with severe consequences provides more robust confirmation of the trends identified and, at the same time, highlights the most serious events that occurred and their impact on overall accident statistics. Accidents with multiple fatalities rarely escape the attention of the media and the public, so data on these are assumed to be complete. Historical data on serious accidents that caused five or more fatalities in the EU-27, Norway, Switzerland and the United Kingdom, herein referred to as major accidents, are collected by ERA, in addition to regulatory data collection.

### Indicators

Indicators are the number of accidents resulting in five or more fatalities and the number of fatal train collisions and derailments (the latter includes train collisions, train derailments and train fires following collisions or derailments in which one or more people are killed, covering thus the most serious operational accidents).

### Findings

An overall downwards trend in major accidents (and in the number of corresponding fatalities) has been observed since 1980. In 2020 and 2021, as in 2018, no accidents resulting in five or more fatalities were registered; two such accidents occurred in 2019.

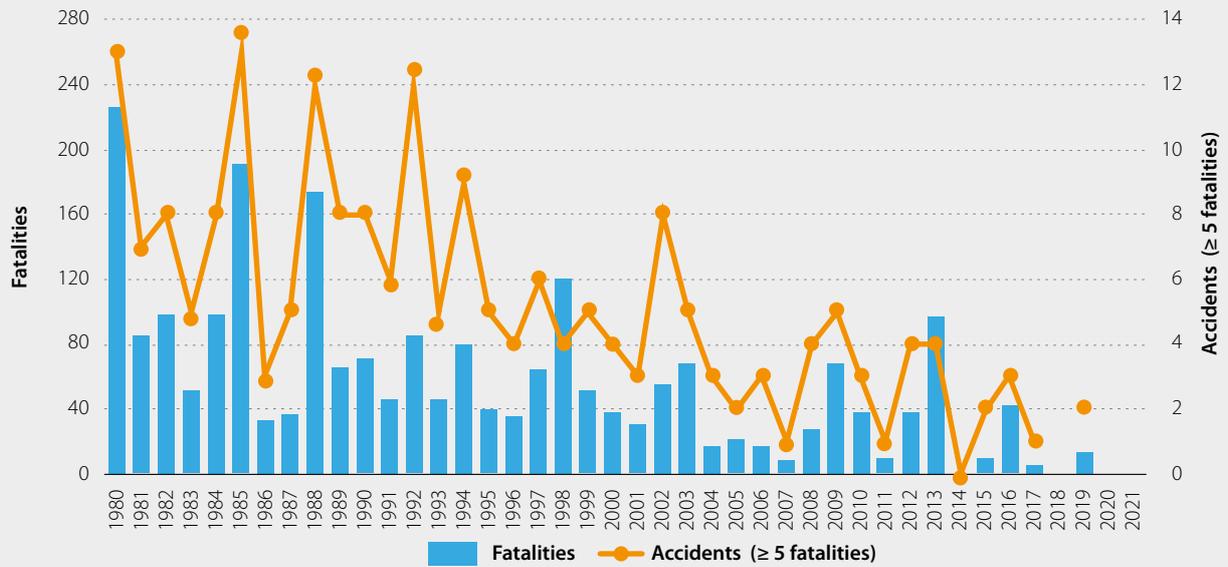
Fatal train collisions and derailments are situated between significant and major accidents; despite the downwards trend in recent years, in 2020 eight fatal collisions and derailments were registered. The accident rates (taking into account the underlying changes in traffic volume) follow the same pattern, with the 5-year moving average decreasing steeply since 1990 but flattening in recent years.

### Sources and limitations

Both major accidents and fatal train collisions and derailments rarely escape attention of the media and of the authorities and several sources were used to compile the archive of historical accidents in Europe, originally developed by Professor Andrew Evans (Imperial College London) for ERA. The agency continues to rely on that database for historical accident data and on the kind cooperation of Professor Evans.

**Figure A-5: Major accidents in Europe (EU-27 + CH + NO + UK, 1980–2021)**

Railway accidents resulting in five or more fatalities

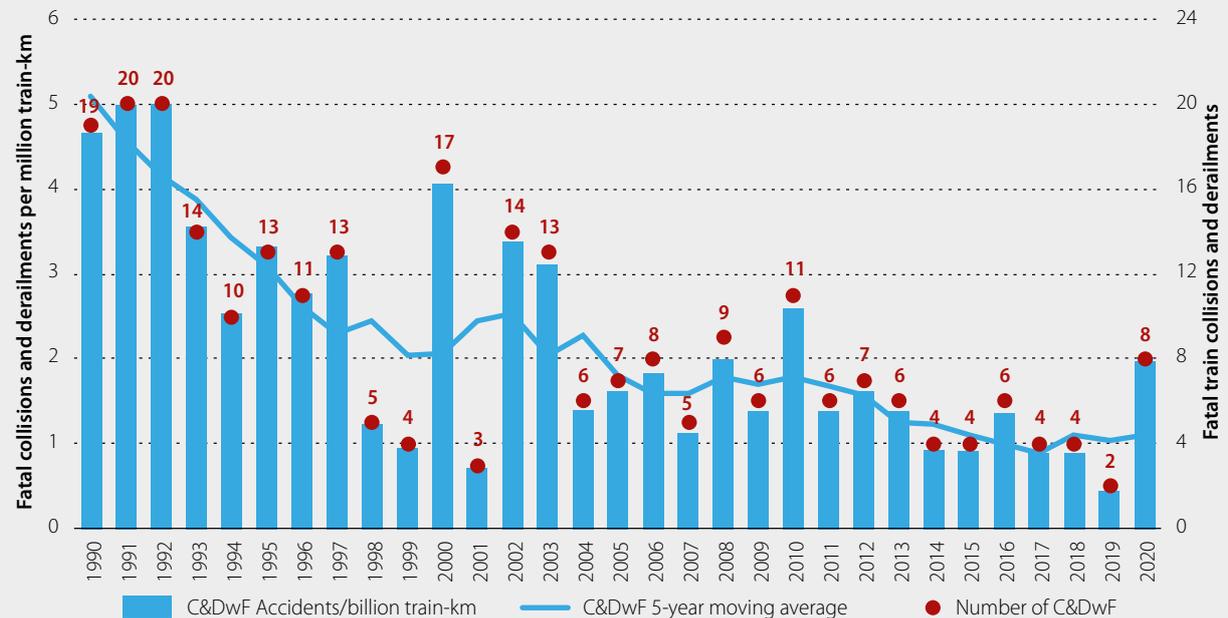


Note: Data for the United Kingdom are available up to the end of 2020.

Source: ERAIL and database of historical accidents developed by Professor Andrew Evans (Imperial College London)

**Figure A-6: Fatal train collisions and derailments in Europe (EU-27 + CH + NO + UK, 1990–2020)**

Accidents and accidents rates per million train-km



Note: C&DwF, collision and derailment accidents with fatalities

Source: ERAIL and database of historical accidents developed by Professor Andrew Evans (Imperial College London)

## A-4 Trends in accident and casualty rates and their variations

### Purpose

As traffic volume is the single most explanatory factor in the occurrence of accidents, accident statistics are often normalised against traffic data.

### Indicators

The main indicators used here are significant accident and fatality rates, that is significant accidents per million train-km, railway fatalities per million train-km (capturing the manifested overall risk of railway operation) and passenger fatalities per billion passenger-km (capturing the manifested risk for people using trains). In addition, the trend over years in the FWSI rate is analysed.

### Findings

The overall fatality rate in 2020 was around 0.2 fatalities per million km (one fatality for every 5 million train-km on average), whereas the overall passenger fatality rate was 0.046 passenger fatalities per billion passenger-km (around one fatality for every 22 billion passenger-km).

All the analysed rates have decreased substantially since 2010, with the accident and fatality rates also decreasing in 2020. However, although the number of passenger fatalities fell in 2020, the passenger fatality rate, once the significant drop in passenger-km due to the COVID-19 pandemic is taken into account, was higher than in 2019, showing a slightly rising trend that has been observed since 2017.

The variation in FWSI rate among Member States (measured through the standard deviation) decreased over 2010–2020 at the same pace as the average FWSI rate, with the coefficient of variation staying close to 1, because of the variability of the values around the mean. Achieving a single safety area implies comparable safety levels across EU countries.

### Sources and limitations

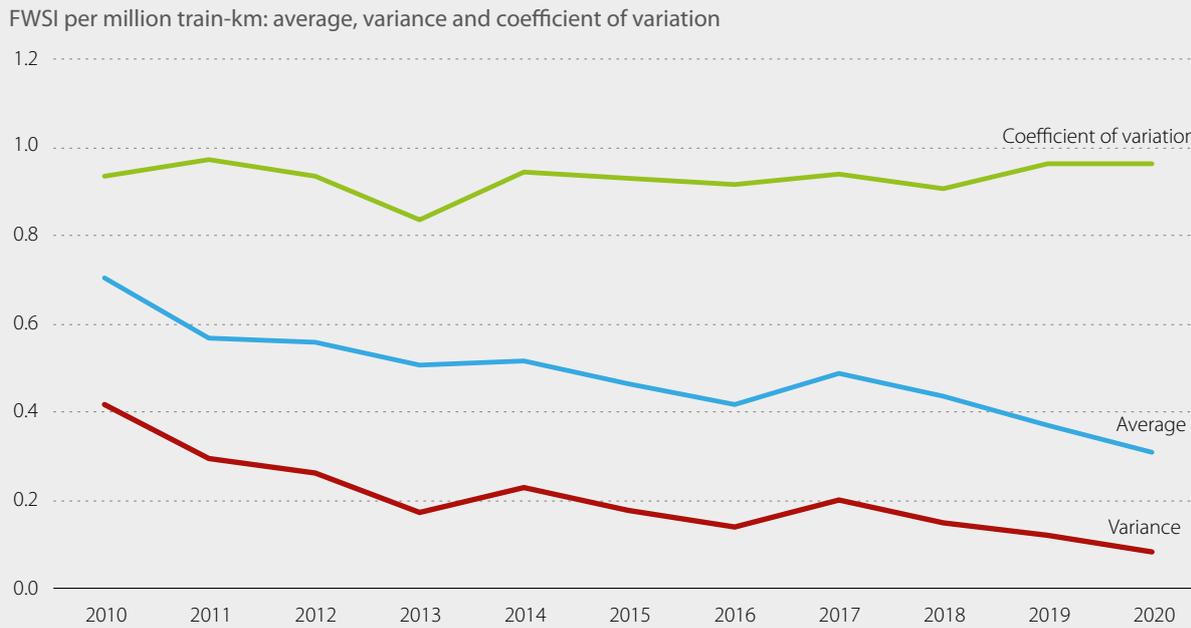
Data used to monitor progress with safety outcomes are part of CSIs supplied by the NSAs to ERA. More than 10 years of continuous work on data quality in Member States and at the agency provides assurance on the accuracy of the data.

**Figure A-7: Trends in accident and fatality rates (EU-27, 2010–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-8: Fatalities and weighted serious injuries rates (EU-27, 2010–2020)**



Source: CSIs as reported by NSAs to ERA.

## A-5 Railway and passenger fatality rates

### Purpose

Behind the general EU picture, a much more diverse reality exists, with notably large differences in casualty rates among Member States. Plotting the fatality rates for individual Member States unveils the extent of the existing disparities in safety levels. Sorting the countries provides further insight into these differences.

### Indicators

Two main indicators are used here: fatality rate (railway fatalities normalised by train-km, capturing the manifested overall risk of railway operation) and passenger fatality rate (passenger fatalities per passenger-km, capturing the personal manifested risk for people using trains).

### Findings

The figures reveal at least a 10-fold difference in fatality rates between countries with the lowest rates and those with the highest rates. In both cases, the median values are much lower than mean values, as the rates for Member States with relatively high rates are much higher than rates for other countries. For railway fatality rate, a cluster of 11 countries emerges with values that are in stark contrast to the remaining EU Member States.

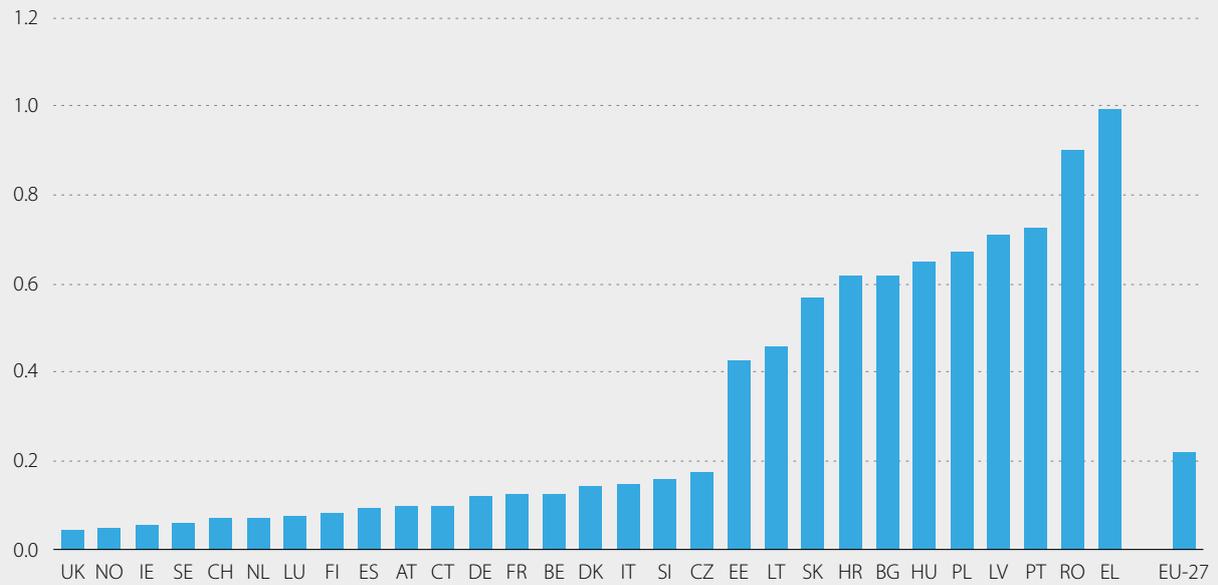
### Sources and limitations

Although the rates are estimated in the case of fatality rate over a period of 3 years and in the case of passenger fatality rate over a period of 10 years, major accidents with large number of passenger casualties still weigh heavily on the estimates. An extreme case is the derailment in Santiago de Compostela, which occurred in 2013 and makes the passenger fatality rate for Spain the highest in Europe.

Data used to monitor progress with safety outcomes are part of CSIs supplied by the NSAs to ERA. More than 10 years of continuous work on data quality in Member States and at the agency provides assurance on the accuracy of the data.

**Figure A-9: Railway fatality rates (2018–2020)**

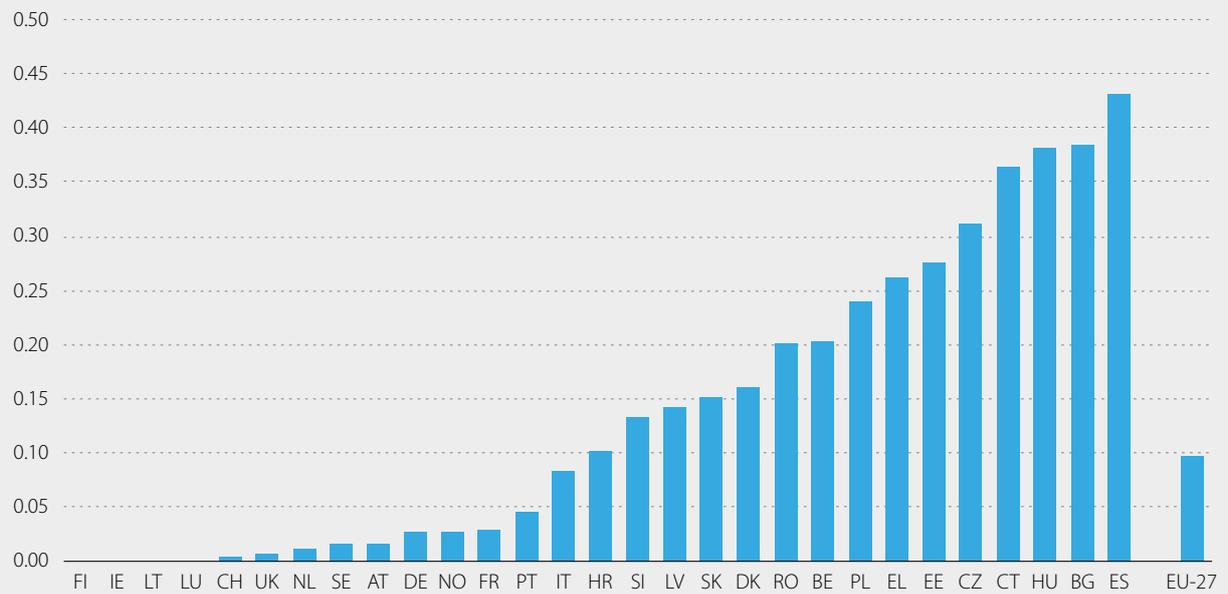
All fatalities per million train kilometers (average over 2018-2020)



Source: CSIs as reported by NSAs to ERA.

**Figure A-10: Railway passenger fatality rates (2010–2020)**

Passenger fatalities per billion passenger kilometers (average over 2010-2020)



Source: CSIs as reported by NSAs to ERA.

## A-6 Safety of different transport modes

### Purpose

Different means of transport involve different levels of risk for travellers. In this section, the user fatality risk is estimated for the four main transport modes for which comparable data are available.

### Indicators

The indicator used measures the risk of death for a passenger travelling over a given distance using different transport modes. The indicator looks at a 5-year block of data (2015–2019). Although the use and nature of transport modes differ widely, a direct comparison of safety levels is possible using certain travel scenario hypotheses.

### Findings

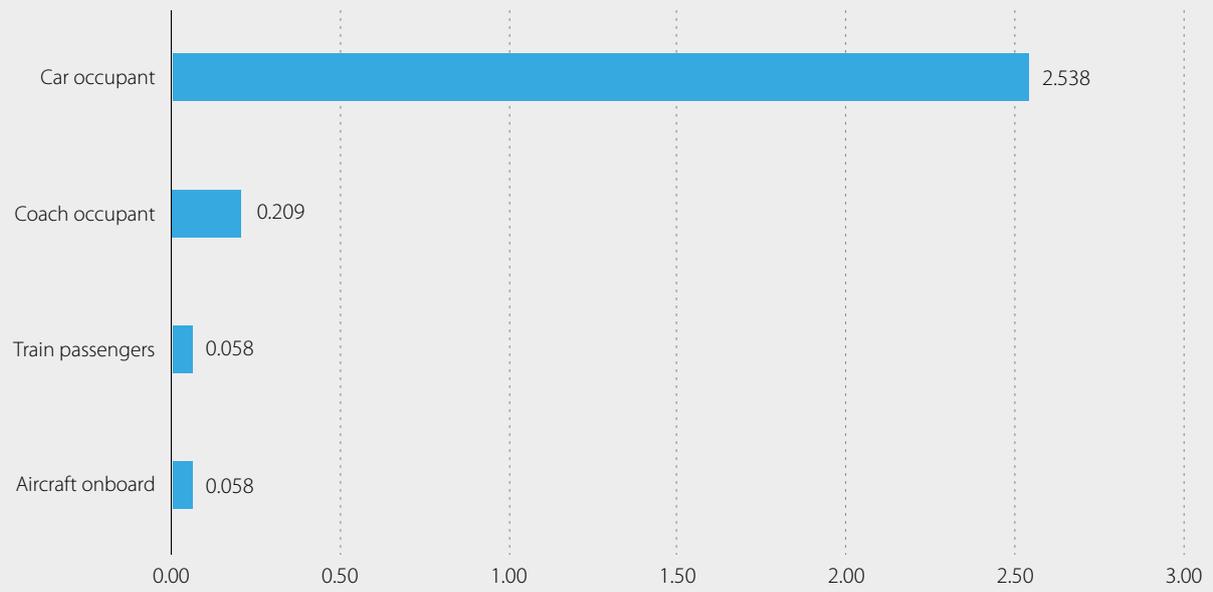
The fatality risk for a train passenger is around one fourth of the risk for a bus/coach passenger, and similar to that for a commercial aircraft passenger. The use of individual means of transport, such as a passenger car, carries a substantially higher fatality risk: car occupants have an almost 50 times higher likelihood of dying than a train passenger travelling over the same distance. The fatality risk for an average train passenger is now about 0.058 fatalities per billion passenger-km, making it comparatively the safest mode of land transport in the EU.

### Sources and limitations

The risk estimated for commercial air travel, but also for bus and train travel, is subject to greater variation, as a single accident may result in dozens of fatalities. As the annual numbers of aircraft, train and coach accidents resulting in fatalities are relatively small, the risk estimated for a relatively short period, in this case for 5 years, should be interpreted with caution. Last but not least, the results of such a comparative exercise also strongly depend on the type of exposure data considered.

**Figure A-11:** Passenger and driver fatality rates for different transport modes (EU-27, 2015–2019)

Onboard fatalities per billion passenger kilometers



Note: Fatalities are for all people occupying the vehicle, except for rail (includes passengers only). Passenger-km for air include only domestic and intra-EU transport

Sources: CARE (DG MOVE), EASA, 2021 Statistical Pocketbook (DG MOVE), CSIs reported to ERA

## A-7 Worldwide railway safety

### Purpose

Despite structural differences, the overall safety level of the EU railway system can be benchmarked against safety levels in various countries worldwide. In ERA's view, the entire sector should aspire to make the EU railway system the safest in the world.

### Indicators

The indicators used are the railway fatality rate and the passenger fatality rate, estimated for a 5-year period. This longer period is used to account for fluctuations between individual years and for randomness in the data. A more accurate comparison is available as a result.

### Findings

Based on railway fatality rates estimated in five jurisdictions, the EU railway system is the second safest after that of South Korea. Unfortunately, it was not possible to collect reliable and comparable data for other countries (e.g. China, Japan and Russia).

A passenger on board a train in the EU railway system also enjoys relatively the lowest risk after passengers in South Korea and Japan. No passenger fatalities were registered in the past 5 years in Japan. The gap in passenger fatality rate between Europe and Japan may be challenging to close in the medium term.

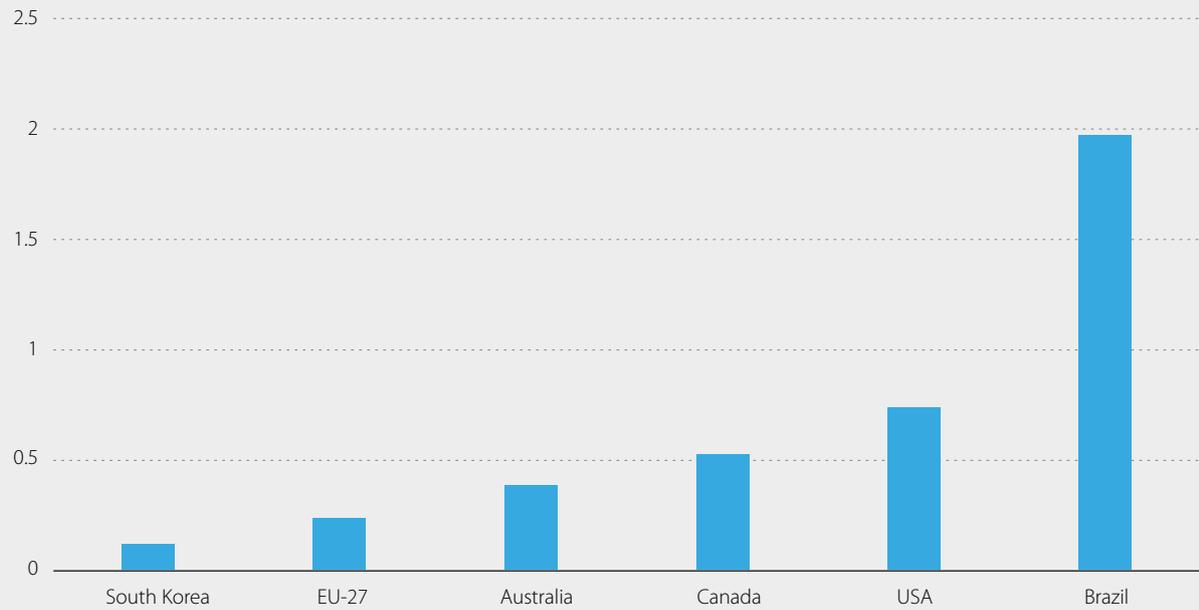
### Sources and limitations

Data used for this indicator are taken from statutory reports and/or public databases from national railway safety administrations or safety administrations of the jurisdictions concerned. Data for South Korea are for high-speed railway lines and conventional lines and were provided by the railway safety division of the Korean Transport Safety Authority.

There is no guarantee that all the countries use the same, internationally agreed, definition of a railway fatality, that is a fatality occurring 'within 30 days of [the] accident', or that train-km are recorded in the same fashion for all RUs. The possible exclusion of trespasser fatalities (to exclude possible suicide fatalities) is also likely to be an issue. Nevertheless, the comparability of the data may be satisfactory for the given purpose of an international benchmark. Lastly, the selection of countries used in the two benchmark figures is driven by the comparability of the railway system in terms of size and volume and the availability of comparable data.

**Figure A-12:** Railway fatality rates for different countries worldwide (2016–2020)

All railway fatalities per million train-km

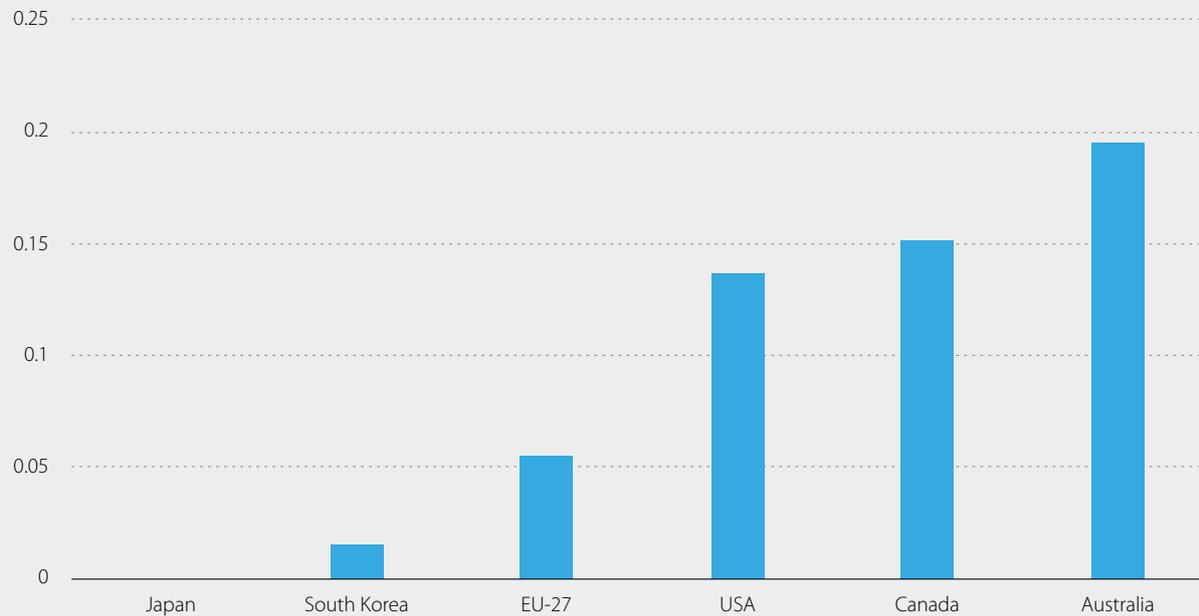


Note: Data (referring to high-speed rail and conventional lines) for South Korea were provided by the Korean Transport Safety Authority's railway safety division

Source: Statutory reports produced by national administrations of the jurisdictions concerned.

**Figure A-13:** Passenger fatality rates for different countries worldwide (2016–2020)

Railway passenger fatalities per billion passenger kilometers



Note: Data (referring to high-speed rail and conventional lines) for South Korea were provided by the Korean Transport Safety Authority's railway safety division

Source: Statutory reports produced by national administrations of the jurisdictions concerned.

## A-8 Achievement of safety targets

### Purpose

Common safety targets are the lowest acceptable safety levels prescribed for the railway systems of the EU and of Member States. They are used as a reference when assessing if the current safety levels are at least maintained. In the long term, they could also help to drive efforts to reduce the current variation in safety levels across the EU. Rail is the only mode of transport for which targets have been prescribed by European legislation. The achievement of safety targets is assessed by the ERA annually, by applying the common safety method on common safety targets <sup>(4)</sup>. The latest assessment available is the 2022 assessment, which compares the 2020 safety levels with the set reference values <sup>(5)</sup>.

### Indicators

The safety level is measured in terms of the number of FWSIs per train-km and is assessed for the following categories: passengers, employees, level crossing users, unauthorised persons on railway premises and society as a whole.

### Findings

The result of this latest assessment indicates that safety performance remains acceptable at EU level, whereas a possible deterioration in safety performance was identified in eight instances. Such a result is in line with the 10 previous assessments, which typically identified possible deteriorations in a few countries and categories.

Member States are more likely to achieve acceptable safety performance in the category of passengers than in any other category. A possible or probable deterioration in safety performance is most frequently registered for employees and unauthorised persons on railway premises, and in recent years this has also been observed for the category 'others'. Although possible or probable deterioration has been identified in 17 countries, in only one Member State this was the finding in the large majority of assessments. In a further four countries, nine or more instances have been identified since 2008. In contrast, in 10 countries, possible or probable deterioration has never been identified.

### Sources and limitations

Risk categories as defined in the RSD are used. For passenger category, two measures are applied: FWSI per passenger train-km (1.1) and FWSI per passenger-km (1.2). FWSIs are a measurement of the consequences of significant accidents combining fatalities and serious injuries, where one serious injury is considered statistically equivalent to 0.1 fatalities. For more information on the weaknesses and strengths of the method, see the *ex post evaluation of the common safety method for assessment of achievement of safety targets* <sup>(6)</sup>.

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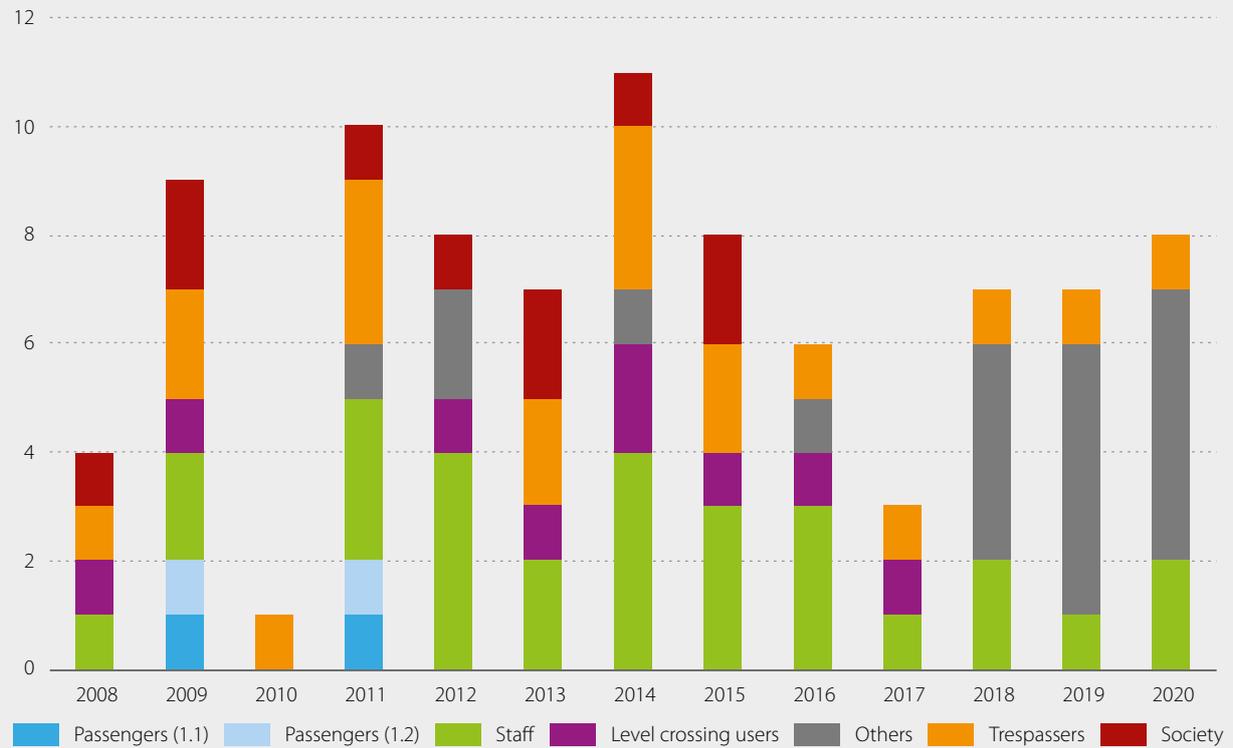
<sup>(4)</sup> Commission Decision 2009/460/EC (also contains detailed information on the method and definitions of the categories).

<sup>(5)</sup> Commission Decision 2012/226/EU.

<sup>(6)</sup> [https://www.era.europa.eu/sites/default/files/library/docs/report\\_ex-post\\_csm\\_cst\\_final\\_public\\_en.pdf](https://www.era.europa.eu/sites/default/files/library/docs/report_ex-post_csm_cst_final_public_en.pdf)

**Figure A-14:** Instances of possible/probable deterioration in safety performance by risk category (EU-27 + NO, 2008–2020)

Probable or possible deterioration of safety performance as per annual CST assessment



Source: Annual common safety target assessment reports published by ERA.

**Figure A-15:** Instances of possible/probable deterioration in safety performance by country (EU-27 + NO, 2008–2020)

Instances across all risk categories

	BE	HR	LT	LV	ES	DE	NL	CZ	PT	IT	FR	HU	SE	BG	NO	RO	SK	Total
2008	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	4
2009	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	4	9
2010	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1
2011	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	4	4	10
2012	0	1	0	0	0	0	0	0	0	0	0	0	1	2	1	2	1	8
2013	0	0	0	0	0	0	0	0	0	1	0	0	0	1	2	1	2	7
2014	0	0	0	0	0	0	0	0	0	1	1	2	1	1	2	1	2	11
2015	0	0	0	0	0	0	0	0	0	1	0	0	1	1	3	0	2	8
2016	0	0	0	0	0	0	0	0	0	1	0	2	0	2	0	0	1	6
2017	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	3
2018	0	0	0	1	0	0	0	1	1	0	1	1	0	1	0	0	1	7
2019	1	0	0	0	0	1	1	1	1	0	1	0	1	0	0	0	0	7
2020	0	0	0	0	1	1	1	1	1	0	1	0	1	0	0	0	1	8
Total	1	1	1	1	1	2	2	3	3	4	5	5	7	9	9	16	19	

Note: Colours correspond to the number of occurrences

Source: Annual common safety target assessment reports published by ERA.

## A-9 Significant accidents

### Purpose

Significant accidents represent the basis for the harmonised monitoring of safety occurrences across the EU and beyond. Their scope is limited to accidents resulting in significant harm such as fatal or serious injuries, significant damage or major traffic disruption. Their further subcategorisation allows the identification of the parts of the railway systems with a relatively high prevalence of accidents and those relatively underperforming over time.

### Indicators

The indicators used are the absolute number of significant accidents disaggregated in two ways: (1) per type of railway accident, as prescribed by the RSD; and (2) per type that reflects the presence of a third party.

### Findings

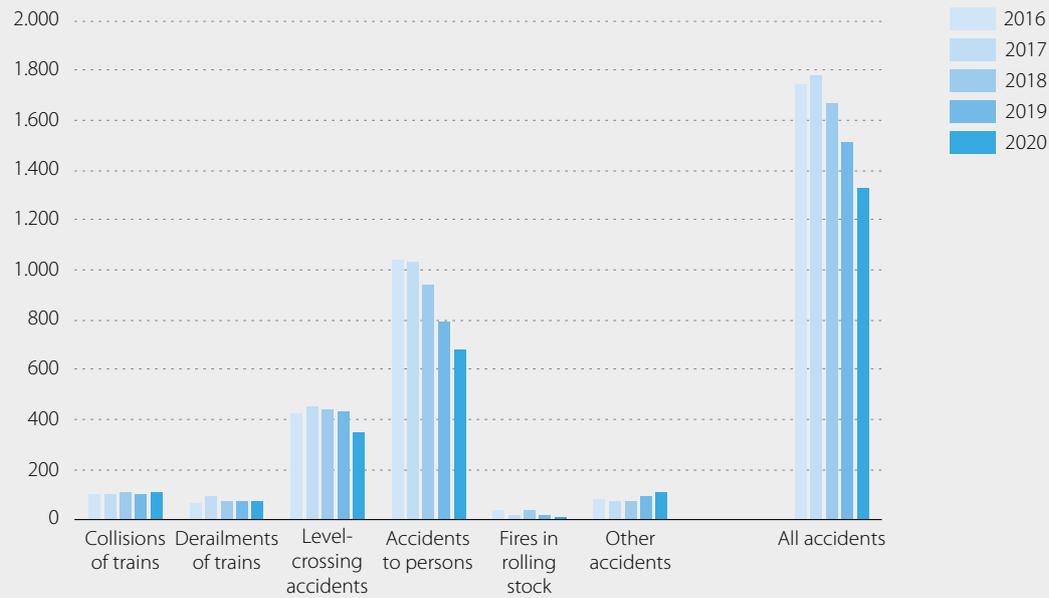
A total of 1 331 significant accidents were reported by Member States for 2020 alone, almost four per day on average. This is the lowest number recorded since 2010. However, the decrease has mainly been driven by a reduction in 'external' accidents involving a third party (trespasser and level crossing users), and the trend in 'internal' accidents has been more stable in recent years. Derailments, level crossing accidents, accidents to persons and fires in rolling stock decreased in 2020 compared with 2019, while a small increase in collisions and other accidents was recorded (continuing the slightly rising trend observed in recent years).

A wide range of accidents, not included in the specific types mentioned previously, are included in the category 'other accidents'. The 107 cases reported in 2020 include collisions and derailments of shunting rolling stock / maintenance machines, release of dangerous goods during transport and electrocution in connection with rolling stock in motion.

### Sources and limitations

Data used to monitor progress with safety outcomes are part of the CSIs supplied by the NSAs to ERA. More than 10 years of continuous work on data quality in Member States and at the agency provides assurance on the accuracy of the data.

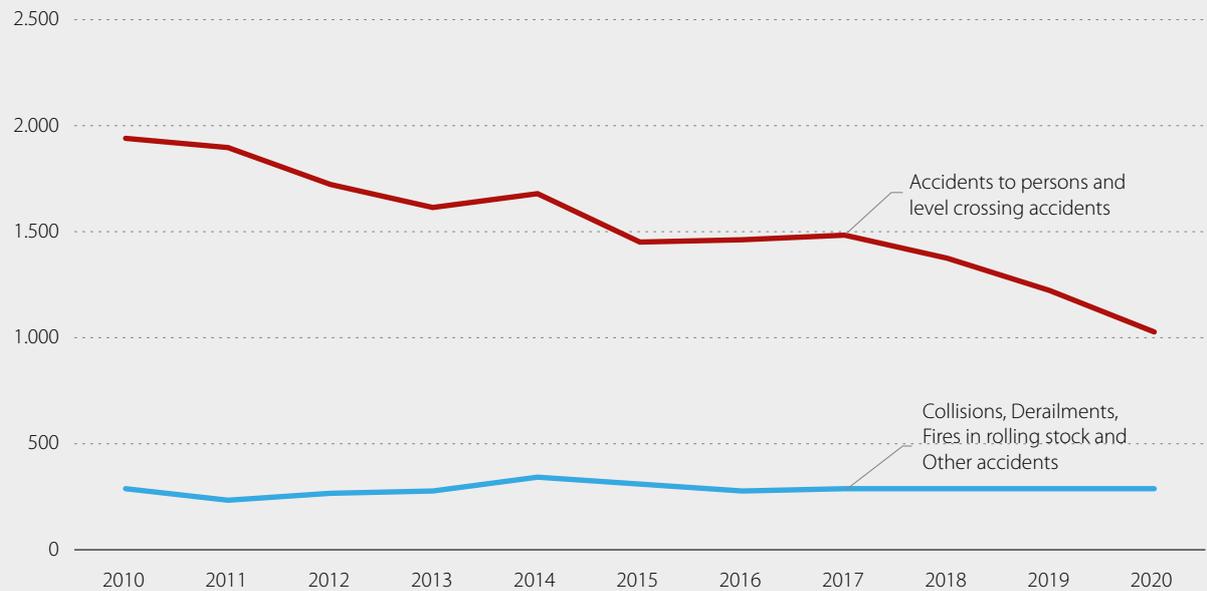
**Figure A-16: Significant accidents per type (EU-27, 2016–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-17: Railway 'internal' and 'external' significant accidents (EU-27, 2010–2020)**

Collisions, derailments, fires in rolling stock and other accidents against accidents to persons and level-crossing accidents



Source: CSIs as reported by NSAs to ERA.

## A-10 Accidents and incidents involving the transport of dangerous goods

### Purpose

Owing to its potential for disastrous consequences, the TDG is subject to extra regulatory provisions and supervision by NSAs and TDG competent authorities. Nevertheless, accidents involving the TDG continue to occur and besides being reported among the CSIs are also subject to a particular reporting regime under the convention for the international carriage of dangerous goods by rail (RID).

### Indicators

The indicator used is the number of accidents involving the TDG (as indicated in the RSD, that is any accident or incident that is subject to reporting in accordance with Section 1.8.5 of the RID / the European agreement concerning the international carriage of dangerous goods by road), with or without the release of those goods.

### Findings

The current reporting scheme for accidents involving the TDG can be difficult to understand and to implement (owing to what is considered a release according to the current version of the RID, which also includes near-miss releases), leading to possible non-homogeneous reporting across Member States.

In this context, a relatively large number of accidents involving the TDG was recorded in 2018–2020, but it cannot currently be established with certainty whether this actually corresponds to a degradation in safety or variations in the interpretation of the applicable legislation. The peak in 2018 and 2019 was mainly due to a single country reporting 34 accidents involving at least one railway vehicle transporting dangerous goods in those years. For 2020, 10 Member States reported accidents involving dangerous goods, totalling 53 accidents, of which 17 involved the release of the dangerous goods being transported by rail.

### Sources and limitations

A number of activities linked to the development and publication of the inland TDG risk management framework have taken place since 2018 <sup>(?)</sup>, including a proposal for the clarification of the categories of releases to be reported, as suggested in the risk estimation guide.

In addition to the publication of the risk management framework, the development of a proposal for improving Section 1.8.5 of the RID/ADR/ADN is currently examined by an informal working group of the UNECE/OTIF Joint Meeting.

Moreover, the common safety methods on the assessment of safety level and safety performance will soon establish a more consistent (and more complete) regime for reporting of the TDG occurrences, combining, without duplication, the information from the reports under the RSD and under the RID.

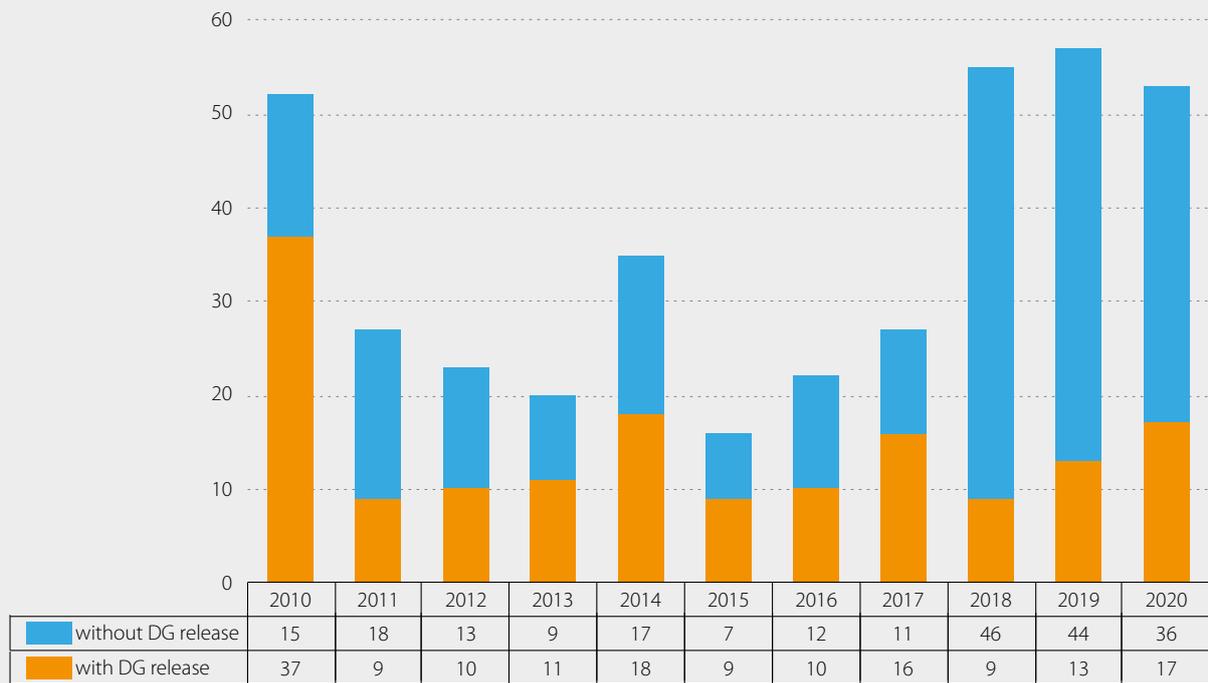
A fully consistent reporting scheme is expected to be completed with the publication of the 2025 version of the RID following the adoption of the regulation concerning the common safety methods on the assessment of safety level and safety performance, allowing for the delivery of more reliable safety indicators in the field of the TDG.

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<sup>(?)</sup> See also [Guide for Risk Estimation](#).

**Figure A-18: Accidents involving the transport of dangerous goods (EU-27, 2010–2020)**

Railway accidents with and without release of dangerous goods



Source: CSIs as reported by NSAs to ERA.

## A-11 Casualties from significant accidents

### Purpose

The seriousness of accidents, as reflected in the number of casualties, differs for different types of accidents. Monitoring the casualties per accident type thus enables the targeting of those types with relatively high impacts.

### Indicators

The indicator used is the number of fatalities from significant accidents per type of accident, as set out in Annex I to the RSD.

### Findings

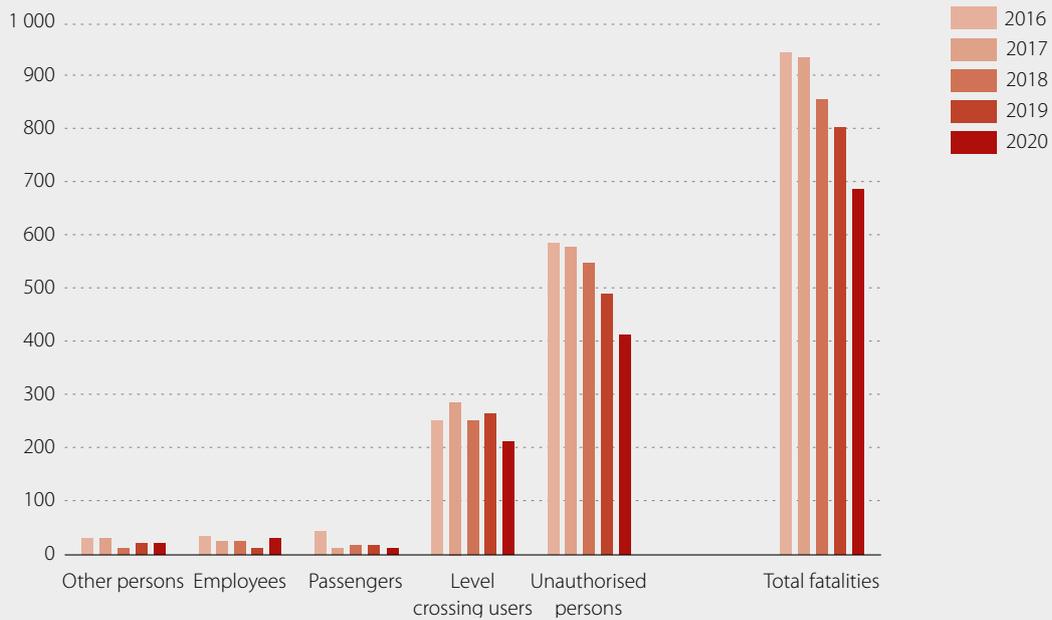
In parallel with the decrease in railway accidents, the total number of casualties, excluding suicides, has fallen steadily in recent years. Between 2016 and 2020, the number of railway fatalities decreased by 27 %; 687 fatalities were reported for 2020, a 14 % decrease from the previous year (802 fatalities were recorded in 2019). The decrease between 2019 and 2020 in fatalities of passengers, level crossing users and unauthorised persons on railway premises could be partially linked to the lockdown measures (and the related travel restrictions) imposed during the COVID-19 pandemic. The number of fatalities of employees and other persons registered in 2020 was higher than in 2019. If suicide fatalities are excluded, the majority of fatalities on railway premises are due to accidents to persons. Fatalities resulting from level crossing accidents account for 30 % of the total, while fatalities due to collisions and derailments represent around 2.5 % of all railway fatalities. Around 9 % of people killed on EU railways in 2020 were strictly internal to railway operation (passengers, employees and other persons).

### Sources and limitations

Data on fatalities from railway accidents have been recorded for several decades. As a result, it is probably the most accurate metric of railway safety in the EU.

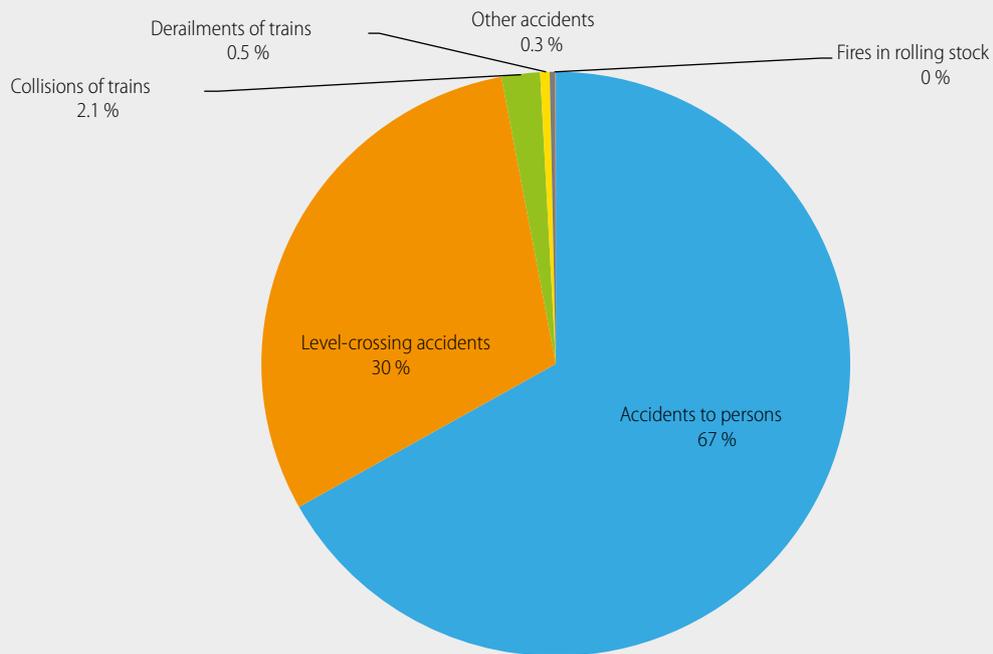
Data on seriously injured persons are slightly less reliable than statistics on deceased persons. This is because reporting and hospital procedures may vary in Member States and may evolve over time. This has only a limited impact on the common safety target framework, in which the weight attributed to a seriously injured person is relatively low, but may have an impact on casualty statistics.

**Figure A-19: Fatalities per victim category, excluding suicides (EU-27, 2016–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-20: Fatalities per type of significant accident (EU-27, 2016–2020)**



Source: CSIs as reported by NSAs to ERA.

## A-12 Suicides and trespasser fatalities

### Purpose

'Death by railway' is a specific category of safety of the railway system, focusing on 'external' fatalities among those not intending to use or maintain the railway system. As these fatalities have serious consequences in terms of the safety and quality of railway system operation, their monitoring is essential in proactive safety management.

### Indicators

The indicators used are suicide (intentional) and trespasser (unintentional) fatalities on railway premises.

### Findings

Suicides are reported separately from accident fatalities. They represent around 75 % of all fatalities on railways and, together with fatalities of unauthorised persons on railway premises, constitute an overwhelming 90 % of all fatalities occurring within the railway system. In 2020, on average around six suicides were recorded every day on railways in the EU-27, totalling 2 204.

While trespasser fatalities have been steadily decreasing since 2007, suicides rose following the financial crisis of 2008, peaked in 2012, and have been decreasing since.

Countries situated in the lower right quadrant of Figure A-22 have relatively high third-party fatality rates, while their exposure to running trains is low (train frequency is relatively low). In many of those countries, trespassing is relatively common, while there is limited fencing around railway lines. However, other factors also play a role. Neither of the two indicators sufficiently takes into account the density of the population along the railway lines, which is another known risk factor.

### Sources and limitations

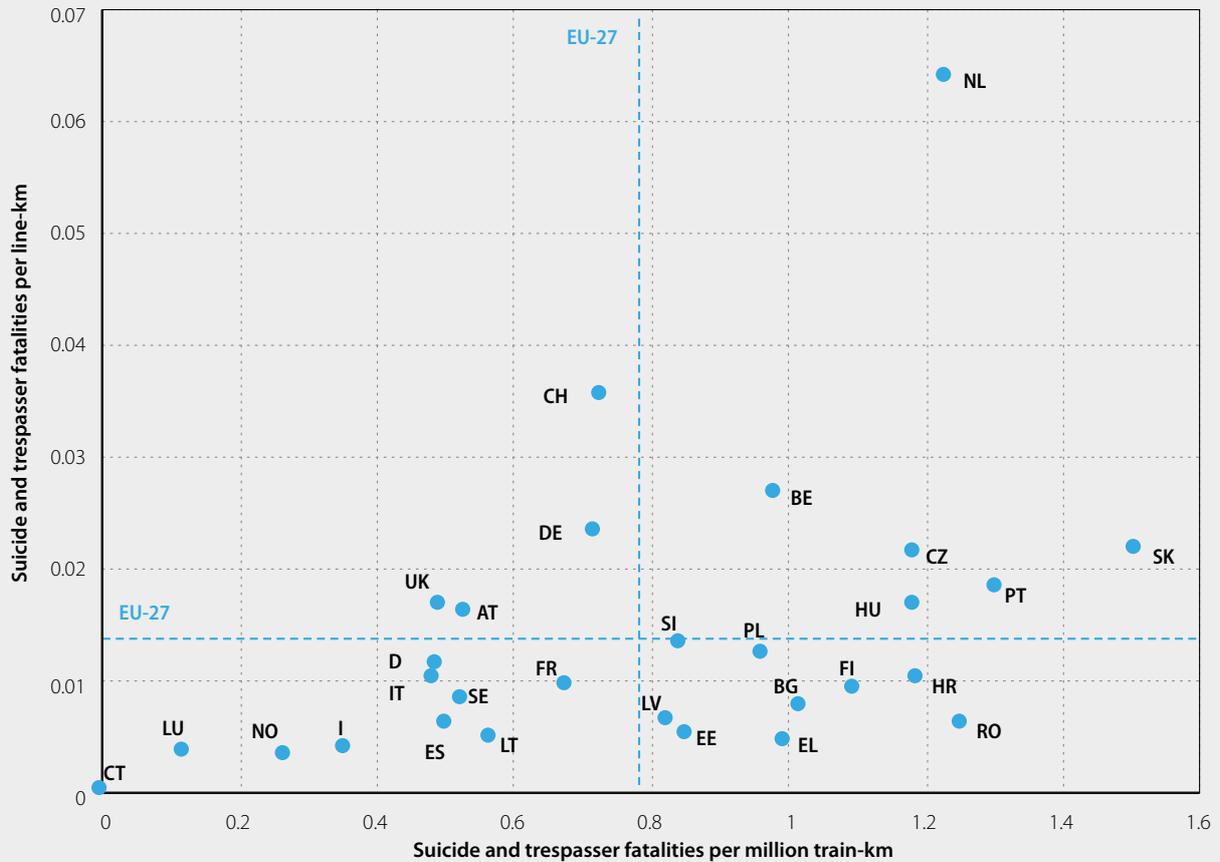
Given the objective difficulties in classifying some third-party fatalities on railways and diverging national practices in their classification and reporting, suicides and trespasser fatalities are considered together when comparing countries. Two rates take into consideration potential exposure to running trains: third-party fatalities per train-km and third-party fatalities per line-km.

**Figure A-21: Railway suicides and trespasser fatalities (EU-27, 2007–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-22: Suicide and trespasser fatality rates (EU-27 + CH + NO + UK, 2018–2020)**



Source: CSIs as reported by NSAs to ERA.

## **A-13** Railway suicides versus overall suicides

### **Purpose**

Plotting the railway suicide rate against suicide mortality in individual countries provides an indication of how those managing the railway system have succeeded in curbing suicides.

### **Indicators**

The railway suicide rate (suicides per million train-km) and suicide mortality rate (suicides per 100 000 population) are used as indicators.

### **Findings**

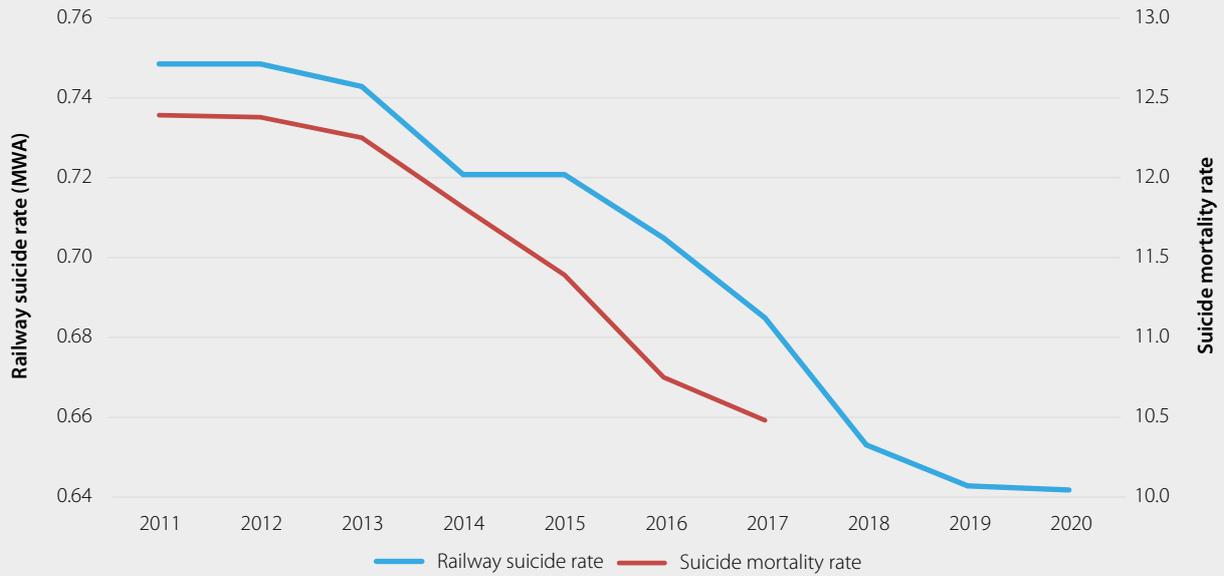
Suicides on railway premises have decreased in recent years. However, the total number of suicides in society has also decreased. Plotting trends in railway suicide rate (suicides per million train-km) alongside the suicide mortality rate (suicides per 100 000 population) reveals a strong correlation between the two indicators. This means that the decrease in railway suicides over the past years is unlikely to be associated only with measures taken within the railway system.

However, the countries with a high train frequency and population density along railway lines remain heavily disadvantaged in this comparison. In general, in countries below the trend line, suicide fatalities occurring on railways account for a relatively high proportion of all suicides.

### **Interpretation**

Railway suicide data are the result of the classification of fatalities on railways by coroner's courts, the police or other judicial bodies. This judicial classification, for example suicide or trespasser, is supplied by the NSAs to ERA. Data on suicide mortality are collected by health authorities of Member States and provided by their statistical offices to Eurostat. There is a significant delay in data becoming available at EU level, which means that data relating to more recent years are not yet included.

**Figure A-23:** Railway suicide rate (EU-27, 2011–2020) and suicide mortality rate (EU-27, 2011–2017)

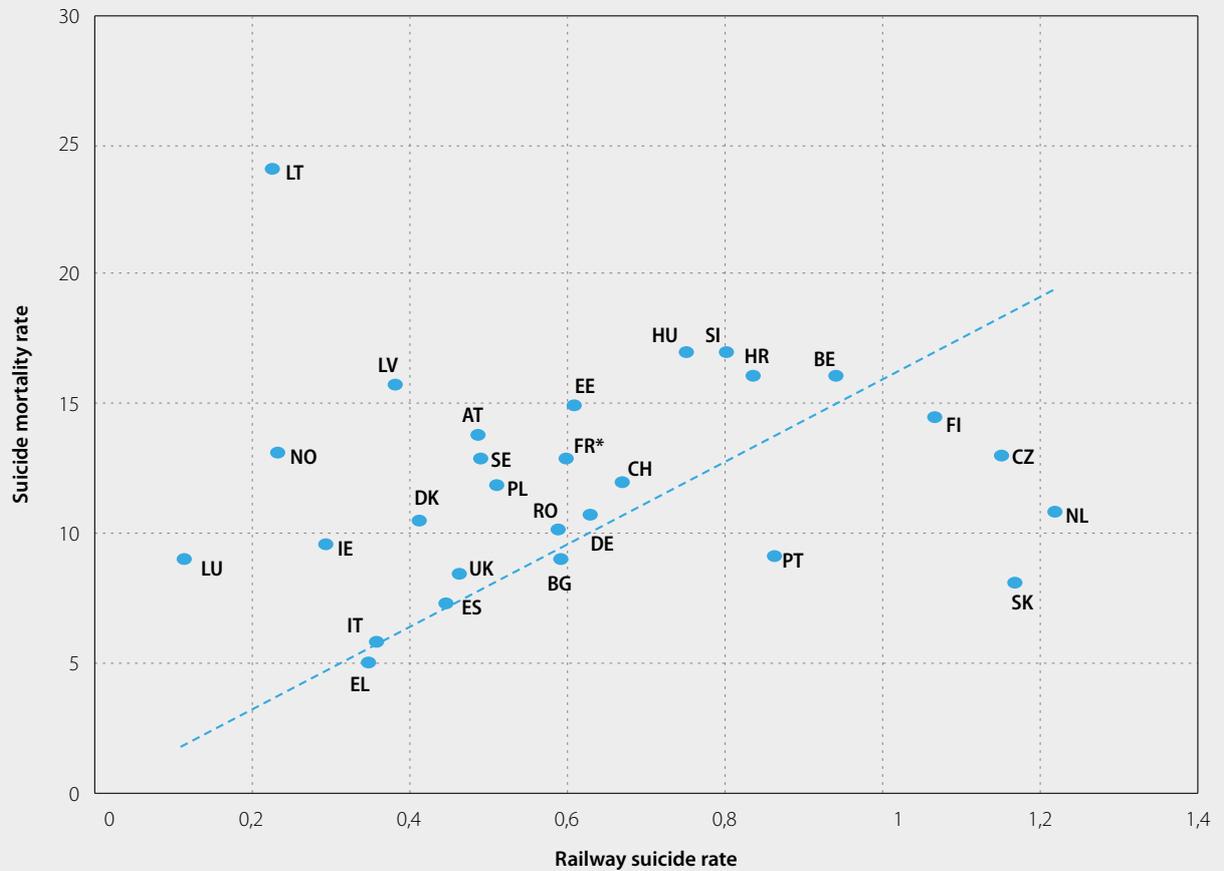


Note: MWA, moving weighted average

Source: Railway suicide rate – CSIs as reported by NSAs to ERA; suicide mortality rate – Eurostat (dataset ‘Death due to suicide, by sex’ (TPS00122)).

**Figure A-24:** Suicide mortality rate compared with railway suicide rate (EU-27 + CH + NO + UK)

Suicides per 100 000 population in 2018, suicides per million train-km 2018-2020



Note: (\*) Suicide mortality rate for France is based on data for 2017

Source: Suicide mortality rate – Eurostat (dataset ‘Death due to suicide, by sex’ (TPS00122)).

## **A-14** Railway workers' safety

### **Purpose**

A century ago, the majority of victims of railway accidents were railway employees. However, as a result of a continuous focus on staff safety, railway operators have succeeded in significantly reducing staff casualties. Many operators have adopted a policy of zero tolerance of fatal injury in the workplace and to this end have implemented certain policies and measures. Statistics on workers' safety provide an indication of how successful railway operators are in limiting safety risks for their staff and contractors.

### **Indicators**

The indicators used here are railway worker (employees and contractors) casualties and for comparison railway passenger and employee fatality rates.

### **Findings**

No clear progress in reducing railway workers casualties in absolute terms has been seen since 2014. In each year since then (except in 2019), the number of fatalities reported among railway workers in the EU-27 has been close to 30, with a further 40 or more employees seriously injured each year.

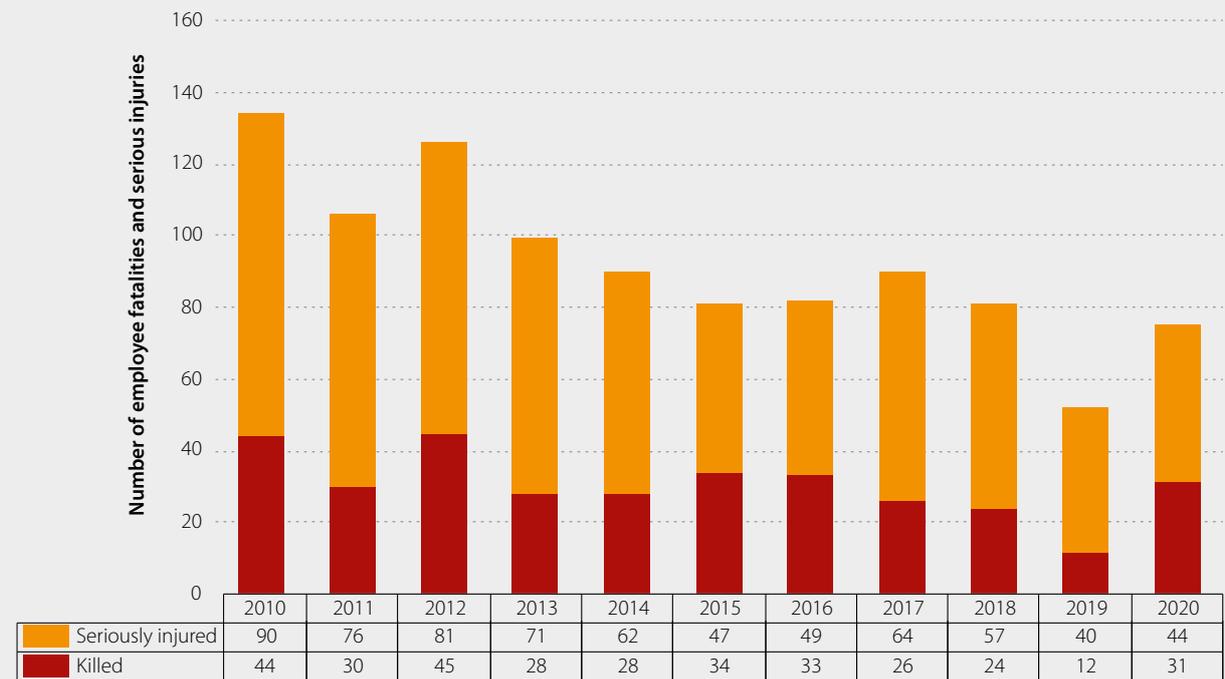
After a significant decrease until 2018, both the railway passenger fatality rate and the employee fatality rate have increased slightly in the past 2 years. In 2020, the number of passenger fatalities declined, but, when the significant drop in passenger-km (due to the COVID-19 pandemic) is taken into account, passenger fatality rates were slightly higher than in 2019.

### **Sources and limitations**

Data used to monitor progress in safety outcomes are included in the CSIs supplied by the NSAs to ERA. More than 10 years of continuous work on data quality in Member States and at the agency provides assurance on the accuracy of the data.

**Figure A-25: Railway employee casualties (EU-27, 2010–2020)**

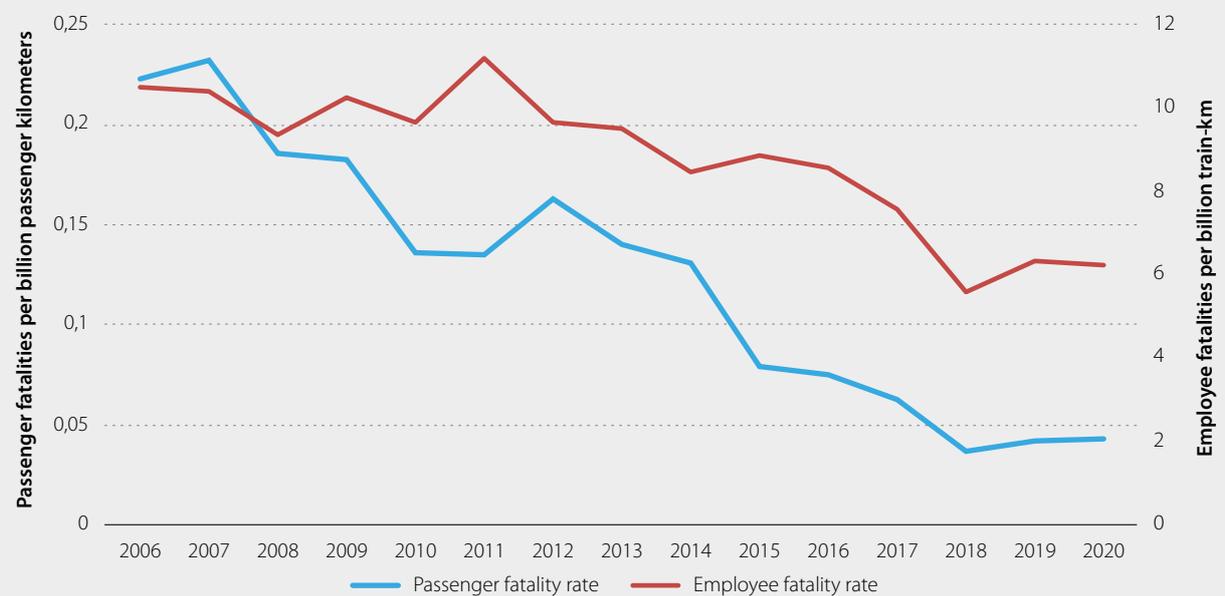
Fatalities, serious injuries



Source: CSIs as reported by NSAs to ERA.

**Figure A-26: Railway passenger and employee fatality rates (EU-27, 2006–2020)**

Passenger fatalities per billion passenger kilometers, Employee fatalities per billion train kilometers, 3-years moving average



Source: CSIs as reported by NSAs to ERA.

## **A-15** Level crossing safety

### **Purpose**

Level crossing accidents represent more than one quarter of all significant accidents on EU railways. Level crossings represent not only the physical intersection of a railway track and a road, but also an intersection of responsibilities and interests. The high-level monitoring of outcomes therefore provides objective evidence for efficient safety improvements.

### **Indicators**

The indicators used are the absolute numbers of significant level crossing accidents, resulting fatalities and serious injuries, and the accident rate (significant accidents per train-km).

### **Findings**

After a stagnating trend in recent years (since 2016), in 2020 there was a significant decrease in level crossing accidents and related fatalities compared with 2019. This reduction should be interpreted with caution, as it could be partially linked to the lockdown measures and the subsequent travel restrictions imposed during the COVID-19 pandemic.

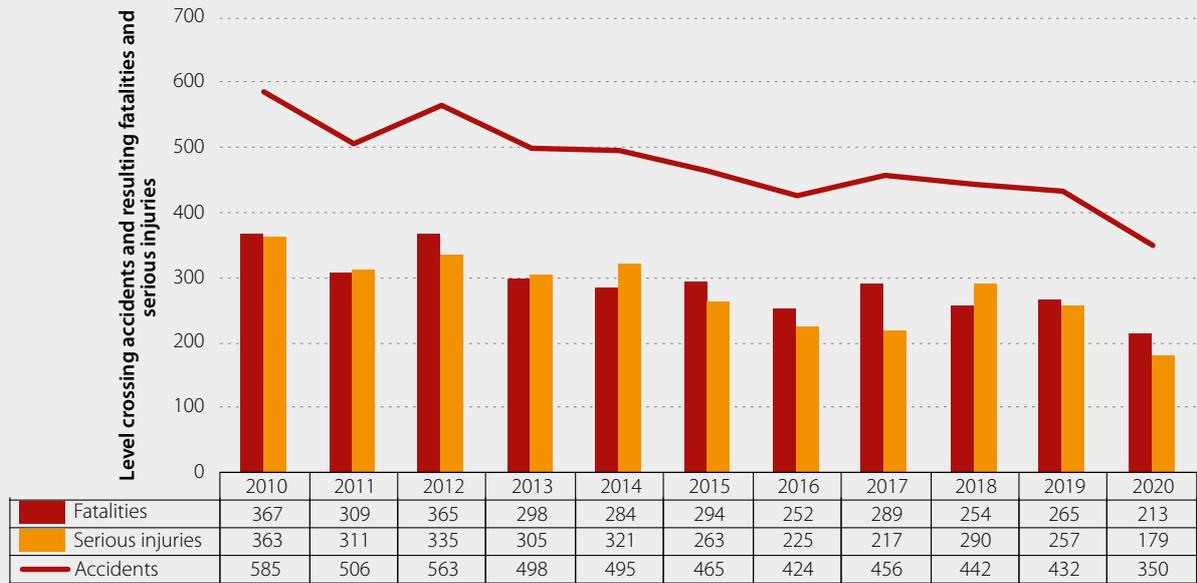
Level crossing accident rates vary considerably among EU Member States. The countries with the lowest accident rates have typically developed comprehensive strategies to improve the safety of level crossings, and this has translated into a small number of level crossings with poor or no protection. Common features of the countries with the highest accident rates are a low population density and low railway traffic volumes. These conditions perhaps provide less incentive for the comprehensive management of level crossing safety.

### **Sources and limitations**

Data used to monitor progress with safety outcomes are part of CSIs supplied by the NSAs to ERA. More than 10 years of continuous work on data quality in Member States and at the agency provides assurance on the accuracy of the data.

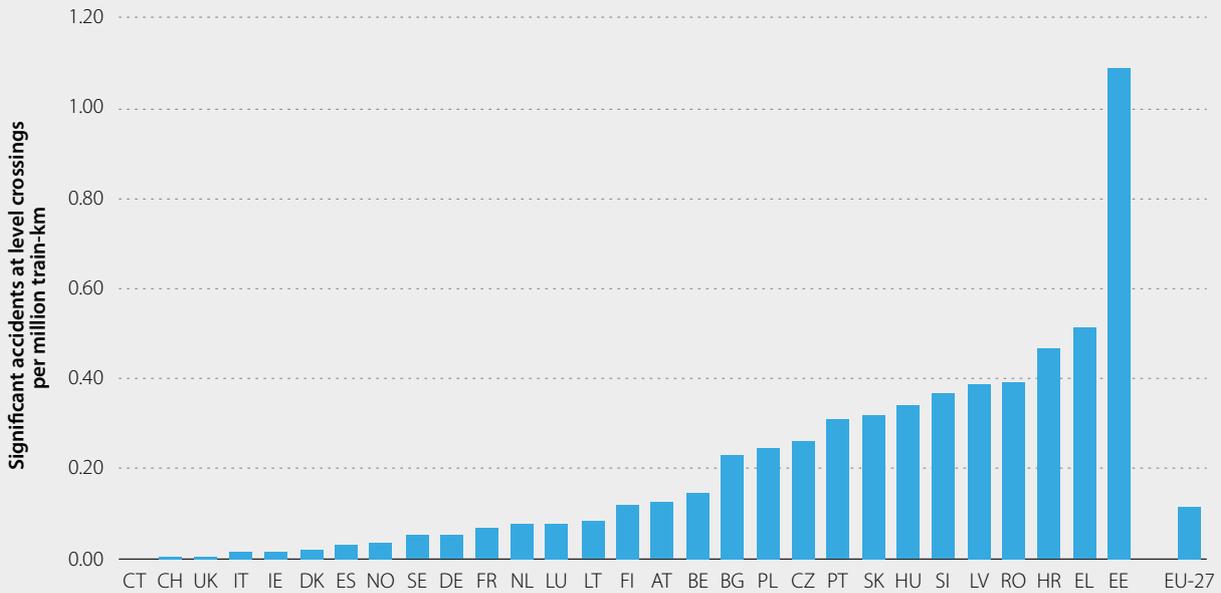
**Figure A-27: Level crossing accidents and resulting casualties (EU-27, 2010–2020)**

Significant accidents, fatalities and serious injuries



Source: CSIs as reported by NSAs to ERA.

**Figure A-28: Level crossing accident rates (EU-27 + CH + NO + UK, 2018–2020)**



Source: CSIs as reported by NSAs to ERA.

## A-16 Precursors to accidents

### Purpose

As accidents on railways are rare, an essential tool in a proactive safety management system is the monitoring of events that occur on railways even if they have no harmful consequences. Precursors to accidents are incidents that, under other circumstances, could have led to an accident.

### Indicators

The indicators available at EU level are broken rails, track buckles, signals passed at danger (SPADs), wrong-side signalling failures, broken wheels and broken axles. Their absolute numbers provide an initial indication of their relevance and trends.

### Findings

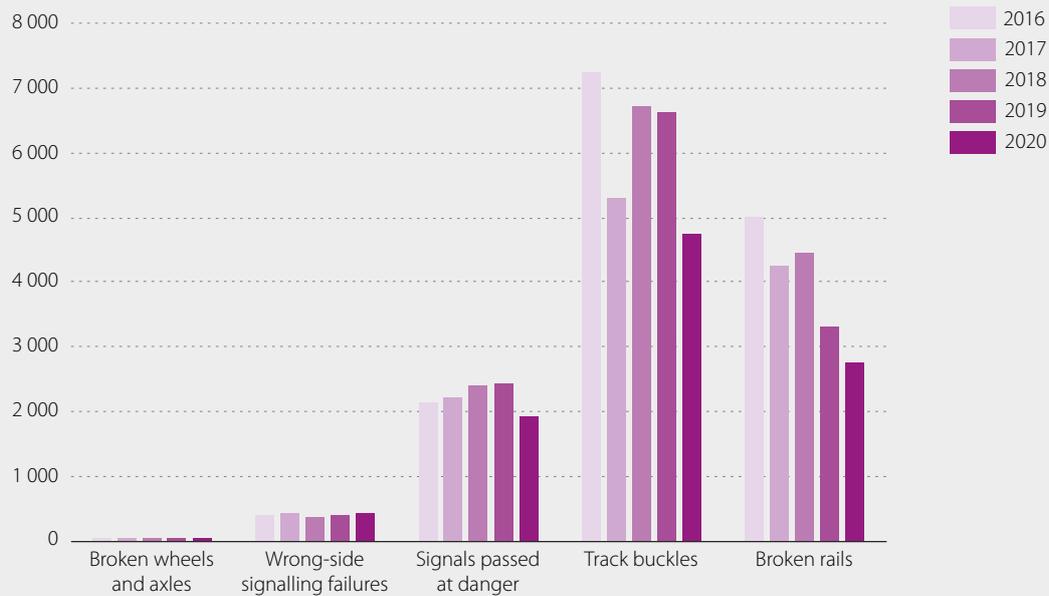
Between 2016 and 2020, EU Member States reported more than 12 100 precursors to accidents as defined under the CSIs on average each year. This works out as a ratio of about 7 precursors to 1 significant accident. However, if we disregard accidents to persons caused by rolling stock in motion, the ratio of the precursors to accidents rises to 17:1. This highlights the learning potential of precursors to accidents. Among the SPAD incidents, those in which a danger point was passed represent a particularly high risk of collision. Of the 2 200 SPAD incidents on EU railways recorded on average each year during the period 2016–2020, fewer than one quarter were of this type. It would be interesting, in future editions of this report, to explore the possible relationship between the number of SPADs and the level of automatic train protection or European Train Control System (ETCS) implementation.

The variation in yearly occurrence of track buckles and broken rails is indicative of poor precursor reporting in several Member States and does not provide a true picture of the situation. This is further illustrated by plotting accident precursors to accident ratio.

### Sources and limitations

Despite gradual improvements in the precursor data's quality, the data may not yet be fully comparable between Member States, so a degree of caution should be exercised when interpreting the results. Under-reporting is not uncommon in the case of incidents in general, and for certain accident precursors in particular.

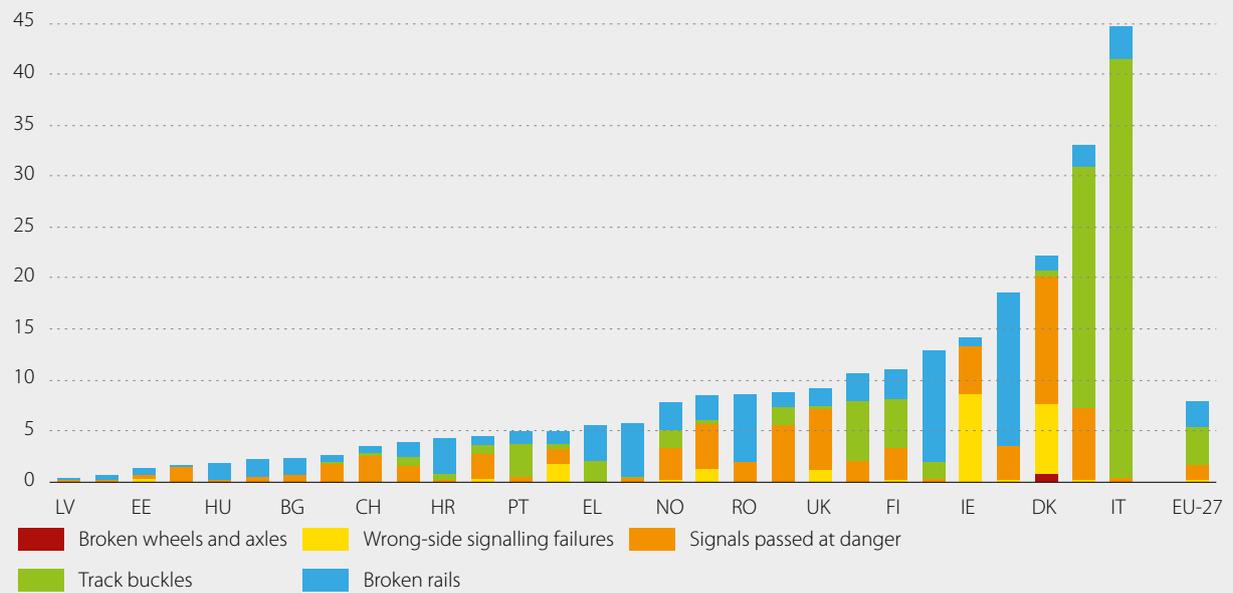
**Figure A-29: Precursors to accidents (EU-27, 2016–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-30: Accident precursor to accident ratio per country (EU-27 + CH + NO + UK, 2016–2020)**

Ratios of CSI precursors to total number of CSI significant accidents



Source: CSIs as reported by NSAs to ERA.

## A-17 Accident investigations

### Purpose

Independent investigations into the causes of accidents are invaluable to society in general and in terms of learning potential in particular. They ensure that lessons are drawn from past accidents and that action can be taken to prevent similar accidents from happening in the future. Independent accident investigation is a responsibility of each Member State, with the role of ERA being limited to supporting the relevant national bodies in carrying out their tasks. The RSD requires that serious accidents are investigated by an independent NIB.

### Indicators

The indicators used are the number of accidents and incidents investigated by NIBs and their further subclassification according to investigation compulsoriness, accident type and availability of the final report.

### Findings

Since 2006, the NIBs have opened investigations into 208 accidents and incidents per year on average, with final reports available in European Railway Accident Information Links (ERAIL) database for some 91 % of these. Occurrences for which a mandatory independent investigation is legally required (by the RSD) represent 18 % of all investigated occurrences. As this proportion has been stable, it could indicate stability in NIBs' overall priorities and available budget.

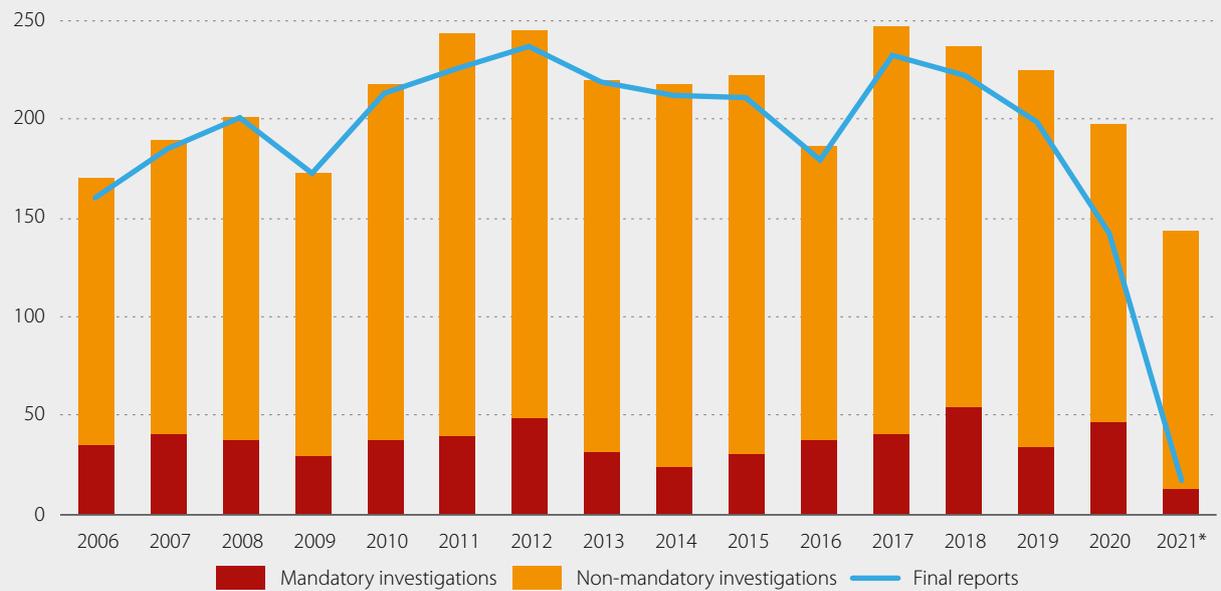
NIBs have the discretion to investigate certain occurrences on top of those they must investigate. Regarding the distribution of accident types investigated and accompanied by a final report published since 2006, it appears that the NIBs are more inclined to investigate derailments and level crossing accidents (even when non-mandatory). Non-mandatory investigations (under the RSD) are carried out for all accident types, but also for incidents (especially for SPADs). It should be noted that in some Member States, according to national legislation, the investigation of derailments, SPADs and/or level crossing accidents is mandatory, regardless of the consequences of the accident.

### Sources and limitations

Investigations by NIBs were recorded in the ERAIL database until its disconnection at the end of 2020; since then, an Excel database (based on the information retrieved from ERAIL) has been updated with the information on the new investigations reported to ERA. The completeness of data depends on the inputs provided by the NIBs.

**Figure A-31: Accidents and incidents subject to independent investigation (EU-27 + CH + NO + UK, 2006–2021)**

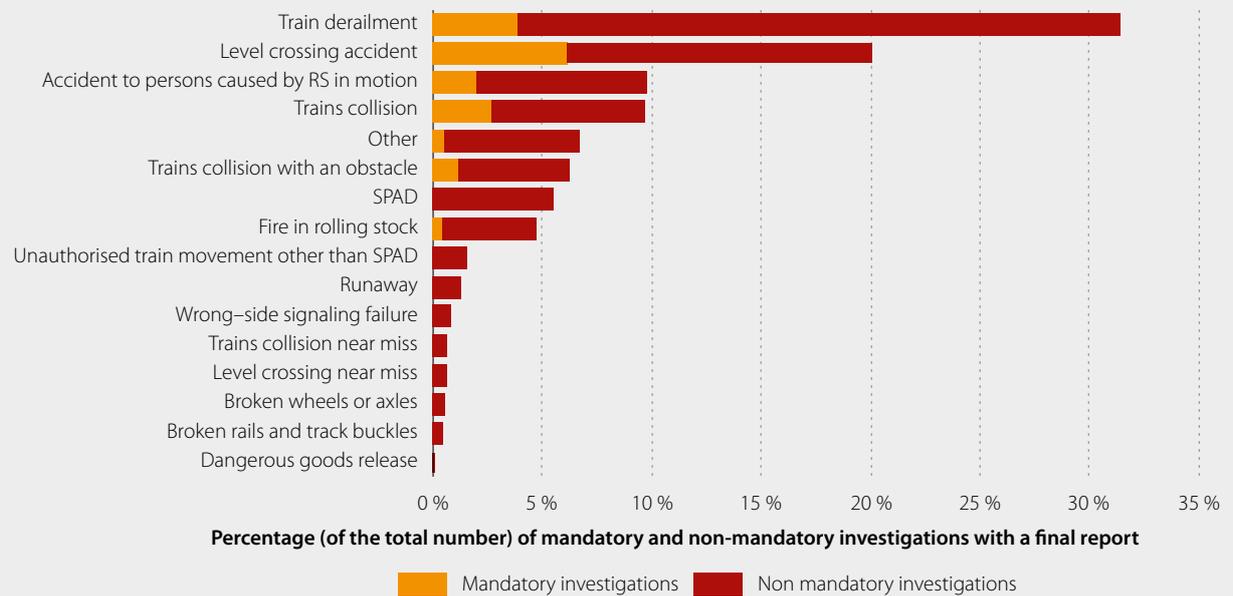
Mandatory and voluntary investigations by National Investigation Bodies per year of occurrence



Note: Data for UK available until end 2020; (\*) Final reports are presented by year of the occurrence (not by year of publication); for example for accidents occurred in 2021 final reports are expected to be issued within 1 year from the date of occurrence.

Source: Investigations by NIBs reported to ERA (ERAIL database), as of the end of 2021.

**Figure A-32: Accident types of NIB-investigated accidents (EU-27 + CH + NO + UK, 2006–2021)**



Note: Data for UK available until end 2020; 'Mandatory' refer to the obligations under the Safety Directive, excluding national rules which can impose more restrictive investigations rules

Source: ERAIL database; this includes the data been provided by NIBs as of the end of 2021.

## **A-18** National safety authority monitoring

### **Purpose**

ERA, as mandated by Regulation (EU) 2016/796, monitors the performance and decision-making of NSAs through audits and inspections on behalf of the European Commission. The agency is entitled to audit the capacity of NSAs to execute tasks related to railway safety and interoperability as well as the effectiveness of the monitoring by NSAs of safety management systems of actors as referred to in the RSD. During the first NSA audit cycle (2019–2021), the monitoring scope was limited to the NSAs' competence management and supervision activities.

### **Indicators**

The indicator used is the number of findings (in terms of deficiencies) issued by ERA during the first NSA audit cycle.

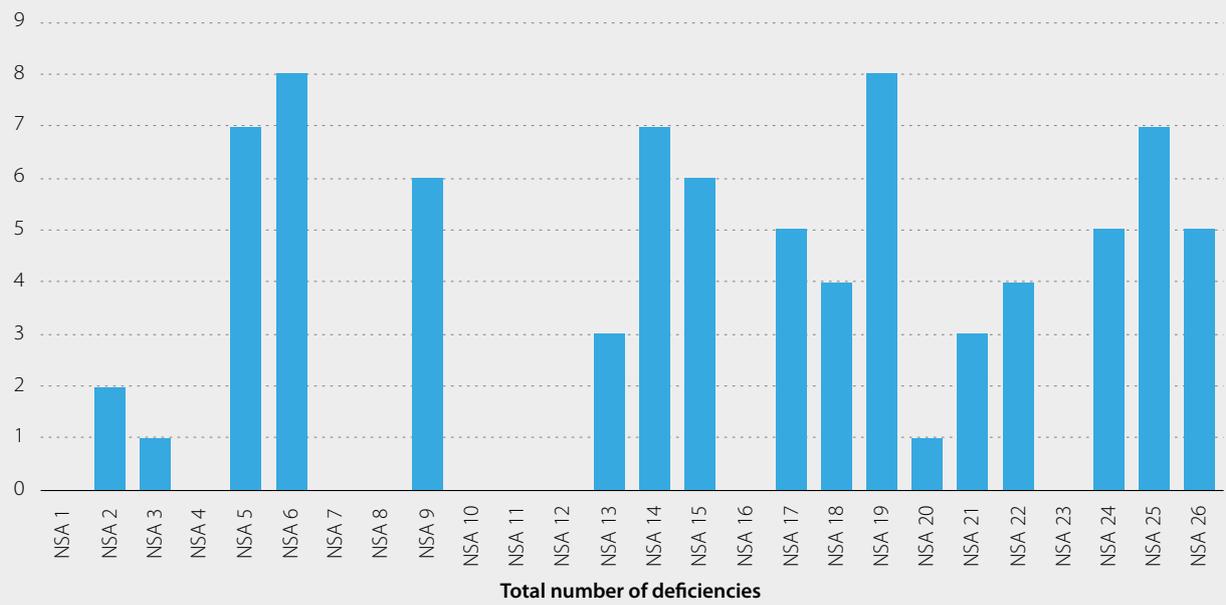
### **Findings**

During the first NSA audit cycle, a total of 82 deficiencies were identified (with at least one deficiency detected in 17 of the 26 NSAs audited). The results of the monitoring are quite variable: nine NSAs performed well (with no deficiencies identified), whereas more than four deficiencies were identified in 10 NSAs. In the second NSA audit cycle, it will be interesting to verify the effectiveness of the follow-up measures applied by the NSAs to address the deficiencies identified during the first cycle.

### **Sources and limitations**

The complete NSA audit cycle involved 25 EU NSAs (EU-27, excluding Cyprus and Malta) plus Switzerland, which volunteered to be audited. The numbering reported in the figure (e.g. NSA 1 and NSA 2) were assigned randomly.

**Figure A-33:** Findings issued during the monitoring of NSAs (EU-27, excluding Cyprus and Malta, plus Switzerland, end of 2021)



Source: ERA's internal database on NSA monitoring.

## A-19 Deployment of train protection systems on railway lines

### Purpose

The installation of TPSs is widely considered one of the most effective railway safety measures for reducing the risk of collisions between trains. The deployment of these systems on the national railway network and their use is monitored under the CSIs. Given the wide range of types and versions of TPSs in the EU, a classification focusing on three levels of assistance provided to the train driver is considered a solid basis for reporting comparable statistical data.

While TPSs are non-interoperable legacy systems, also known as class B systems, with varying functions, reliability and accuracy, depending on when they were installed, the European Rail Traffic Management System (ERTMS) is the most advanced class A system and its installation across all core/comprehensive networks of the EU is mandated<sup>(8)</sup>. The ERTMS is the European standard system for automatic train protection. It ensures a high level of safety, interoperability, reliability and performance. Some Member States have decided to deploy the ERTMS on their entire rail network, thus going beyond the EU legal requirements. In fact, several TPSs are obsolete, and have low reliability, low safety levels and low performance.

### Indicators

The shares of railway lines equipped with TPSs (per level of assistance) and with the ERTMS are used as indicators.

### Findings

Some EU Member States reported advanced TPSs functional levels (including in some cases the ERTMS or other advanced class B systems), while a few other countries did not report the share of tracks equipped with TPSs (or reported that no tracks were equipped with TPSs). Among countries providing TPS data, Germany, Spain, Italy, Luxembourg, the Netherlands and Romania reported that more than 90 % of their networks are equipped with TPSs that provide the highest level of train protection, that is warning, automatic stop and (discrete or continuous) supervision of train speed. However, a significant proportion of railway lines in other Member States are still not protected by TPSs.

The deployment of the ERTMS has been limited so far; only a few countries have deployed the system on a significant share of their network. The percentage of the national network equipped with the ERTMS is highest (i.e. more than 30 %) in Belgium, Luxembourg and Slovenia.

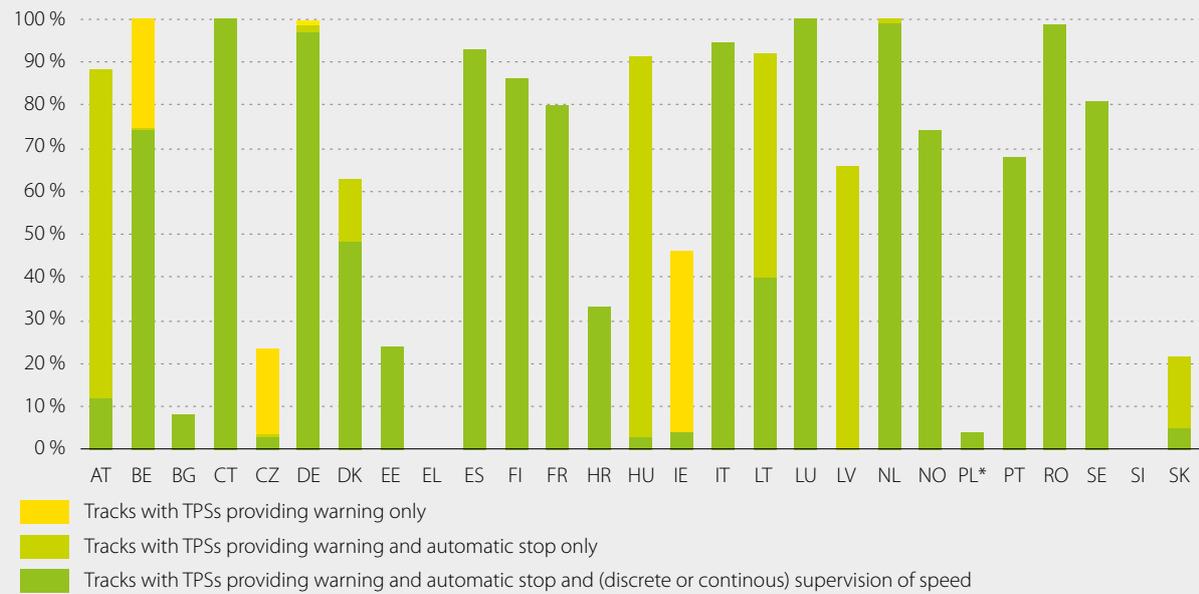
### Sources and limitations

Although the three TPS levels have been part of the CSI data collection for a long time, the levels have been redefined recently with a view to assuring harmonised reporting. However, not all IMs provide these data, and some may still be inaccurate. Regarding the Register of Railway Infrastructure (RINF), as the data are retrieved directly from the database, their reliability depends on the extent to which the information provided is up to date and complete. As specified in the terms of use of the RINF, ERA has no responsibility for or liability with regard to the information submitted and published in the database.

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<sup>(8)</sup> See Regulation (EU) No 1315/2013 (as amended).

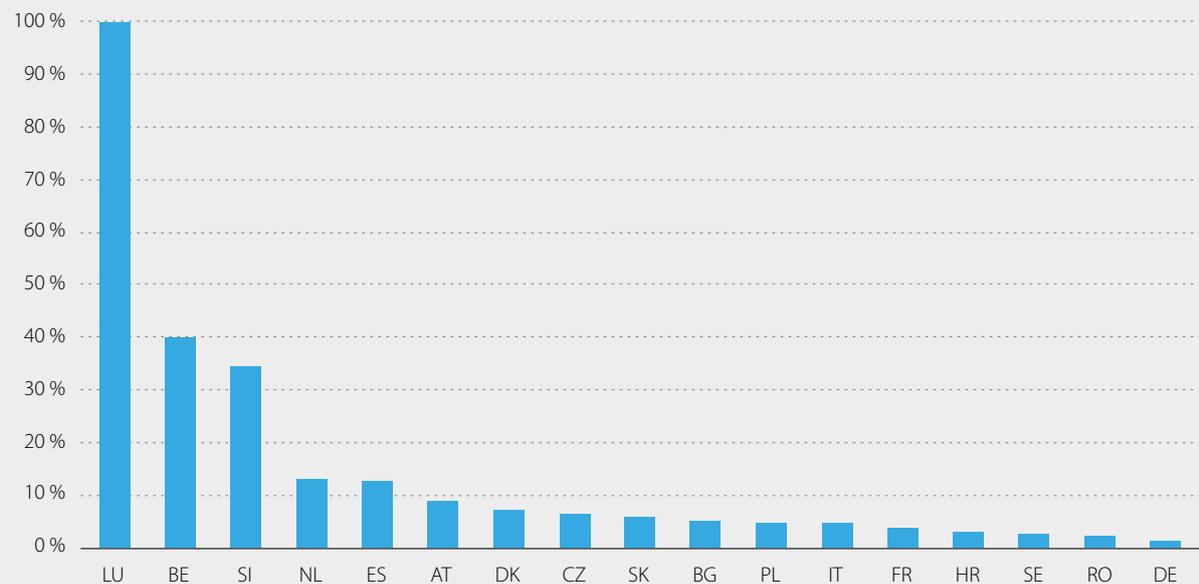
**Figure A-34: Share of tracks equipped with TPSs, % (EU-27 + NO, 2020)**



Note: (\*) No CSI data were provided for Poland on TPSs providing warning and automatic stop; the network statement for 2021–2022 indicates that around 72 % of Polskie Linie Kolejowe railway tracks are equipped with trackside TPSs (with electromagnets for automatic braking)

Source: CSIs as reported by NSAs to ERA, published in ERAIL.

**Figure A-35: Share of railway lines equipped with ERTMS, % (EU-27, end 2021)**



Sources: ERTMS track-side data – RINF, DMT / CNC (TENtec) (Denmark) and a network statement (Luxembourg); total line data – RINF (end of 2021) and Eurostat (end of 2019).

## A-20 Deployment of level crossing protection systems

### Purpose

Level crossings are high-risk spots on the railway network, as they represent an inherent risk to the safety of both road and railway users. The installation of various protection systems has historically been a cheaper, yet less efficient, alternative to their replacement with overpasses, underpasses or bridges. However, they are still expensive to deploy across the whole railway network. Empirical data show that, although any type of protection is better than none, only manual and rail-side protected level crossings reduce the risk of an accident towards zero.

### Indicators

The indicators used are the absolute number of level crossings per type of protection as defined in the RSD (Annex I) and the relationship between the number of level crossing accidents and the number of passive level crossings per country.

### Findings

In 2020, the EU-27 countries reported more than 97 000 level crossings. Passive level crossings account for more than 42 % of the total (ranging from 45 % up to 85 % in 17 countries); these level crossings are usually equipped with a St Andrew's cross traffic sign, but do not provide any active warning to road users. Level crossings with user-side protection (arm barriers and flashing lights) are the most common type of active level crossings (40 %). Level crossings that combine full road-side protection with rail protection (17 320) represent around 18 % of all level crossings.

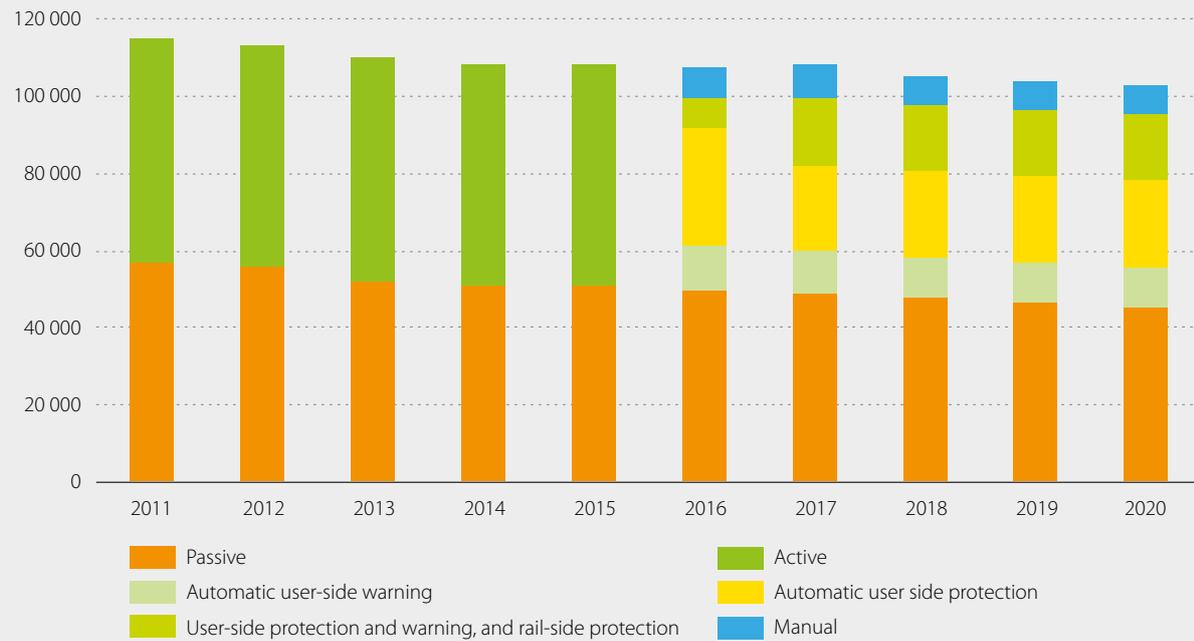
In general, passive level crossings and level crossings are being eliminated at a quite slow rate.

There is a possible relationship between the average number of passive level crossings between 2018 and 2020 among European countries and the average number of level crossing accidents. In all but a few countries (e.g. Finland, Norway, Sweden and the United Kingdom), where further analysis is merited, a higher number of passive level crossings is associated with a higher number of level crossing accidents.

### Sources and limitations

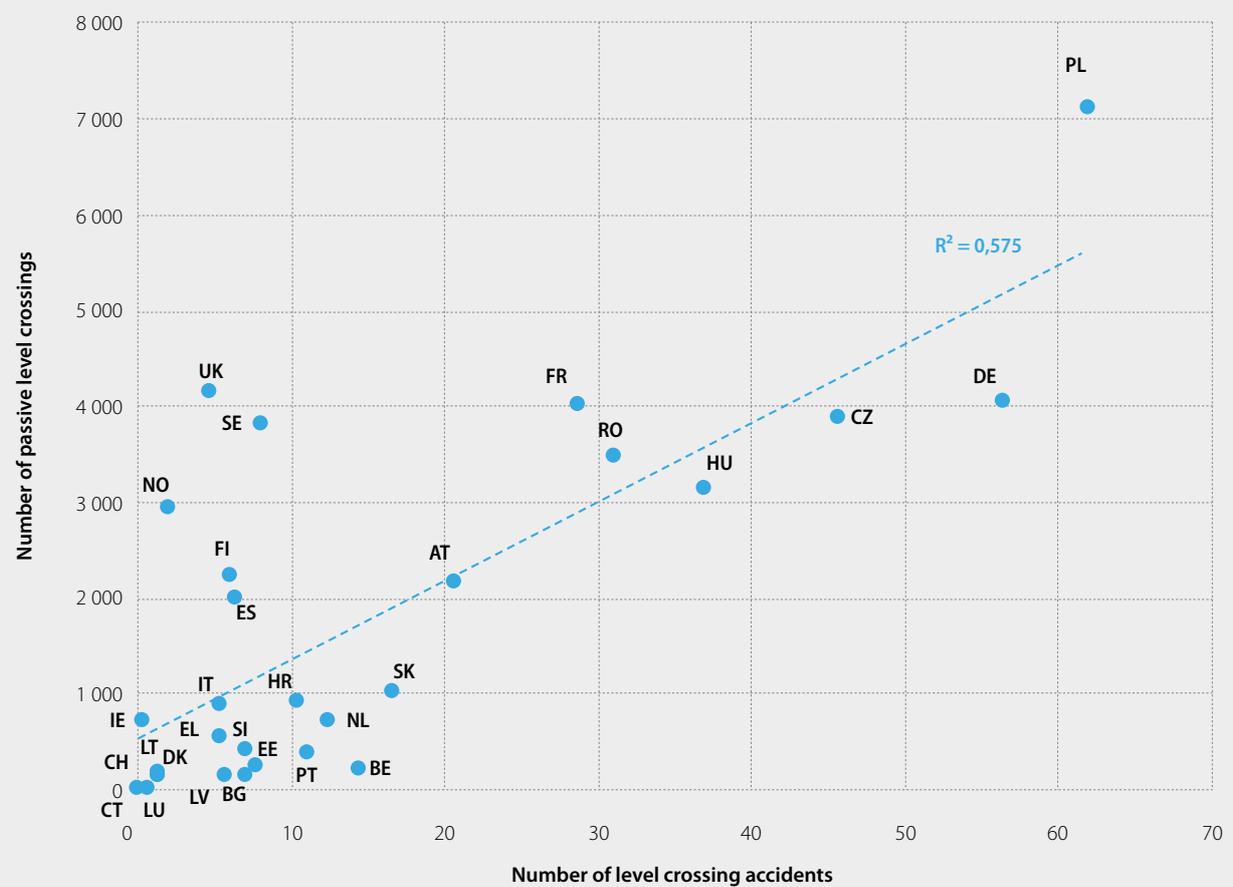
As there is no standard for level crossing protective equipment, dozens of types, with various combinations of features, exist in Europe. However, a basic classification has been agreed, featuring five main types, characterised by their main functional capacities and risk reduction potential.

**Figure A-36: Level crossings per type of protection (EU-27, 2011–2020)**



Source: CSIs as reported by NSAs to ERA.

**Figure A-37: Number of level crossing accidents and number of passive level crossings per country (EU-27 + CH + NO + UK, 2018–2020)**



Source: CSIs as reported by NSAs to ERA.

## A-21 Safety certification

### Purpose

The RSD requires the RUs to hold a safety certificate issued by the NSA to access the railway infrastructure. Historically, until the fourth railway package entered into force, the safety certificate comprised a valid part A safety certificate (certification confirming the acceptance of the RU's safety management system) and at least one part B safety certificate (certification confirming the acceptance of the provisions adopted by the RU to meet specific requirements necessary for the safe supply of its services on the relevant network). A single safety certificate is now gradually replacing the old scheme, being the fourth railway package technical pillar fully applicable across the EU since 31 October 2020.

### Indicators

The indicators used are the number of valid part A safety certificates and the number of SSCs valid at the end of each year over a 3-year period, per country and per type of service.

### Findings

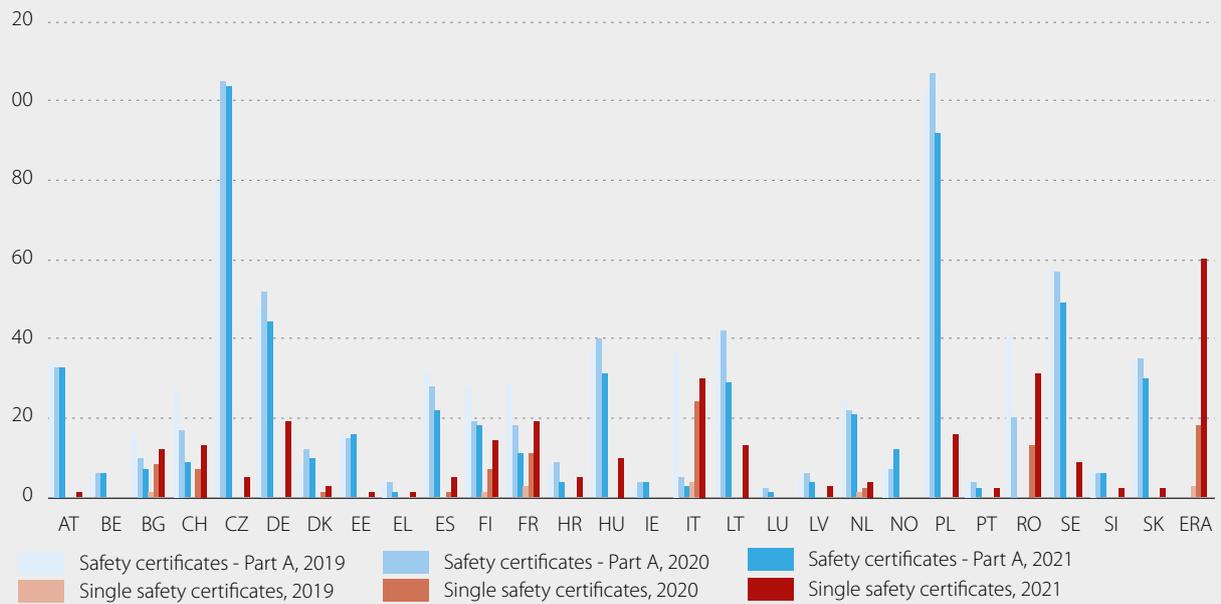
The trend over the past 3 years confirms the gradual transition from the old (i.e. safety certificates, parts A and B) to the new scheme (i.e. SSCs); since 2019, the number of part A safety certificates has decreased in various countries, accompanied by an increase in the number of SSCs. The number of part A safety certificates appears to have remained quite stable in other countries (with no or very few SSCs), which can be explained by, among other things, the renewal of these safety certificates before the transposition date of the fourth railway package and by specific measures taken by some Member States to extend their validity.

According to the figures for the EU-27, Norway and Switzerland, at the end of 2021, almost 570 valid part A safety certificates and more than 270 SSCs were in use, with the majority of all certificates related to freight services.

### Sources and limitations

ERADIS still contains data on safety certificates (parts A and B) granted by NSAs, as well as data on SSCs issued by NSAs or ERA. Data reliability depends on the extent to which information provided is up to date and complete; as specified in the terms of use of ERADIS, ERA has no responsibility or liability with regard to the data submitted by NSAs and published in the database.

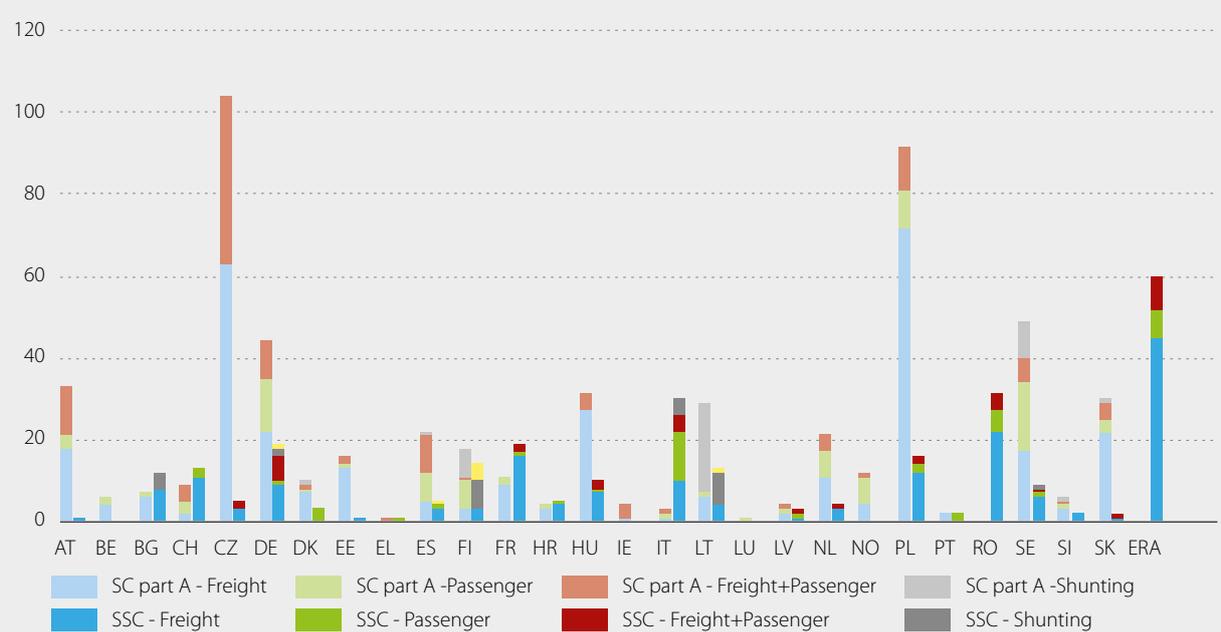
**Figure A-38:** Number of safety certificates (part A) and SSCs valid at the end of 2019, 2020 and 2021 by issuing country / ERA (EU-27 + CH + NO)



Note: SSC data from June 2019. In 2019 and 2020, full transposition did not occur in all Member States

Source: ERADIS (ERA).

**Figure A-39:** Number of safety certificates and SSCs valid at the end of 2021 by type of service (EU-27 + CH + NO)



Note: Yellow bars indicate a few SSCs for which the market segment is not available

Source: ERADIS (ERA).

## A-22 Entity in charge of maintenance certificates

### Purpose

Commission Implementing Regulation (EU) 2019/779 (as amended by Commission Implementing Regulation (EU) 2020/780) lays down detailed provisions on a system of certification of ECMs of vehicles pursuant to the RSD and in accordance with Annex A to the uniform rules concerning the technical admission of railway material used in international traffic (Appendix G to the Convention concerning International Carriage by Rail). Data on ECM certificates and maintenance function certificates are reported in ERADIS.

### Indicators

The indicators used are the numbers of ECM certificates and of maintenance function certificates (including maintenance workshop certificates) per country of the certified entity and the number of ECM certificates for freight wagons or for other vehicles.

### Findings

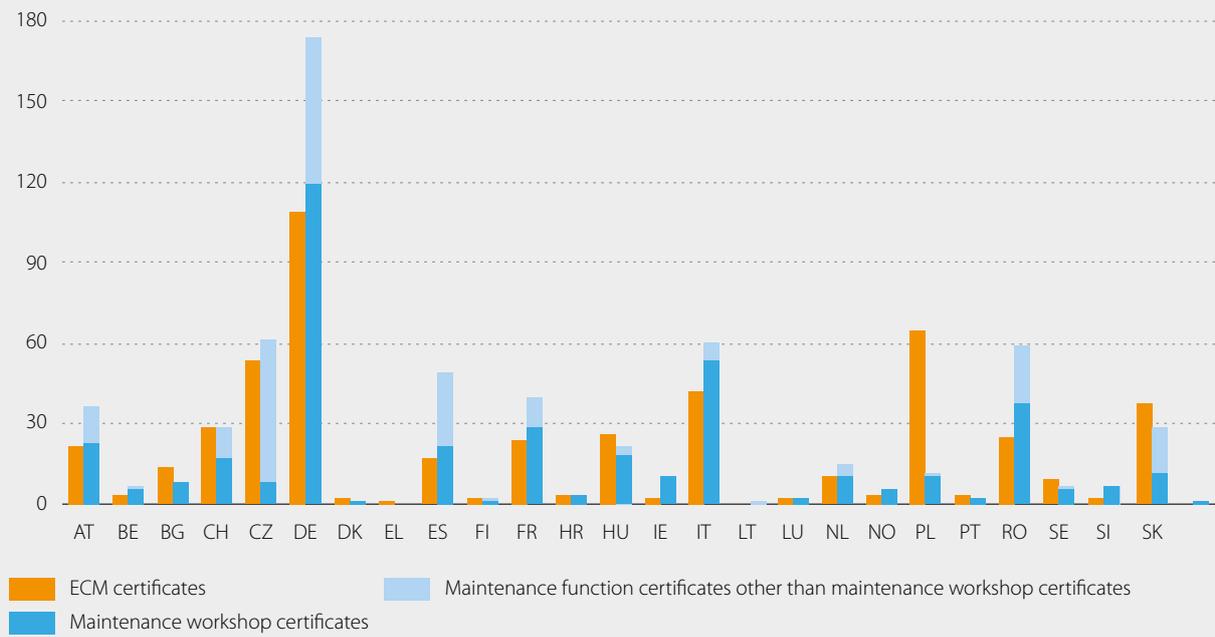
ERADIS reports 511 ECM certificates and 642 maintenance function certificates (of which 412 were for maintenance workshops) valid on 31 December 2021 in the EU-27, Norway and Switzerland. There is significant variation across Member States, with the highest numbers reported in Germany.

Although not yet mandatory (i.e. all ECMs for vehicles other than freight wagons should comply with Commission Implementing Regulation (EU) 2019/779, as amended, by 16 June 2022), at the end of 2021, 223 ECM certificates for vehicles other than freight wagons were reported in ERADIS (out of the 511 in total).

### Sources and limitations

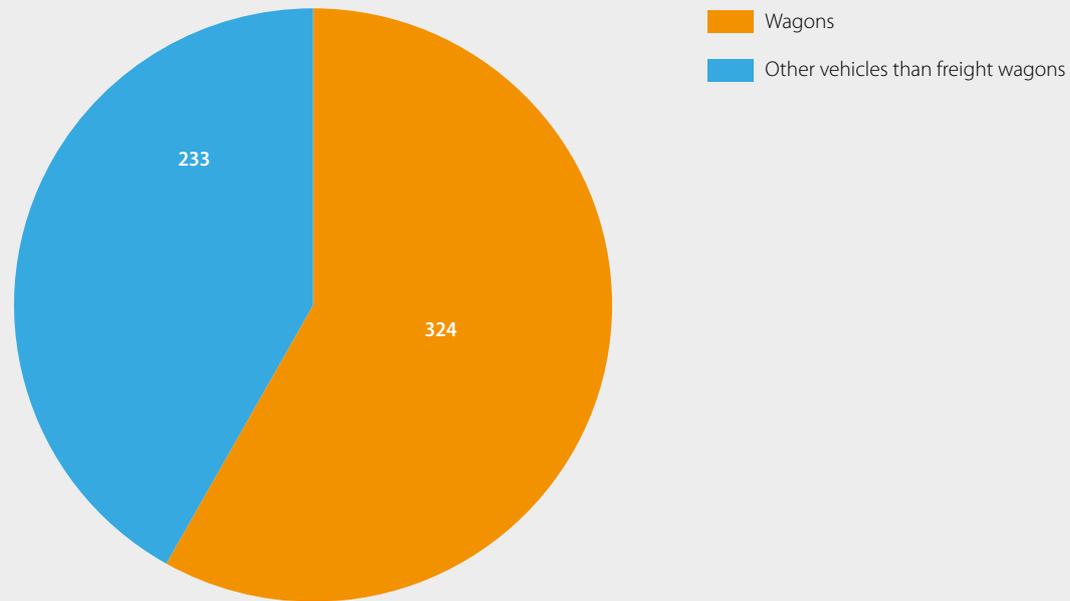
Data on ECM certificates and maintenance function certificates are available in ERADIS, and their reliability depends on the extent to which information provided is up to date and complete; as specified in the terms of use, ERA has no responsibility or liability with regard to the data on ECM certificates and maintenance function certificates submitted and published in ERADIS.

**Figure A-40:** Number of ECM certificates active at the end of 2021 per country of the certified entity (EU-27 + CH + NO)



Source: ERADIS.

**Figure A-41:** Number of ECM certificates for wagons and other types of vehicles (end 2021)



Source: ERADIS.



## B. Progress with interoperability



## Summary

Although the interoperability of the EU railway system is improving, progress has been slow so far, and it appears to be unequal/uneven across different areas. Solid progress has been achieved in aligning rules and procedures, whereas improvements have been slow in the area of rolling stock and infrastructure, partly owing to their long-life nature. Progress in the widespread adoption of technical standards supporting information availability and data exchange has also been delayed across the EU, often resulting in parallel developments, which in turn reduces the effectiveness of investments.

As a result of this uneven progress, EU railways have not increased their modal share in the past decade, despite being currently the most sustainable mode of transport. The relative share of people and goods transported by rail, as compared with other modes of transport, appears to have stagnated at rather low levels (around 7 % and 12 %, respectively). In fact, owing to the COVID-19 pandemic (and the related travel restrictions), the freight tonne-km in Europe decreased by around 7 % in 2020 compared with 2019, and the drop in passenger-km was much higher (over 45 %). Even disregarding the figures for 2020 and considering data until 2019, rail passenger volumes have increased slightly but consistently, while freight volumes have remained stable. International rail traffic is significant only for freight services (accounting for slightly more than 50 % of the total rail freight traffic), and appears to account for quite a small proportion of passenger services (around 6 %). These proportions are largely unchanged since 2006, suggesting that the EU is far from achieving its climate policy ambitions in this area.

The regular monitoring of rail traffic volumes, transfer time and punctuality at border sections may provide an indication of the development of rail interoperability across Europe year on year; in this report, for the first time, possible indicators are presented based on data provided by RailNetEurope (RNE), drawing on information from the RNE Train Information System. Traffic volumes are significant for some cross-border sections but quite low in other areas, and, in the majority of the sections analysed, the average real transfer time in 2021 was higher than planned (for both freight and passenger trains). On average, transfer times were longer, and punctuality poorer, for freight trains than for passenger trains. The current dataset does not cover all European cross-border points and therefore the results cannot yet be considered representative of the overall situation in Europe; data coverage is expected to increase over time. In future editions of this report, it will be possible to generate additional findings, for example by comparing year-on-year changes in individual border sections in order to monitor the progress of these indicators over time in every location.

The degree of implementation by operators of single functions under the technical specifications for interoperability (TSIs) concerning the telematics applications for passenger services (TAP) and for freight services (TAF) varies considerably among functions, but in general implementation is progressing very slowly; the average value for TAP TSI functions is now above 50 %, while for the TAF TSI only two functions have been fully implemented by more than 65 % of respondents.

The total number of national rules for vehicle authorisation (in addition to the latest TSIs in force) has decreased significantly since 2016, with some differences among countries. Although there has been an impressive decrease in the number of published rules over the past 6 years, the trend has flattened since 2019, as potentially removable rules are becoming scarce. A further reduction in the number of national rules is expected after the next revisions of the TSIs (as a result of further harmonisation, for example due to the closure of open points).

The deployment of the ETCS at EU level has been slow so far and varies considerably among Member States. Progress has also been uneven among core network corridors (CNCs), with a substantially greater effort needed to meet the European deployment plan targets.

Non-application of TSI requirements remains a common practice, as visible from the number of derogation requests addressed to the Commission. After a peak in 2017, the number has stabilised and even decreased in some areas; there is quite significant variation across Member States.

The number of train drivers licensed in line with the requirements set out in the train drivers directive (TDD) has been increasing steadily in recent years; despite a small delay, as of the end of 2020 the implementation of the EU certification scheme appeared to be complete in all Member States.

Records in ERADIS indicate a total of 214 part B safety certificates valid in more than one Member State at the end of 2021 (in the EU-27, Norway and Switzerland); these figures may not be fully representative of international rail traffic because of the possible creation of subsidiaries in the different Member States where the RUs plan to operate. Furthermore, 33 SSCs with international areas of operation were issued by ERA (and valid at the end of 2021). More freight services than rail passenger services are registered or operated internationally. International rail passenger services appear still quite limited.

Around 1 280 vehicle authorisation applications were submitted and handled by ERA in 2021, with more than 14 800 vehicles authorised; the figures demonstrate an increasing trend in recent years. The majority of authorisations in 2021 were related to wagons, followed by locomotives and train sets, while more than 1 040 authorisations (for more than 13 480 vehicles) concerned an area of use in multiple countries (with almost all of the wagons authorised for use in more than one Member State).

The average time to obtain a vehicle authorisation in conformity to type has decreased significantly over time, fluctuating in recent months around the target of 5 working days for processing by ERA. As of the end of 2021, the average duration for all the other authorisations (since June 2019) was below the legally required 5-month target.

The completeness and accuracy of data in the RINF a major challenge to the effective use of the register's data. As of the beginning of 2022, about 81 % of the Member States' railway networks are described, while for the technical parameters 81 % of parameters for sections of lines and 88 % of parameters for operational points are currently available in the RINF.

# Overview of indicators and figures

## Part B: Progress with interoperability

Indicator	Figure	Indicator/Figure(s)	Category	Area
<b>1</b>		<b>Rail transport figures</b>	Final outcomes	Rail transport figures
	1	Rail transport figures (passengers, EU-27, 2006–2020)		
	2	Rail transport figures (freight, EU-27, 2006–2020)		
<b>2</b>		<b>Number of international passenger/freight trains at selected border stations</b>	Outcomes	Cross borders train services
	3	Border crossing points included in the analysed dataset (location and border ID)		
	4	Number of (freight and passenger) trains crossing the selected border sections (2021)		
<b>3</b>		<b>Transfer time of international trains at selected border sections</b>		Seamless cross border train operations
	5	Planned and real transfer times at selected border sections (international freight trains, 2021)		
	6	Planned and real transfer times at selected border sections (international passenger trains, 2021)		
<b>4</b>		<b>Punctuality of international trains at selected border crossing points</b>	Punctuality of international train services	
	7	Entry and exit punctuality at selected border sections (international freight trains, 2021)		
	8	Entry and exit punctuality at selected border sections (international passenger trains, 2021)		
<b>5</b>		<b>TAP TSI implementation</b>	Operating procedures	
	9	Degree of implementation of TAP functions (end 2020)		
<b>6</b>		<b>TAF TSI implementation</b>	Humans	
	10	Degree of implementation of TAF functions (end 2020)		
<b>7</b>		<b>Train drivers with EU license</b>	Fixed installations	
	11	Train drivers with an EU licence per country (EU-27 + CH + NO, end 2020)		
<b>8</b>		<b>Railway stations accessible to PRMs</b>	Humans	
	12	Railway stations per type of PRM accessibility (17 EU Member States, end 2020)		
	13	Railway stations accessible to PRMs by EU Member State (end 2020)		
<b>9</b>		<b>Non-applications of fixed installations-related TSIs</b>	Fixed installations	
	14	Non-applications of fixed installation-related TSIs (EU-27 + UK, end 2021)		
	15	Non-applications of fixed installation-related TSIs per year (EU-27 + UK, 2011–2021)		
<b>10</b>		<b>ERTMS trackside deployment</b>	Outputs	
	16	Length of railway lines equipped with the ETCS (EU-27, end 2021)		
	17	Deployment of the ERTMS on CNCs (end September 2021)		
<b>11</b>		<b>Non application of TSIs related to rolling stock</b>	Rolling stock	
	18	Non-applications of rolling stock-related TSIs (EU-27 + UK, 2011–2021)		
	19	Non-applications of rolling stock-related TSIs per country (EU-27 + UK, end 2021)		
<b>12</b>		<b>Applicable national technical rules for vehicles</b>	Rolling stock	
	20	National rules for vehicle authorisation in addition to the latest TSIs (EU-27 + CH + NO, November 2021)		
	21	National rules for vehicle authorisation (EU-27 + CH + NO + UK, 2016–2021)		
<b>13</b>		<b>ERTMS on board deployment</b>	Rolling stock	
	22	Vehicles in operation equipped with ERTMS OBU (EU-27 + CH, end 2020)		
	23	Contracted ERTMS vehicles (EU-27 + CH + NO + UK, 2010–2020)		

Indicator	Figure	Indicator/Figure(s)	Category	Area	
<b>14</b>		<b>Safety certificates or single safety certificates for RUs with an international area of operation</b>	Outputs	Area of operations in more than one MS	
	24	Member States concerned with part B safety certificates for RUs operating in more than one Member State by type of service (end 2021)			
	25	Member States concerned with SSCs issued by ERA per type and area of operation (end 2021)			
<b>15</b>		<b>Vehicle authorisations handled by ERA, per area of use and type of vehicle</b>		Area of use in more than one MS	
	26	Number of vehicle authorisations and vehicles authorised by ERA per area of use (2019–2021)			
	27	Number of vehicle authorisations and vehicles authorised by ERA per type of vehicle and area of use (2021)			
<b>16</b>		<b>Licence documents</b>		Licences	
	28	Number of valid licence documents active at the end of 2021 by country (EU-27 + CH + NO)			
<b>17</b>		<b>RINF completeness</b>		Inputs	Enablers
	29	RINF network description completeness (EU-27, beginning of January 2022)			
	30	RINF technical parameters completeness (EU-27, beginning of January 2022)			
<b>18</b>		<b>ETCS trackside costs</b>			
	31	Average CAPEX per ETCS-L2-equipped line-km (EU-27, 2014–2018)			
	32	Average CAPEX per ETCS-L1-equipped line-km (EU-27, 2014–2018)			
<b>19</b>		<b>ETCS on-board costs</b>			
	33	Average CAPEX per ETCS-L1-equipped vehicle (EU-27, 2014–2019)			
	34	Average CAPEX per ETCS-L2-equipped vehicle (EU-27, 2014–2019)			
<b>20</b>		<b>EU-funded projects with a cross-border impact and/or for rail interoperability</b>			
	35	Allocation of funds to CEF-T railways actions with a cross-border impact (2014–2020)			
	36	EU-funded projects for rail interoperability and RFCs (2014–2018)			
<b>21</b>		<b>Time to obtain vehicle authorisation</b>			
	37	Time to obtain vehicle authorisation in conformity to type (2019–2021)			
<b>22</b>		<b>ERTMS trackside approvals</b>			

## **B-1** Rail transport figures

### **Purpose**

Rail transport is increasingly considered as one of the key elements of a more sustainable European mobility strategy owing to its strategic value, high level of safety, high transport volumes and relatively low externalities. EU policy contains explicit goals to increase the share of rail transport and provide public support to reach these goals; this justifies the close monitoring of developments in rail transport.

The relative share of people and goods transported by railways, as compared with all other modes of transport, reflects the competitive position of rail transport in terms of its efficiency and performance. Seamless, timely operation is one of the inherent advantages of rail transport and one of the key performance parameters and is further enhanced by an interoperable railway system, which aims to facilitate cross-border and international traffic. Therefore, the modal share of transport and the percentage of international rail traffic across Europe are considered indirect measures of the impact of railway interoperability on actual transport performance.

### **Indicators**

The modal split is calculated on the basis of the transport performance, measured in passenger-km and tonne-km, of five transport modes: road, rail, inland waterways, air and maritime. It is presented alongside the absolute rail transport volumes (both domestic and international), providing background information on the underlying trends.

### **Findings**

Owing to the COVID-19 pandemic (and the related travel restrictions) the freight tonne-km in Europe (EU-27) decreased by around 7 % in 2020 compared with 2019, while the reduction in passenger-km was much higher (i.e. over 45 %).

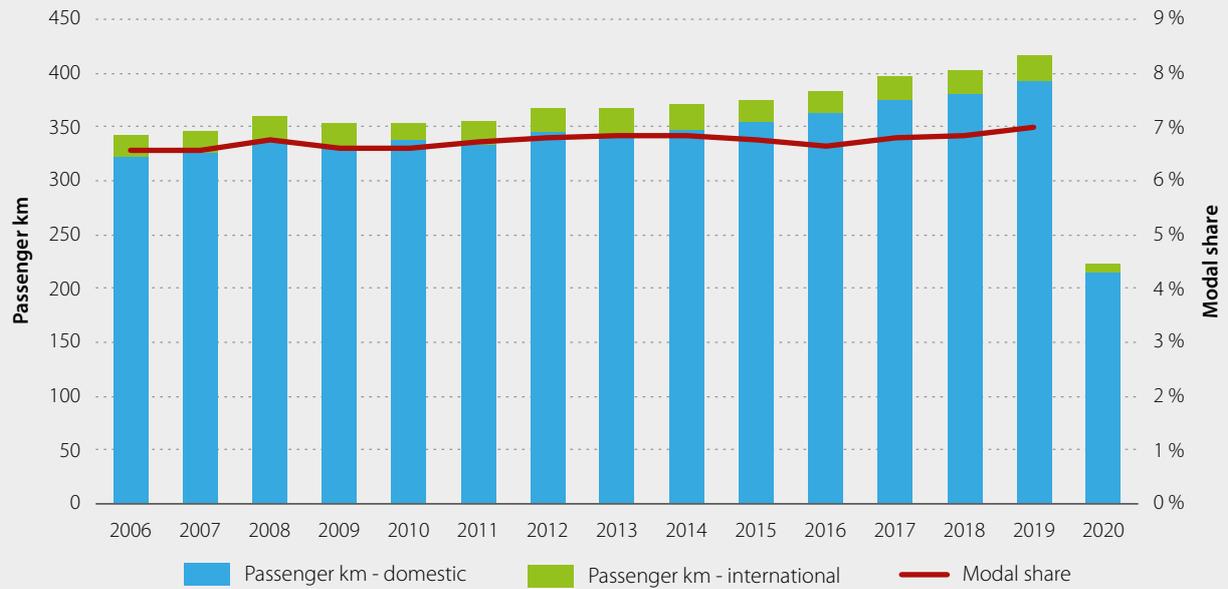
Even disregarding the figures for 2020, European rail traffic has increased very little over the last decade. Rail passenger volumes increased slightly in recent years up to 2019, while freight volumes remained stable. The relative share of people and goods transported by railways, as compared with other modes of transport, appears to have stagnated at rather low levels (i.e. around 7 % and 12 %, respectively). International rail traffic is significant only for freight services (accounting for slightly more than 50 % of total rail freight traffic), and appears to account for quite a small proportion of passenger services (around 6 %). These figures have been largely stable since 2006.

### **Sources and limitations**

The data on rail traffic have traditionally been compiled by Eurostat, relying on inputs from national statistical offices. Eurostat has notably developed and applied methodologies allowing the territorialisation of the transport flows at Member State level and to avoid double counting transport flows on single territories (e.g. in the case of road transport). The quality of these administrative data could be considered high, as the data collection and data production practices are well established. Figures on the modal share are retrieved from the 2021 statistical pocketbook (published by the Directorate-General for Mobility and Transport).

**Figure B-1: Rail transport figures (passengers, EU-27, 2006–2020)**

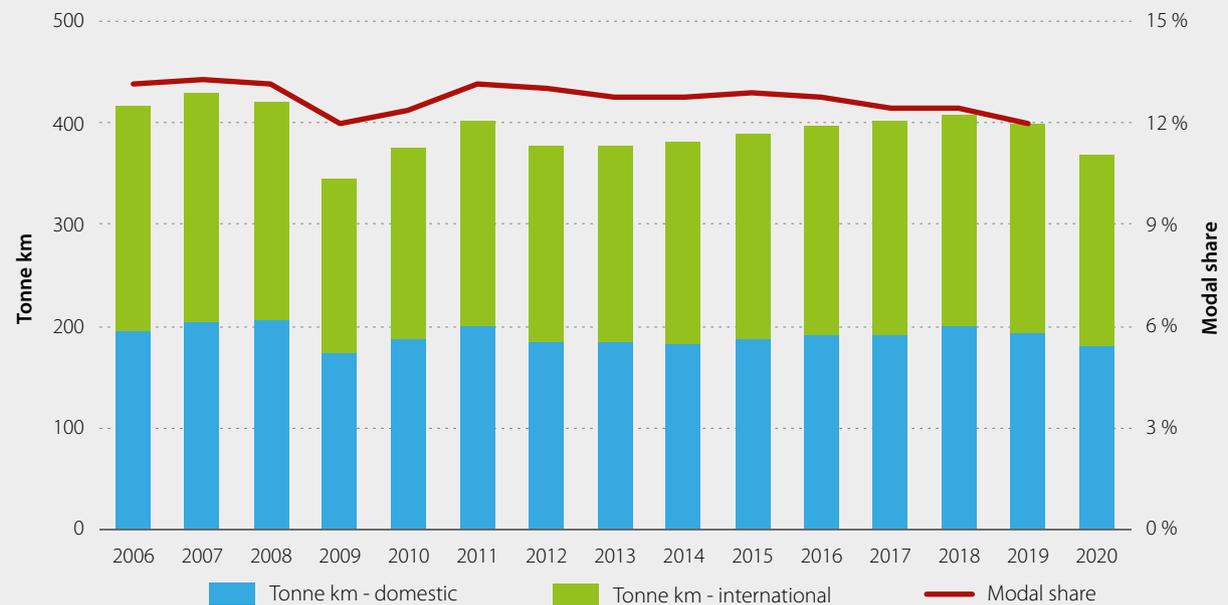
Passenger km (billions) for domestic and international traffic and modal share (%)



Source: Estimations based on Eurostat tables 'rail\_pa\_total', 'rail\_pa\_quartal' and 'rail\_pa\_typepas', Statistical Pocketbook 2021 (Directorate-General for Mobility and Transport).

**Figure B-2: Rail transport figures (freight, EU-27, 2006–2020)**

Tonne km (billions) for domestic and international traffic and modal share (%)



Source: Estimations based on Eurostat tables 'rail\_go\_total', 'rail\_go\_quartal' and 'rail\_go\_typepas', Statistical Pocketbook 2021 (Directorate-General for Mobility and Transport).

## **B-2** Number of international passenger/freight trains at selected border stations

### **Purpose**

As mentioned in the section on transport figures, the volume of international rail traffic across Europe can be considered an indirect measure of the impact of railway interoperability on actual transport performance. Therefore, the purpose of this indicator is to monitor traffic volumes in terms of international passenger/freight trains at selected border stations, as an outcome of the interoperability of the European railway system.

### **Indicators**

The metric used is the number of passenger and freight trains crossing selected sections of borders, collected by RNE automatically from the Train Information System (TIS) based on the results of the RNE border section project; the figures refer to the total number of trains over 2021. For some borders, only freight data or only passenger data are provided; this does not necessarily mean that the related line is dedicated to one type of traffic (i.e. data for the other type of the traffic could be incomplete owing to operational restrictions or data quality problems).

### **Findings**

As shown in Figure B-3, the border sections considered in the analysis are not geographically distributed along all national borders of the Member States. For this reason, the results presented in this section and in the following sections should not be considered representative of the overall picture in Europe. In future editions of this report, it will be possible to generate additional findings, for example by comparing year-on-year changes in individual border sections in order to monitor the evolution of traffic volumes over time.

Traffic across the selected border sections in 2021 varied from 225 to more than 32 500 freight trains per year (i.e. from 1 to around 90 per day) and from more than 1 500 to almost 55 000 passenger trains per year (i.e. from 4 to 150 per day); crossing volumes are significant for some sections but quite limited in other areas. The variance in traffic volumes across the selected border sections may reflect not only possible limitations to interoperability but also different demand levels, capacity and/or operational planning. As this is the first time we have published this indicator, no temporal trend analysis is yet possible (to evaluate the possible progress/variation for selected border areas).

### **Sources and limitations**

Data are collected by RNE automatically from the TIS, following the results of the RNE border section project. The border sections vary in length from 10 to 30 km, covering both sides of the geographical border between two Member States and all major points where procedures related to border crossing normally occur. Only a sample of the 250 border crossing points analysed for the SERA network (i.e. the 31 border crossing points with the best data quality) was used to obtain the figures provided. Detailed reliability checks were carried out by RNE with experts from its member IMs in order to provide the best sample of data. The number of borders considered is expected to increase in the coming years (thanks also to ongoing initiatives by RNE to improve data quality). The current dataset does not cover all European border crossing points and therefore the results should not be considered a picture of the overall situation in Europe; however, data coverage is expected to increase in the coming years.

International trains may have two unlinked train numbers (i.e. an international train may have a different national train number on each IM network section). If the two numbers are unlinked, both are counted in this indicator (i.e. there is potential error due to double counting). In the future, improvements in linking train numbers (e.g. through the full implementation of the TAFTSIs train ID concept and/or based on the train composition message) could lead to a decrease in the number of international passenger/freight trains at selected border stations (such a reduction in traffic volumes may be driven by improved data quality, eliminating double counting, and not by an actual decrease in rail traffic).

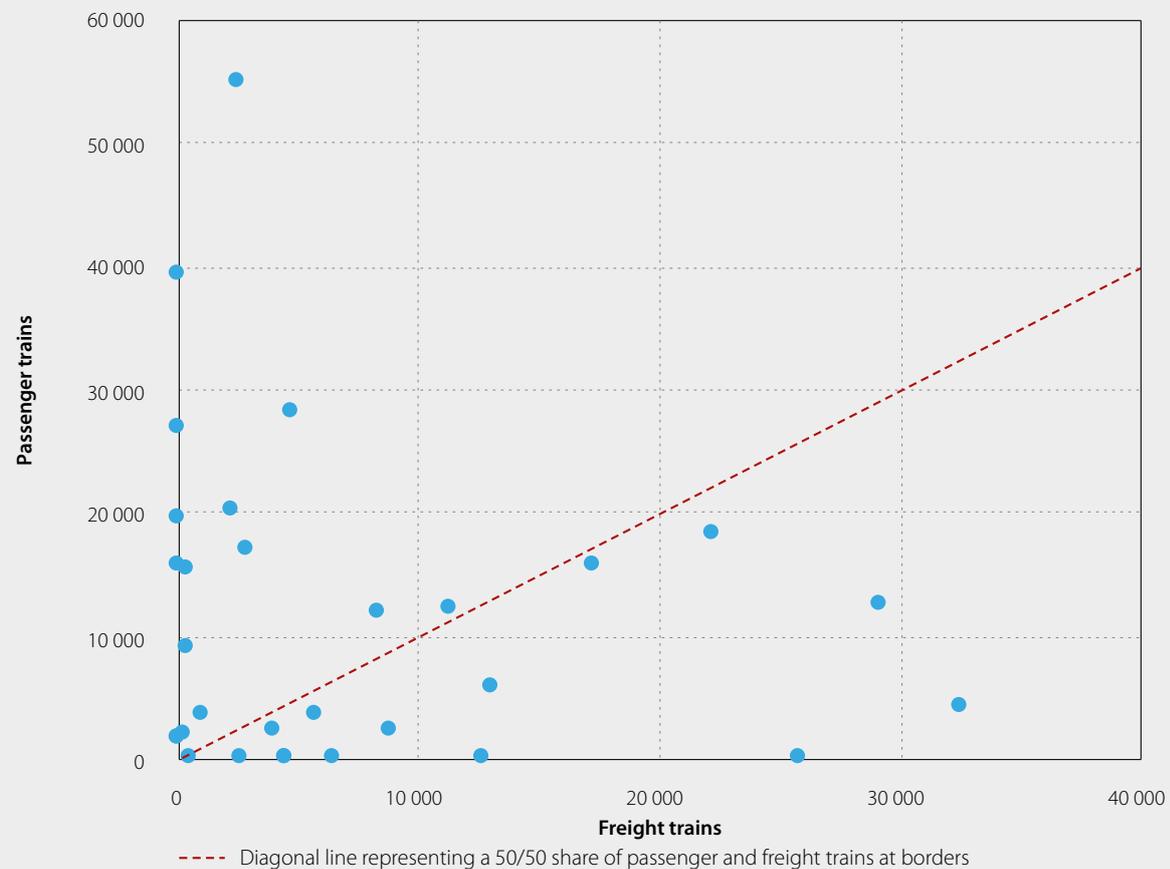
**Figure B-3:** Border crossing points included in the analysed dataset (location and border ID)



Source: RNE TIS.

**Figure B-4:** Number of (freight and passenger) trains crossing the selected border sections (2021)

Yearly number of freight and passenger trains crossing the border sections in 2021



Note: Number of cross-border passenger trains partly decreased during 2020 and 2021 due to COVID related restrictions (e.g. CBP ID 9); Border IDs 189 - traffic restrictions due to major construction works

Source: RNE TIS.

## **B-3** Transfer time of international trains at selected border sections

### **Purpose**

Seamless train operation across national borders is one of the main goals of an interoperable railway system. The regular monitoring of transfer time at border sections may provide an indication of the development of rail interoperability across Europe year on year. Border section transfer time is considered a suitable (dwell time-related) indicator for policy advice. However, long transfer/dwell times are possible for several reasons: change of locomotive, change of crew, operational choices of RUs, lack of availability of immediate train paths on following infrastructure, capacity constraints, engineering works, the administrative burden of train handover or checks at borders (breaking tests, national rules, customs, etc.).

### **Indicators**

The metrics proposed focus on the variance of planned and real transfer times (including running and dwell times) at selected border sections (measured in minutes), calculated based on data from the RNE TIS, following the results of the RNE border section project. The figures presented are calculated as averages (over 2021) weighted on the yearly number of trains at each location. The section transfer time represents a compatible measurement for all borders with a focus on the total time that a train spends in the border section area. The main focus of the analysis is on the difference between planned transfer time and real transfer time, to identify the operational obstacles causing transfer times that are longer than planned. In the future, if/once data for more years become available, it could be interesting to analyse the year-on-year variations in the transfer time for selected border sections, in order to monitor the progress over time in every location.

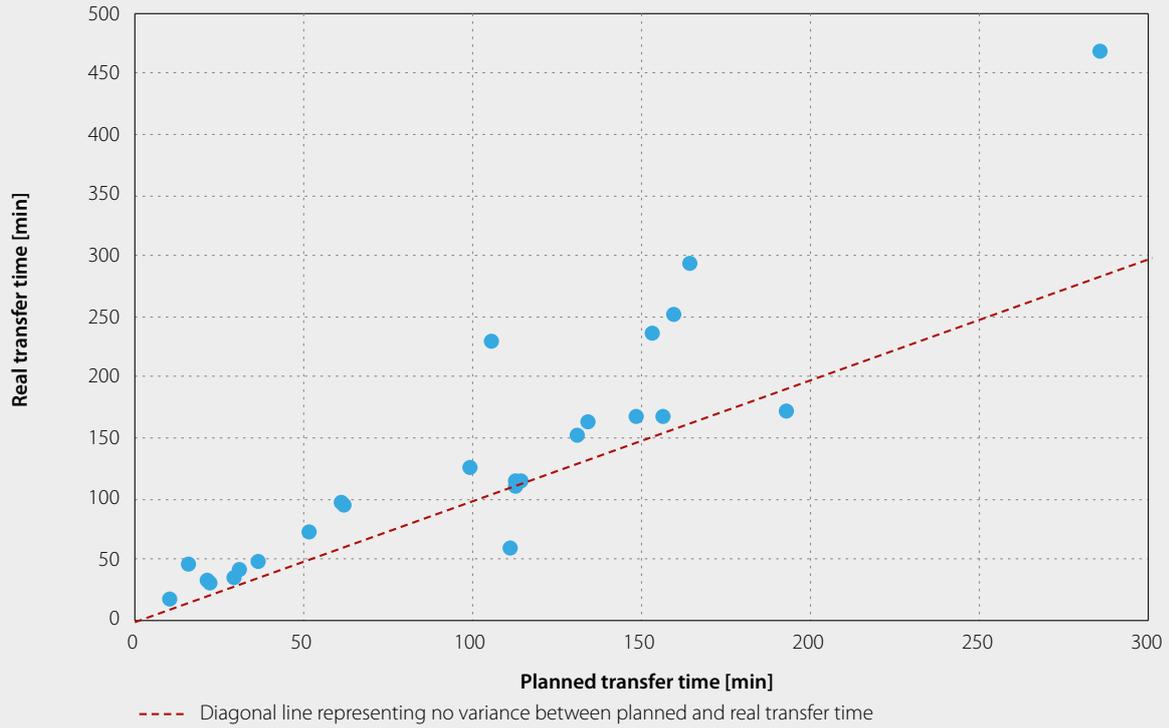
### **Findings**

For the majority of the analysed border sections, the average real transfer time in 2021 was higher than the planned transfer time for both freight and passenger trains; in many border areas this difference was trivial, while in some cases (especially for freight) it appeared to be more marked. For all but one of the 18 border sections with both freight and passenger train crossings reported, the transfer time for freight is (significantly) higher than the transfer time for passengers. As this is the first time we have published this indicator, no temporal trend analysis is yet possible (to evaluate the possible variations for selected border areas). Benchmarking the difference in transfer time across the border points should not be the focus of the analysis, as the underlying causes of extended running and dwell times are not directly available, and may not reflect the limitations to interoperability stemming from the physical or regulatory constraints. The different border sections may have high or low transfer times depending on the sections' length, type of traffic, geography and infrastructure design, among other things, as well as, for example, possible necessary changes of technical systems (e.g. locomotive and/or crew). In addition to technical conditions, commercial aspects can influence transfer time. In some instances, the constraints would reflect operations planning and notably capacity restrictions. For these reasons, the indicator can be only a proxy measure of interoperability.

### **Sources and limitations**

Data are calculated by RNE based on data from the RNE TIS and following the results of the RNE border section project. The border sections vary in length from 10 to 30 km, covering both sides of the geographical border and all major points where procedures related to border crossing normally occur. Only a sample of the 250 border crossing points analysed for the SERA network (i.e. the 31 border crossing points with the best data quality) was used to obtain the figures provided. Detailed reliability checks were carried out by RNE with experts from its member IMs in order to provide the best sample of data for as many borders as possible. The current dataset does not cover all European border crossing points and therefore the results should not be considered a picture of the overall situation in Europe; data coverage is expected to increase over time. To evaluate the planned and real times, only cross-border trains with the same train number on both sides of the border or trains with linked numbers were considered; given the possible cases of unlinked trains, the actual traffic volumes at the borders may be slightly higher than the volumes considered.

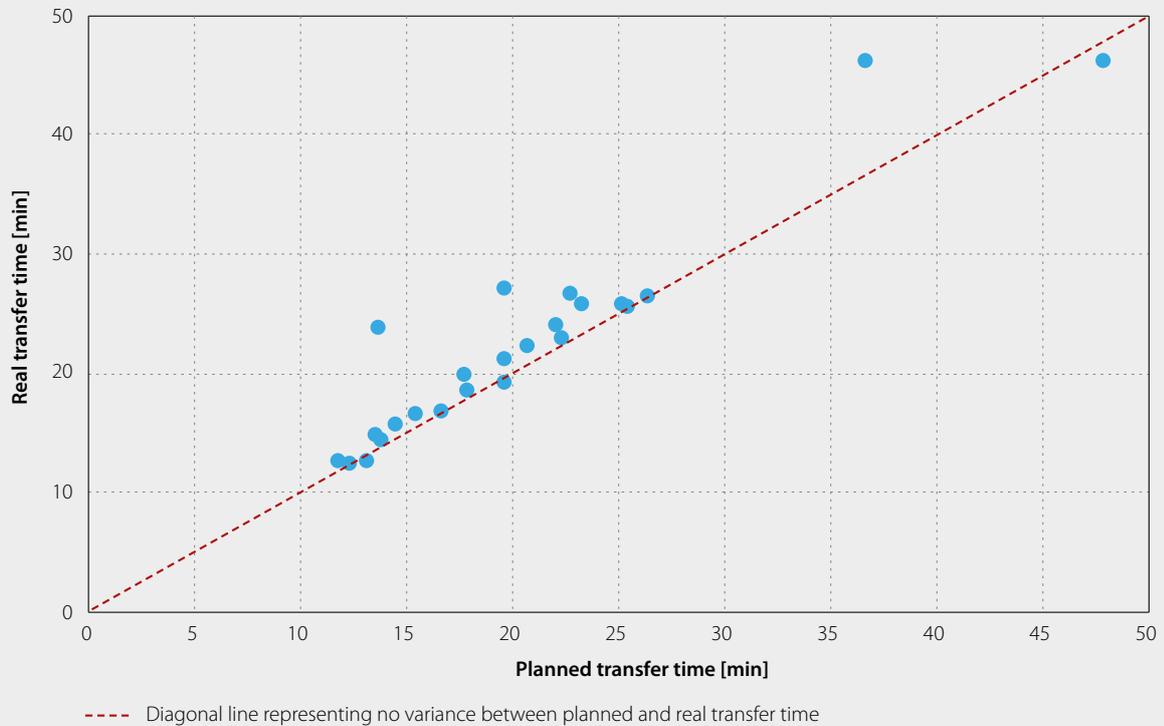
**Figure B-5:** Planned and real transfer times at selected border sections (international freight trains, 2021)



Note: For some borders incorrect or missing data may influence the figures; only a limited sample of trains (compared with all trains crossing the border) was considered for calculations (owing to the issue of unlinked trains)

Source: RNE TIS.

**Figure B-6:** Planned and real transfer times at selected border sections (international passenger trains, 2021)



Note: For some borders incorrect or missing data may influence the figures; only a limited sample of trains (compared with all trains crossing the border) was considered for calculations (owing to the issue of unlinked trains)

Source: RNE TIS.

## **B-4** Punctuality of international trains at selected border crossing points

### **Purpose**

Monitoring the performance of cross-border trains in terms of punctuality may provide a further indication of the quality/constraints of train operations across national borders. The difference between entry and exit punctuality at the selected border sections may help to identify possible delays accumulated during rail operations in the considered sections' areas.

### **Indicators**

The metrics proposed focus on the difference between the entry and exit punctuality at selected border sections, as defined for policy advice within the RNE border section project. Entry and exit punctualities are measured as percentages of trains arriving in or leaving the border section with a delay of less than 30 minutes for freight trains and less than 5 minutes for passenger trains. The figures are calculated as averages (over 2021) weighted on the yearly number of trains considered at each location. Given that in some cases trains may change number once they cross borders and therefore may not be captured in the available dataset (i.e. unlinked numbers), the real traffic volumes at the borders could be higher than the figures considered. In the future, once data for more years become available, it could be interesting to analyse the year-on-year variation at selected border sections, in order to monitor progress over time.

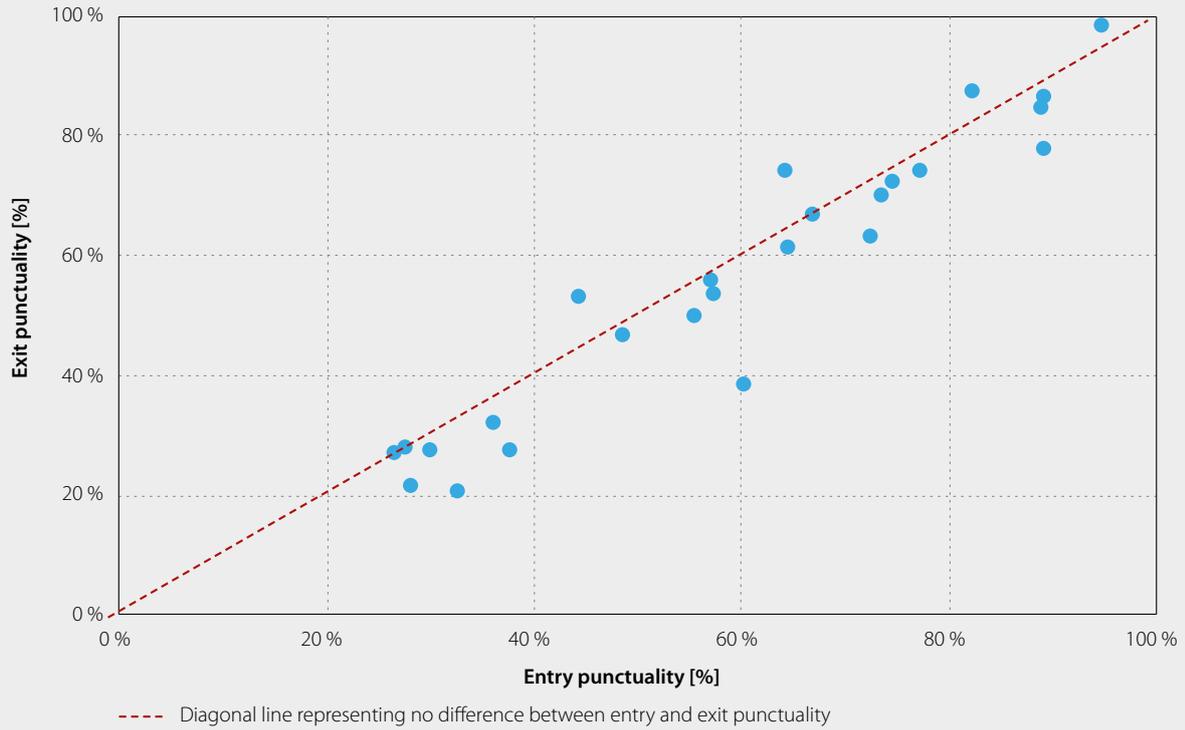
### **Findings**

On average (for 15 out of the 18 border sections with both freight and passenger train crossings reported) the punctuality of freight trains appears to be lower than the punctuality of passenger trains; the difference between entry and exit punctuality is more than 11 % in eight border sections for freight services and in five border sections for passenger trains.

### **Sources and limitations**

Data are calculated by RNE based on data in the RNE TIS and following the results of the RNE Border section project. The border sections considered vary in length from 10 to 30 km, covering both sides of the border and all major points where procedures related to border crossing normally occur. Only a sample of the 250 border crossing points analysed for the SERA network (i.e. the 31 border crossing points with the best data quality) was used to obtain the figures provided. Detailed reliability checks were carried out by RNE with experts from its member IMs in order to provide the best sample of data for as many borders as possible. The current dataset does not cover all European border crossing points and therefore the results should not be considered a picture of the overall situation in Europe. The number of borders considered and the data coverage are expected to increase over time (also thanks to ongoing initiatives by RNE to improve data quality).

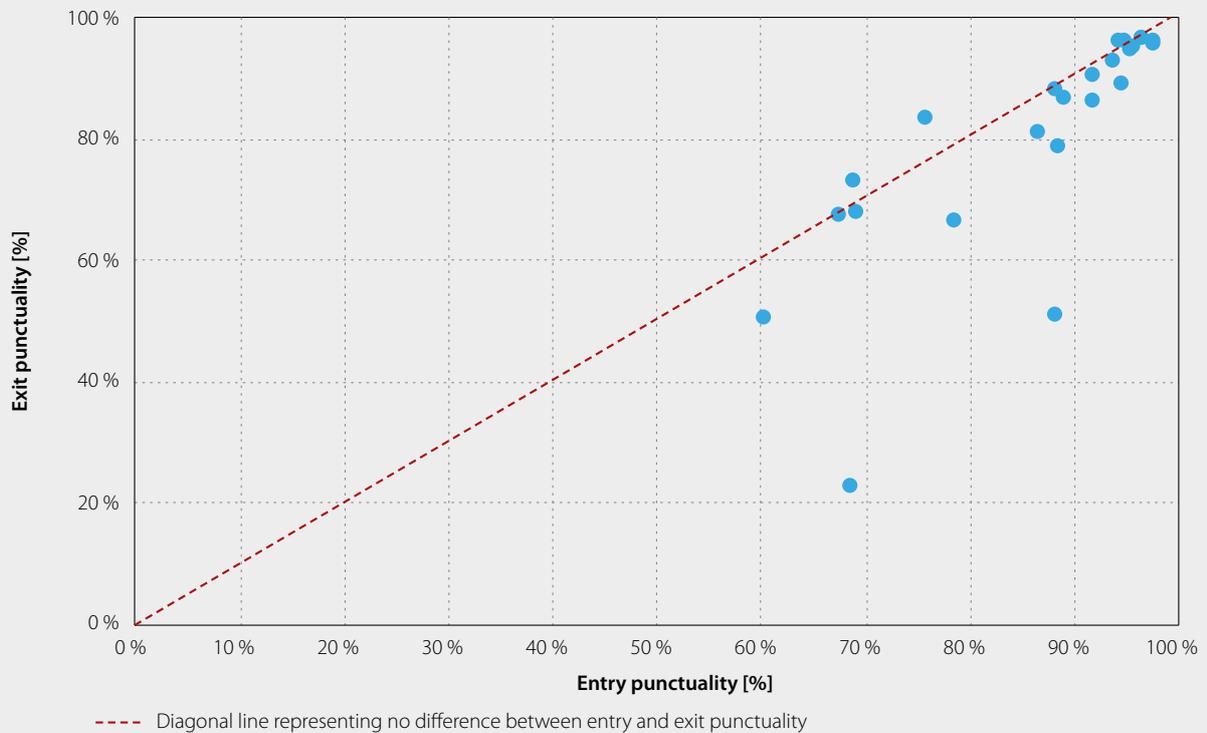
**Figure B-7: Entry and exit punctuality at selected border sections (international freight trains, 2021)**



Note: For some borders incorrect or missing data may influence the figures; only a limited sample of trains (compared with all trains crossing the border) was considered for calculations (owing to the issue of unlinked trains)

Source: RNE TIS.

**Figure B-8: Entry and exit punctuality at selected border sections (international passenger trains, 2021)**



Note: For some borders incorrect or missing data may influence the figures; only a limited sample of trains (compared with all trains crossing the border) was considered for calculations (owing to the issue of unlinked trains). In 2021, COVID-19 measures affected the punctuality of passenger trains in some border sections (e.g. border crossing point 9)

Source: RNE TIS.

## **B-5** Implementation of technical specifications for interoperability concerning telematics applications for passenger services

### **Purpose**

The TAP TSIs were introduced to facilitate the harmonisation/standardisation of procedures and data and the exchange of messages between the computer systems of multiple railway companies and of independent ticket vendors in order to provide reliable information to passengers and to enable the issue of tickets for journeys across the EU railway network. Furthermore, data exchange between the RUs and IMs is standardised in order to make information to passengers on connections, delays, transport of persons with reduced mobility (PRMs) and disruptions, among other things, more accurate, supporting the requirements concerning the passenger information of the rail passenger rights regulation (Regulation (EU) 2021/782).

The implementation of TAP by RUs and IMs is under way in the EU. The railway operators have been gradually integrating TAP standards into their IT systems. In a first step, the governance functions were set up by a European entity, the TAP TSI Services Governance Association and are available since 2019. This entity provides central services for the European RUs. The RUs have implemented specific functions for retail as well for communication between them and the IMs.

### **Indicators**

The indicator used to monitor progress on the implementation of TAP TSI-specific functions by the railway sector is the share of operators that have implemented a certain TAP function in their IT systems, weighted by train-km on a European scale. The target value for the indicator is to implement 100 % of the individual functions, as communicated in the TAP TSI master plan, which sets the deployment schedule for the RUs.

### **Findings**

The degree of implementation of single functions by operators varies considerably among functions, but in general implementation is progressing very slowly; the average value for TAP functions is now above 50 %. With the exception of the function providing for car carriage reservation requests and two specific tariff-related functions, all functions have already been implemented in more than 50 % of the market. The highest degree of implementation is for timetable data provision (73 %) and for the acceptance of paper tickets in international and foreign sales (65 %).

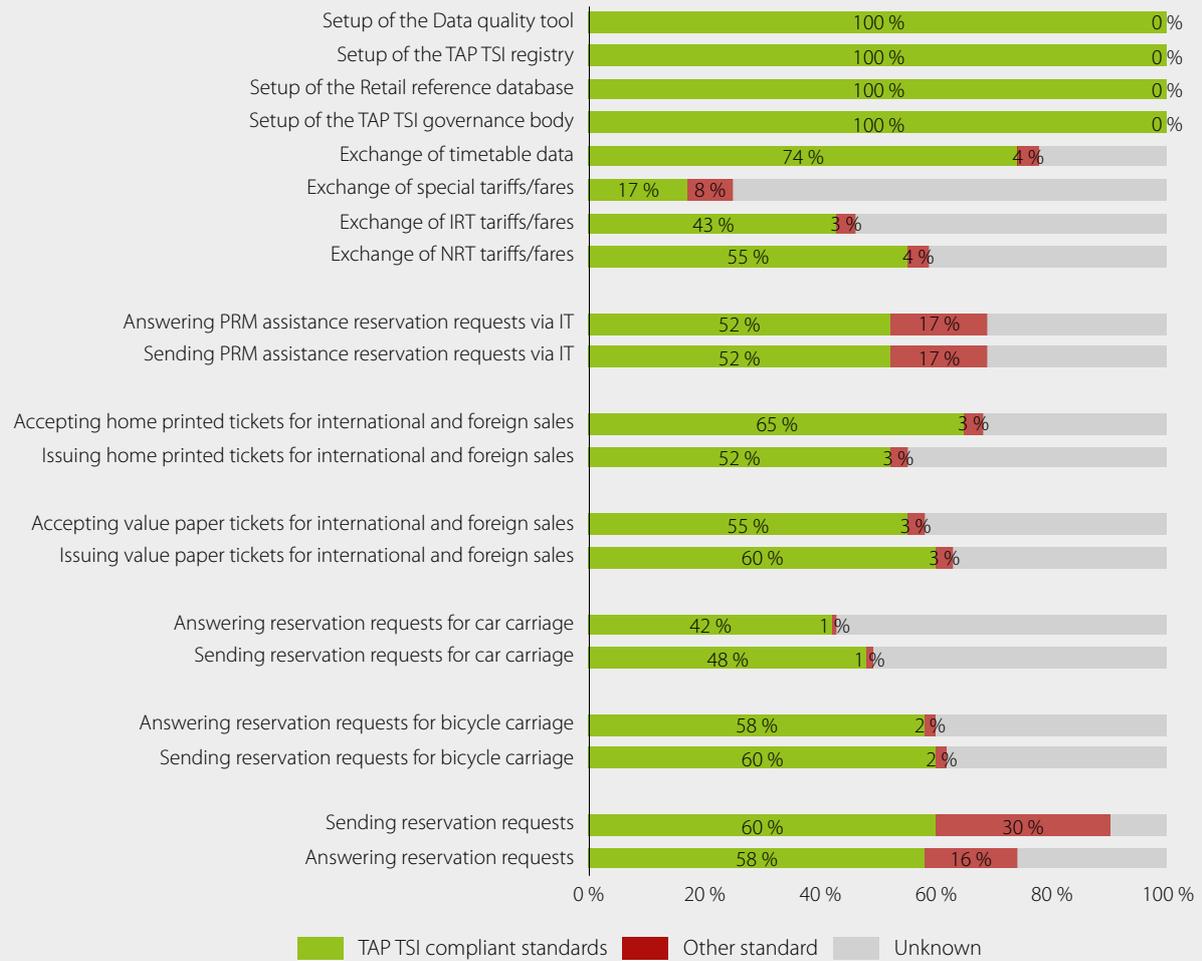
A specific Implementation Cooperation Group led by ERA and involving the sector and the national contact points was set up to collect data on the implementation of the TAP TSIs. The group developed a dedicated tool that allows RUs and IMs to report once a year on the degree of implementation of specific TAP TSI functions. Data provided by RUs and IMs have a good degree of reliability. While analysing the trends in the deployment of the functions, attention should be paid to the fact that the population of respondents may not be identical across various reporting periods.

Overall, it has to be considered that the implementation of TAP TSI functions is mainly in place for the incumbent RUs, whereas for new-entrant RUs less progress has been achieved so far.

### **Sources and limitations**

A regular survey of railway operators (RUs and IMs) is carried out in a coordinated way, using a fixed methodology. Being a survey, the quality of statistical estimates depends on the response rate.

**Figure B-9:** Degree of implementation of TAP functions (end of 2020)



Note: IRT, integrated reservation tickets; NRT, non-integrated reservation tickets

Source: TAP surveys of RUs and IMs carried out by ERA.

## **B-6** Implementation of technical specifications for interoperability concerning telematics applications for freight services

### **Purpose**

The TAF TSIs set the functional and technical standards for exchanging harmonised information between IMs, RUs, terminal operators, wagon keepers and other identifiable stakeholders involved in the freight service.

After years of design and development, implementation by the RUs and IMs is under way in the EU. The railway operators have been gradually integrating TAF standards into their IT systems in line with national implementation programmes.

### **Indicators**

The indicator used to monitor progress with the implementation of TAF TSI-specific functions by the railway sector is the share of operators that have implemented the TAF functions, based on the results of a regular survey carried out among the three major types of organisations carried out by the Implementation Cooperation Group.

### **Findings**

The degree of implementation of single functions by operators varies considerably among functions, but only two functions (company codes and rolling stock reference database) have been fully implemented by more than 65 % of respondents.

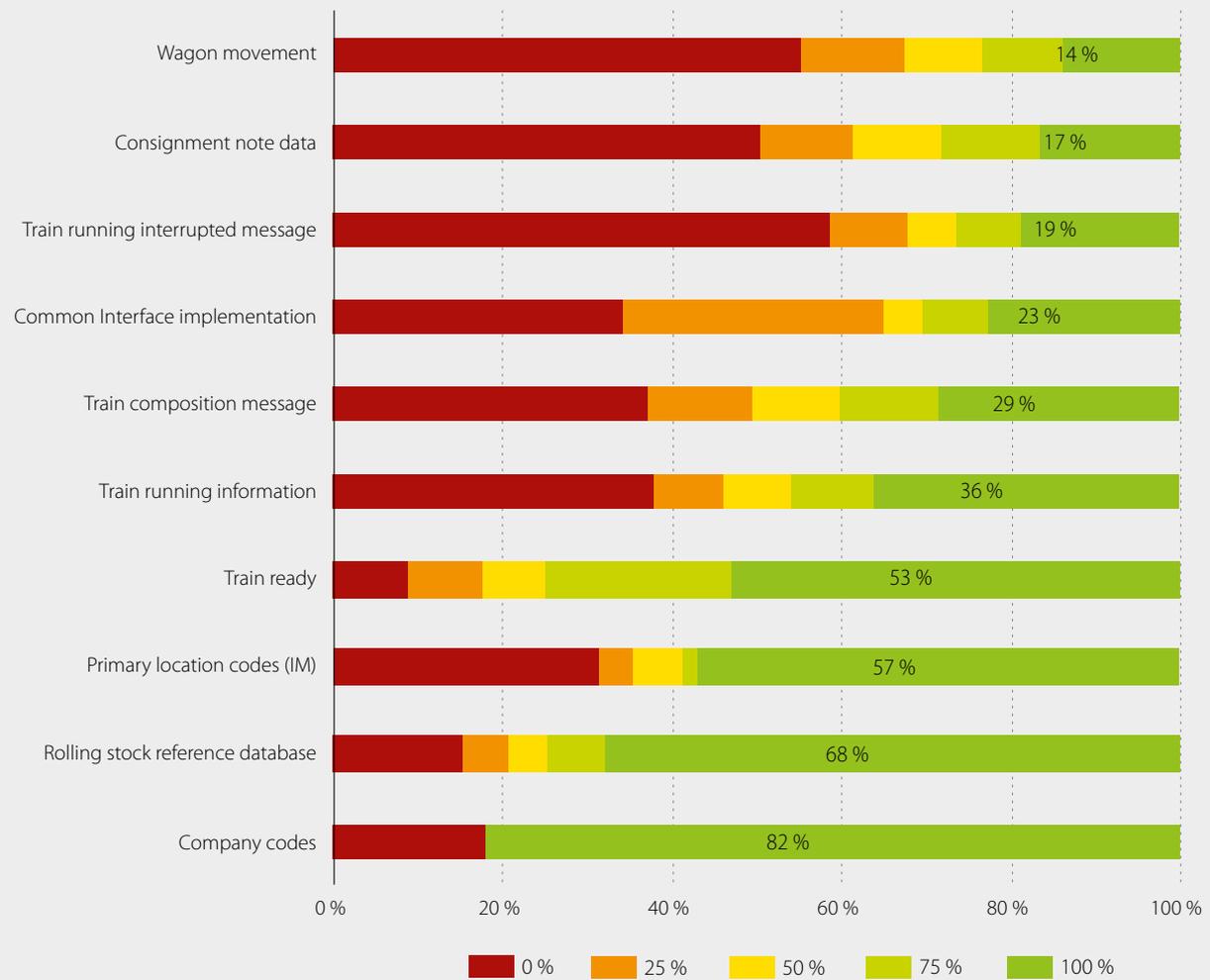
The higher implementation rate amongst IMs, combined with their potential to drive the TAF TSI implementation process forward, should encourage RUs to catch up in the near future. The deployment of IM-specific functions at European rail freight corridor (RFC) level is relatively good for most of the corridors.

A revision of the TAF TSIs is now under way. The revised version is aimed at enhancing multimodal links through further involvement of ports and terminal operators in the TAF TSIs as well as the inclusion of combined transport operators. This would translate into an accelerated modal shift triggered by a significant increase in the implementation of some functions, such as train preparation, train running information and train running forecasts.

### **Sources and limitations**

A specific Implementation Cooperation Group led by ERA and involving the sector and the national contact points was set up for the purpose of collecting data on TAF TSI implementation. The group developed a dedicated survey that allows RUs, IMs and wagon keepers to report once a year on the degree of implementation of specific TAF TSI functions. Although not all organisations respond, the number of respondents has grown steadily year by year and the degree of representativeness of the data sample is relatively high, as the responding organisations represent major players in the railway market. For this reason, while analysing the trends in the deployment of the functions, attention should be paid to the fact that the population of respondents may not be identical across various reporting periods.

**Figure B-10:** Degree of implementation of TAF functions (end 2020)



Source: TAF surveys of RUs, IMs and wagon keepers by the Implementation Reporting Group of the TAF Joint Sector Group.

## **B-7** Train drivers with a European Union licence

### **Purpose**

The EU train driver licence is a means of facilitating cross-border operations and labour mobility. It is obtained and maintained based on the common requirements valid in all Member States for all train drivers involved in train operation covered by the RSD. It was introduced by the TDD, which foresees its gradual implementation in the EU Member States. Since October 2018, all train drivers in Europe have been required to hold a licence, in conformity with the TDD. They also need to be certified by the RU for the rolling stock and infrastructure that they can operate on. This is part of the RUs' safety management system.

### **Indicators**

The indicator used to measure the implementation of the EU train driver licence scheme is the number of train drivers with a valid EU licence.

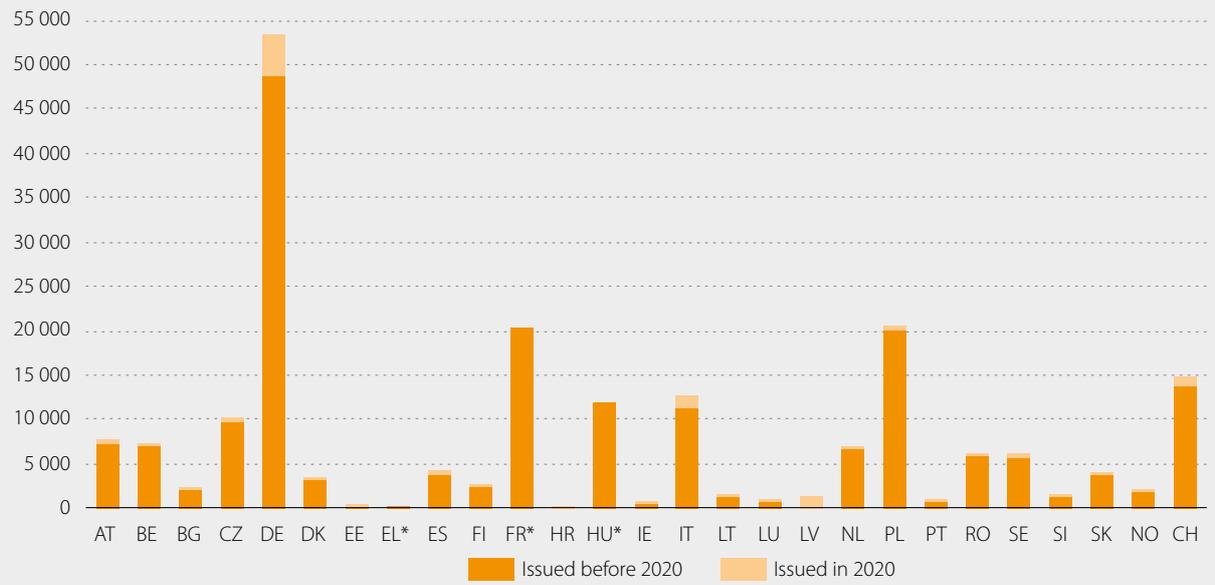
### **Findings**

The number of train drivers licensed in line with the TDD requirements has been increasing steadily in recent years; despite a small delay, at the end of 2020 the implementation of the EU certification scheme appeared to be complete in all Member States. According to the data provided by the NSAs, there were more than 200 000 train drivers with a valid EU licence in the EU-27, Norway and Switzerland by the end of 2020; this number varies significantly among countries owing to the difference in the sizes of their railway sectors.

### **Sources and limitations**

The data on the total number of train drivers licensed in accordance with the TDD are provided by the NSAs in each Member State, who are the licensing authority. Although the quality of these data can be considered satisfactory, inconsistencies are possible (e.g. as the underlying data were not available in the case of three Member States, values from 2019 were used, that is from the previous NSA survey).

**Figure B-11: Train drivers with an EU licence per country (EU-27 + CH + NO, end 2020)**



Note: (\*) Data as of end 2019 (from the survey of NSAs in 2020)

Source: Survey of NSAs in late 2021.

## **B-8** Railway stations accessible to persons with reduced mobility

### **Purpose**

There are over 100 million persons with disabilities living in the EU <sup>(9)</sup>. An additional 50 million Europeans have reduced mobility due to disability, age or pregnancy <sup>(10)</sup>. They often avoid taking the train because of physical barriers that are present at the railway stations. The PRM TSI specifies that all EU Member States should work towards improving the accessibility of their rail systems for persons with disabilities and PRM. More specifically, all Member States are required to develop and endeavour to put into practice a national implementation plan setting out how they will progressively eliminate all identified barriers to accessibility across the rail network. These plans were to be submitted to the European Commission by January 2017.

### **Indicators**

Stations may have various degrees of accessibility to PRM. The indicators used to measure the degree of accessibility are the share of railway stations compliant with the PRM TSI requirements and the share of accessible stations. Full TSI compliance means full conformity with the PRM TSI requirements, as demonstrated by a notified body (NoBo) certificate. Partial TSI compliance means conformity with some (but not all) PRM TSI requirements, as demonstrated by the NoBo certificate. An accessible station means a station considered accessible under national legislation (i.e. no NoBo certificate is available).

### **Findings**

According to the data supplied by the NSAs, by the end of 2020 there were at least 131 stations with full TSI compliance, and 212 stations with partial TSI compliance. At EU level, around 2 % of all reported stations are fully TSI compliant, and around 3 % are estimated to be partially TSI compliant. An additional 31 % of all stations offer step-free access to platforms and are considered accessible under national legislation.

### **Sources and limitations**

The quality of the data used to produce these estimates is currently limited: there are sometimes inconsistencies in the data on railway stations available from various sources, and their classification as per the categories above is a relatively new concept, not yet properly implemented in all national data.

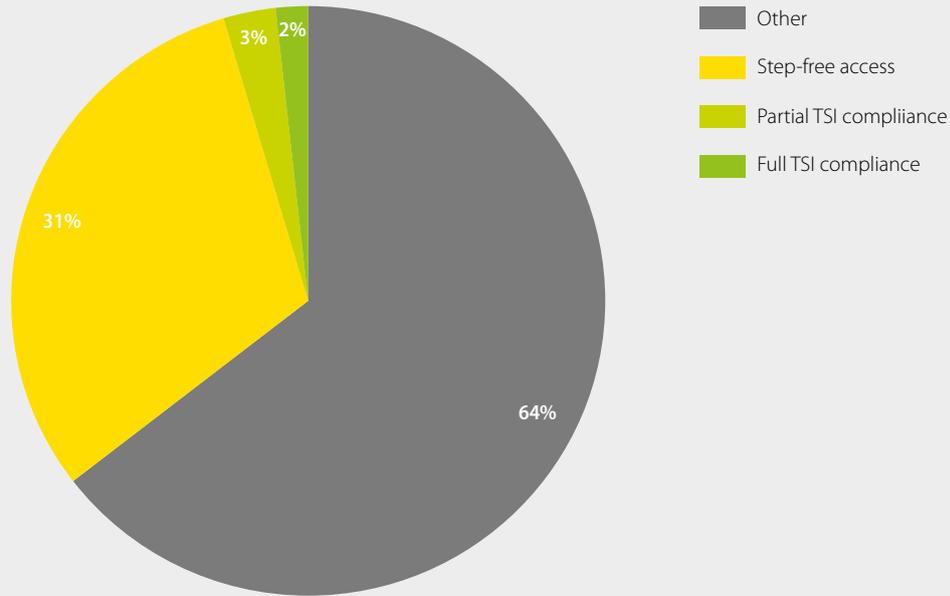
Substantial differences exist among Member States. The most progressive countries seem to be the smaller ones, often located in Eastern Europe. The available data further demonstrate the need for an ever closer monitoring of progress towards the goal of mobility for all. For this report, data were available for 17 EU Member States.

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<sup>(9)</sup> Source: [European Disability Forum](#) (accessed 15 March 2020).

<sup>(10)</sup> Study: Railway costs and benefits data collection (ERA 2017 38 RS) by INECO-Ecorys.

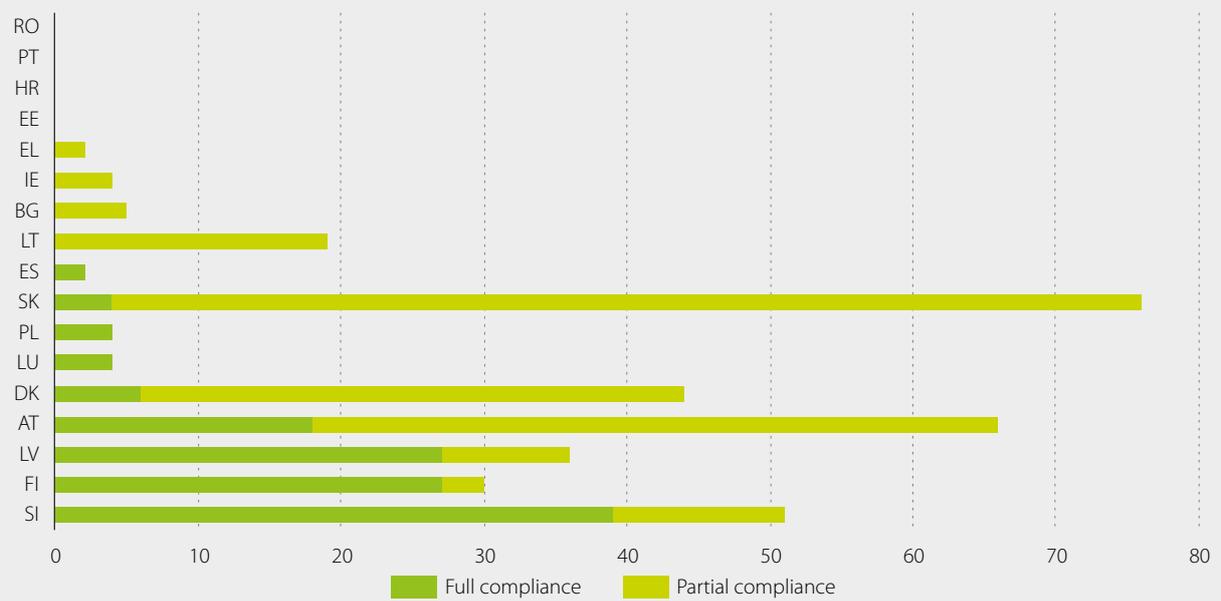
**Figure B-12:** Railway stations per type of PRM accessibility (17 EU Member States, end 2020)



Notes: ERA estimates based on sample data from 17 EU countries  
 Source: Survey among NSAs carried out by ERA at the end of 2021.

**Figure B-13:** Railway stations accessible to PRMs by EU Member State (end 2020)

PRM-TSI compliant stations



Source: Survey among NSAs carried out by ERA at the end of 2021.

## **B-9** Non-applications of fixed installation-related technical specifications for interoperability

### **Purpose**

A number of legal grounds specified in Article 7(1) of the railway interoperability directive (Directive (EU) 2016/797) allow the non-application of TSI requirements, if a particular sub-system cannot fulfil all TSI requirements. This is often applicable to projects at an advanced stage when a new TSI comes into force. As each category of TSIs specifies transition rules (the control and command signalling (CCS) TSIs introduced transitions after their amendment in 2019), most ongoing projects can still apply previous requirements during a certain period without requesting a non-application.

Article 7(1)(a) gives Member states the possibility to grant a non-application that will need to be verified by the European Commission. However, certain justifications require a positive assessment by the European Commission (e.g. Article 7(1)(e) on isolated networks) and ratification by the Committee on the interoperability and safety of the European rail system (e.g. Article 7(1)(c) on economic viability).

Non-applications of fixed installation-related TSIs may represent technical barriers. In general, the lower the number of non-application requests, the higher the level of interoperability of the EU railway system. Nevertheless, the procedure set out in Article 7 of the railway interoperability directive aims to achieve a balance between exceptional but justified non-applications to guarantee the feasibility of the projects while ensuring the highest possible level of interoperability.

### **Indicators**

The indicator used here is the number of non-application requests (INF, ENE, SRT, PRM and CCS trackside) submitted by Member States under the previous railway interoperability directive (Directive 2008/57/EC) and the current railway interoperability directive. All requests for non-applications received by the European Commission are counted (except those that were rejected). They concern general infrastructure projects and apply to either a single railway line or an area of a network depending on the geographical scope of the request.

### **Findings**

The non-applications of fixed installation-related TSIs most frequently concern the CCS TSIs and refer to the requirements of the 2008 interoperability directive. From July 2020 onwards all non-applications are based on the 2016 interoperability directive. Several non-applications of the CCS TSIs since 2017 may concern on-board unit (OBUs) of rolling stock and not fixed installations.

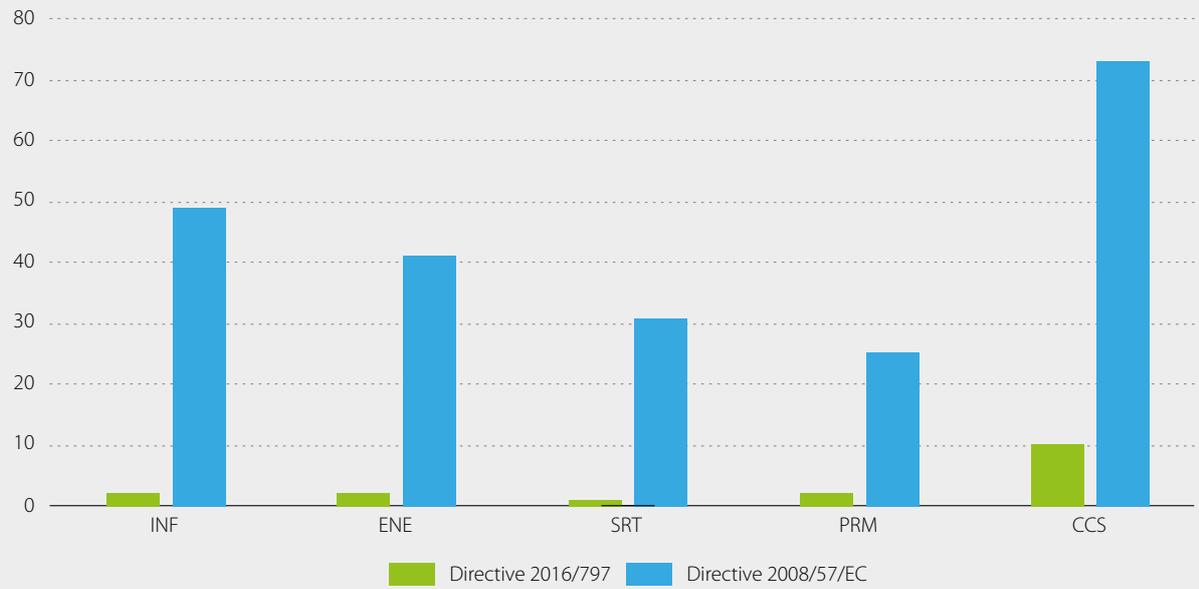
On average, 17 non-application requests have been received each year since 2008. There was a substantial increase in requests in 2017, most likely linked to the recast of the relevant TSIs; the annual number of requests has decreased since then.

### **Sources and limitations**

While an analysis per Member State is not shown in this report, the data show that non-applications are submitted by many Member States. Interestingly, in a few cases, some countries but not others have made non-application requests in relation to the same project, despite the fact that the railway interoperability directive (Article 7) requires applications to be made on an individual national basis. The data are directly retrieved from an internal database of the European Commission (Directorate-General for Mobility and Transport), where all submitted non-applications requests are recorded. Their quality is considered satisfactory for the given purpose.

**Figure B-14:** Non-applications of fixed installation-related TSIs (EU-27 + UK, end of 2021)

TSI INF, ENE, SRT, PRM, CCS

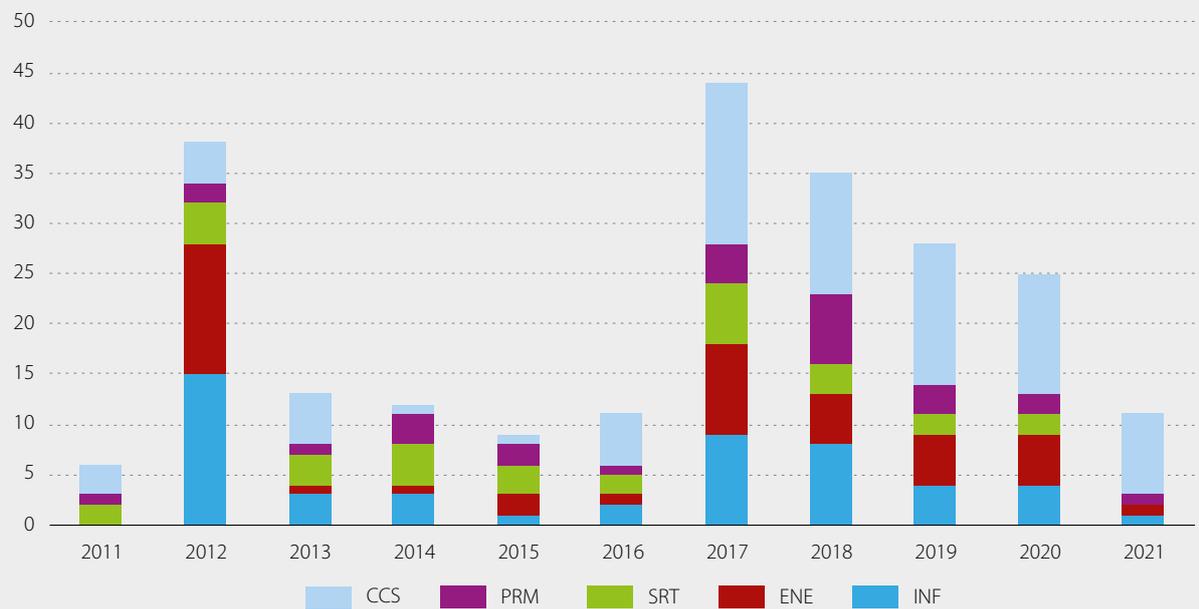


Note: From July 2020, all non-applications are based on Directive (EU) 2016/797

Source: Directorate-General for Mobility and Transport internal database.

**Figure B-15:** Non-applications of fixed installation-related TSIs per year (EU-27 + UK, 2011–2021)

TSI INF, ENE, SRT, PRM, CCS



Source: Directorate-General for Mobility and Transport internal database.

## B-10 ERTMS trackside deployment

The ERTMS is intended to replace legacy TPSs and is designed to replace the many incompatible safety systems currently used by European railways. It will allow an interoperable railway network in Europe, while providing additional benefits in terms of increased operational efficiency, capacity and safety. Although ideally all core/comprehensive networks<sup>(11)</sup> in the EU would be equipped with the system, emphasis has been put on nine CNCs, with a view to maximising the return on investment. The long-term target adopted by the European Commission is to have the whole core trans-European transport network equipped with the ERTMS by 2030 and the whole comprehensive network equipped by 2050<sup>(12)</sup>.

### Indicators

The indicators used are the length of lines equipped with the ERTMS (per Member State and per level) and the share of lines equipped with the ETCS and the Global System for Mobile Communications – Railway (GSM-R) (the two components of the ERTMS<sup>(13)</sup>) on the CNCs.

### Findings

The deployment of the ETCS on the EU railway network has been slow so far; it currently stands at about 10 100 km of railway lines in the EU-27 (on the whole network). Deployment varies considerably among the Member States, reflecting national rail transport policy and investment priorities. According to records in the RINF, the leading implementers (in terms of kilometres of all lines equipped with the ETCS) are Spain, Belgium and France, followed by Poland and Italy. In the case of the Member States not represented, either ETCS has not been deployed at all or data are missing.

ERTMS deployment on the CNC network had reached 14 % (ETCS) and 60 % (GSM-R) at the end of September 2021. Compared to the 2019 deployment figures, the length of CNC lines with ETCS in operation increased by 2 020 km (3 %) and the length of CNC lines with GSM-R in operation increased by 5 700 km (10 %) (14). However, the length of lines equipped with ETCS doubles when the projects currently under construction are also considered. Nevertheless, with 8 100 km of CNC lines equipped with the ETCS (at the end of September 2021), a substantially greater effort is needed to meet the European deployment plan target of 15 700 km by 2023 and the Trans-European Transport Network guideline<sup>(15)</sup> target of 57 000 km on CNCs by 2030. Progress has been uneven among individual corridors. Progress has been notable in the case of the Rhine–Alpine and the Baltic–Adriatic corridors, with around 29 % of lines (by length) equipped with the ETCS, compared with 10–18 % in other corridors.

### Sources and limitations

The underlying data relating to the entire national rail networks are reported by Member States to the RINF, maintained by ERA, while data relating to the CNCs are provided by the Member States to the European Commission through the European Commission's Information System to coordinate and support the Trans-European Transport Network Policy database under the European deployment plan<sup>(16)</sup>. The quality of the available CNC data is deemed satisfactory. In the case of the RINF, data reliability depends on the extent to which the information provided is up to date and complete; as specified in the term of use, ERA has no responsibility or liability with regard to the information submitted and published in the RINF.

(11) See Regulation (EU) No 1315/2013 (as amended).

(12) The Commission's proposal for a reviewed Trans-European Transport Network regulation aims to accelerate the deployment of the comprehensive network by 2040.

(13) The ERTMS consists of two systems: the ETCS, that is automatic train protection, and the GSM-R.

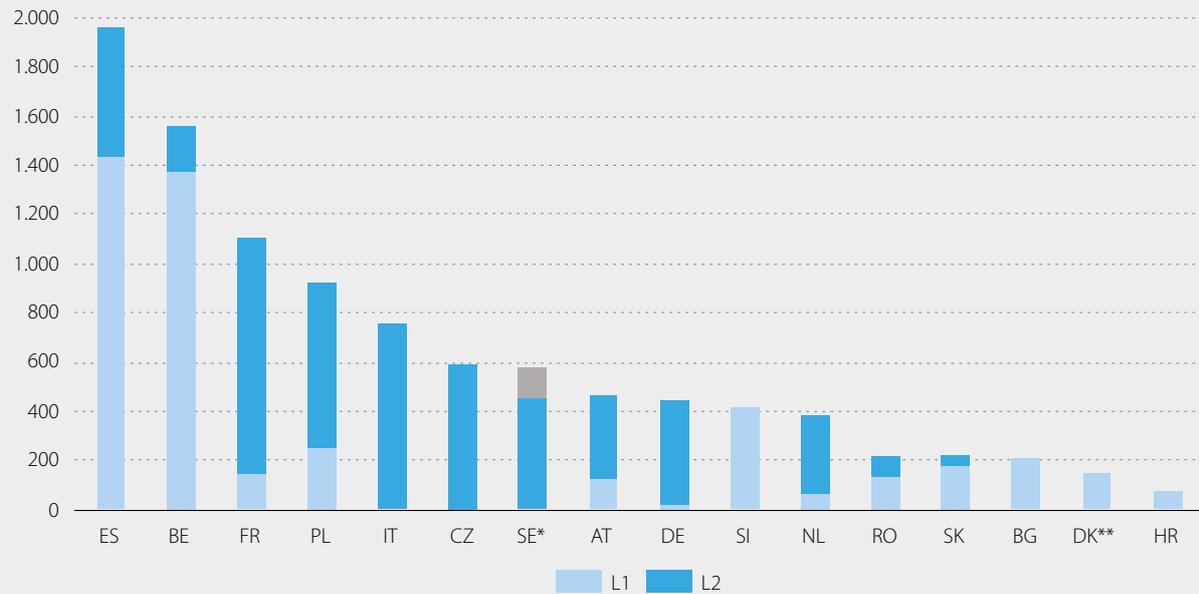
(14) The CNCs' length was increased and the United Kingdom was excluded from CNCs in 2021 by the connecting Europe facility 2 funding programme. See Regulation (EU) No 2021/1153.

(15) See Regulation (EU) No 1315/2013 (as amended).

(16) Commission Implementing Regulation (EU) 2017/6 on the European Rail Traffic Management System European deployment plan.

**Figure B-16:** Length of railway lines equipped with the ETCS (EU-27, end 2021)

Length in kilometers per ETCS level

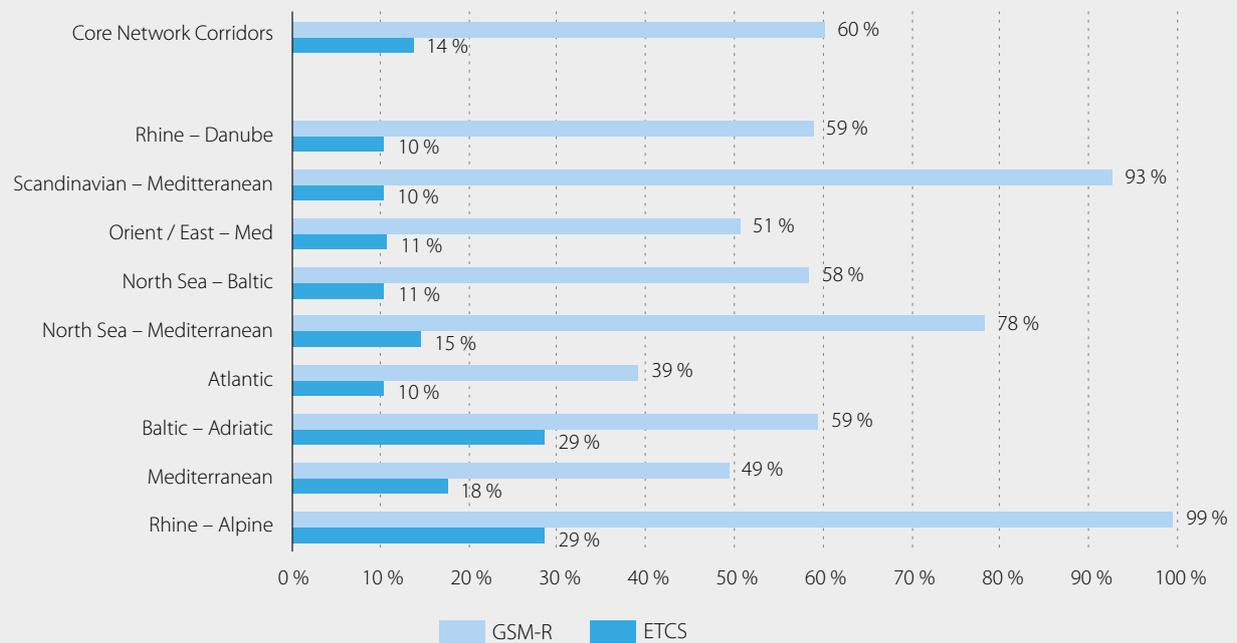


Note: (\*) Grey bar refers to an ERTMS regional solution without a train integrity function implemented on low-traffic lines (<https://www.ertms.net/wp-content/uploads/2021/06/19.ERTMS-in-Sweden.pdf>); (\*\*) Data for Denmark are limited to CNCs

Source: RINF (data extracted on 4 January 2022).

**Figure B-17:** Deployment of the ERTMS on CNCs, (end of September 2021)

ETCS and GSM-R equipped lines among core network corridor lines



Source: DMT / TENtec (Directorate-General for Mobility and Transport).

## **B-11** Non-applications of technical specifications for interoperability related to rolling stock

### **Purpose**

Requests for non-applications of current TSIs for vehicles may reflect technical barriers that hinder migration towards an interoperable target system. They may be triggered by a non-interoperable trackside infrastructure within the area of use of these vehicles.

In general, the lower the number of non-application requests, the higher the level of interoperability of the EU railway system.

### **Indicators**

The indicator used here is the number of requests for non-applications of rolling stock-related TSIs (LOC&PAS, WAG, PRM, SRT, NOI and on-board CCS) submitted by Member States. All requests for the non-application of TSIs received by the European Commission are counted, except those that were rejected.

The indicators represent the non-application of TSIs under Directive 2008/57/EC and Directive (EU) 2016/796.

### **Findings**

There have been 10 non-application requests per year on average since 2008; altogether, 139 requests for non-applications of TSIs were submitted to the European Commission under Directive 2008/57/EC and Directive (EU) 2016/796. The number of requests varies from year to year, with peaks in 2017–2020; there is also quite significant variation across Member States.

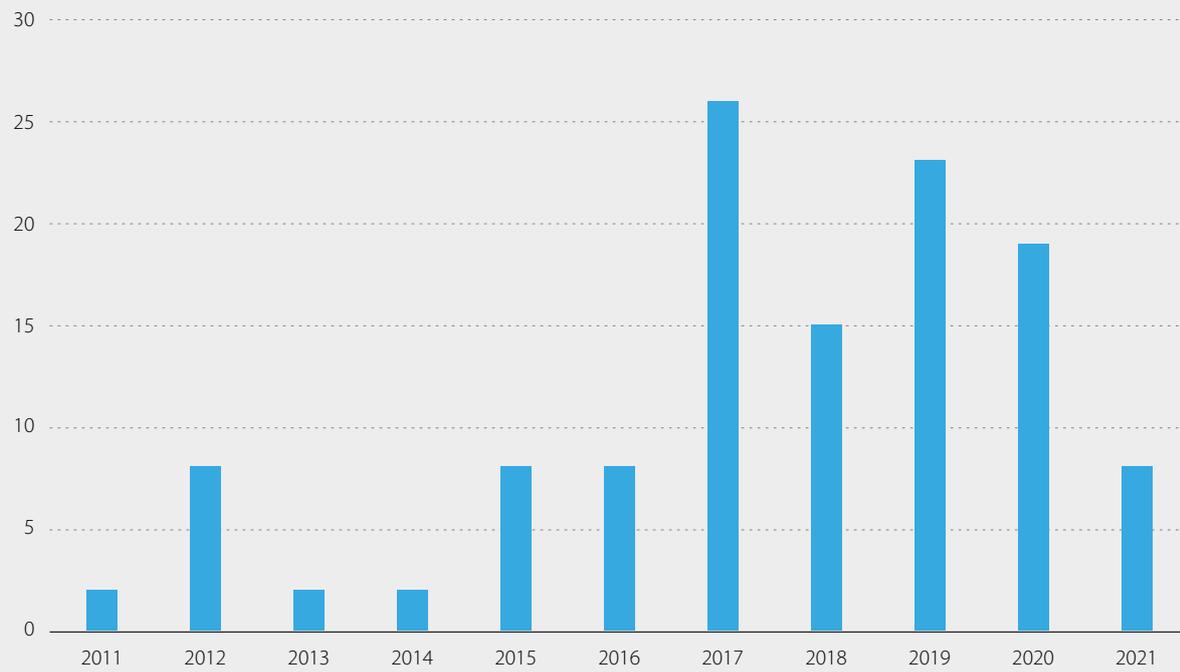
A recent task force organised by ERA focused on creating a harmonised transition and migration framework for all the rolling stock-related TSIs (including on-board CCS), with the aim of reducing the complexity of adopting new TSI requirements for existing projects, which should lead to fewer non-application requests.

### **Sources and limitations**

Non-applications requests are received and processed by the European Commission (Directorate-General for Mobility and Transport), which also keeps track of them through an internal database.

**Figure B-18:** Non-applications of rolling stock-related TSIs (EU-27 + UK, 2011–2021)

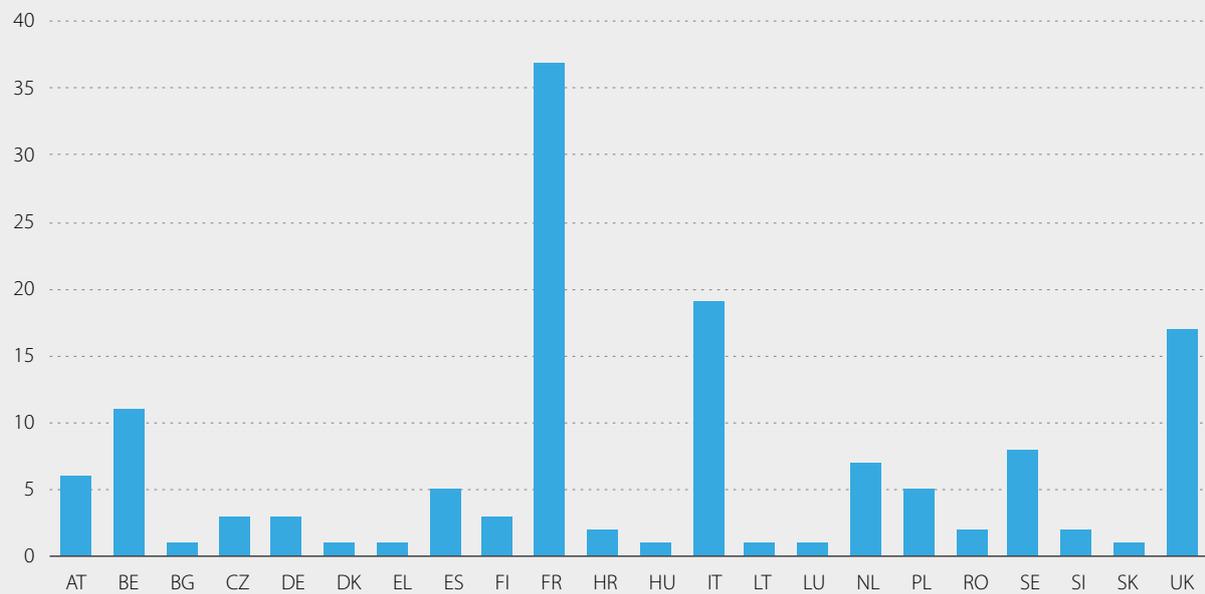
TSI WAG&NOI, LOC&PAS, RST, CCS



Source: Directorate-General for Mobility and Transport internal database.

**Figure B-19:** Non-applications of rolling stock-related TSIs per country (EU-27 + UK, end 2021)

TSI WAG&NOI, LOC&PAS, RST, CCS



Source: Directorate-General for Mobility and Transport internal database.

## **B-12** Applicable national technical rules for vehicles

### **Purpose**

Existing national technical rules can also be technical barriers to the vehicle authorisation process because vehicles have to be compliant with these rules. This is especially the case when the national rules are not notified and assessed against the harmonised TSIs and other applicable EU legal frameworks.

Member States have to notify the European Commission of the national rules; ERA has to assess the national rules. The existence and use of rules that are not notified leads to unnecessary uncertainty and costs, and can affect interoperability. A process of 'cleaning up' the rules is ongoing. The remaining national technical rules should cover only open points in TSIs, specific cases in TSIs, aspects of vehicle compatibility with the network (e.g. class B signalling systems) and other limited cases as set out in Directive (EU) 2016/797. The cleaning-up process ensures that only the relevant rules are published in the publicly accessible Reference Document Database and transferred to the future Single Rules Database.

### **Indicators**

The indicator used is the number of national rules for vehicle authorisation in place in the EU-27, Norway and Switzerland since January 2016.

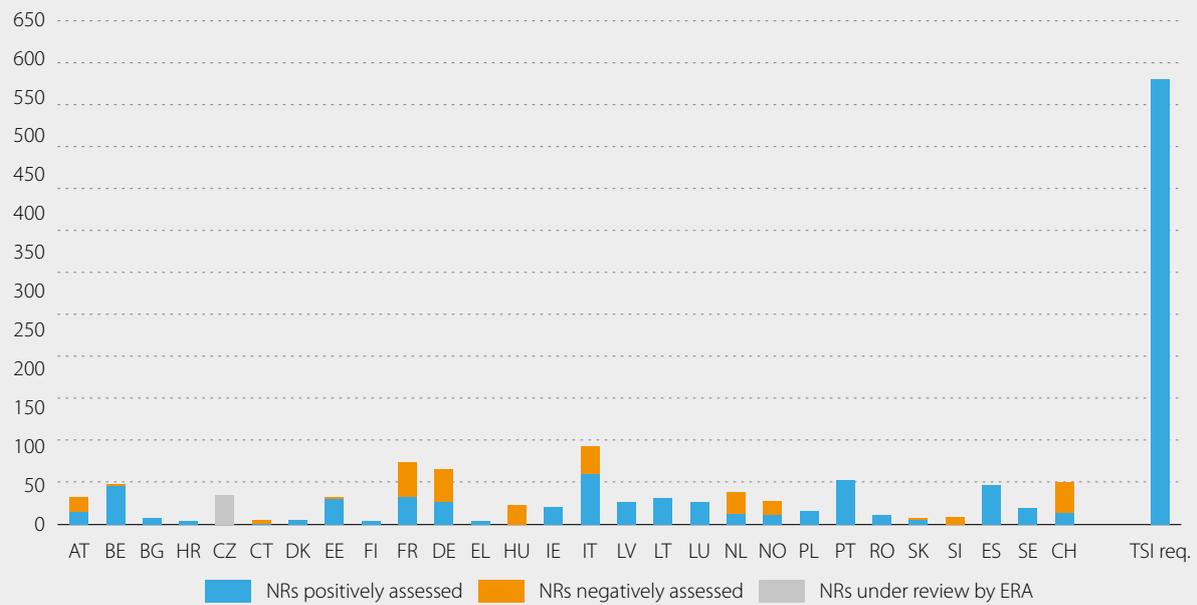
### **Findings**

At the level of the EU-27, Norway and Switzerland, the total number of national rules for vehicle authorisation (in addition to the latest TSIs in force) dropped from about 13 450 in January 2016 to 862 in November 2021, with some differences among the countries. Although there has been an impressive decrease in the number of published rules in the past 6 years, this trend has flattened since 2019, as potentially removable rules are becoming scarce. After cleaning up, a further reduction in the number of national rules is expected in the next revision of the TSIs.

### **Sources and limitations**

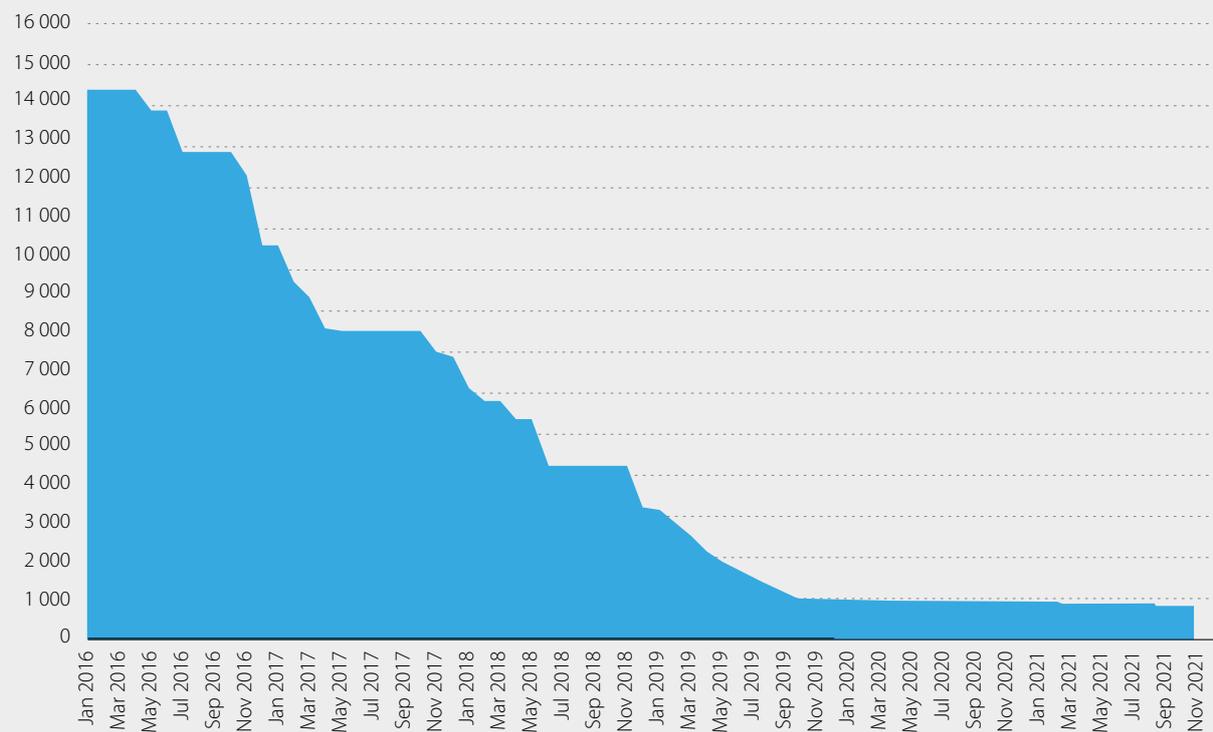
As the data are retrieved directly from ERA's Reference Document Database after being uploaded by the Member States, the reliability of the data depends on the extent to which the information from the Member States is up to date and complete.

**Figure B-20: National rules for vehicle authorisation in addition to the latest TSIs (EU-27 + CH + NO, November 2021)**



Source: Reference Document Database, maintained by ERA.

**Figure B-21: National rules for vehicle authorisation (EU-27 + CH + NO + UK, 2016–2021)**



Note: NRs from UK are considered until 2021

Source: Reference Document Database, maintained by ERA.

## **B-13** ERTMS on-board deployment

### **Purpose**

The deployment of ERTMS equipment on board tractive vehicles is a prerequisite for ERTMS-compatible train operation. It is achieved either through purchasing new vehicles or by retrofitting the existing fleet.

### **Indicators**

The indicators used to measure the extent of on-board deployment of the ERTMS are the total number of tractive rolling stock vehicles in operation equipped with the ERTMS authorised by EU Member States (and Switzerland) for operations on the EU railway network and the number of ERTMS-equipped vehicles contracted (delivered or to be delivered) in the EU-27, Norway, Switzerland and the United Kingdom.

### **Findings**

The number of contracted vehicles with the ERTMS has increased steadily since 2010, with over 8 250 vehicles contracted in EU Member States (over 12 100 in the EU-27, Norway, Switzerland and the United Kingdom) at the end of 2020. However, the time lag between contracting vehicles with the ERTMS and their operation should be taken in account.

The countries reporting the highest number of vehicles equipped with the ERTMS in operation in 2020 were Switzerland, Germany and Belgium. The survey of NSAs indicated that on average (among the countries that provided data) around 17 % of the operating tractive vehicles (including train sets) were equipped with the ERTMS at the end of 2020.

To achieve successful deployment of the ERTMS in the core network by the target date of 2030, greater effort is needed to accelerate the on-board deployment of the ERTMS.

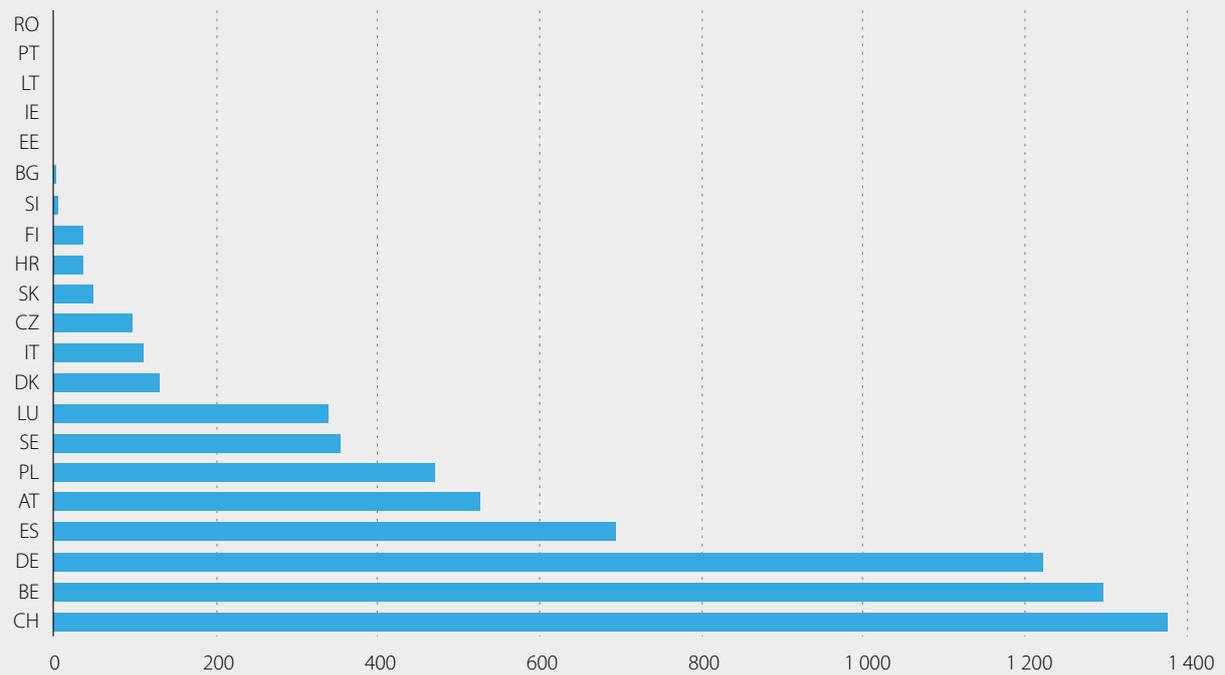
### **Sources and limitations**

The underlying data are not readily available and have to be compiled from various sources. One source is a survey on vehicles in service, conducted among NSAs by ERA; the other source is a survey of the rolling stock manufacturers' association, the Association of the European Rail Industry (UNIFE), among their members on vehicles contracted. In the case of national data supplied by NSAs, the data are not available for 10 countries. In the case of Association of the European Rail Industry data, the data are deemed accurate enough.

NSA survey data are provided by the NSAs and some discrepancies between these data and data from other sources are possible. The number of operated tractive vehicles comprises the number of owned, leased and rented minus the number of rented-out vehicles equipped with the ETCS. Vehicles without power units are excluded. Multiple units and train sets are counted as one equipped vehicle. Data include vehicles that are operated to transport freight or passengers. Vehicles under pilot yellow fleet operations, vehicles for track maintenance and other IM vehicles are not included. Data refer only to vehicles that are registered in the country in which the RUs conduct their main business activities.

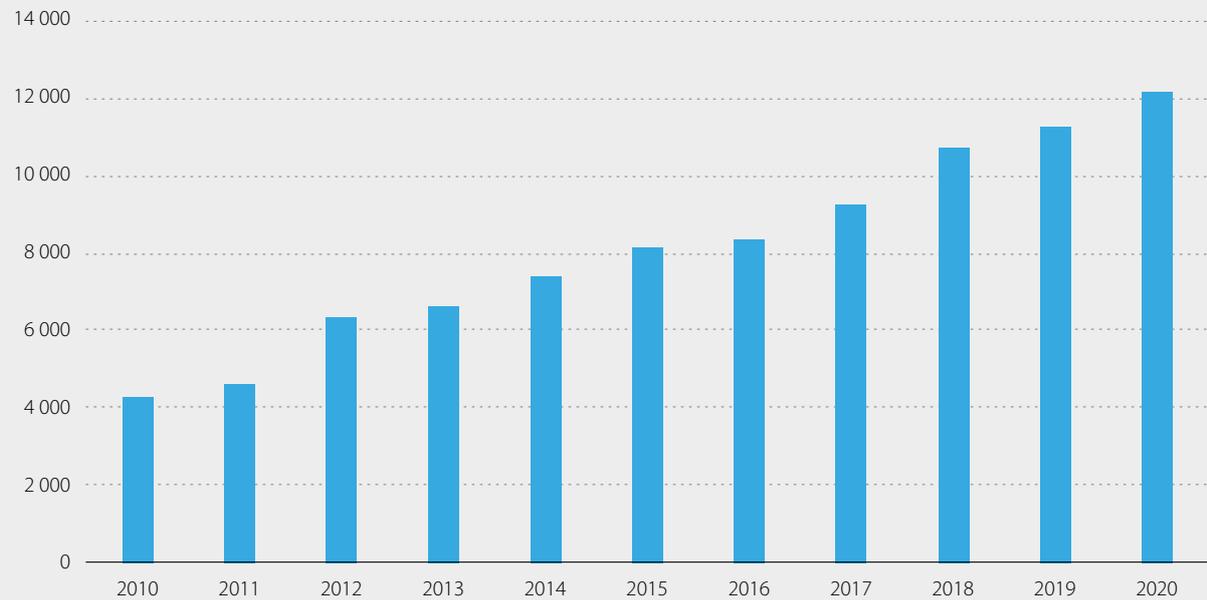
**Figure B-22:** Vehicles in operation equipped with ERTMS OBUs (EU-27 + CH, end 2020)

New and retrofitted vehicles



Source: Survey among NSAs carried out by ERA at the end of 2021.

**Figure B-23:** Contracted ERTMS vehicles (EU-27 + CH + NO + UK, 2010–2020)



Source: European Rail Supply Industry Association (UNIFE).

## **B-14** Safety certificates or single safety certificates for railway undertakings with an international area of operation

### **Purpose**

The number of RUs holding valid part B safety certificates in more than one Member State and the number of SSCs with a multicountry area of operation may provide an indication of international rail services across Europe.

### **Indicators**

Member States concerned with an international operation of RUs (i.e. area of operation in more than one Member State) holding part B safety certificates and/or SSCs issued by ERA.

### **Findings**

Records in ERADIS indicate that a total of 214 part B safety certificates were valid (in more than one Member State) at the end of 2021 in the EU-27, Norway and Switzerland. In Czech Republic, Germany and Slovakia more than 20 part B safety certificates were registered for RUs operating internationally. However, these figures may not be fully representative of international rail traffic because of the possible creation of subsidiaries in the different Member States where the RUs plan to operate (with different names and national certificates).

Furthermore, 28 out of the 61 SSCs issued by ERA and valid at the end of 2021 concerned domestic operations (i.e. area of operation limited to a single Member State); this figure is mainly driven by Germany owing to the change in legislation (requiring, with certain exceptions, all RUs, domestic and international, to apply for a SSC).

The other 33 SSCs with international areas of operation covered 19 Member States, with more than 10 RUs with a SSC providing cross-border operations in Germany and Austria.

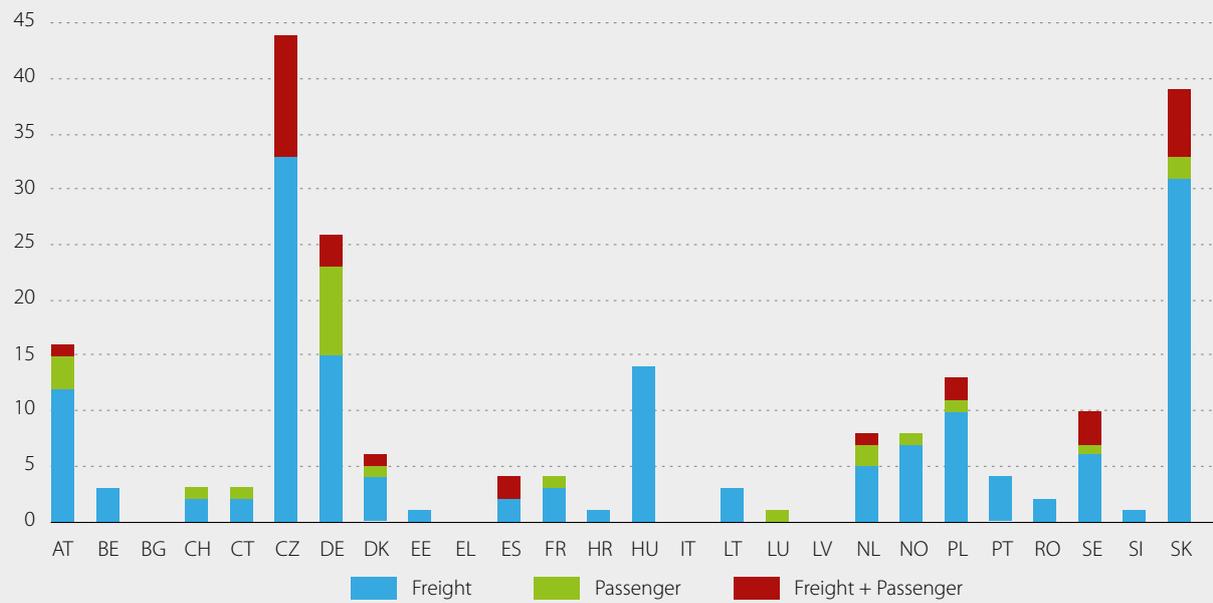
The number of rail services that are registered or operate internationally is greater for freight than for passengers. It appears that international rail passenger services are still quite limited, which can be partially explained by the fact that for passenger transport RUs rely on partnership agreements with other RUs (i.e. they can operate under the safety certificate of the partner RU without applying to ERA for a SSC).

### **Sources and limitations**

The safety certificates (part B) were submitted by NSAs in ERADIS. Data reliability depends on the extent to which the information provided is up to date and complete; as specified in the terms of use, ERA has no responsibility or liability for the data submitted by NSAs and published in ERADIS. Data for SSCs issued by ERA, instead, are available in ERADIS but were retrieved from the One-Stop Shop (OSS).

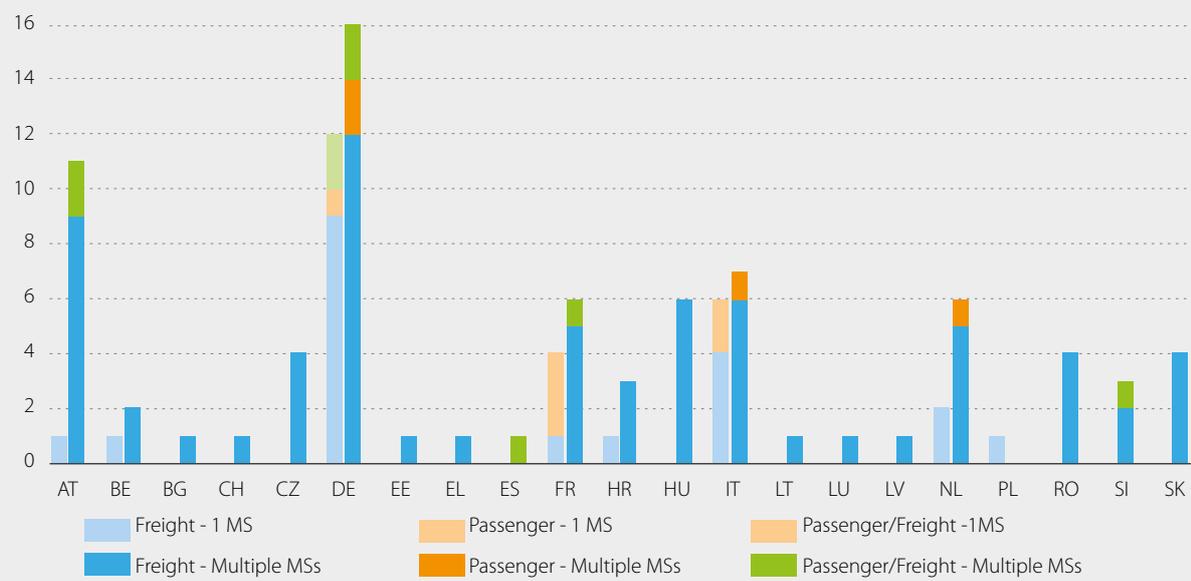
Subsidiaries of RUs are not detected and counted if registered nationally (in each country of operation).

**Figure B-24:** Member States concerned with part B safety certificates for RUs operating in more than one Member State by type of service (end 2021)



Source: ERADIS (ERA).

**Figure B-25:** Member States concerned with SSCs issued by ERA per type and area of operation (end 2021)



Source: OSS.

## **B-15** Vehicle authorisations handled by the European Union Agency for Railways per area of use and type of vehicle

### **Purpose**

Before a new or modified railway vehicle is permitted to operate on the EU railway network, it must be authorised. A vehicle and/or vehicle type authorisation is valid for a defined area of use, that is a network or networks within one or more Member States where the vehicle may be used; further authorisation is required if changes are made to the area of use (e.g. extension of the area of use). According to the interoperability directive, when the area of use is limited to a network or networks within one Member State, the applicant is able to choose whether it submits its application for vehicle authorisation to the NSA of that Member State or to ERA. However, in the case of vehicles intended for use in more than one Member State, the authorisation must be issued by ERA. The number of vehicle authorisations handled by the agency with area of use in multiple countries may provide an indication of the vehicles authorised for international use across Europe.

### **Indicators**

The relevant indicator is the number of vehicle authorisations and vehicles authorised by ERA per area of use and type of vehicle.

### **Findings**

Around 1 280 vehicle authorisations were submitted and handled by ERA in 2021, with more than 14 800 vehicles authorised. The number of authorisations of all types (e.g. conformity to type, first authorisation, renewal and extension of area of use) shows an increasing trend in recent years (which can also be attributed to progress in transposition of the fourth railway package).

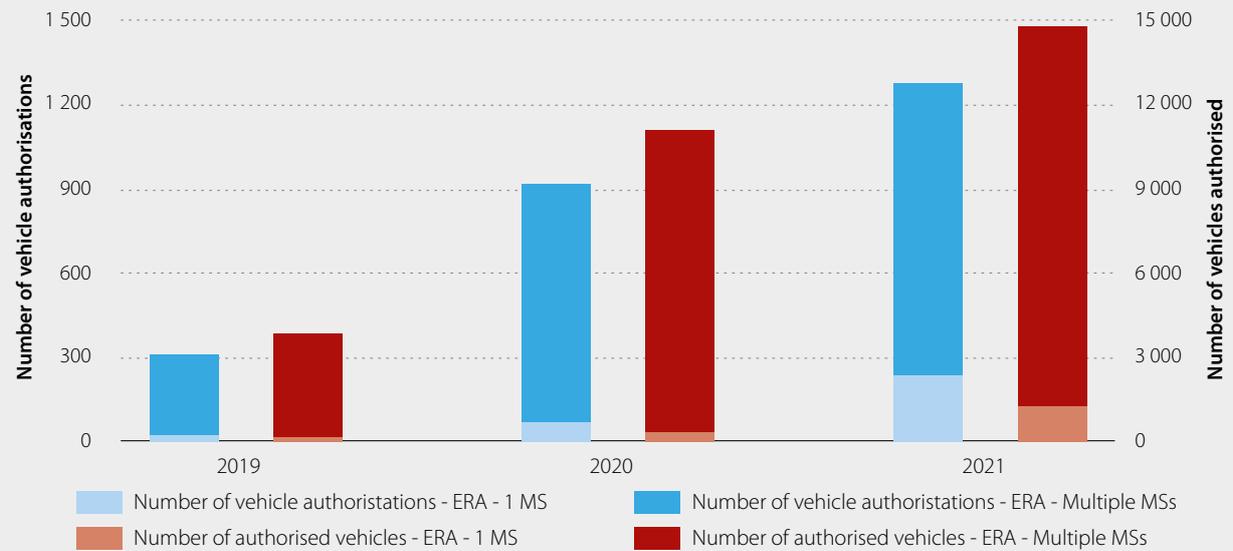
The majority of authorisations in 2021 were related to wagons, followed by locomotives and train sets, while more than 1 040 authorisations (for more than 13 480 vehicles) concerned an area of use in multiple countries (with almost all of the wagons authorised for the use in more than one Member State).

### **Sources and limitations**

Data on vehicle authorisations and vehicles authorised by ERA are retrieved from the OSS and can be considered fully reliable. The figures presented refer to all types of authorisations. Data for 2019 refer to vehicle authorisations from July; moreover, in 2019 and 2020 the new rules were not fully transposed in all Member States.

**Figure B-26: Number of vehicle authorisations and vehicles authorised by ERA per area of use (2019–2021)**

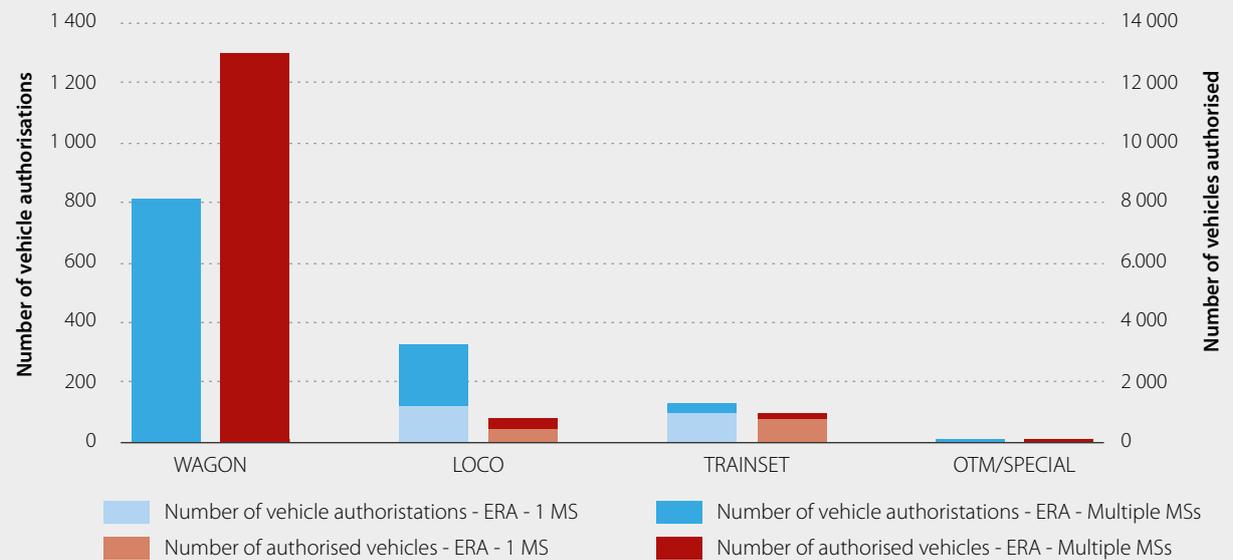
Area of use in 1 or more Member States



Source: OSS.

**Figure B-27: Number of vehicle authorisations and vehicles authorised by ERA per type of vehicle and area of use (2021)**

Area of use in 1 or more Member States



Source: OSS

## **B-16** Licence documents

### **Purpose**

Directive 2012/34/EU as amended lays down the criteria applicable to the issuing, renewal or amendment of licences by a Member State intended for RUs that are or will be established in the EU. Data on licences for the performance of rail transport services within the EU and the European Economic Area are submitted by the national licensing authorities, are monitored by the Commission and are available in ERADIS<sup>(17)</sup>.

### **Indicators**

The indicator used is the number of licence documents valid at the end of 2021 per country and type of service.

### **Findings**

ERADIS reports more than 1 100 licence documents<sup>(18)</sup> valid on 31 December 2021 (in the EU-27, Norway and Switzerland) for freight, passenger and freight/passenger services. The majority of licences relate to freight services, and there is a significant difference in the number of licence documents across Member States, with the highest numbers reported in Germany, Poland and Czech Republic.

### **Sources and limitations**

Data on the licence documents are submitted by the national licencing authorities, monitored by the Commission and published in ERADIS. Data reliability depends on the extent to which the information provided is up to date and complete; as specified in the terms of use, ERA has no responsibility or liability with regard to the information submitted and published in ERADIS.

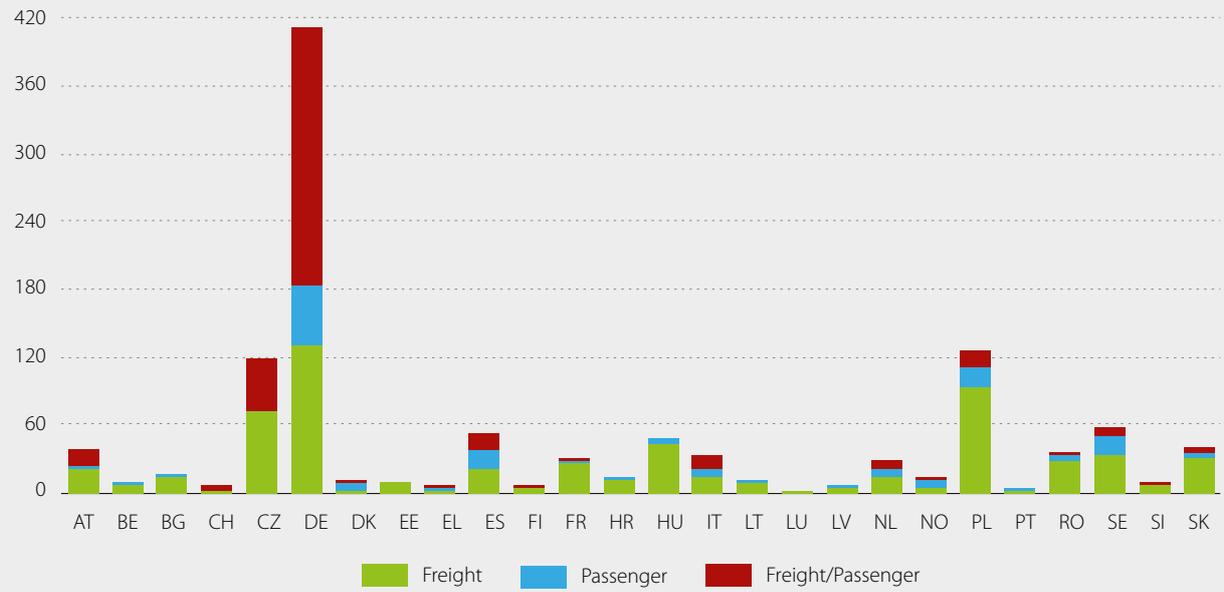
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<sup>(17)</sup> <https://eradis.era.europa.eu/>

<sup>(18)</sup> A RU with a licence may not necessarily be operational.

**Figure B-28:** Number of valid licence documents active at the end of 2021 by country (EU-27 + CH + NO)

Documents valid on 31 December 2021, for passenger, freight and freight/passenger services



Note: A RU with a licence may not necessarily be operational

Source: ERADIS.

## **B-17** RINF completeness

### **Purpose**

The RINF is a common European register hosted by ERA and intended to contain and provide specified technical data about rail infrastructure. It has been implemented in the context of technical specifications that support interoperability on the railway networks within the European Community. The register should, in particular, provide seamless access to static infrastructure data to RUs for planning and preparing railway services within the EU, and the main benefits are expected to arise from the possibility to carry out vehicle–route technical compatibility checks before service planning.

Data availability is a key success factor for the register. As with other databases, its usefulness is based on the accuracy and completeness of the data it contains.

### **Indicators**

Two indicators are presented: network description completeness and technical parameter completeness. The former refers to the percentage of the national railway network for which a geometrical description is available. The latter refers to the technical parameters provided for the railway network described in the register. The indicators focus on the availability of data for the related parameters, not on the accuracy of the information provided.

### **Findings**

As of the beginning of 2022, about 91 % of the Member States' railway network had been described in the RINF through sections of lines (SoLs) and operational points (OPs). One national network is still not described, and the availability of values for mandatory technical parameters varies among Member States. The availability of values for mandatory technical parameters for those SoLs/OPs varies greatly between Member States. In respect of the parameters mandatory since 1 January 2021, 81 % of parameters for SoLs and 88 % of parameters for OPs are currently available in the RINF. These figures focus on the availability of data and not on their accuracy (which is another key factor for vehicle–route compatibility checking, for example). The completeness and accuracy of the data in the RINF represent a major hurdle for the effective use of the register's data and minimise the return on investments made so far. The latest RINF regulation foresees the further development of the RINF, including the integration of new functions. This brings a challenge in managing this evolution in a way that benefits linked to the original functions can be harvested as well as those for new functions.

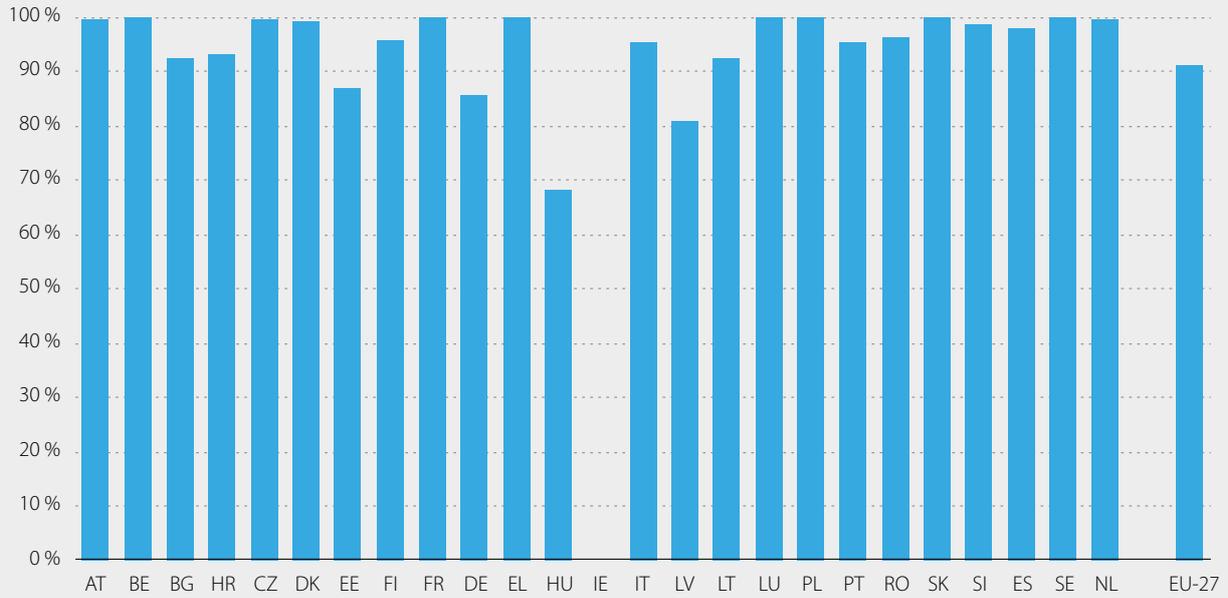
### **Sources and limitations**

The statistics are produced at the level of railway lines; the length of lines in the RINF is evaluated from data available as of the beginning of January 2022, which are analysed in combination with information from Eurostat (2020 data) for establishing the reference length of the national network. In the case of the technical parameters, the estimates are produced for all SoLs/OPs in the RINF, across single parameters mandatory as of 1 January 2021.

As the data are retrieved directly from the RINF, their reliability depends on the extent to which the information provided is up to date and complete; as specified in the term of use, ERA has no responsibility or liability with regard to the information submitted and published in the RINF.

**Figure B-29:** RINF network description completeness (EU-27, 04/01/2022)

Estimated share of railway line described in RINF

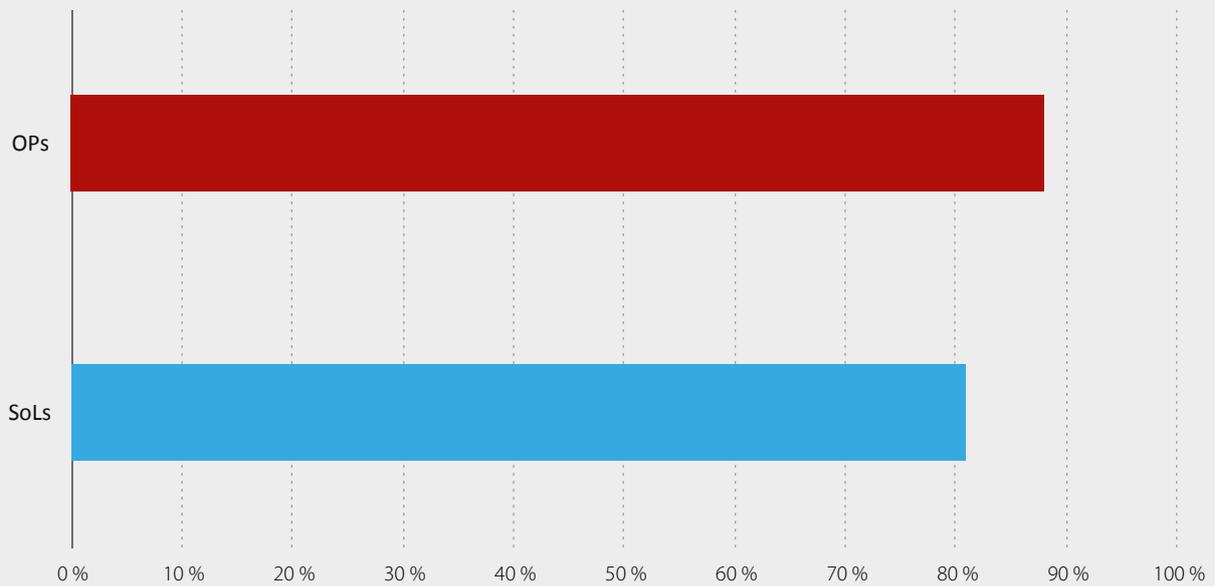


Note: Physical descriptions of the tracks of the lines and not attributes are counted

Source: RINF and Eurostat, retrieved on 4 January 2022.

**Figure B-30:** RINF technical parameters completeness (EU-27, 04/01/2022)

Share of SoL/OPs in RINF with encoded technical parameters across Member States



Note: Average of data completeness across 152 parameters for Section of Lines (SoL) and 60 parameters for Operational Points (OPs) mandatory as of 1 January 2021

Source: RINF and Eurostat, retrieved on 4 January 2022.

## **B-18** ETCS trackside costs

### **Purpose**

ETCS deployment is a means of achieving technical interoperability in train control and signalling in Europe. However, its progress has been limited, mainly because of high costs. A mature set of technical specifications, richer experience of the sector, increased competition and economies of scale can be expected to drive down unit costs over time.

### **Indicators**

The indicator used to monitor the ETCS trackside costs is the weighted average cost for ETCS trackside installation on 1 km of a double-track line equivalent (standard two-track line) expressed as average capital expenditure (CAPEX).

### **Findings**

There have been no new ETCS level 1 (ETCS-L1) trackside projects since 2016, when the weighted average unit cost was EUR 81 000 per line-km (double-track line equivalent). A decrease in ETCS level 2 (ETCS-L2) trackside installation costs since 2014 is also apparent, levelling off in recent years at around EUR 100 000 per line-km. Overall, the number of projects and line-km to be equipped decreased in 2017 and 2018, partly because the end of the EU financing period was approaching and partly because of the budget available for the most recent calls.

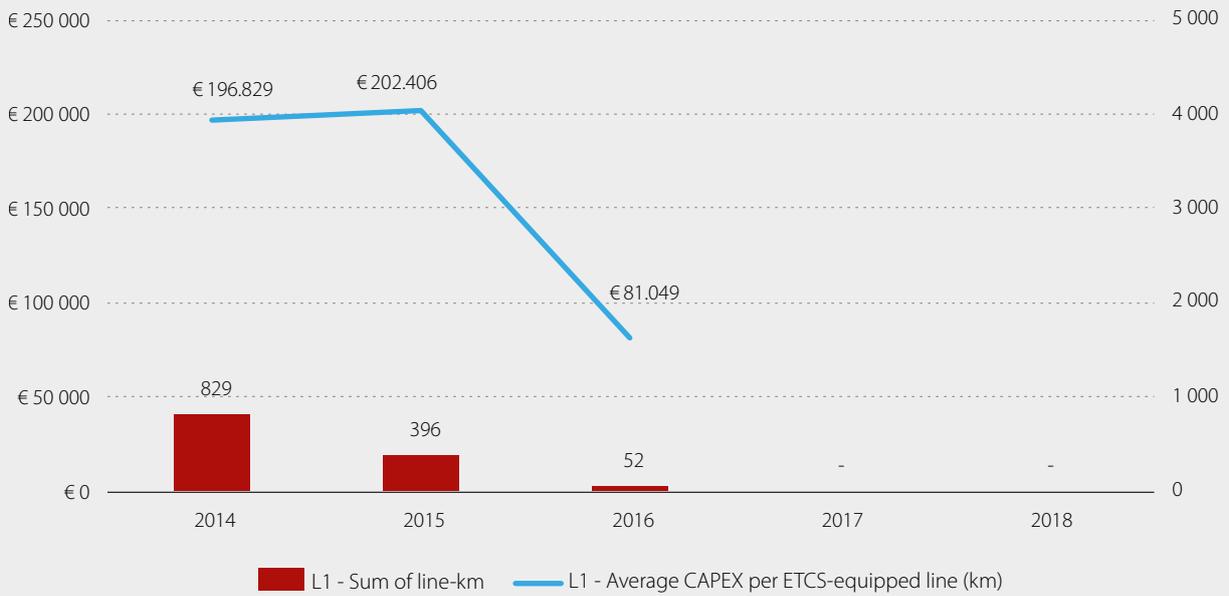
An increase in competition among ERTMS trackside suppliers as well as their production capacity may help to further drive down unit costs. It is clear that applicants for Connecting Europe Facility (CEF) funding prefer level 2 installations over level 1 installations.

### **Sources and limitations**

Although the quality of the data is estimated to be high, the accuracy of the indicator is limited because both the total number of projects and the number of projects for which comparable data are available are small; no projects related to ERTMS trackside deployment were supported in 2019, 2020 and 2021. Data are sourced from grant agreements of ongoing and closed ERTMS projects submitted to and retained under CEF transport calls for proposals organised by the European Climate, Infrastructure and Environment Executive Agency (CINEA). Therefore, other ERTMS trackside projects not supported by the CEF budget are not captured by the indicator.

**Figure B-31: Average CAPEX per ETCS-L1-equipped line-km (EU-27, 2014–2018)**

Unit costs per km of double track line

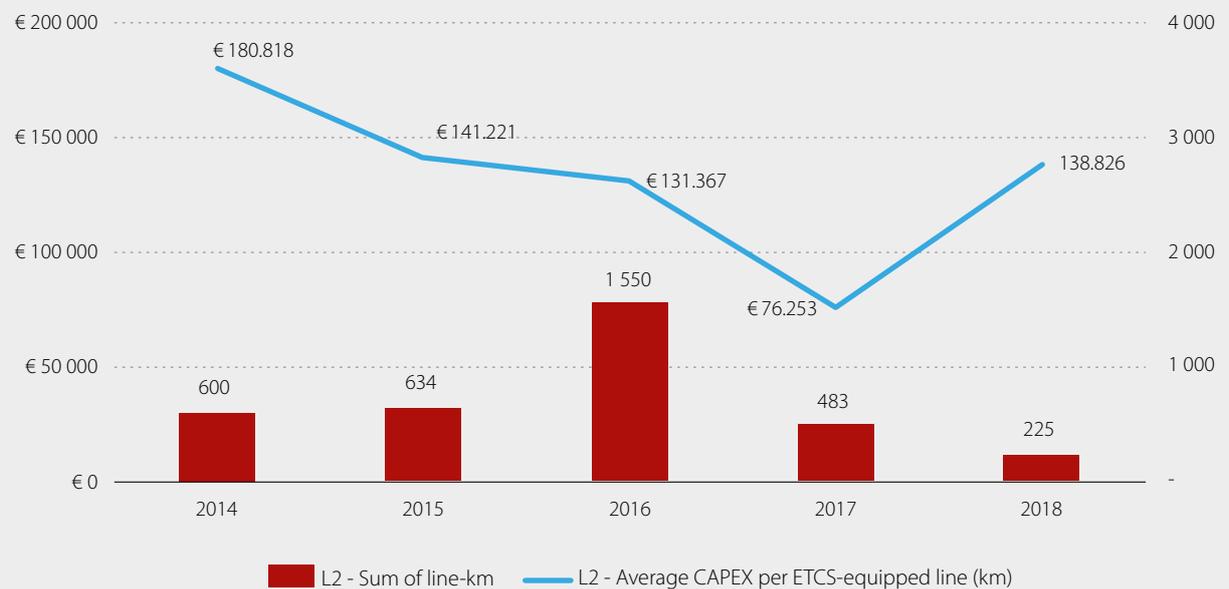


Note: Unit costs derived as weighted averages

Source: CINEA data from CEF applications.

**Figure B-32: Average CAPEX per ETCS-L2-equipped line-km (EU-27, 2014–2018)**

Unit costs per km of double track line



Note: Unit costs derived as weighted averages

Source: CINEA data from CEF applications.

## **B-19** ETCS on-board costs

### **Purpose**

The on-board deployment of the ETCS follows the trackside deployment in assuring technical interoperability in train control and signalling in Europe. Like trackside deployment, progress in equipping the vehicles providing traction has been limited, mostly because of high costs. A mature set of technical specifications, richer experience of the sector, increased competition and economies of scale can be expected to drive down unit costs over time.

### **Indicators**

The indicator used to measure the costs for the on-board deployment of the ETCS is the weighted average investment cost needed for fitting, retrofitting or upgrading OBUs on an existing vehicle.

### **Findings**

The data on ETCS on-board costs show a relatively stable trend in the cost of on-board deployment of the ETCS-L2, with an average unit cost of approximately EUR 163 000 per OBU, compared with a cost per ETCS-L1 OBU of around EUR 278 000 in 2019. The unit cost of ETCS OBUs therefore remains quite high.

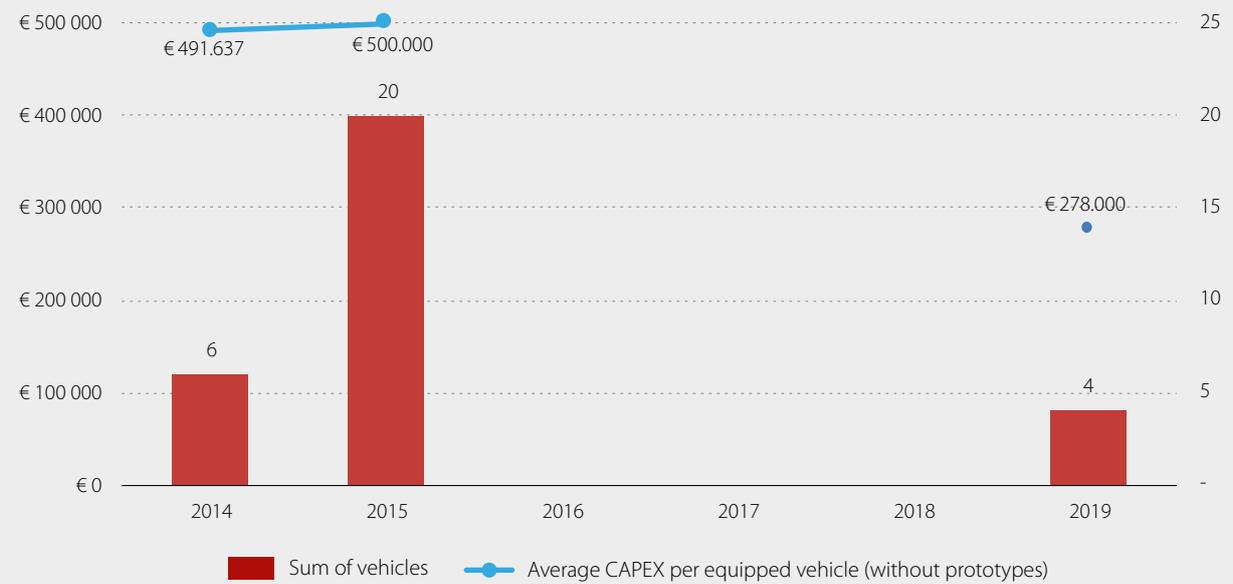
Specific actions such as those linked to the fourth railway package (single authorisation) are expected to reduce the fixed costs of multiple authorisations. The future deployment of 'ETCS only' vehicles rather than vehicles with both the ETCS and other class B systems on board is also expected to reduce the costs of ETCS OBUs.

### **Sources and limitations**

The data are retrieved from grant agreements of ongoing and closed ERTMS projects submitted to and retained under CEF transport calls for proposals organised by CINEA. The metric focuses only on CAPEX for fitting, retrofitting and upgrading existing vehicles, excluding prototyping. Although the quality of the data is estimated to be high, the accuracy of the metric is limited owing to the limited number of projects for which comparable data are available; no projects related to the on-board deployment of the ETCS were supported in 2020 and 2021. Other ETCS OBU projects not supported by the CEF budget are not captured by the indicator.

**Figure B-33: Average CAPEX per ETCS-L1-equipped vehicle (EU-27, 2014–2019)**

Unit costs per vehicle

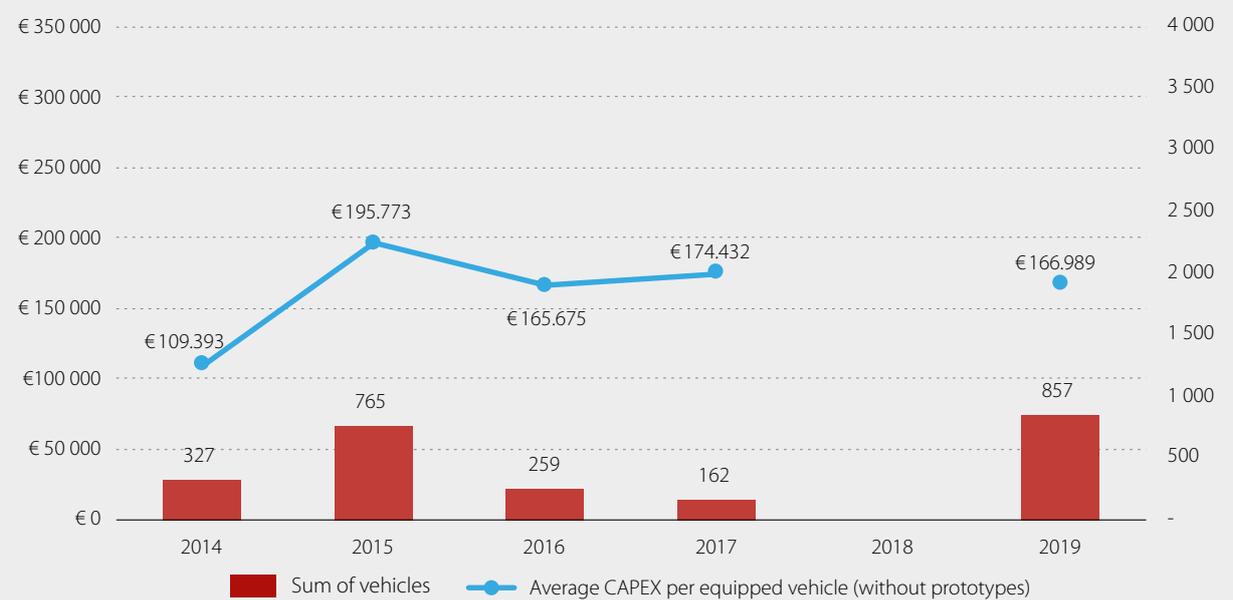


Note: Unit costs derived as weighted averages

Source: CINEA data from CEF applications.

**Figure B-34: Average CAPEX per ETCS-L2-equipped vehicle (EU-27, 2014–2019)**

Unit costs per vehicle



Note: Unit costs derived as weighted averages

Source: CINEA data from CEF applications.

## **B-20** EU-funded projects with a cross-border impact and/or for rail interoperability

### **Purpose**

Among the projects submitted to CEF calls for proposals organised by CINEA, it is possible to identify those EU-funded projects with a cross-border impact and/or aimed at improving rail interoperability (including support actions for RFCs). This indicator aims to give an indication of EU-related funding allocated to enhancing interoperability but excluding the ERTMS.

### **Indicators**

The indicator used is the allocation of funds to CEF railway actions with a cross-border impact, for rail interoperability and for RFCs.

### **Findings**

Between 2014 and 2020, a total of EUR 6.074 billion of CEF railway funding was allocated to 104 projects with identified cross-border impacts. The projects included EU initiatives to address cross-border sections (e.g. the Fehmarnbelt Tunnel, Turin–Lyon, the Brenner Base Tunnel and Rail Baltica) and national initiatives to address cross-border bottlenecks. The majority of these EU funds were assigned to projects related to improving lines (both conventional and high speed).

In addition, an actual contribution of EUR 88 million has been allocated to 18 projects for rail interoperability while EUR 29 million has been assigned to the 18 CEF actions supporting the RFCs, including 11 of the programme support action type.

### **Sources and limitations**

The data are retrieved from application files for projects submitted to CEF calls for proposals organised by CINEA. Projects with a cross-border impact and projects for rail interoperability and support actions for RFCs were considered. The quality of the data is estimated to be high.

**Figure B-35:** Allocation of funds to CEF transport railway actions with a cross-border impact (2014–2020)

Mode categories	Number of actions	Actual contribution (billion EUR)
Conventional lines	63	2.348
Conventional lines/High speed lines	7	0.878
Conventional lines/Rail-road terminals/Platforms	2	0.193
High-speed lines	10	2.535
Rail-road terminals/Platforms	3	0.011
Rolling stock	12	0.080
-	7	0.028
<b>Total</b>	<b>104</b>	<b>6.074</b>

Source: CINEA data from CEF call application files.

**Figure B-36:** EU-funded projects for rail interoperability and RFCs (2014–2018)

Type	Number of actions	Actual contribution (billion EUR)
Rail Freight Corridors Actions, including CEF Programme Support Action	18	0.029
CEF-Transport funded rail interoperability actions	18	0.088
<b>Total</b>	<b>36</b>	<b>0.117</b>

Source: CINEA data from CEF call application files.

## **B-21** Time to obtain vehicle authorisation

### **Purpose**

The fourth railway package introduced a scheme for single EU vehicle authorisation, the single safety certification of RUs and for ERTMS trackside approval as a means of enhancing interoperability and improving the efficiency of the railway sector. In particular, reducing the time necessary to obtain formal regulatory documents needed for train operation was one of the promises of the technical pillar of the fourth railway package, as time directly translates into costs to the railway sector.

### **Indicators**

The metric used to monitor the duration of the railway vehicle authorisation process is the time elapsed between the submission of the application through the OSS and the issuance of the authorisation.

### **Findings**

The average time to obtain an authorisation in conformity to type has decreased significantly over time, fluctuating in recent months (i.e. the second half of 2021) around the target cap of 5 working days. As of the end of 2021, the average duration of all other authorisations (since June 2019) was around 140 days, below the legally required 5 months.

### **Sources and limitations**

Data on vehicle authorisations and vehicles authorised by ERA were retrieved from the OSS and can be considered fully reliable. The figures presented refer to all types of authorisations.

**Figure B-37:** Time to obtain vehicle authorisation in conformity to type, (2019–2021)

Average duration (over the month) in working days, July 2019 - December 2021



Source: OSS.

## **B-22** ERTMS trackside approvals

As of the end of 2021, two ERTMS trackside approvals had been issued by ERA, while 70 applications were ongoing in line with the relevant planning and tendering schedules of IMs.

# Annexes

# Annex I: Methodological information

## Progress with safety

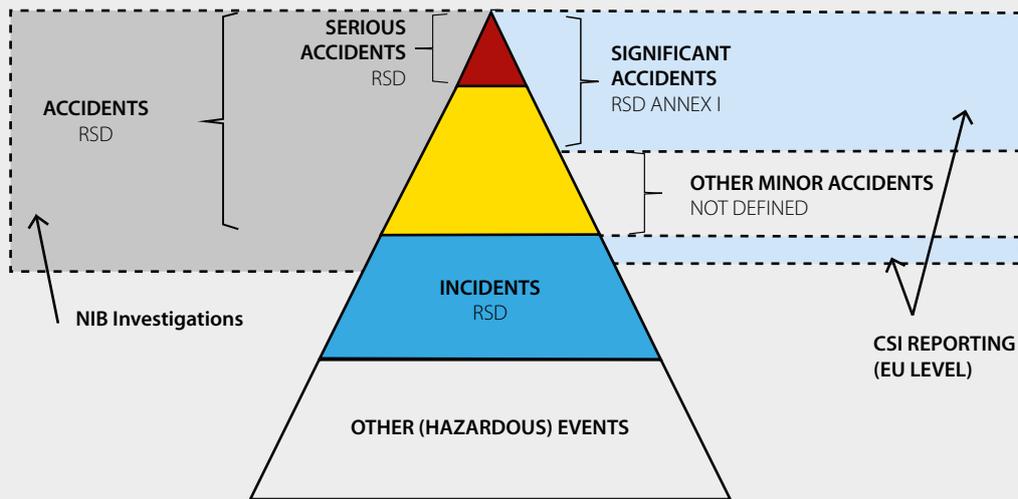
This report is mainly based on CSI data as of the end of December 2020 reported to ERA by the NSAs. Any changes after that date have not been taken into account. Information on serious accidents and their investigations is based on reports available to ERA on 31 December 2020. Any event occurring after that date is not covered by this report.

European legislation requires Member States to report to ERA on significant accidents and serious accidents occurring in their territory. The NSAs must report all significant accidents. The NIBs must investigate all serious accidents, notify ERA of these investigations and, when closed, send the investigation reports to ERA. The term 'significant accident' covers a wider range of events than serious accidents. The RSD (Directive (EU)2016/798) provides the following definitions and ways of reporting for these two groups of accident.

Significant accident (Appendix of Annex I of the RSD, point 1.1)	Serious accident (Article 3.12 of the RSD)
'[A]ny accident involving at least one rail vehicle in motion, resulting in at least one killed or seriously injured person, or in significant damage to stock, track, other installations or environment, or extensive disruptions to traffic'. Accidents in workshops, warehouses and depots are excluded. Significant damage is damage that is equivalent to EUR 150 000 or more.	'[A]ny train collision or derailment of trains resulting in the death of at least one person or serious injuries to five or more persons or extensive damage to rolling stock, the infrastructure or the environment', and any other similar accident with an obvious impact on railway safety regulation or the management of safety. "[E]xtensive damage" means damage that can immediately be assessed by the investigating body to cost at least EUR 2 million in total.'
Annual safety reports by NSAs	Accident investigation reports by NIBs

The current legislative framework does not require Member States to collect information on all railway accidents. Reporting is often limited to significant accidents and a selection of incidents (precursors to accidents). At Member State level, the information on incidents is not necessarily collected by RUs/IMs, and the NSAs usually rely on accident data when planning their supervisory activities. This absence may represent an obstacle to efficient learning and the early identification of recurring safety issues in the EU railway system.

To facilitate the long-term monitoring of railway safety, this report also uses the accident category 'major accidents' (which includes accidents resulting in five or more fatalities) and the category of 'fatal train collisions and derailments' (which includes train collisions, train derailments and train fires following collisions or derailments in which one or more persons are killed).



## Progress with interoperability

Unlike the EU regulatory framework for railway safety, the interoperability regulatory framework does not contain common indicators for monitoring interoperability. A set of indicators has therefore been developed by ERA, in concertation with stakeholders, for assessing the extent to which trains are able to operate safely without interruption while achieving the required level of performance. However, data availability remains an issue: for example, directly measuring the dwell times on national borders in a harmonised way is still in its infancy, and data cannot always be made available centrally for relevant indicators.

This report makes use of various sources of data: databases and registers hosted by ERA, databases of the Commission and other agencies and databases of representative bodies and international organisations. A regular biennial survey was run among NSAs in late 2021 to gather specific data that are available only at national level; this survey was integrated into the recommended template for the annual safety report, and several NSAs provided interoperability data on voluntary basis as part of this statutory report. In early 2021, an almost 100 % response rate to this survey was reached; however, data were not always available for all topics. Therefore, in some instances, assumptions had to be made to produce EU-wide estimates.

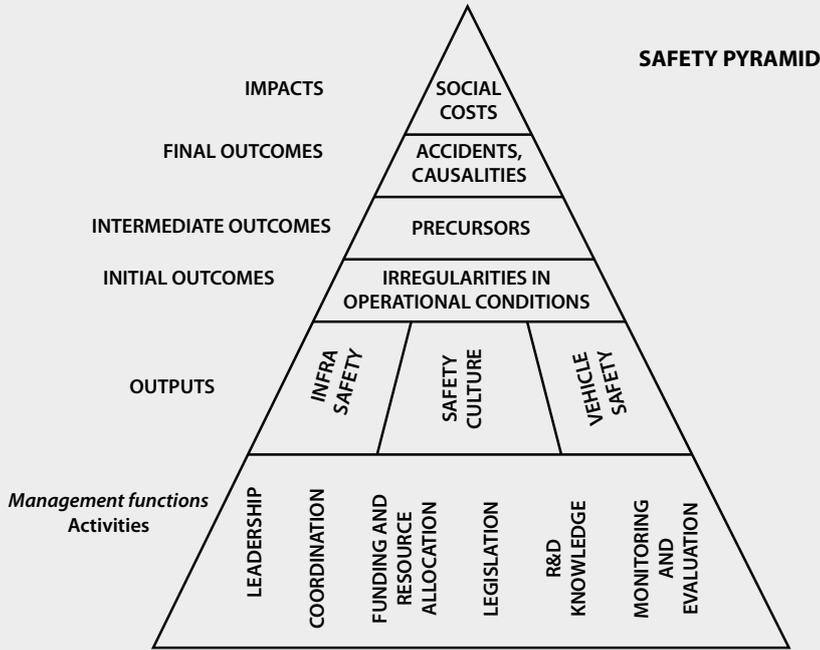
The standard reference dates for this report are the end of 2020 or the end of 2021, depending on the data source (e.g. NSA survey or database/register). The data available for EU-27 Member States, Norway, Switzerland, the United Kingdom and the Channel Tunnel are included. The EU aggregate is representative of the EU-27 (as of the end of 2020, therefore excluding the United Kingdom).

# Annex II: Methodological framework for monitoring safety and interoperability

The methodological framework used in this report builds on the universal results framework. Outcomes and impacts are the main focus of a results framework; inputs and implementation processes are generally not emphasised, although outputs are often noted. This conceptual presentation of a results chain (outputs, outcomes and impacts) is often accompanied by a more detailed plan for monitoring progress towards the ultimate objectives through measuring the achievement of outputs, outcomes and impacts at different time intervals. Results are typically defined through indicators, which are often, but not always, quantifiable and measurable or observable. Some indicators are qualitative. The monitoring plan typically includes baseline values and targets expected for outputs and outcomes, and it specifies the measures that will be used to gather data to ensure that the results framework is actually populated with data, updated with information at key points during programme/project implementation and used in decision-making.

## Methodological framework for safety monitoring

In the framework for safety monitoring, the impacts refer to evidence on whether outcomes are actually changing beneficiary long-term factors that are important from a societal perspective (e.g. a healthy population or a more efficient transport system), whereas final outcomes consist of long-lasting desirable results, in terms of a reduction in accidents and resulting casualties. Intermediate outcomes are indicators of unsafe operational conditions, with the accident precursors representing the closest directly available measurements. Initial outcomes may then be represented by specific irregularities in operational conditions. In the case of outputs, the conditions and performance of infrastructure, vehicles and humans can be distinguished. The activities can be grouped in a number of ways. Six areas, which can also be viewed as system management functions, are proposed.

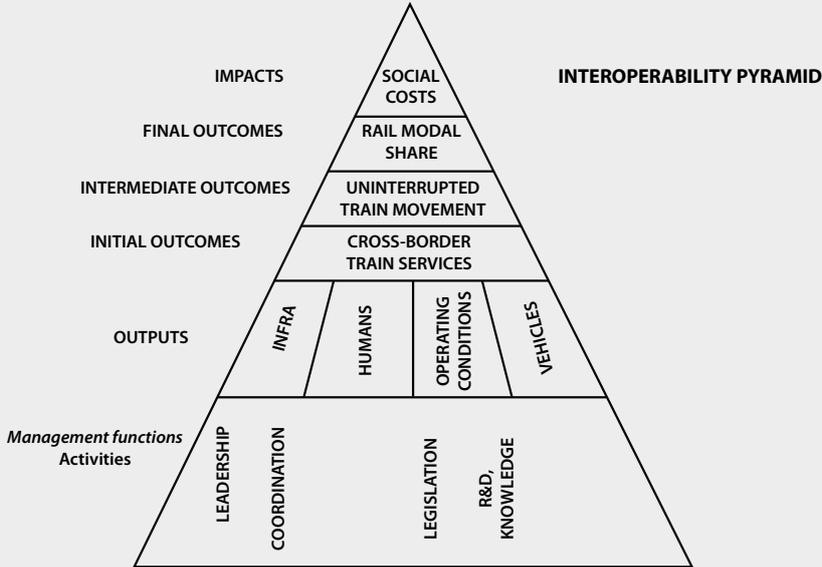


The CSIs include indicators at the levels of impacts, final outcomes and intermediate outcomes and a few at the level of outputs. Safety culture is a complex concept, and no common indicators exist at EU level; however, ERA has established a safety culture model <sup>(19)</sup> to allow a shared understanding and provide support to stakeholders. Measurements at the level of activities are crucial for a complete understanding of the full chain and notably of the contribution of organisational, regulatory and other factors. They need to be assessed thoroughly in any evaluation activity. However, for the monitoring of safety performance they remain a secondary focus, also because the underlying cause–effect relationships are not well understood.

### Methodological framework for interoperability monitoring

In the proposed framework for interoperability performance monitoring, the impacts refer to evidence on whether outcomes are actually changing beneficiary long-term conditions of interest (such as reduced economic costs of transport / improved economic prosperity and reduced environmental impacts). The final outcomes consist of long-lasting desirable results (e.g. an increase in rail modal share). Intermediate outcomes are indications of seamless train operation, related notably to unnecessary train stops at national borders. Initial outcomes may be represented by cross-border operating services. In the case of outputs, the conditions and performance of infrastructure, vehicles and humans along with the overall operating conditions can be identified. Activities can be grouped in a number of ways. Five areas, which can also be viewed as system management functions, are proposed.

The European regulatory framework does not introduce any interoperability indicators, and so far ERA has been looking mainly at the outputs level. The impacts have not yet been systematically assessed. However, in this report, for the first time, additional indicators for outcomes (final, intermediate and initial) have been explored and are presented.



<sup>(19)</sup> More information is available on ERA's website ([https://www.era.europa.eu/activities/safety-culture\\_en#meeting2](https://www.era.europa.eu/activities/safety-culture_en#meeting2)).

# Annex III: Overview of technical specifications for interoperability

**Table IIIa.** Structural TSIs and their amendments by year

Year	INF		ENE		TSI SRT	TSI PRIM	RST				CCS			
	HS TSI INF	CR TSI INF	HS TSI ENE	CR TSI ENE			HS TSI RST	CR TSI LOC&PAS	CR TSI WAG	TSI NOI	HS TSI CCS	CR TSI CCS		
1999														
2000													Decision 1999/569 on basic parameters EIF: 29/07/1999	
2001													Decision 2001/260 on basic parameters	
2002	Decision 2002/732 <b>(1st HS INF TS)</b> EIF: 30/11/2002												Decision 2002/731	
2003			Decision 2002/733 <b>(1st HS ENE TSI)</b> EIF: 30/11/2002										<b>(1st HS CCS TSI)</b>	
2004									Decision 2004/446 (on basic parameters) (CR only)	Decision 2004/446 (on basic parameters) (CR only)			Decision 2004/447 (amendment)	Decision 2004/447 (on basic parameters)
2005													Decision 2006/860 <b>(1st CR CCS TSI)</b> DoA: 28/9/2006	Decision 2006/679 <b>(1st CR CCS TSI)</b> DoA: 28/9/2006
2006													Decision 2006/860 <b>(2nd HS CCS TSI)</b> DoA: 7/11/2006	Decision 2007/153 (amendment) DoA: 7/3/2007
2007													Decision 2007/153 (amendment) DoA: 6/3/2007	Decision 2007/153 (amendment) DoA: 7/3/2007

Year	INF		ENE		TSI SRT	TSI PRIM	RST				CCS	
	HS TSI INF	CR TSI INF	HS TSI ENE	CR TSI ENE			HS TSI RST	CR TSI LOC&PAS	CR TSI WAG	TSI NOI	HS TSI CCS	CR TSI CCS
2008	Decision 2008/217 <b>(2nd HS INF TSI)</b> EIF: 21/12/2007 DoA: 1/7/2008		Decision 2008/284 <b>(2nd HS ENE TSI)</b> EIF: 6/3/2008 DoA: 1/10/2008		Decision 2008/163 <b>(1st SRT TSI)</b> EIF: 21/12/2007 DoA: 1/7/2008	Decision 2008/164 <b>(1st PRIM TSI)</b> EIF: 27/12/2007 DoA: 1/7/2008	Decision 2008/232 <b>(2nd HS RST TSI)</b> EIF: 21/2/2008 DoA: 1/9/2008		Decision 2006/861 <b>(1st CR WAG TSI)</b> DoA 31/01/2008		Decision 2008/386 (amendment) DoA: 1/6/2008	Decision 2008/386 (amendment) DoA: 1/6/2008
									Decision 2009/107 (amendment) DoA: 1/7/2009			Decision 2009/561 (amendment) DoA: 1/9/2009
2009												
2010											Decision 2010/79 (amendment) DoA: 1/4/2010	Decision 2010/79 (amendment) DoA: 1/4/2010
2011	Decision 2011/275 <b>(1st CR INF TSI)</b> DoA: 1/6/2011			Decision 2011/274 <b>(1st CR ENE TSI)</b> DoA: 1/6/2011	Decision 2011/291 (amendment) DoA: 1/6/2011			Decision 2011/291 <b>(1st CR LOC&amp;PAS TSI)</b> DoA: 1/6/2011		Decision 2011/229 <b>(2nd NOI TSI)</b>		

Year	INF		ENE		TSI SRT	TSI PRIM	RST			CCS	
	HS TSI INF	CR TSI INF	HS TSI ENE	CR TSI ENE			HS TSI RST	CR TSI LOC&PAS	CR TSI WAG	TSI NOI	HS TSI CCS
<b>2012</b>	Decision 2012/462 (amendment) DoA: 24/1/2013		Decision 2012/462 (amendment) DoA: 24/1/2013				Decision 2012/462 (amendment) DoA: 24/1/2013		Decision 2012/462 (amendment) DoA: 4/1/2013	Decision 2012/463 (amendment) DoA: 24/1/2013	Decision 2012/463 (amendment) DoA: 24/1/2013
	amending Decisions 2006/861/EC, 2008/163/EC, 2008/164/EC, 2008/217/EC, 2008/232/EC, 2008/284/EC, 2011/229/EU, 2011/274/EU, 2011/275/EU, 2011/291/EU etc.					Decision 2012/464/EU				Decision 2012/88 (1st merged CCS TSI) DoA: 26/7/2012	
<b>2013</b>								Regulation 321/2013 (2nd WAG TSI) EIF: 13/4/2013 DoA: 1/1/2014		Decision 2012/696 (amendment) DoA: 1/1/2013	
<b>2014</b>								Regulation 1236/2013 (amendment) EIF: 4/12/2013 DoA: 1/1/2014			
<b>2015</b>	Regulation 1299/2014 (1st merged INF TSI) EIF/DoA: 1/1/2015		Regulation 1301/2014 (1st merged ENE TSI) EIF/DoA: 1/1/2015		Regulation 1303/2014 (2nd SRT TSI) EIF/DoA: 1/1/2015	Regulation 1300/2014 (2nd PRIM TSI) EIF/DoA: 1/1/2015	Regulation 1302/2014 (2nd LOC&PAS TSI) EIF/DoA: 1/1/2015	Regulation 2015/924 (amendment) DoA: 01/07/2015	Regulation 1304/2014 (3rd NOI TSI) EIF/DoA: 1/1/2015	Decision 2015/14 (amendment) DoA: 1/7/2015	
			Corrigendum L 13/13 (2015) (editorial corrections)		Corrigendum L 10/45 (2015) (editorial corrections)						

Year	INF		ENE		TSI SRT	TSI PRIM	RST				CCS		
	HS TSI INF	CR TSI INF	HS TSI ENE	CR TSI ENE			HS TSI RST	CR TSI LOC&PAS	CR TSI WAG	TSI NOI	HS TSI CCS	CR TSI CCS	
<b>2016</b>					Regulation 2016/912 (correction) EIF: 30/6/2016							Regulation 2016/919 (Recast) EIF: 05/07/2016 Corrigendum L 279/94 (2016) (editorial corrections)	
<b>2017</b>													
<b>2018</b>			Regulation 2018/868 (amendment) EIF: 04/07/2019				Regulation (EU) 2018/868 (amendment) EIF: 04/07/2019						
<b>2019</b>	Regulation 2019/776 (amendment) EIF: 16/06/2019		Regulation 2019/776 (amendment) EIF: 16/06/2019		Regulation 2019/776 (amendment) EIF: 16/06/2019	Regulation 2019/772 (amendment) EIF: 16/05/2019	Regulation 2019/776 (amendment) EIF: 16/06/2019	2019/776 (amendment) EIF: 16/06/2019	2019/774 (amendment) EIF: 16/06/2019			2019/776 (amendment) EIF: 16/06/2019	
<b>2020</b>							Regulation 2020/387 (amendment) EIF: 09/03/2020	Regulation 2020/387 (amendment) EIF: 09/03/2020				Regulation 2020/387 (amendment) EIF: 09/03/2020 Regulation 2020/420 (amendment only DE language) EIF: 21/03/2020	

Note: CR, conventional; DoA, date of application; EIF, entry into force; ENE, energy; HS, high-speed; INF, infrastructure; LOC&PAS, locomotive and passenger rolling stock; NOI, noise; RST, rolling stock; SRT, safety in railway tunnels; WAG, wagon.

**Table IIIb. Functional TSIs and their amendments by year**

Year	TSI OPE		TA	
	HS TSI OPE	CR TSI OPE	CR TSI TAF	TSI TAP
<b>2002</b>				
<b>2003</b>				
<b>2004</b>	Decision 2002/734 <b>(1st HS OPE TSI)</b> DoA: 12/3/2003		Decision 2004/446  (on basic parameters)	
<b>2005</b>				
<b>2006</b>		Decision 2006/920 <b>(1st CR OPE TSI)</b> DoA: 18/05/2007		
<b>2007</b>				
<b>2008</b>	Decision 2008/231 <b>(2nd HS OPE TSI)</b> DoA: 1/9/2008	Decision 2009/107  (amendment) DoA: 1/7/2009	Regulation 62/2006  <b>(1st TAF TSI)</b> EiF: 19/1/2006	
<b>2009</b>				
<b>2010</b>	Decision 2010/640 (amendment) DoA: 25/10/2010 and 1/1/2014*	Decision 2010/640  (amendment) DoA: 25/10/2010 and 1/1/2014*		
<b>2011</b>		Decision 2011/314 <b>(2nd CR OPE TSI)</b> DoA: 1/1/2012**		Regulation 454/2011  <b>(1st TAP TSI)</b> EiF: 13/5/2011
<b>2012</b>	Decision 2012/464 (amendment) DoA: 24/1/2013		Regulation 328/2012  (amendment) EiF: 08/5/2012	Regulation 665/2012  (amendment) EiF: 22/7/2012
<b>2013</b>				
<b>2014</b>	Decision 2012/757 OPE:2012 <b>(1st merged OPE TSI)</b> DoA: 1/1/2014		Regulation 280/2013  (amendment) EiF: 24/3/2013	Regulation 1273/2013  (amendment) EiF: 8/12/2013
<b>2015</b>	Regulation 2015/995  (amendment) EiF/DoA: 20/07/2015		Regulation 1305/2014  <b>(2nd TAF TSI)</b> EiF/DoA: 1/1/2015	Regulation 2015/302  (amendment) EiF: 18/03/2015
<b>2016</b>				Regulation 2016/527  (amendment) EiF: 25/04/2016
<b>2017</b>				
<b>2018</b>			Regulation 2018/278  (amendment) EiF: 16/3/2018	
<b>2019</b>	Regulation 2019/773  <b>(2nd OPE TSI)</b> EiF: 16/6/2021***		Regulation 2019/778  (amendment) EiF: 16/6/2019	Regulation 2019/775  (amendment) EiF: 16/6/2019

(\*) DoA of 1 January 2014 is only for point 6 of Annex I and point 5 of Annex II.

(\*\*) Appendices P and Pa have different dates of application, that is Appendix P applies from 1 January 2012 until 31 December 2013 and Appendix Pa applies from 1 January 2014.

(\*\*\*) Sections 4.2.2.1.3.2 and 4.4 of the Annex apply from 16 June 2019. Section 4.2.2.5 and Appendix D1 of the Annex to this regulation apply from 16 June 2019 in the Member States that have not notified ERA and the Commission in accordance with Article 57(2) of Directive (EU) 2016/797. Section 4.2.2.5 and Appendix D1 of the Annex to this regulation apply from 16 June 2020 in the Member States that have notified ERA and the Commission in accordance with Article 57(2) of Directive (EU) 2016/797. Appendices A and C of the Annex to this regulation will apply from 16 June 2024 at the latest.

Note: DoA, date of application; EiF, entry into force; OPE, operation and traffic management.

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