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Deliverable D1.1

Analysis of level crossing safety in Europe and beyond

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Consortium - List of partners

Partner No	Short name	Name	Country
1	UIC	International Union of Railways	France
2	VTT	VTT Technical Research Centre of Finland Ltd	Finland
3	NTNU	Norwegian University of Science and Technology	Norway
4	IFSTTAR	French institute of science and technology for transport, development and networks	France
5	FFE	Fundación Ferrocarriles Españoles	Spain
6	CERTH-HIT	Centre for Research and Technology Hellas - Hellenic Institute of Transport	Greece
7	TRAINOSE	Trainose Transport – Passenger and Freight Transportation Services SA	Greece
8	INTADER	Intermodal Transportation and Logistics Research Association	Turkey
9	CEREMA	Centre for Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning	France
10	GLS	Geoloc Systems	France
11	RWTH	Rheinisch-Westfaelische Technische Hochschule Aachen University	Germany
12	UNIROMA3	University of Roma Tre	Italy
13	COMM	Commsignia Ltd	Hungary
14	IRU	International Road Transport Union - Projects ASBL	Belgium
15	SNCF	SNCF	France
16	DLR	German Aerospace Center	Germany
17	UTBM	University of Technology of Belfort-Montbéliard	France

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Executive summary

The aim of this deliverable was to identify the differences in level crossing environments between countries. Through a questionnaire designed ad-hoc (*Country Information Collection Form*), nominated partners and UIC collaborators were responsible for collecting information from relevant experts and operational staff from their country. Information was received from twenty-four countries: Albania, Austria, Belgium, Canada, Finland, France, Greece, Ireland, Italy, Latvia, Lithuania, Macedonia, Montenegro, the Netherlands, Norway, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Summary of the results concerning level crossing safety arrangements

This section examined the basic level crossing protection arrangements and rules of application used in the surveyed countries as well as any additional safety arrangements attached to level crossings to tackle safety.

- *Selection of level crossing protection*

The most commonly found type of crossing are passive level crossings, found in all but one of the surveyed countries. Of the active level crossing types, automatic protection systems are present to a far greater extent than those operated manually.

Level crossing protective arrangements are decided based on a combined set of criteria, most commonly the volume of road and rail traffic and the maximum train speed and to a slightly lesser degree the conditions of the road and rail (i.e. type of road and number of railway tracks). At level crossings with no protection (most notably passive LCs and LCs with automatic user side warning only), the sighting distance and conditions are also important factors taken into consideration.

In 16 of 24 responding countries (66%), local circumstances are considered when deciding the protective arrangements to apply at level crossings, most notably previous accidents and the proximity of the crossing to amenities that generate a high volume of level crossing users (including vehicles and pedestrians).

- *Level crossing protection decision-making body*

In general terms, the responsibility for deciding the form of level crossing protection falls onto the railway infrastructure manager (just over a third of countries) (n=9) and then amongst the remaining countries the responsibility is distributed between the responsible government ministry (all-encompassing transport) (n=5); decision shared between different agencies (n=5); or is reported to be based on regulation (n=5).

- *Level crossing warning time and rules*

The average level crossing warning time is 32.7 seconds, except for Austria, Italy, Macedonia and Russia who have higher warning times than other countries. In some countries, the warning time differs depending on the type of level crossing and/ or road, with other factors also including types of users; distance to the crossing; and speed of the train.

- *Additional safety arrangements attached to level crossings*

In terms of additional safety arrangements, the most commonly found type of measure are physical and technological measures with cameras, rubber panels and warning lights being used in a large proportion of the responding countries.

Public awareness and educational measures are employed as additional measures in a considerable number of the responding countries, with particular emphasis on school safety campaigns and general campaigns.

A smaller number of countries have additional organizational and procedural safety arrangements. Of those countries the most common types of measures adopted were risk management tools, safety management information system and specific rail and road arrangements at level crossings.

Summary of the results concerning legal aspects of level crossing safety

This section has explored the legal framework for the design, operation and management of level crossings in the surveyed countries.

As a first step, the key common rules for the safety regulation at level crossings in Europe and beyond were explored. Currently, the common legal framework regarding safety at level crossings is limited to treaties and recommended guidelines (not mandatory) produced by international organisations and policy-making bodies such as the United Nations Economic Commission for Europe (UNECE), International Union of Railways (UIC) and the International Road Union (IRU). On the rail side, the European railway safety directive (2016/798) brings together rules covering safety of the railway system, albeit not including specific details on managing level crossing safety.

Next, a descriptive analysis of the legal and strategic framework around level crossing safety in each country was carried out, revealing the following:

- Overall there is a greater level of adherence to the Vienna Conventions on Road Traffic and Road Signs and Signals than the UIC leaflets (75% vs. less than 20%). Given the nature of the Vienna Conventions this in turn indicates a greater level of harmonization with road side rules than those applied specifically to the operation and management of level crossings.
- A large proportion (between 42–46%, n=10–11) of survey respondents gave no response to the question of adherence to the UIC leaflets 760; 761; and 762. This could indicate lack of knowledge regarding these rules and whether they are applied in the surveyed country.
- In some countries, there are specific level crossing safety policies: level crossing removal policy (92% of countries, n=22); level crossing protection policy (67% of countries, n=16); organisational and strategic development policy (30% of countries, n=8); and education and enforcement policy (25% of countries, n=5).

The analysis of the national legal framework applied to the design, operation and management of level crossings indicate:

- In all countries responsibility for level crossing safety legislation falls on ministries or government departments responsible for transport, encompassing both road and rail and in many cases also infrastructure.

- A number of common legal themes can be found across the responding countries, most notably: rules regulating the safeguarding of level crossings (83% of countries, n=20); rules governing level crossing usage (58% of countries, n=14); rules concerning railway safety and train traffic management (37%, n=9); etc.
- In 18 countries, the rules are applied equally throughout the country, with the exception of six countries: Albania, Canada, France, Italy, Spain and the United Kingdom where there are some regional variations often due to the rail or road infrastructure being managed regionally.
- In Finland and Canada, the focus of the improvement is to further develop existing protection systems to be more cost effective and energy efficient.
- Finally, the next legislative steps to improve level crossing safety were proposed. Results highlighted: level crossing reduction; improved cross-agency working; greater level of education and enforcement for correct level crossing usage; a range of strategic and legal related development and actions; and review of technical rules.

Summary of the results concerning division of responsibilities regarding level crossings

This section analysed the division of roles and responsibilities for the design, operation, management and enforcement of safety at level crossings, including the stakeholders involved and the scope of their responsibility in addition to the existence of cross agency working and whether there is an independent or specific government body dedicated to promoting safety at level crossings.

- *Design of level crossing safety*

The rail infrastructure manager holds the greatest level of responsibility for the design of level crossing safety, with sole responsibility in one third of surveyed countries and shared responsibility with the road administrator in one quarter of countries. In terms of division of responsibilities, the elements on the road side of the level crossing fall within the domain of the road administrator, particularly design of road signs, whilst the elements making up the level crossing itself is responsibility of the rail administrator.

- *Safe operation of level crossings*

Responsibility for the safe operation of level crossings falls most heavily on rail (in just over half of countries) closely followed by joint rail and road responsibility (in just under a third of countries). The scope of responsibility most notably relates to road and rail side maintenance and repair but also encompasses the rail and road side users´ responsibility to adhere to railway operating rules and road traffic regulations respectively.

- *Management of safety at level crossings*

Responsibility for the management of level crossing safety falls within the remit of various stakeholders, principally the rail infrastructure manager but also the road infrastructure manager, rail operator, police, responsible ministry and national safety agency. The tasks associated with managing level crossing safety are, in general terms, performance related, from ensuring the efficient and safe operation of level crossings and monitoring the achievement of objectives to maintenance of the crossing.

- *Enforcement of safety at level crossings*

There is a large degree of variation in terms of the distribution of roles and responsibilities, with different compositions of stakeholders holding responsibility for enforcing safety at level crossings. The rail infrastructure manager continues to have the greatest level of responsibility across the countries, closely followed by the police and transport authority. Enforcement of safety is principally performed through the supervision of rail infrastructure activities (by national safety authorities or similar) on the one hand and the enforcement of road side user rules (by the police) on the other.

- *Cross agency working for the management and operation of safety at level crossings*

In the majority of countries (88%, n=21) there is some form of cross agency working for the management and operation of safety at level crossings. This principally takes the form of multi-stakeholder working groups; joint rail and road level crossing inspections; and cooperative arrangements between involved partners.

- *Existence of dedicated government or independent level crossing safety body*

Half of the countries report to have a government body or independent organization dedicated to promoting safety at level crossings operating in their country. In most cases it takes the form of existing government or non-government entities that carry out functions or activities as part of wider road safety or railway safety work. This is with the exception of Canada where there is a specific and independent organisation set up with this objective, Operation Lifesaver and Russia where there is an Interdepartmental Working Group on Traffic Safety at Level Crossings.

Summary of the results concerning user requirements in level crossings

The different railway and road contexts (e.g. road and rail traffic volumes, speed, rules, etc.) together with various cultural factors, are likely to impact level crossing safety and attitudes to risk in the different countries. Measures to manage safety at level crossings are liable to be more effective when targeting identified issues, based on an understanding of the profile of use of particular crossings. On this basis the SAFER-LC project also aims to analyse level crossing user needs, by identifying national safety arrangements related to user requirements and how these needs are identified.

Most countries report to have some form of safety arrangement that takes into account the need of specific user groups although these account more for motorized road users (transport professionals, heavy vehicles and farm vehicles) than vulnerable road users, (most notably cyclists and pedestrians) with the UK providing the most complete set of examples of measures targeting a wide range of level crossing users.

In terms of reaching the end user, survey responses indicate a strong focus on education and awareness raising actions and to some extent increased enforcement. Interestingly there appear to be very few examples of work or policies towards developing forgiving and self-explaining infrastructures amongst the surveyed countries, with just one notable example of this taking place in Sweden.

Summary of the results concerning the lessons learnt regarding level crossing safety

There is substantial cross over between those factors that have been identified to facilitate and those that act as barriers to level crossing safety. The main factors reported in the survey tool are summarised in the following.
Factors facilitating the level crossing safety:

- Strategic level
  - Cross-agency working
  - Political backing and investment
  - Evidence based decision making
  - Setting ambitious safety targets
- Operational level
  - Investment in level crossing protection.
  - Effective programme of maintenance.
  - Investment in level crossing removal.
- Educational and enforcement level
  - Information and education and sanctioning level crossing misuse.

Factors that act as barriers to achieving level crossing safety:

- Strategic level
  - Political acceptance and public investment
  - Lack of cross-agency working
- Operational level
  - Cost and complexity of LC removal and upgrade process
  - Limitations of current protection arrangements
  - Maintenance
- Human factors level
  - Public acceptance
  - Level crossing misuse
  - Public awareness

Summary of the results concerning best practices on level crossings

This section was intended to provide some first contributions to four key objectives of the SAFER-LC project:

- Collect synthesized information on successful experiences, projects, case studies and/or technological developments regarding level crossings safety.
- Identify the most innovative experiences carried out by the railway infrastructure managers, universities, technological centres and companies.
- To disseminate this information amongst the international railway sector.
- Generate shared knowledge and experience sharing.

Twenty case studies and/or project results at a European and international level were reported. In some cases, the measures are already implemented but in others, they are only at a design or conceptual phase. These examples represent a diverse spread of safety arrangements, including two organisational and procedural actions, seventeen physical and technological measures and only one educational intervention.

The organisational and procedural measures encompassed a level crossing safety manual and level crossing safety analysis tool used for the allocation of safety measures. Just one educational measure was cited, a Safety at Level Crossings rule book directed for use by railway staff, schools and railway police. Under the physical and technological category a wide range of examples were reported, from low cost measures to more sophisticated technological solutions. Examples include the following:

- Physical elements applied to the road approach that act as a warning and/or facilitate road user crossing (e.g. road markings; rumble strips; rubber/plastic cattle grids) (n=3);
- Technologies (e.g. video, satellite etc) that detect and communicate LC risk between rail and road vehicles and between infrastructure and road vehicles (n=3).
- Low cost measures to improve visibility of the roadside user (e.g. traffic mirrors;“V” Boards for management of vegetation overgrowth) (n=2)
- Flashing yellow light warnings at passive LCs (n=2)
- In-vehicle warning systems and protection device (in concept/design phase) (e.g. TEDS-Train Early Detection System; Junavaro project; wheel detector sensor technology) (n=3)
- Viaduct over level crossing (n=1)
- Camera for enforcement of red light violation (n=1).

In order to extract useful lessons from the best practice examples provided and explore cross-national circumstances, an evaluation exercise was developed (16 evaluations). The evaluation sought to identify some of the factors that should be taken into account when considering the feasibility of implementing the measure in different country contexts.

This is conceived as a preliminary exercise to highlight some best practices. In order to conduct further work on the lessons to be extracted from the best practice examples, further information on national factors such as the extension of the rail network, public investment, historical factors, socio-cultural factors, etc. should be taken into account.

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1. INTRODUCTION

A level crossing is where a railway line is crossed by a road or right of way without the use of a tunnel or bridge (ORR web). Level crossings represent a critical safety point for the train and road user. The complex interaction between the components that make up this intersection is often unpredictable, particularly road user behaviour. The influence of the rail environment at level crossings adds a further layer of complexity in terms of the coordination between different organisations responsible for managing risks at these points.

It is necessary therefore to have protection measures in place, not only for the safe running of trains but above all to safeguard road traffic which is in a much more vulnerable position in the event of a collision, given its comparative vehicle mass. Despite having technical systems in place to make the intersection between the road and railway tracks safer, accidents at level crossings continue to occur and the consequences of these are amongst the most serious of all road traffic accidents (Davey et al, 2005).

Indeed the risk of collision at level crossings has increased along with the growing volume of global freight and passenger traffic, both road and rail (UIC, 2016). In low and middle-income countries the levels of motorization are rapidly rising and in high-income countries, there is an increasing use of bicycles as inhabitants become more environmentally conscious, also highlighting the need to take into account the interests of vulnerable road users (UNECE, 2010b).

According to the European Railway Agency, the ultimate safety goal for infrastructure managers should be the elimination of level crossings, however, in the meantime and in parallel, the right mix of non-technical or operational measures jointly implemented by road and rail authorities is needed to reduce the risks in the short term (ERA, 2016).

In response to this situation, SAFER-LC aims to improve safety and minimize risk by developing a fully integrated set of cross-modal innovative solutions and tools for the proactive management and design of level-crossing infrastructure.

Work Package 1 studies level crossings in Europe and beyond, identifying and analysing national and international best practice and research results in order to provide requirements and recommendations for road and rail safety management. These recommendations will be taken into account in the subsequent work packages in the development and evaluation of innovative solutions to enhance the safety of level crossing road as well as rail users.

1.1. Purpose of the document

Task 1.1 aims to identify the differences in level crossing environments between countries. The analysis focuses on various aspects of level crossing safety in the selected countries: level crossing legislation; division of responsibilities for the safeguarding of level crossings; safety arrangements (organizational and procedural; physical and technological; public awareness and educational; others); user requirements for safe access and use of level crossings (taking into account for example age groups, cultures, nationalities, languages and physical limitations). The task also seeks to identify examples of good practice and innovations related to level crossing safety arrangements

with an emphasis on identifying breakthroughs in terms of organizational and procedural aspects, physical measures, new technologies, public awareness and educational measures.

This analysis will contribute towards creating a knowledge base that will allow the proposal of trans-modal (road-rail) security solutions at level crossings, focused on human processes and aimed at better coordination and cooperation between the managers of different transport modes.

Task 1.1 has sought to analyse the differences in level crossing environments within a wider European and international context, using where applicable, common regulatory frameworks from the United Nations and the European Union. Albeit a comprehensive set of common rules and regulations regarding level crossing safety is lacking at a European level and the international rules are not mandatory.

The analysis is principally based on information gathered by SAFER-LC task partners and other non-project stakeholders, provided in the Country Information Collection Form, the survey tool developed for this task. This information collection tool was designed to obtain rich and detailed information concerning different aspects of LC safety in the participating countries. Data were collected using the most appropriate means available with information sources encompassing level crossing safety laws and regulations, strategic documents, project reports, studies and consultation with experts.

1.2. Structure of the document

- The report begins by explaining the **Source of data and methodology** used in the task, an overview of the responses received and some reflections on the data analysis process and challenges experienced.
- Before presenting the results of Task 1.1 survey, **Section 3** provides a general introduction and context to level crossings across Europe and beyond, based on the review and analysis of secondary data sources.
- **Section 4** presents the results of the Country Information Collection Form.
- The report ends with final **Conclusions and proposals** section.

1.3. Abbreviations

Table 1. Country abbreviations

Abbreviations	Country
AL	Albania
AT	Austria
BE	Belgium
CA	Canada
FI	Finland
FR	France
EL	Greece
IE	Ireland
IT	Italy
LV	Latvia
LT	Lithuania
MK	Republic of Macedonia
ME	Montenegro
NL	Netherlands
NO	Norway
RO	Romania
RU	Russia
RS	Republic of Serbia
SK	Slovakia
ES	Spain
SE	Sweden
CH	Switzerland
TR	Turkey
UK	United Kingdom

2. SOURCE OF DATA AND METHODOLOGY

2.1. Method and information sources

The data was collected via a **Country Information Collection Form** (see Annex A). The Country Information Collection Form was designed to be used as a self-completion questionnaire (semi-structured) or as an interview guide, allowing nominated partners and UIC collaborators to consult with relevant experts and operational staff from their country (National Railway Safety Authority; National Highway Safety Authority; Railway undertakings; Infrastructure manager; Local authorities with responsibility for level crossings etc.) as appropriate.

At the inception of Task 1.1, a working paper was produced setting out the methodological approach for data collection which was distributed to all task partners. This proposed that one task partner from each country be nominated as responsible for collecting national data. The nominated country information collection partners were:

- Belgium: IRU
- Finland: VTT
- France: SNCF
- Greece: CERTH
- Italy: Uniroma3
- Norway: NTNU
- Spain: FFE
- Turkey: INTADER

In order to reach other European and non-European countries for their inclusion in the study, task partners were asked to collect information from neighbouring or other countries where possible. Most notably, UIC made contact with a range of countries through its level crossing networks via ILCAD and other related international work (UNECE Group of Experts on Improving Safety at Level Crossings) distributing the aforementioned survey tool. The efforts made by the UIC together with other individual task partners helped secure participation from a number of other non SAFER-LC project countries in Task 1.1.

As a semi-structured survey tool, the Country Information Collection Form mainly comprised open-ended questions that sought qualitative information under the following sections:

- Section I: General Information, explored level crossing and safety arrangements in different countries.
- Section II: Legal Aspects of Level Crossings examined the adherence of each country to international level crossing safety rules and guidelines and the national situation in terms of safety policy and legislation; legal responsibility and the future vision for level crossing safety legislation.
- Section III: Division of Responsibilities between the Stakeholders Involved which aimed to identify the stakeholders responsible for the design, operation, management and enforcement of safety at level crossings and the extent of cooperation between the different stakeholders.

- Section IV: User Requirements at Level Crossings sought to understand user requirements taking into account the different user groups, especially vulnerable users.
- Section V: Lessons Learnt Regarding Safety at Level Crossings identified the factors that support or act as barriers to implementing safety measures at level crossings.
- Section VI: Experiences and Best Practice Regarding Level Crossing Safety required task participants to share their knowledge of project results, case studies and technological developments regarding level crossings safety, including a brief evaluation exercise of measures to assess their transferability between countries. More detail regarding the method used in rating the measures is provided in Section 9 of this report.

2.2. Geographic coverage of study results

Data for this study was received from twenty-four countries (see Table 2).

Table 2. Geographic scope of study results

Partner countries	Other European countries	Country beyond
Belgium	Albania	Canada
Finland	Austria	
France	Ireland	
Greece	Latvia	
Italy	Lithuania	
Norway	Macedonia	
Spain	Montenegro	
Turkey	Netherlands	
	Romania	
	Russia	
	Serbia	
	Slovakia	
	Sweden	
	Switzerland	
	United Kingdom	

The analysis carried out has covered Task 1.1 partner countries: Belgium, Finland, France, Greece, Italy, Norway, Spain and Turkey as well as other European countries, including: Albania, Austria, Ireland, Latvia, Lithuania, Macedonia, Montenegro, the Netherlands, Romania, Russia, Serbia, Slovakia, Sweden, Switzerland and United Kingdom and one country beyond Europe, Canada.

As can be observed, responses to the study have been received from all parts of the EU, with representation from both northern and southern European countries as well as from the East and West. This wide geographic spread not only contributes to the representativeness of the results but

also the richness of the data in terms of cultural diversity with inputs from member states with different cultural backgrounds, attitudes to risk, safety levels or policies (see Figure 1 below).

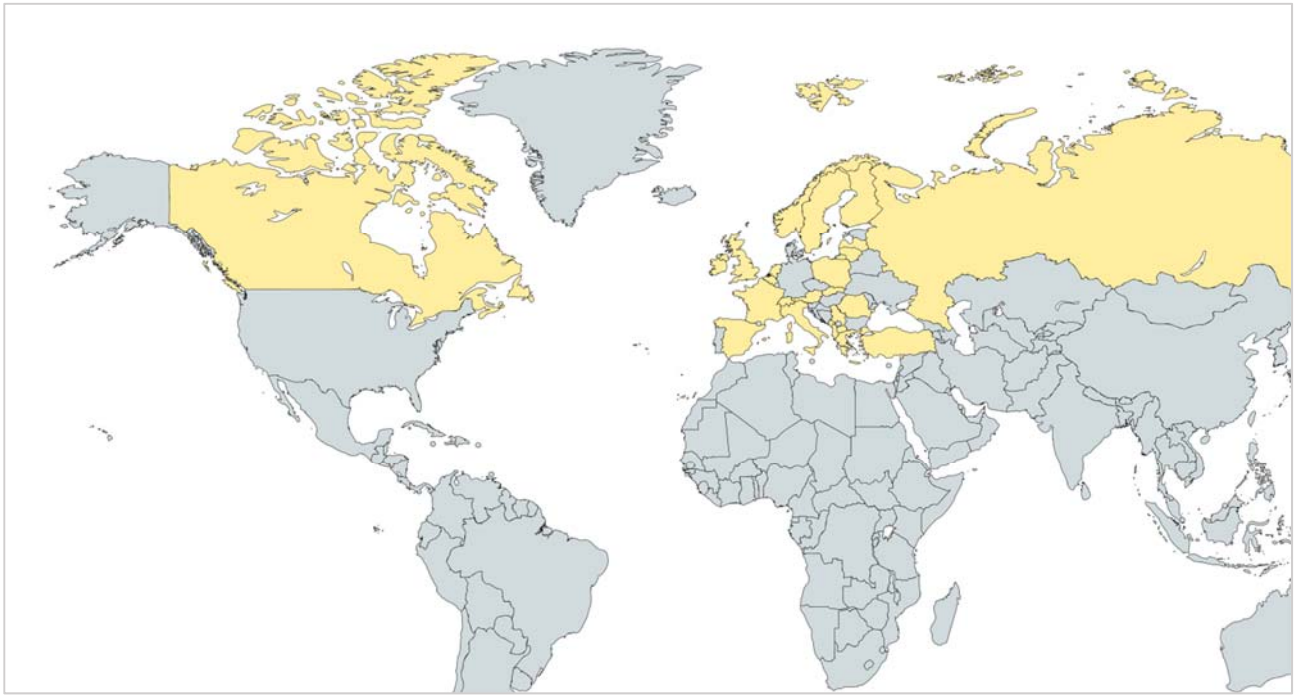


Figure 1. Geographic scope of study

The completed Country Information Collection Forms can be found in the separate annex document *Annex. Completed country information collection forms.*

2.3. Response rate to the Country Information Collection Form

In general, the response rate of countries to the information requested in the Country Information Collection Form was very high (see Table 3). From the 24 countries who returned the filled form, 9 countries answered all the questions: Austria, Finland, France, Ireland, Lithuania, Spain, Serbia, Switzerland and Turkey. Half of the countries (n=12) answered 91% of the questions: Albania, Belgium, Canada, Greece, Italy, Latvia, Macedonia, Norway, Romania, Slovakia, Sweden and the United Kingdom. Russia answered 86% of the questions. Montenegro and the Netherlands were the countries with the lowest response rates: 82% (Annex B).

The section on Experiences and Best Practice Regarding Level Crossing Safety had the lowest response rate (42%). However, there were countries reporting more than one experience and best practice, such as Austria (2), Finland (4), France (2), Ireland (5) and Spain (2).

Table 3. Response rate by question type

Type of question	Response rate
Section I. General information on LCs and safety arrangements	99%
Section II. Legal aspects on LCs	98%
Section III. Division of responsibilities between the stakeholders involved	100%
Section IV. User requirements at LCs	100%
Section V. Lessons learnt regarding safety at LCs	100%
Section VI. Experiences and best practice regarding LC safety	42%

2.4. Data processing from Country Information Collection Form

The information collected in the Country Information Collection Form was cleansed and reviewed by the Spanish Railways Foundation (FFE).

In several cases survey respondents were re-contacted to seek further clarification in the event that their answers were incomplete, did not respond to the question or required further explanation.

The information was then collated, summarised question by question and analysed using a descriptive analysis method with cross-country comparisons made where possible. For the analysis of the results, where possible, responses were coded under different categories or themes. Please note that these categories do not correspond with options given in the original survey tool (which mainly comprised open questions) rather were constructed based on the responses given in the survey[1].

Despite the great effort made to respond to the survey tool some challenges were experienced to analyse the information collected resulting in the following:

- discrepancies in the quality of information provided by different countries;
- inconsistency in the quality of information between sections and questions;
- not all countries cited the sources of information that had been used in completing the form.
- in some cases, the sources of information were not in English.

These challenges have meant that only a very general comparison has been possible and only on some factors where more standard information was available (e.g. legal framework).

[1] A substantial amount of additional information was received from France following the review of the draft Deliverable. Unfortunately, given the time available, it was not possible to incorporate these new results into the Final Deliverable.

3. LEVEL CROSSINGS IN EUROPE AND BEYOND: MAPPING AND BACKGROUND

3.1. Mapping of level crossings in Europe

In 2014 there were 114,580 level crossings in the European Union (EU) (28 EU Member States) (ERA, 2016). Many differences could be found between European countries however. For example, France, Germany and Poland had the highest number of level crossings in Europe (more than 9,000) and Ireland, Portugal, Slovenia, Bulgaria, Latvia, Estonia and Luxemburg had the lowest number of level crossings (fewer than 1,000) (see Figure 2).

On average, there were five level crossings per 10 line-km in the EU, but this share varied considerably between countries. For example, Sweden, Austria, the Czech Republic and Hungary had the highest density of level crossings in terms of level crossings per line-kilometre (more than 75 per 100 kilometres) and, Bulgaria and Spain had the lowest density of level crossings (fewer than 25 level crossings per 100 line kilometres) (ERA, 2016).

At the international level, these differences between countries are also evident. In Australia, there are roughly 23,500 level crossings (RISSB, 2017). In Canada, in 2016 there were approximately 37,000 highway/railway crossings encompassing public, private and pedestrian, crossings. In Argentina, in 2014 there were 14,000 level crossings. In New Zealand, there were 3,200 level crossings. In South Africa, in 2010 there were 1,168 level crossings. In Mongolia, there were 276 level crossings in 2014 (ILCAD, 2017).

It must be taken into account that level crossings are a critical part of railway infrastructure. For this reason, at the general level, strategies have focused on introducing technical improvements to level crossings and infrastructures and eliminating level crossings, but also combining these measures with others that reduce the risks to users of level crossings (e.g. educational measures).

For example, the number of level crossings saw a continuous slight decrease of about 4% per year over the past five years (2009–2014) across Europe. In some countries, the reduction is even higher. For example, in Serbia, the number of level crossings decreased about 5.8% between 2010 and 2014. At European level, with the current rate of reduction half of these passive level crossings will remain after 2030.

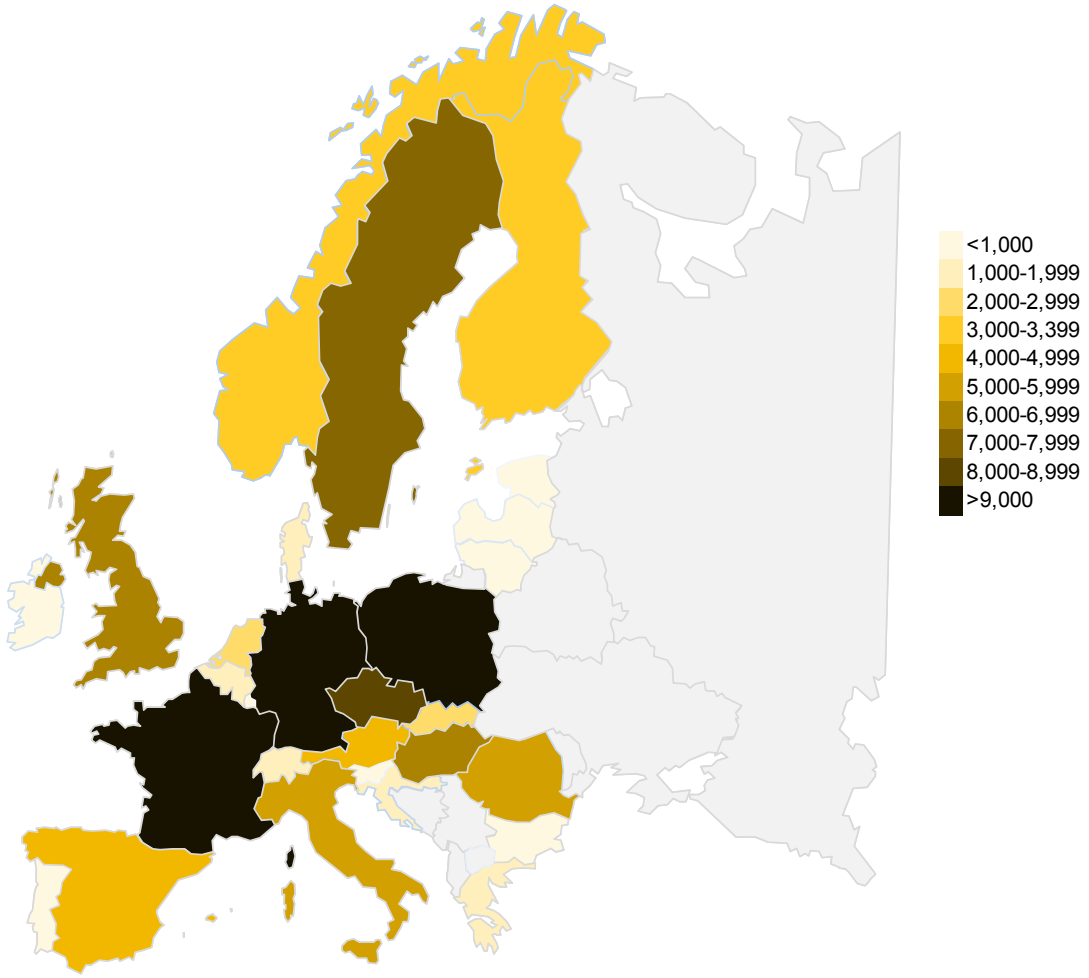


Figure 2. Total number of level crossings in Europe, 2014 (ERA 2016).

3.2. Types of level crossings in Europe

In 2014, passive (unprotected) level crossings represented 47% of all level crossings. These level crossings are usually equipped with a St Andrew cross traffic sign but do not provide any active warning to the road users (ERA, 2016).

Active level crossings (protected) represented 53% of all crossing types. In Europe in 2014, level crossings with automatic user-side protection and warning (barriers with lights) were the most common type of active crossings (57.1%) closely followed by the level crossings with the automatic user-side warning (typically flashing lights and sound) (18.2%) (see Figure 3).

In countries such as Australia, 79% of level crossings are passives (with a 'Stop' or 'Give way' sign) and 21% are active level crossings (with boom gates and/or flashing lights) (ARTC, 2016).

Although there is no data for all countries, the information available indicates that majority of accidents at level crossings occur on passive level crossings. For example, in Romania in 2014 of a total of 50 accidents in level crossings, 36 occurred on passive level crossings, 12 on automatic level crossings with a user-side warning and 2 on automatic level crossings with user-side protection.

In the following section, we detail the accidents in level crossings.

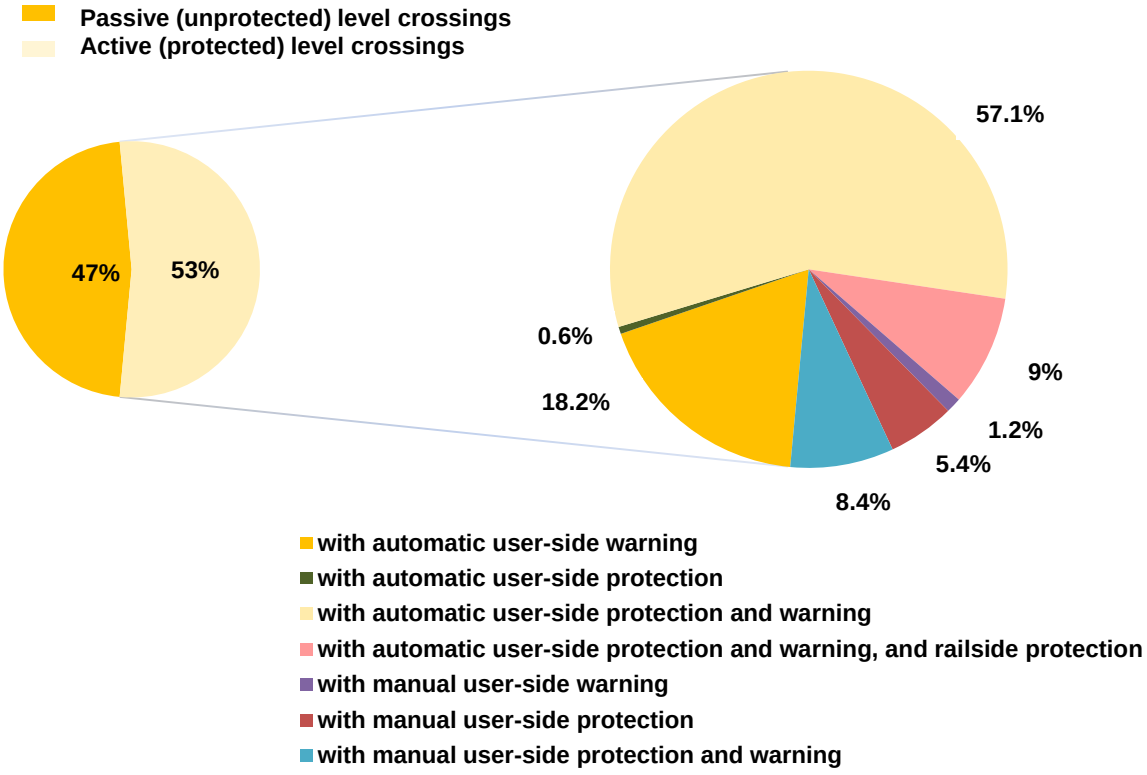


Figure 3. Types of level crossing in EU-28, 2014 (Percentages) (ERA 2016)

3.3. Accidents at level crossings

Level crossings constitute a significant safety concern. In recent years, on average, every day, one person has been killed and close to one seriously injured at level crossings around Europe (ERA, 2016). In Europe, the number of fatalities in all kinds of railway accidents has decreased, except for those related to level crossing accidents. This can be partly explained by the continuous increase in road traffic across Europe, which may increase the likelihood of a level crossing accident (ERA, 2016).

This may partly explain that, while level-crossing safety is viewed as a road-safety problem by railway infrastructure managers, it is viewed as a secondary problem by the road authorities. It appears that the concept of shared and delegated responsibility in road safety often fails to deliver the targeted results when it comes to level-crossing safety (ERA, 2014).

According to ERA (2016), there was stagnation in the number of level crossing accidents, with 506 accidents recorded on railways of the EU countries in 2014, compared to 510 accidents in 2013. However, since 2009, a slightly decreasing trend has been observed. The number of level crossing accidents has reduced a 3% per annum. In 2014, 506 significant level crossing accidents occurred in the EU-28 resulting in 282 fatalities and 287 serious injuries. Level crossing accidents represent

24.4% of all significant railway accidents and 26.8% of all fatalities on the railway, suicides excluded (see Figure 4).

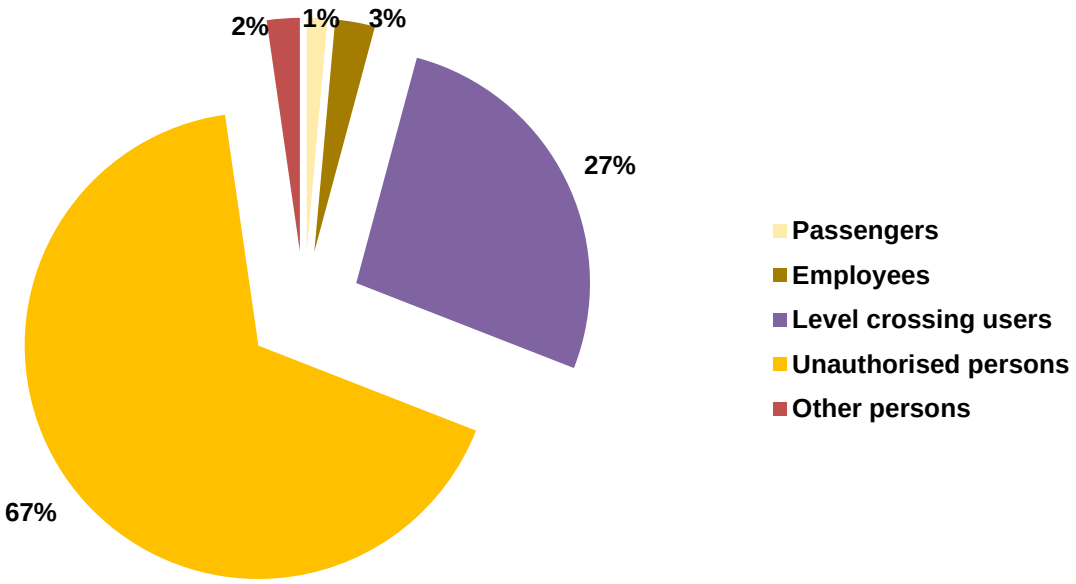


Figure 4. Railway fatalities per user category. EU-28, 2014 (Percentages) (ERA 2016)

According to ERA data (2016), in 2014, Germany and Poland were the countries with more level crossings user fatalities in EU-28 (41 and 38, respectively). Other countries by the number of level crossing users fatalities are France (25) and Czech Republic (23) (see Figure 5). In Russia, in 2014 57 fatalities in level crossings were produced and in Serbia 9 fatalities (ILCAD, 2017).

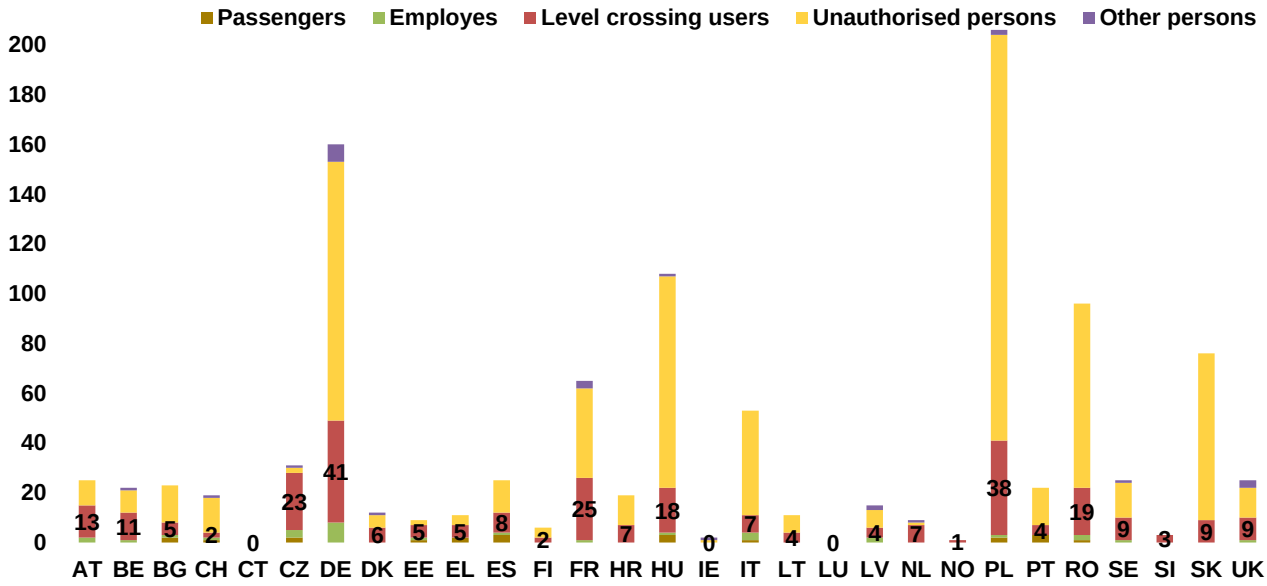


Figure 5. Railway fatalities per user category by country (EU-28), 2014 (Absolute values) (ERA 2016)

4. RESULTS

4.1. Level crossing safety arrangements

Level crossings are classified in accordance with the type of protection systems applied. In order to facilitate the collection of comparable data, the level crossing types referred to in the Country Information Collection Form were based on the European Common Safety Indicators (indicators related to technical safety) reported to the Agency (formerly European Railway Agency). The following definitions of these level crossing types are based on the classifications provided in the latest European Railway Safety Directive (2016/798):

- **Passive level crossing**: is one without any form of warning system or protection activated when it is unsafe for the user to traverse the crossing. As a minimum, fixed warning signs and road markings may be used (e.g. St Andrews Cross, unprotected LC warning sign.
- **Active LC with automatic user side warning**: a level crossing where user-side warning is activated by the approaching train (including visible devices (lights) and audible devices (bells, horns, klaxons, etc.).
- **Active LC with automatic user side protection**: a level crossing where user-side protection is activated by the approaching train. Users may be protected by the use physical devices, including half barriers, full barriers or gates.
- **Active LC with automatic user side protection and warning**: a level crossing where user-side warning and protection is activated by the approaching train. Users may be protected by a combination of the protection and warning devices listed in the previous two classifications.
- **Active LC with automatic user side protection and warning and rail-side protection**: a level crossing where user-side warning and protection is activated by the approaching train and where a signal or other train protection system permits a train to proceed once the level crossing is fully user-side protected and is free from incursion.
- **Active LC with manual user-side warning**: a level crossing where user-side warning is manually activated by a railway employee.
- **Active LC with manual user-side protection**: a level crossing where user-side protection is manually activated by a railway employee.

4.1.1. Distribution of level crossing type

As can be observed in Table 4, passive level crossings are the most commonly found type of crossing, found in all countries except Russia. Of the active level crossings, automatic protection systems are used to a far greater extent than those operated manually, with a number of respondents indicating that manual protection is rapidly in decline and being replaced by automatic systems. Of the active level crossings, automatic user side protection and warning is found with greatest frequency across the countries surveyed (n=21) followed by automatic user side warning (n=19).

The least commonly found type of level crossing uses automatic user side protection (n=5) (AL; LT; RS; SK). Five countries (AL; LT; RU; RS; SK) make the greatest use of manual protection systems whereas four countries (AT; CA; IT; SE) use no manual level crossings.

Table 4. Distribution of level crossing types by surveyed countries (n=24)

	Passive	Active automatically controlled				Active manually controlled		
		User side warning	User side protection	User side protection & warning	User side protection, warning & rail-side protection	User-side warning	User-side protection	User-side protection and warning
AL	X	X	X	X		X	X	X
AT	X	X		X				
BE	X	X		X				X
CA	X			X	X			
FI	X	X		X			X	
FR	X	X		X				X
EL	X			X	X			X
IE	X	X			X		X	
IT	X			X	X			
LV	X	X		X	X	X	X	
LT	X	X	X	X	X	X	X	X
MK	X			X	X			
ME	X	X		X				
NL	X	X		X			X	
NO	X	X		X				X
RO	X	X			X	X	X	X
RU		X	X	X	X	X	X	X
RS	X	X	X	X	X	X	X	X
SL	X	X	X	X		X	X	X
ES	X	X			X		X	X
SE	X	X		X	X			
CH	X	X		X	X		X	
TR	X			X	X		X	
UK	X	X		X	X		X	
Total	**23**	**19**	**5**	**21**	**15**	**7**	**14**	**11**
%	**96%**	**79%**	**21%**	**88%**	**67%**	**29%**	**63%**	**42%**

4.1.2. Systems of level crossing protection and criteria of selection

Countries were asked to specify the system of protection employed at each type of level crossing and the criteria followed in the selection of the level crossing type. A summary of the protection arrangements applied at the different level crossings in the surveyed country together with a graphic representation of the criteria applied in the selection of these arrangements is presented in Table 5 to 12. For a breakdown of the selection criteria by country and type of level crossing see Annex H.

Drawing on the information presented in these tables, a detailed analysis of the protection system(s) used and selection criteria applied at the eight types of level crossings is presented below.

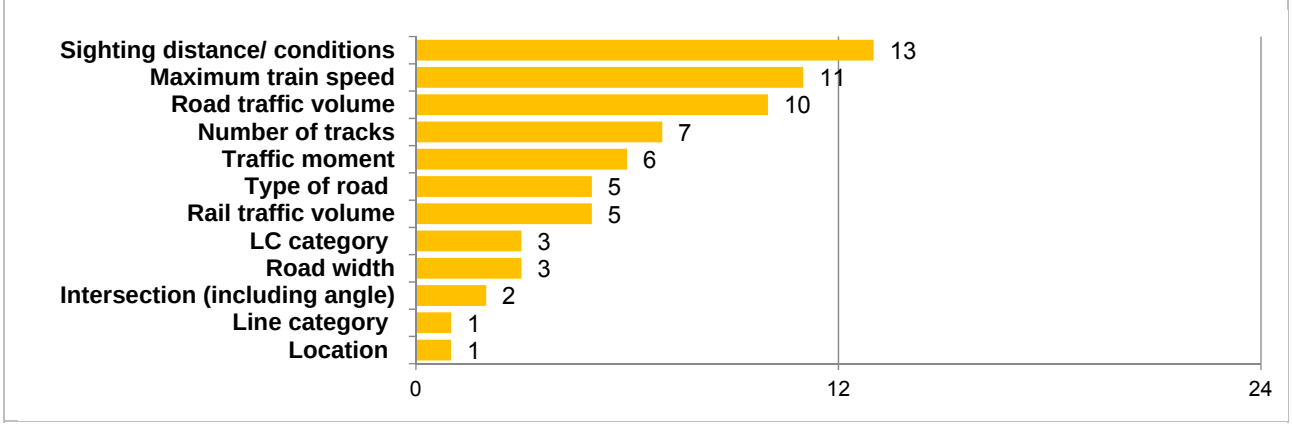
Passive level crossings: protection system(s) used and selection criteria

Table 5 brings together information on the systems of protection employed at *passive level crossings* and the criteria followed in the selection of this level crossing type. These results show that most countries indicate that some form of road signage is used to warn road side users of the approaching crossing, most notably the St. Andrews Cross sign which was reported by 8 countries.

A wide range of selection criteria is used in deciding whether to employ this form of crossing. The most frequently used criteria are sighting distance and conditions which is considered in 13 countries. Another important factor is the maximum train speed (n=11), road traffic volume (n=10) number of tracks (n=7) and type of road (n=5).

Table 5. Systems of protection used at passive level crossings and selection criteria (n=23)

LEVEL CROSSING TYPE: PASSIVE	
System(s) of protection	**Country**
➢ **Road traffic signs** (e.g. St. Andrews Cross, Stop sign, unprotected LC sign…)	All countries except Russia
Additional measures – Road markings: *ES* – Manual barriers for pedestrians or farm use, including gates, manually operated farm gates, chicane barrier: *NL; IE; SE*	
Selection criteria passive (number of countries reporting the selection criteria)	

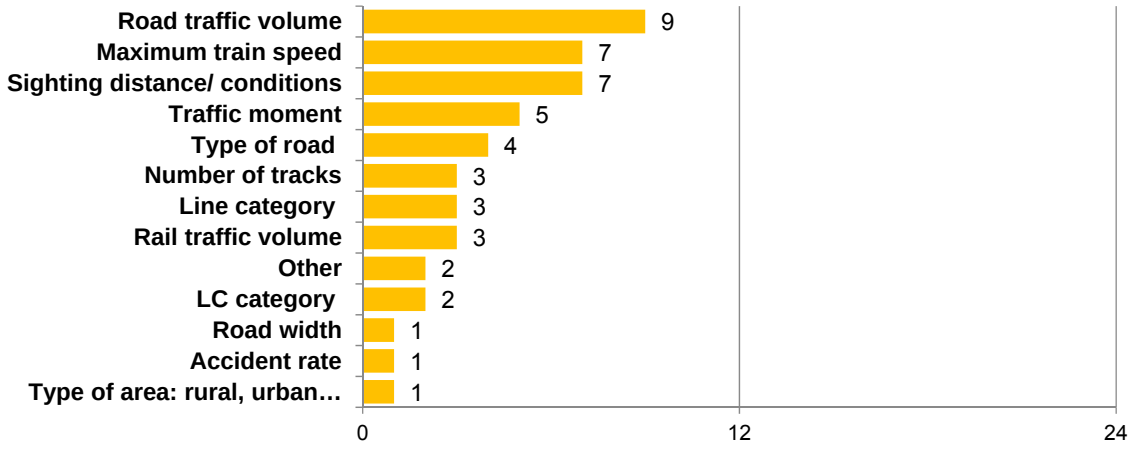


Automatic user-side warning crossing: protection system(s) used and selection criteria

Table 6 presents information regarding the systems of protection employed at *automatic user-side warning level crossings* and the criteria followed in the selection of this level crossing type. These results reveal that the systems of protection reported in most cases include a combined visual and acoustic warning through flashing lights (either red or green depending on the country, though principally red), road traffic lights, railway signals and warning bells. In four of the countries the warning is indicated by lights alone. The most important criteria cited for countries employing this type of crossing is road traffic volume (n=9) followed by maximum train speed (n=7), sighting distance and conditions (n=7), traffic moment (n=5) and type of road (n=4).

Table 6. Systems of protection used at automatic user side warning level crossings and selection criteria (n=19)

LEVEL CROSSING TYPE: AUTOMATIC USER-SIDE WARNING	
System(s) of protection	**Country**
➢ **Visual and audible warning**: flashing lights (red; red and green), road traffic lights, railway signals and bells	AT; BE; FI; FR; IE; LV; LT; NL; NO; RO; ES; SE; RU; ME; UK (n=15)
➢ **Visual warning only:** lights, flashing lights	AL; RS; SK; CH (n=4)
Additional measures: - Whistle boards to sound horn as supplementary audible warning: *UK* - Security camera used in conjunction with light and sound warning: *LT* - Three-aspect road traffic lights at controlled junction; two aspect road traffic lights at simple crossing: IE - Yellow light for 4 seconds then continuous red light: *AT*. - Variety of warning light systems (flashing lights; traffic light system): *CH* - Vertical risk/warning signals and ordering signals: AL - Two alternating red flashing lights; pedestrians light signal and demarcated area: *ES*	
Selection criteria automatic user-side warning (number of countries reporting the selection criteria)	

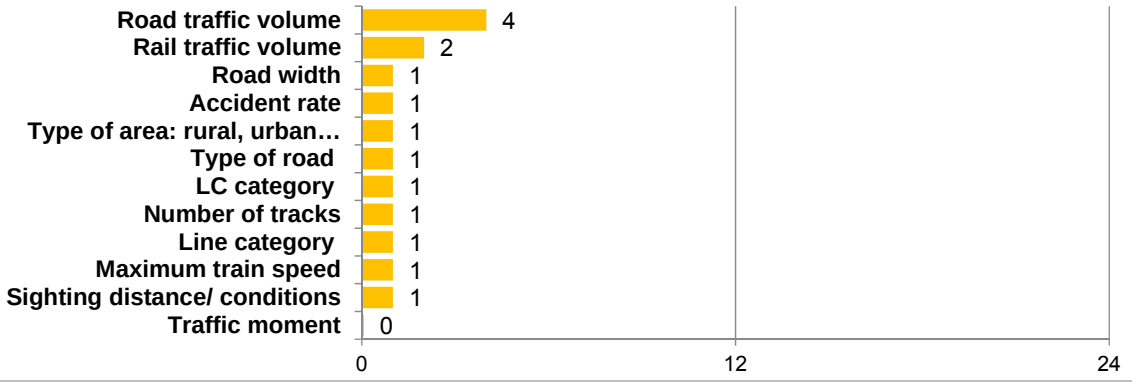


Automatic user-side protection crossing: protection system(s) used and selection criteria

Table 7. presents information regarding the systems of protection employed at *automatic user-side protection level crossings* and the criteria followed in the selection of this level crossing type. This is the least commonly reported level crossing type, being much more frequent to have protection accompanied by some sort of warning system. Above all it has been reported by countries in the east of Europe. Please note that in the responses for Albania and Lithuania there was no mention of barriers being used, rather road signs, railroad signs, security cameras (reported for Lithuania). Road and rail traffic volume are the factors most frequently taken into account when deciding protection at this type of crossing.

Table 7. Systems of protection used at automatic user side protection level crossings and selection criteria (n=5)

LEVEL CROSSING TYPE: AUTOMATIC USER-SIDE PROTECTION	
System(s) of protection	**Country**
➢ **Barrier** **Other systems:** ➢ **Road signalling** for automatic user side protection.	RU; RS; SK; LT (n=4) AL (n=1)
Additional measures – LC lifting barrier, anti-collision devices and traffic mirrors: RU – Semi barrier for road traffic: RS – Automatic or mechanical barriers, sound-signalling device: SK	
Selection criteria Automatic user-side protection (number of countries reporting the selection criteria)	

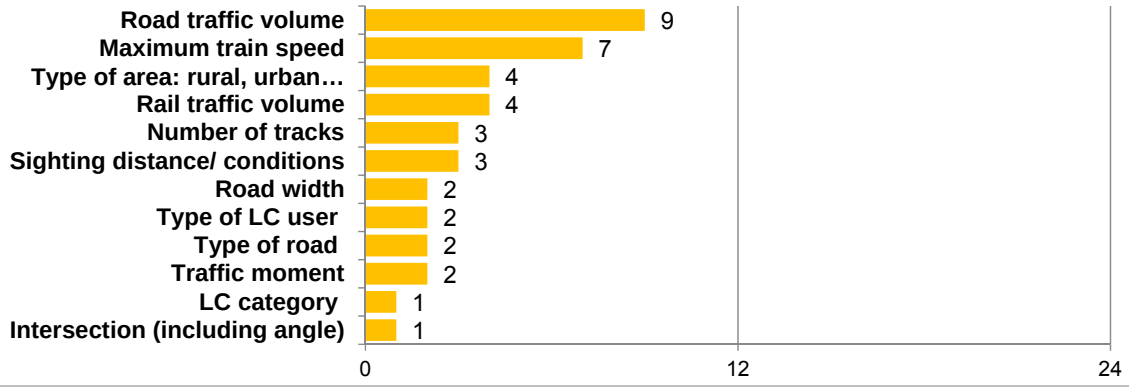


Automatic user-side protection and warning crossing: protection system(s) used and selection criteria

Table 8 presents information regarding the systems of protection used at *automatic user-side protection and warning level crossings* and the criteria followed in the selection of this level crossing type. This commonly reported level crossing type in most cases employs a combination of barriers (full and/or half), visual warning through light signals, road traffic signs and railway signals and bells to produce a sound warning. In far fewer cases the barrier is accompanied by just a visual warning and in one country the barrier is activated along with a sound warning alone. Please note that in the response for Albania road signalling for automatic user side protection was reported, but no explicit mention of a barrier. By far the factor taken into greatest consideration when selecting this crossing type is the volume of road traffic with just under half of the user countries considering this criterion (n=9) followed by the maximum train speed (n=7).

Table 8. Systems of protection used at automatic user side protection and warning level crossings and selection criteria (n=21)

LEVEL CROSSING TYPE: AUTOMATIC USER-SIDE PROTECTION AND WARNING	
System(s) of protection	**Country**
➢ **Barrier** (full and half), **visual** (light signals, road traffic signs, railway signals) **and audible warning** (bells).	BE; CA; IT; FI; FR; LV; LT; MK; ME; NL; NO; SK; SE; CH; TR; RU; UK (n=17)
➢ **Barrier and visual warning** (light signals, St Andrews cross),	AT; FR; RS (n=3)
➢ **Barrier and audible warning**	EL (n=1)
➢ **Other systems reported: Road signalling**	AL (n=1)
Additional measures - Positive white light: SK - LC lifting barrier, anti-collision devices and traffic mirrors: RU - Fast blinking red traffic light and simultaneous bell ringing; barrier covered with a striped reflector foil and equipped with small flashing light units activated when barrier moves or is in down position: *FI* - Gate and light used for pedestrians: *FR*	
Selection criteria automatic user-side protection and warning (number of countries reporting the selection criteria)	



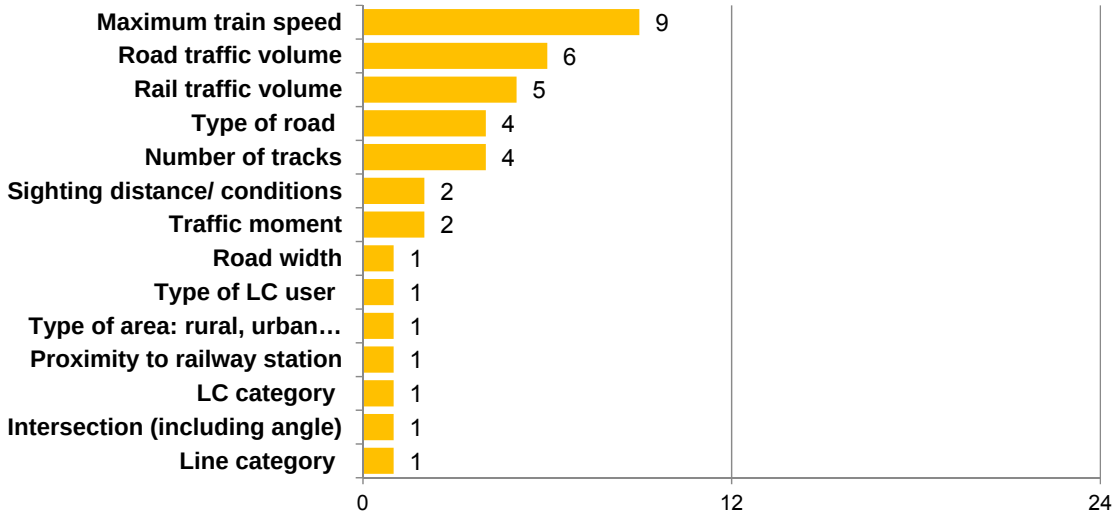
Automatic user-side protection and warning and rail-side: protection system(s) used and selection criteria

Table 9 presents information regarding the systems of protection employed at *automatic user-side protection and warning and rail-side protection* level crossings and the criteria followed in the selection of this level crossing type. In almost all cases the user side warning and protection comprises a barrier together with visual and acoustic warnings whilst the rail side protection varies somewhat between countries. The most commonly found rail side arrangements are signs and signals (n=6). In Spain this consists of a “Whistle” sign and light signals that warn the train driver about the signalling situation on the road. In Serbia railway distant signals are used for train protection.

A wide variety of parameters are considered in selection of this type of crossing, the most commonly applied being the maximum train speed (n=9) followed by road traffic volume (n=6) and rail traffic volume (n=5). Of relative importance is the type of road and number of tracks which is considered in 4 countries.

Table 9. Systems of protection used at automatic user side protection and warning and rail-side protection level crossings and selection criteria (n=15)

LEVEL CROSSING TYPE: AUTOMATIC USER-SIDE PROTECTION AND WARNING AND RAIL-SIDE PROTECTION	
System(s) of protection	**Country**
➢ **User-side:** Barrier, visual (light; road traffic signs); audible warning. ➢ **Rail-side:** Railway signs and signals ("Whistle" sign and light signals warning the train driver about the signalling situation on the road; railway barrage signals; railway distant signals)	LV; LT; RO; RS; ES; UK (n=6)
➢ **User-side:** Barrier, visual (light; road traffic signs); audible warning. ➢ **Rail-side:** Railway circulation protection with block sections in the event of crossing failures.	CA; IT; MK (n=3)
➢ **User-side:** Barrier, visual and audible warning; ➢ **Rail-side:** Control systems on the rail side: protective signal, control light, train control.	CH (n=1)
➢ **User-side:** Barrier, visual and audible warning ➢ **Rail-side:** A train driver warning system	TR (n=1)
➢ **User-side:** Barrier and audible warning ➢ **Rail-side:** Anti-collision devices and traffic mirrors	RU (n=1)
➢ **User-side:** barrier and audible warning ➢ **Rail-side:** surveillance and obstacle detection to notify level crossing protection status and authorize train for safe passing.	EL (n=1)
Additional measure: Red and white lights barriers where poor visibility; road crossing traffic lights compatible with the LC warning lights in urban areas: *ES*	
NB: The protection arrangement for Ireland and Sweden were not specified	
Selection criteria automatic user-side protection and warning and rail-side protection (number of countries reporting the selection criteria)	



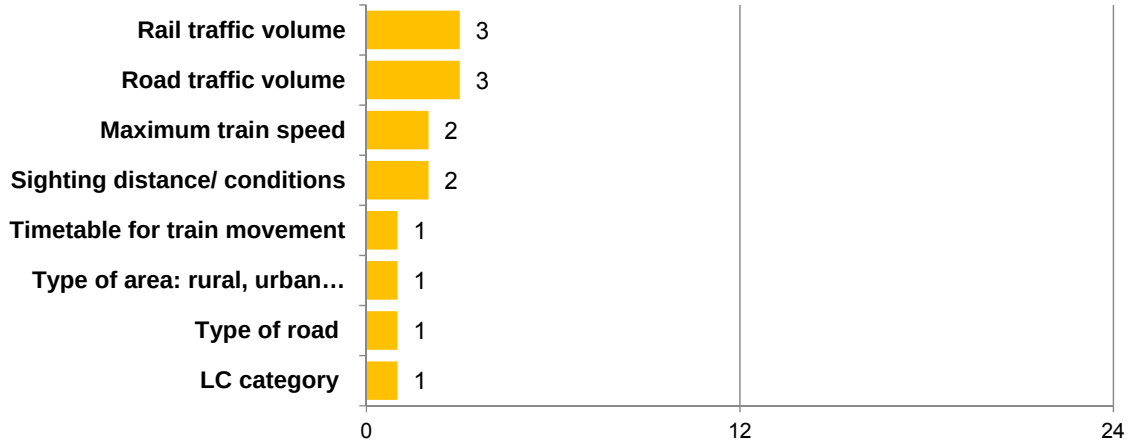
Manual user-side warning crossing: protection system(s) used and selection criteria

Table 10 presents information regarding the systems of protection employed at *manual user-side warning crossing* and the criteria followed in the selection of this level crossing type. Of the manually activated crossings this type is the least commonly reported, consisting as a minimum in traffic signs

and in three cases also visual (road traffic lights and signs), audible warnings and railway signs and signals. In Lithuania the audible warning is operated by railroad worker. The most important considerations for selecting this type of crossing is the rail and road traffic volume (n=3 respectively).

Table 10. Systems of protection used at manual user side warning level crossings and selection criteria (n=7)

LEVEL CROSSING TYPE: MANUAL USER-SIDE WARNING	
System(s) of protection	**Country**
➢ **Visual** (road traffic lights and signs) and **audible warning** and **railway signs and signals**.	3 countries: LV; LT; RO
➢ **Traffic signs**	4 countries: AL; RS; SK; RU
Selection criteria manual user-side warning (number of countries reporting the selection criteria)	



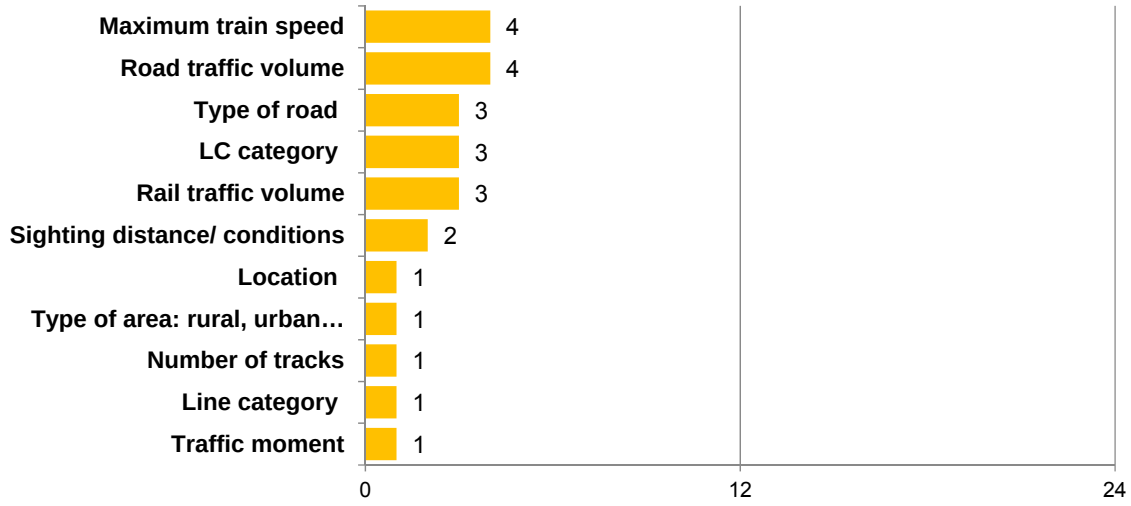
Manual user-side protection crossing: protection system(s) used and selection criteria

Table 11 presents information regarding the systems of protection employed at manual user-side protection crossings and the criteria followed in the selection of this level crossing type. The most frequently reported type of manual crossing, the protection systems employed either comprise manually controlled barriers together with visual warning lights and road traffic signs (St. Andrew´s Cross, “Stop” sign and “Gated LC” sign) (n=5) or simply a manual or mechanical barrier (n=5).

In the United Kingdom, hand worked gates, power operated gates, hand/power operated barriers with red/green lights are employed. In Spain a full or half-barrier is operated by a crossing keeper whilst in Russia mechanical barriers (horizontal swing) are used. In Finland these types of crossings are only for professional use where the barrier or gate is remotely monitored. In Switzerland no signalling is used, rather operating staff regulate road traffic. In one country, Lithuania, the protection reported was road and railroad signs, but no mention of barrier were made in the country information collection form. Again the most relevant criteria reported to be applied in selecting the protection at this type of crossing is the maximum train speed together with the road traffic volume (n=4 in both cases).

Table 11. Systems of protection used at manual user side protection level crossings and selection criteria (n=14)

LEVEL CROSSING TYPE: MANUAL USER-SIDE PROTECTION	
System(s) of protection	**Country**
➢ **Manually controlled barriers** and **visual warning lights** and **road traffic signs** (St. Andrew's cross, "Stop" sign, "Gated LC" sign).	5 countries: RO; SK; ES; TR; UK
➢ **Barriers only** (manual, mechanical barriers)	5 countries: FI; LV; NL; RU; RS
➢ **Road signs, railroad signs**	1 country: LT
➢ Operating staff regulate road traffic (no signalling)	1 country: CH
NB: The protection arrangement for Albania, Ireland were not specified	
Selection criteria manual user-side protection (number of countries reporting the selection criteria)	

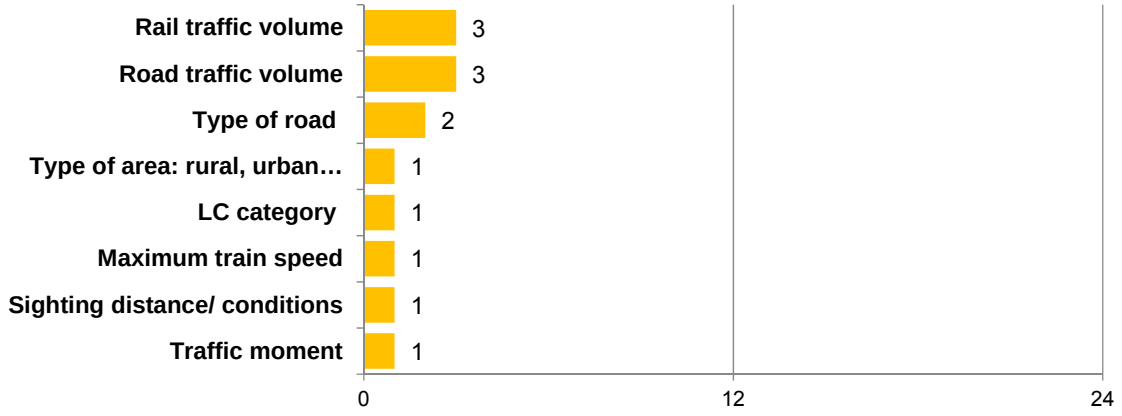


Manual user-side protection and warning: protection system(s) used and selection criteria

Table 12 presents information regarding the systems of protection employed at manual user-side protection and warning crossings and the criteria followed in the selection of this level crossing type. This type of crossing, reported to be used in just under half of the surveyed countries, reveals some variation in the systems of protection used between countries. The most common arrangement comprises the use of a manual barrier together with audible and visual warning and railway signals (n=4). In 2 countries mechanical barriers (horizontal swing) together with traffic signs and sound-signalling devices are used and in individual cases either a manually controlled barrier with road traffic signals is used, or an audible warning is activated by the approaching train, or barricades/barriers together with road signs, railroad signs, road traffic lights, and audible warning (railroad worker) are applied. The volume of rail and road traffic is the most frequently considered criteria to be reported (n=3 respectively).

Table 12. Systems of protection used at manual user side protection and warning level crossings and selection criteria (n=11)

LEVEL CROSSING TYPE: MANUAL USER-SIDE PROTECTION AND WARNING	
System(s) of protection	**Country**
➢ **Manual barrier, audible and visual warning** (traffic light signals and road traffic signs) and **railway signals**.	4 countries: BE; NO; RO; ES
➢ **Mechanical barriers** (horizontal swing) **and traffic signs, sound-signalling device**	2 countries: RU; SK
➢ **Manually controlled barrier, road traffic signals**	1 country: RS
➢ **Audible warning activated by the approaching train, barricades and barriers.**	1 country: EL
➢ **Road signs, railroad signs, road traffic lights, audible warning, (railroad worker)**	1 country: LT
Additional measures: – Railway agent activates the optical signs stopping the road traffic and an acoustic warning is sounded by the locomotive; chains or manually controlled barriers and half-barriers: *ES* – Power operated barriers with amber/red flashing lights, audible warning, hand-worked gates and gates worked by rods from a local cabin are employed: *UK*	
The protection arrangements for Albania and France were not specified	
Selection criteria manual user-side protection and warning (number of countries reporting the selection criteria)	



4.1.3. Local circumstances addressed by level crossing protection

In order to understand if any further factors are considered when deciding the protective arrangements to apply at level crossings, survey respondents were asked to indicate whether the selection of protective arrangements take into account the local circumstances at individual crossings.

The responses reveal that in the majority of countries, 66% (n=16), various local factors are considered when deciding the safety measures to be taken at level crossings. Four countries reported that no local factors are considered (Greece, Russia, Serbia, Turkey) and a further four countries (Belgium, Ireland, Montenegro, Slovakia) provided answers that did not clearly respond to question (neither denying nor affirming the application of local factors) and as such have been classified as not applicable. See Figure 6 below.

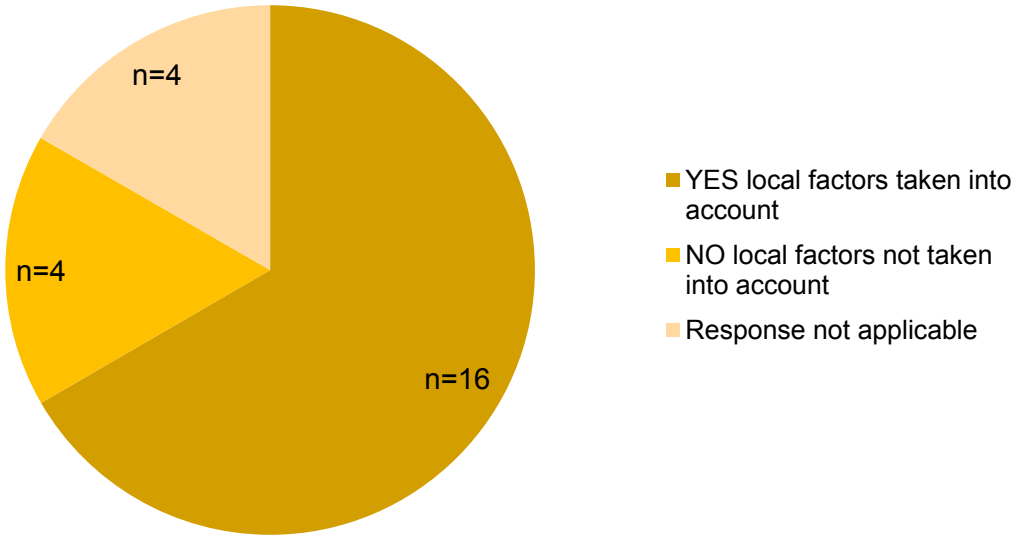


Figure 6. Extent to which local circumstances are taken into account when selecting protective arrangements (n=24 countries)

Table 13. summarises the responses given regarding the circumstances that are taken into account by the responding countries. The two most significant local factors taken into consideration include the history of accidents or incidents at the crossing and the location of the crossing in relation to local amenities that could generate high volumes of users, most notably the proximity to a school. This last point indicates a concern not just with volume of users but the type user, that being young people and school children, many of whom are likely to be pedestrians.

Table 13. Local circumstances considered in the selection of protective arrangements (n=16)

Previous accidents 9 out of 16 countries: 56%	
The history of previous accidents and/or incidents is taken into consideration by half of the countries who account for local factors.	Countries: AL; AT; CA; IT; LV; LT; MK; NO; RO
Proximity to amenities generating high volume of LC users (vehicles or pedestrian) 9 out of 16 countries: 56%	
Within this category all of the respondents indicated the proximity to a school but also and to a lesser degree playground, old people's home, sports facilities or residential area.	Countries: AL; AT; CA; FR; LV; NO; RO; SE; CH
Train circulation conditions 4 out of 16 countries: 25%	
This factor covers a number of circumstances: traffic moment; traffic volume; train frequency; number of tracks; frequent closures of the level crossing due to shunting; and upgraded rail infrastructure and increase in train circulation speed leading to level crossing removal.	Countries: FI; NL; FR; AT
Volume and type of road user 4 out of 16 countries: 25%	
This factor taken into account the number and type of level crossing user, with particular attention to pedestrians and their use in urban areas.	Countries: LV; NL; ES; SE
Road crossing conditions 2 out of 16 countries: 12.5%	
This takes into account number of local road circumstances including number of traffic lanes, whether zigzagging is possible, traffic speed, volume of cyclists, existence of separate cycle lanes, distraction, irritation, clearing possibilities, (un)paved roads.	Countries: NL; ES
Proximity to a station 2 out of 16 countries: 12.5%	
In Switzerland the interest in understanding the vicinity of a station relates to issues around unauthorized access to platform station via the level crossing.	Countries CH; NL

4.1.4. Level crossing protection decision making body

Survey respondents were asked to specify the entity responsible for deciding the form of level crossing protection employed at the different level crossing types in their respective countries (see Table 14 for a breakdown of entities by country). As illustrated in Figure 7, in general terms, the responsibility for deciding the form of level crossing protection falls onto the railway infrastructure manager (N=9) (FI; EL; IE; IT; LT; MK; NL; SE; CH). The responsible government ministry (all-encompassing transport) is accountable in 5 countries (AT; BE; RU; SK; TR). The decision is shared between different agencies in 5 countries (NO; RO; RS; ES; UK). In this latter case the agencies could come from different administrative areas, such as road, rail and other authorities as is the case

in Romania (see Table 14) or between different actors within the same sector, such as rail infrastructure managers together with the national safety authority as in Norway. In the final 5 countries the decision is reported to be based on regulation. What is clear from the results is that the responsibility principally falls within the rail domain rather than the road sector, albeit the ministerial departments involved often encompass both modes.

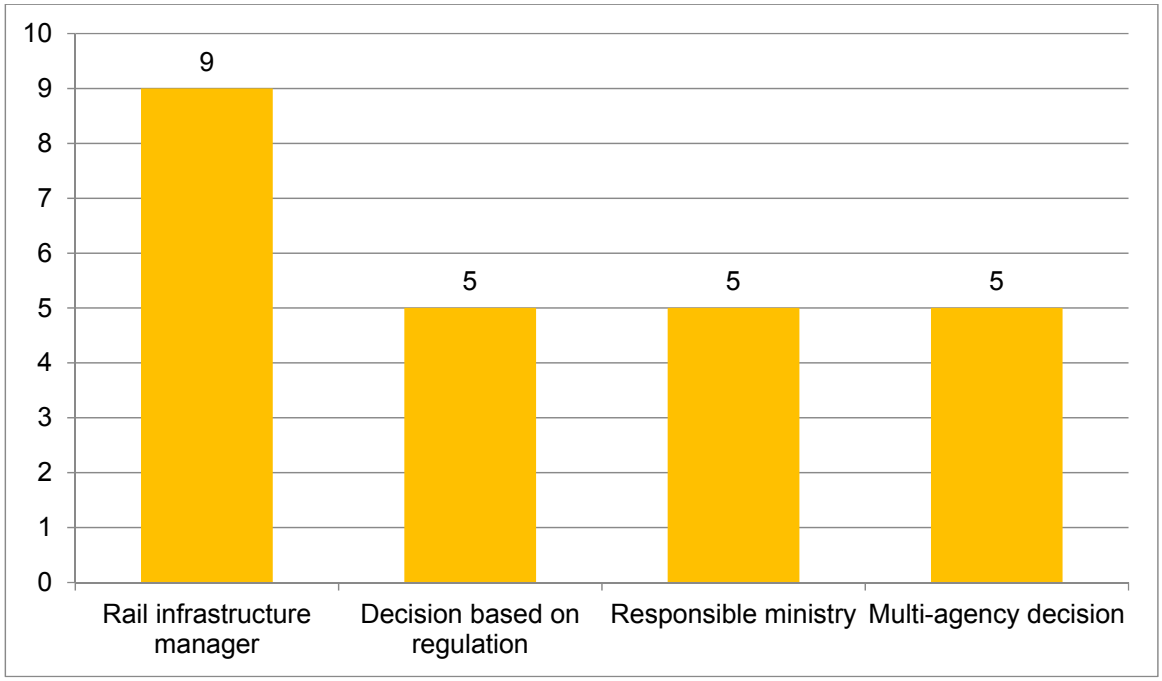


Figure 7. Decision making body regarding level crossing protection (n=24)

Table 14. Decision making body responsible for deciding level crossing protection systems

Country	Decision making body
Albania	Gathered in relevant legislation (Road Code and Road Code: Level crossings)
Austria	Federal Ministry for Transport, Innovation and Technology (BMVIT)
Belgium	Federal government-Mobility and traffic
Canada	Transport Canada Regulations
Finland	The Finnish Transport Agency (state owned railway network)
France	The Ministerial Decree of 18 March 1991
Greece	The Board of Directors of the Hellenic Railways (OSE) after the proposal of the relevant safety department
Ireland	Railway infrastructure manager
Italy	Railway Infrastructure Manager
Latvia	Regulations of Minister Cabinet no. 392
Lithuania	Railway infrastructure manager (in some cases other government authorities can decide the form of level crossing protection employed)
Macedonia	Railway Infrastructure Manager
Montenegro	Gathered in relevant regulations (Instruction 412)
Netherlands	Railway infrastructure manager (ProRail)
Norway	National safety authority, Bane NOR regulations, Rail infrastructure owner (Banesjef), Level crossings projects in Bane NOR
Romania	Railway infrastructure manager + Road infrastructure manager + Road police + Local public authority
Russia	Ministry of Transport of the Russian Federation
Serbia	Legislation designer following approval of the infrastructure manager and the audit by an independent commission/organization
Slovakia	The Ministry of Transport and Construction of the Slovak Republic on the basis of public procedure´s draft
Spain	Ministry of Public Works in consultation with Railway Infrastructure Manager and Ministry of Interior
Sweden	Railway infrastructure manager (Trafikverket´s Railway Traffic Safety department together with Maintenance department)
Switzerland	Infrastructure operator. Legal regulations define the decision criteria
Turkey	Ministry of Transport, Maritime Affairs and Communication
UK	Railway infrastructure manager after consultation with stakeholders including statutory consultees and the Safety Regulator.

4.1.5. Level crossing warning time and rules

A key issue concerning safety at level crossings is the length of time between the start of the warning sequence provided for users and the arrival of the first train at the level crossing.

The average level crossing warning time is 32.7 seconds, except for Austria, Italy, FYR Macedonia and Russia with warning time higher than other countries (see Figure 8 below).

- In some countries, there are differences by type of level crossing and/ or road in the warning time:

- In France, the level crossing warning time is 25 seconds for a level crossing with two half-barriers and 45 seconds for a level crossing with four half-barriers.
- In Ireland, the minimum warning times used by the infrastructure manager are 11 seconds for single track railways, and 13.6 seconds for double track railways.
- In Macedonia, the average time of level crossing closure is about 4 minutes at the automatic level crossing and 10 minutes on the manual level crossing.
- In Montenegro, for single-track railway lines, the minimum technical time of the automatic device for the single track is 30 seconds. This information includes the time of pre-ringing of 15 seconds, the time of lowering the half-barriers 10 seconds and the spare psychological time of 5 seconds. In the case of single-track lines, 36 seconds, because during this time the vehicle's transition time is required as well.
- In Serbia, 33 seconds for the level crossing for single track and 39 seconds for the double track are used.
- In the United Kingdom, the level crossing warning time is 27 seconds on public roads, 40 seconds at private vehicle crossings and 20 seconds at footpath crossings.

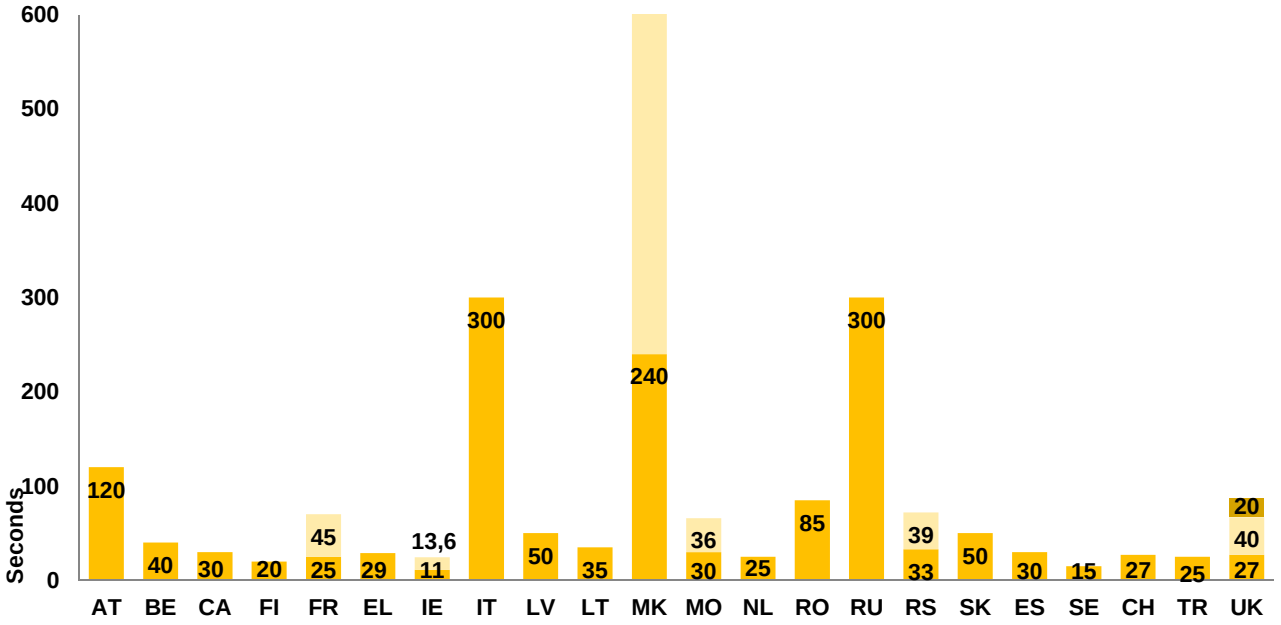


Figure 8. Level crossing warning time by country

Countries were asked to specify the factors that are taken into account when determining level crossing warning time (see Table 15 below). In six countries (Austria, Belgium, Finland, France, Macedonia and Spain) there is a link between the type of level crossing and warning time. Other factors taken into account include: types of users (Austria, Lithuania, Sweden, Switzerland and the United Kingdom); distance to the crossing (Austria, Italy, Latvia, Montenegro, the Netherlands, Switzerland and the United Kingdom); and speed of the train (Belgium, Greece, Latvia, Lithuania, Montenegro, Russia, Serbia, Slovakia and Sweden).

There are countries that consider other elements. For example, in Albania warning time is set according to technical standards. In Ireland, the definition of crossing time used by the infrastructure manager is the time it would take for a farm tractor and trailer of 7.3 metres in combined length and travelling at 5 km/h to cross the railway, considering a danger-zone that extends 2 metres from the running edge of the nearest rail. With a 1.5 second reaction time, this equates to 11 seconds for single track railways, and 13.6 seconds for double track railways.

Table 15. Factors that determine level crossing warning time by country

Factors that determine level crossing warning time	Country
Speed of the train	BE; EL; LV; LT; ME; RU; RS; SK; SE (n=9)
Distance of the crossing	AT; IT; LV; ME; NT; CH; UK (n=7)
Type of level crossing	AT; BE; FI; FR; MK; ES (n=6)
Types of user	AT; LT; SE; CH; UK (n=5)
Other	AL; IE (n=2)

4.1.6. Additional safety arrangements attached to level crossings

Organizational and procedural

The survey respondents were asked to indicate any additional or complementary arrangements used to improve safety at level crossings. The answers provided in relation to organizational and procedural arrangements are presented below (see Table 16 and Annex C. Table I). This shows that sixteen countries reported additional organizational and procedural safety arrangements. Eight countries (Belgium, Ireland, Finland, Lithuania, the Netherlands, Norway, Switzerland and the United Kingdom) use specific risk management tools to improve safety at level crossings. To provide an example, risk evaluation in Ireland allows the prioritisation of interventions. In the United Kingdom, there is a risk management toolkit with best practice for managing specific risks identified through research and ergonomic studies.

Six countries use a safety management information system (Canada, Finland, Lithuania, the Netherlands, Spain and United Kingdom). In Spain there is an annual monitoring for the official level crossings register. The Netherlands uses information from train cameras to analyse incidents and risk behaviour.

Specific rail and road arrangements at level crossings are followed in four countries (Albania, France, Russia and Slovakia). In Albania, safety rules and requirements for level crossings according to the Road Code are used at passive level crossings and for active level crossings, Guidelines for safe working position in railways. In France recommendations on how to organise the area surrounding the level crossing are produced for highway managers in collaboration with the Ministry.

Two countries (Latvia and Sweden) use information signals to improve safety at level crossings. In Latvia, plates include level crossing specific number and phone number to call in case of accident. In Sweden, there are different warning signs on the road for the road users when approaching a level crossing, to increase awareness.

In one of the countries (the United Kingdom), the railway infrastructure manager is developing public education campaigns focused on users of passive level crossings.

Table 16. Summary of safety arrangements under the organizational and procedural category by country

Organizational and procedural safety arrangement	Country
Risk tools	BE; IE; FI; LT; NT; NO; CH; UK (n=8)
Information system	CA; FI; LT; NL; ES; UK (n=6)
Rail and road arrangements	AL; FR; RU; SK (n=4)
Information signals	LV; SE (n=2)
Education campaigns	UK (n=1)

Physical and technological

The following section examines safety arrangements in level crossings under the physical and technological category (see Table 17 and Annex C. Table II). The responses show that there are technological enforcement systems installed at active level crossings. Some of them provide intelligence only and are not used directly for enforcement. In this case, they are used by infrastructure managers and police to identify problem locations prior to deploying police officers or dedicated enforcement cameras (France, Greece, Latvia, Lithuania, Romania, Russia and the United Kingdom). In France, speed/crossing cameras at crossings identified following an inspection or due to high accident rates are used. In Latvia, video files help with any accident investigation or to inform about any trespassers etc.

Table 17. Summary of safety arrangements under the physical and technological category by country

Physical and technological safety arrangement	Country
Cameras	FR; EL; LV; LT; RO; RU; UK (n=7)
Rubber panels	IE; LT; RS; ES; TR; UK (n=6)
Warning lights	CA; FR; ES; UK (n=4)
Barriers	NO; RO (n=2)
Rumble strips	FR (n=1)
Other	IE; FI; ES; CH; TR (n=5)

In addition, rubber panels are commonly used at active level crossings (n=6) as well as warning lights (n=4) and half and/or full gates (barriers) (n=2). For example, in Spain, anti-trespass panels are employed over level crossings and in Canada, a light system to advise locomotive engineers about crossing power failure or other failures (short warning time, etc.) is used. In Norway, full barriers work as obstacle detectors. Countries also use, though to a lesser degree, rumble stripes

(France). Turkey uses technologies to detect trains such as track circuit and axle counters. In Switzerland, there are systems in place to provide the indication of rail track clearance. In addition, four countries use warning signs to improve safety at level crossings. In Ireland, there are cattle grids on either side of level crossings. A further technology used in Spain is the SPN- 900 system that offers an integrated solution for the automatic protection of level crossings, using light and audible signalling (Class B), automatic/interlocked half-barrier (Class c) and pedestrian light signalling (Class F).

Public awareness and educational

The responses show that the majority of the countries deliver education actions developed to prevent unsafe conditions at level crossings (n=21) at all types of level crossings (see Table 18 and Annex C. Table III). In 13 countries, there are level crossing awareness-raising events in schools. In Turkey, the infrastructure manager personnel visit schools which are close to level crossings to educate students about level crossing safety. Similarly, in Norway, there are visits to schools and kindergartens located in the vicinity of level crossings where there have been regular reports of level crossing misuse. In some countries, information material, especially for children, is distributed to raise awareness on safe behaviour at level crossings (for example, in Belgium, Norway and Spain) and in Norway a mascot called *Lukas the Lion* has been.

There are general campaigns in countries to raise awareness about the dangers of level crossings (n=15). For example, in summer 2017, the Finnish Transport Agency together with the Finnish Transport Safety Agency, VR-Group Ltd, the Central Organisation for Traffic Safety in Finland (*Liikenneturva*) and the Police started a campaign on level crossing safety to remind people that trains always win at level crossings. In Spain in 2016 the rail infrastructure manager ran a railway safety education programme, targeting railway trespass and unsafe use of level crossings through different awareness raising activities (posters, workshops and talks etc.).

In other countries (Finland, Lithuania and Norway), videos are produced to inform people about level crossing dangers. In the United Kingdom, the railway infrastructure manager is developing an educational strategy concentrating on television campaigns and in Finland; the current campaign is broadcast on national radio channels as well as social media (e.g. *Facebook*, *YouTube* etc.)

Table 18. Summary of safety arrangements under the public awareness and education category

Public awareness and education safety arrangement		**Country**
General Campaigns		AT; FI; FR; IE; IT; LV; LT; MK; NO; RU; SK; ES; CH; TR; UK (n=15)
Schools Campaigns		AT; FR; EL; IT; LV; MK; NL; NO; SK; ES; CH; TR (n=12)
Materials	Children	BE; NO; ES (n=3)
	Video	FI, LT; NO (n=3)
	Media	FI; UK (n=2)
	Social Media	BE; FI (n=2)

Others

Some countries present other additional safety arrangements related to level crossings (see Annex C. Table IV):

- In Austria, there is a special training for driving instructors related to level crossings.
- In the Netherlands several new concepts are in a testing phase: use of colour and led type lights on the crossing floor and pre-warning for slow or disabled pedestrians.
- In Slovakia, there is a unique identification number for level crossings, a label that enables fast orientation when contacting the emergency services.
- In the United Kingdom, there are mobile phone apps that permit the conversion of text to voice for blind users (*Signly*).

4.2. Legal aspects of level crossings safety

4.2.1. Background

This section explores the legal framework supporting the design, operation and management of level crossings in the surveyed countries. This cross country analysis covers adherence to international rules and guidelines; national level crossing safety policy; legal responsibility for level crossing safety, legal frameworks and future vision for level crossing safety legislation in the surveyed countries. The section begins by establishing the international strategic and legal context before presenting the results from the survey of the legal aspects of level crossings in the different countries.

4.2.1.1. International regulations and strategic actions regarding safety at level crossings

Historically, the need for a harmonised approach to level crossing safety regulation stemmed from the frequent movement of motorised traffic between national borders (Middelraad, 1995) rather so than the cross border movement of trains. Such a common regulatory framework does in fact exist, albeit non-mandatory, and is applied through the following legal instruments:

- Vienna Treaties of 8th November 1968: “Convention on Road Traffic” and “Convention on Road Signs and Signals”;
- European Agreement supplementing the Convention on road traffic;
- UIC leaflets 760, 761, 762 providing regulations for railways regarding forms of level crossing protection and rules of application.
- Consolidated Resolution on Road Traffic” and “Consolidated Resolution on Road Signs and Signals.
- Directive (EU) 2016/798 of the European Parliament and of the Council of 11 May 2016 on railway safety (recast) (Text with EEA relevance).

Further strategic actions to increase safety at the interface of roads and rail systems have been in force at an international level, the most notable being the creation of a United Nations Economic Commission for Europe (UNECE) Group of Experts on Improving Safety at Level Crossings.

United Nations Economic Commission for Europe legal tools

Vienna “Convention on Road Traffic” and “Convention on Road Signs and Signals”

Signed in 1968, the Vienna “Convention on Road Traffic” and “Convention on Road Signs and Signals” are multilateral treaties aimed at facilitating international road traffic and increasing road safety through the standardisation of road traffic signing systems (road signs, traffic lights and road markings). These legal tools, managed by the United Nations Economic Commission for Europe (UNECE), contain a number of level crossing safety provisions and specify the **basic rules of behaviour for road users and pedestrians when crossing railway lines on a common basis**. Under the terms of these conventions, **trains have priority at all level crossings**, with road users and pedestrians obliged to respect the road signs and signals and stop when the train is approaching

(UIC, 2012). The European Agreement supplementing the Convention on road traffic contains even stricter provisions on traffic at level crossings.
Many countries across the world have become Contracting Parties and benefit from the implementation of these Conventions (UNECE web). In those Contracting Party states, domestic legislation must be in conformity with the international legal instruments (UNECE, 2017), albeit the rules, signs and signals in the Convention are subject to amendments if this is demanded by the document signatories.

UIC leaflets: 760, 761, 762

These International Railway Standard documents are targeted at regulating the forms of level crossing protection and rules of application for railways at level crossings.

- **UIC Code 760. Vienna Convention Road Signs and Signals** (7th Edition, September 2007) specifies the requirements for warning signals for road users (including barriers).
  The leaflet sets out rules to mark level crossings for road users, using road signs and signals. The contents of the leaflets are based on valid road regulatory documents.
  The document is divided into two parts. The first part provides definitions, classifications of level crossings and reference to the Vienna Convention on road signs and signals, including the supplementary European Agreement. The second part prescribes the road signs and signals to be applied at individual types of level crossing. All European specific requirements are clearly marked. It includes an Appendix containing signs and symbols to be used at level crossings.
- **UIC Code 761. Guidance on the automatic operation of level crossings** (4th Edition, January 2004). The leaflet gives an overview of the basic parts of a level crossing system, their functionality and the basic conditions to be fulfilled by a level crossing system, including additional features to be considered when designing a level crossing.
- **UIC Code 762. Safety measures to be taken at level crossings on lines operated from 120 to 200 km/h** (2nd edition, July 2005). This leaflet completes the UIC Leaflet 761 with information to be considered when installing a level crossing system on lines with speeds above 120km/h. It outlines the justification for limiting the number of level crossings on lines operated at speeds above 120 km/h; the conditions for warning signals (lights, barriers) that should be taken into account; and finally it makes recommendations regarding the connection with traffic control centre and optimizing the warning time. It fixes a speed limit of 200 km/h above which level crossings can no longer be tolerated and level crossings with no technical protection should not be allowed on lines operated by speeds above 120km/h.

The Vienna Conventions together with the UIC leaflets form a basis for a harmonized level crossing protection system, however their traffic and operational rules are not mandatory and when established gave railways such freedom of action that in practice there is considerable variation in the national rules around level crossing protection (Middelraad, 1995). Perhaps in response to this, more recently and building on from these international instruments, the UNECE published a “Consolidated Resolution on Road Traffic” and “Consolidated Resolution on Road Signs and Signals” (2010). These best practice documents aim to improve road safety and facilitate international road traffic through a greater level of uniformity in road sign and signal regulations and use of road traffic systems across borders.

UNECE consolidated road safety resolutions

Consolidated Resolutions on Road Traffic (R.E.1)

This Consolidated Resolutions on Road Traffic (R.E.1) aims at supplementing the Convention on Road Traffic, 1968, and the European Agreement of 1971, addressing subjects not covered therein. It is a reference tool which presents guidance for countries on the improvement of road safety and a framework allowing greater harmonization of regulations on a voluntary basis at the international level. Recommendations regarding safety at level crossings are addressed in this publication and include the following measures:

- **Rules to observe when approaching and going through a level-crossing** which outlines rules of behaviour to be followed by all road users, whether pedestrians, cyclists, moped or motorcycle riders, or drivers of motor vehicles with four or more wheels, when approaching and going through level-crossings and rules for overtaking.
- **Road user awareness** of the dangers of level-crossings, through information campaigns and specific advice to road user groups: pedestrians; cyclists, drivers of mopeds and motorcyclists; drivers of motor vehicles; drivers of vehicles for the transport of goods and passengers.
- **Infrastructure and equipment** refers to the location of the level crossing in relation to road traffic density and railway speeds; and recommends protection systems and additional automatic systems that detect and penalize infringement of the rules by users. It stipulates that **no level-crossing should be located on high-traffic thoroughfares (motorways and similar roads) or on railways where speeds can exceed 160 km/h**.

Consolidated Resolution on Road Signs and Signals (R.E.2)

The Consolidated Resolution on Road Signs and Signals (R.E.2) addresses the divergences between one country and another as regards to some of the regulations set out in the Convention on Road Signs and Signals of 8 November 1968 and the European Agreement supplementing the Convention of 1 May 1971. It recommends Governments to incorporate into their domestic legislation regulations which conform to the recommendations reproduced in said resolution, and Governments, which are not yet in a position to ratify or accede to the above international instruments nevertheless to apply the provisions of those instruments forthwith to the fullest extent possible.

European Union railway safety legislation

There is no comprehensive set of EU regulations around managing safety at level crossings although national rules are established within a wider common framework as per the European Railway Safety Directive which affects the overall safety of the railway system. In brief terms, the most recent EU railway safety directive, *DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety (recast),* lays down provisions to ensure the development and improvement of the safety of the Union rail system and improved access to the market for rail transport services by: (a) harmonising the regulatory structure in the Member States; (b) defining responsibilities between the actors in the Union rail system; (c) developing common safety targets (‘CSTs’) and common safety methods (‘CSMs’) with a view to gradually removing the need for national rules; (d)setting out the principles for issuing, renewing, amending and restricting or revoking safety certificates and authorisations; (e) requiring the establishment, for each Member

State, of a national safety authority and an accident and incident investigating body; and (f) defining common principles for the management, regulation and supervision of railway safety.

Common safety targets (CST) and common safety methods (CSM) have been gradually introduced to ensure that safety is maintained at a high level and, when necessary and where reasonably practicable, improved. They should provide tools for the assessment of the safety and performance of operators at Union level as well as in the Member States. The CSTs shall establish the minimum safety levels to be reached by the system as a whole, and where feasible, by different parts of the rail system in each Member State and in the Union. The CSTs may be expressed in terms of risk acceptance criteria or target safety levels and shall take into consideration, in particular: (a) individual risks relating to passengers, staff including employees or contractors, level crossing users and others, and, without prejudice to existing national and international liability rules, individual risks relating to trespassers.

Common safety indicators ('CSIs') have been established in order to assess whether systems comply with the CSTs and to facilitate the monitoring of railway safety performance. To this end Member States are required to collect information on common safety indicators through annual reports produced by national safety authorities. Within this there are specific rail safety reporting requirements regarding level crossings, including indicators covering the number of level crossings (total, per line kilometre and track kilometre) by five types); 'level crossing accident` and type of victim: ´level crossing user`.

The **main actors in the Union rail system**, infrastructure managers and railway undertakings, should bear full responsibility for the safety of the system, each for their own part. Whenever appropriate, they should cooperate in implementing risk control measures.

In carrying out their duties and fulfilling their responsibilities, infrastructure managers and railway undertakings should implement a safety management system meeting the Union requirements and containing common elements. Information on safety and on the implementation of the safety management system should be submitted to the Agency (previously the European Railway Agency) and to the national safety authority in the Member State concerned. The implementation of the European railway safety regulation is supervised and monitored by the National Safety Authority present in each member state. Through its processes, the safety management system should ensure that human capabilities and limitations and the influences on human performance are addressed by applying human factors knowledge and using recognised methods.

Each railway undertaking, infrastructure manager and entity in charge of maintenance should also ensure that its contractors and other parties implement risk control measures. To that end, each railway undertaking, infrastructure manager and entity in charge of maintenance should apply the methods for monitoring set out in the common safety methods ('CSMs'). The national investigating bodies play a core role in the safety investigation process. Their work is of the utmost importance in determining the causes of an accident or incident.

International cooperation and strategic partnerships for level crossing safety

In 2011 the UNECE´s Inland Transport Committee expressed the need to address issues related to enhancing safety at level crossings, an issue hitherto not addressed by their other transport related working groups. It was proposed to set up a joint Group of Experts for a limited duration to work on

enhancing safety at level crossings who would report to the Working Party on Road Traffic Safety, in large part due to the lobbying efforts of the UIC, a member of the UNECE Working Party on road traffic safety. The Group of Experts on Improving Safety at Level Crossings was thus formed and brought together specialists from the public and private sectors, as well as academia and independent research from UNECE and non-UNECE member states who worked together from January 2014 to the end of 2016.

The activities of the group culminated in the development of an **Assessment of safety at level crossings** in UNECE member countries and other selected countries and a **strategic framework for improving safety at level crossings** published in March 2017 and presented below.

The *strategic framework for improving safety at level crossings* proposes a **'vision zero'** – no loss of life, any serious injuries at level crossings, and also minimal infrastructure damage, revenue loss, disruptions and delays.

The 'vision zero' can be achieved through the implementation of a safe system approach for level crossings. This requires a joint approach, with relevant national stakeholders from road user education and training, rule enforcement and level crossing design and operations working together to undertake coordinated actions. The end result should be the delivery of appropriate road user specific education, training and enforcement solutions and introduction of appropriate level crossing specific engineering solutions, in addition to reducing the number of level crossings.

Further actions for enhancing level crossing safety at an international level

IRU, the International Union of Railways (UIC) and Operation Lifesaver Estonia (OLE) published three Level Crossing Safety flyers on 3 May 2016 to raise awareness of professional drivers (taxi, trucks and buses) and reduce related accidents at this key interface between road and rail infrastructure.

The flyer aims to raise awareness about level crossing safety amongst transport professionals including situations that may arise when commercial drivers use a level crossing and how to avoid risks that could potentially lead to a collision. The flyer exists in 12 languages and is directed at taxi, truck and bus drivers (see Annex D for an example flyer or https://uic.org/level-crossings#documents).

A further action taking place at the international level to address level crossing safety is the International Level Crossing Awareness Day (ILCAD). This joint commitment continues on from the success of the first European Level Crossing Awareness Day held on 25th June 2009 and benefits from the participation of railway industry representatives, road authorities, academics and more from around the world. Coordinated by UIC, this worldwide event is celebrated in 28 countries to raise public awareness about the dangers associated with roadway-railway crossings.

4.2.2. Adherence to international regulations related to level crossing safety

Survey respondents were asked to indicate their country´s adoption of the following international (non-mandatory) rules regarding safety at level crossings[2]:

- Vienna Convention on road traffic, of 1968.
- Vienna Convention on Road Signs and Signals, of 8 November 1968.
- UIC leaflet 760: Road signs and signals.
- UIC leaflet 761: Guidance on the automatic operation of level crossings.
- UIC leaflet 762: Safety measures to be taken at level crossings on lines operated from 120 to 200 km/h.

Around one fifth of countries (n=5) (Romania, Spain, Italy, Turkey and Russia) report to apply all international regulations (Vienna conventions and UIC leaflets), in some cases with exceptions. Overall however, there is a greater level of adherence to the Vienna Conventions than the UIC leaflets (See Annex E, for a breakdown of the results by country).

As illustrated in Graph 7 below, 75% of countries (n=18) are signatories of the *Vienna Convention on Road Traffic* and the *Vienna Convention on Road Signs and signals* in addition to 13% of countries (n=3) who apply these rules with exceptions (Norway, Serbia and the United Kingdom).

There is the same level of take up of the UIC leaflets, Code 760 (*Road signs and signals*) and 761 (*Guidance on the automatic operation of level crossings)* with adoption in 20.8% of countries (n=5), whilst leaflet 762 (*Safety measures to be taken at level crossings on lines operated from 120 to 200 km/h*) is only applied in 16.6% of the countries (n=4) with 29% (n=7) explicitly stating not to apply these rules. In the case of Albania, whilst no answer was provided regarding their take up of UIC leaflets, it was highlighted that the UIC leaflets have been provided to the working group responsible for drafting the new law on safety and interoperability for integration of Albania to the EU 2017-2020, suggesting their consideration of these tools in the updated legislation.

A large proportion of countries (n=10–11) countries gave no response to the question of adherence to the UIC leaflets 760; 761; and 762. Some of those countries stating not to adhere to the UIC rules highlighted that the operation and safety management at level crossings is governed by national laws and regulations (as is the case in Greece, United Kingdom and Switzerland). In Switzerland leaflet 762 is not applied because the national legal regulations are stricter. Similarly, in the United Kingdom while mainly following the basic principles of the Vienna Convention, signs at level crossings are designed to United Kingdom specific requirements and road traffic signs (including road markings and road studs) must comply with current sign regulations.

[2] Please note that in some cases responses to this question were left blank, particularly regarding application of the UIC leaflets and to a lesser degree the Vienna Conventions. In the event of receiving a blank response, the official UNECE list of Contracting Parties to the Conventions was consulted to confirm the list of participating countries (UNECE b).

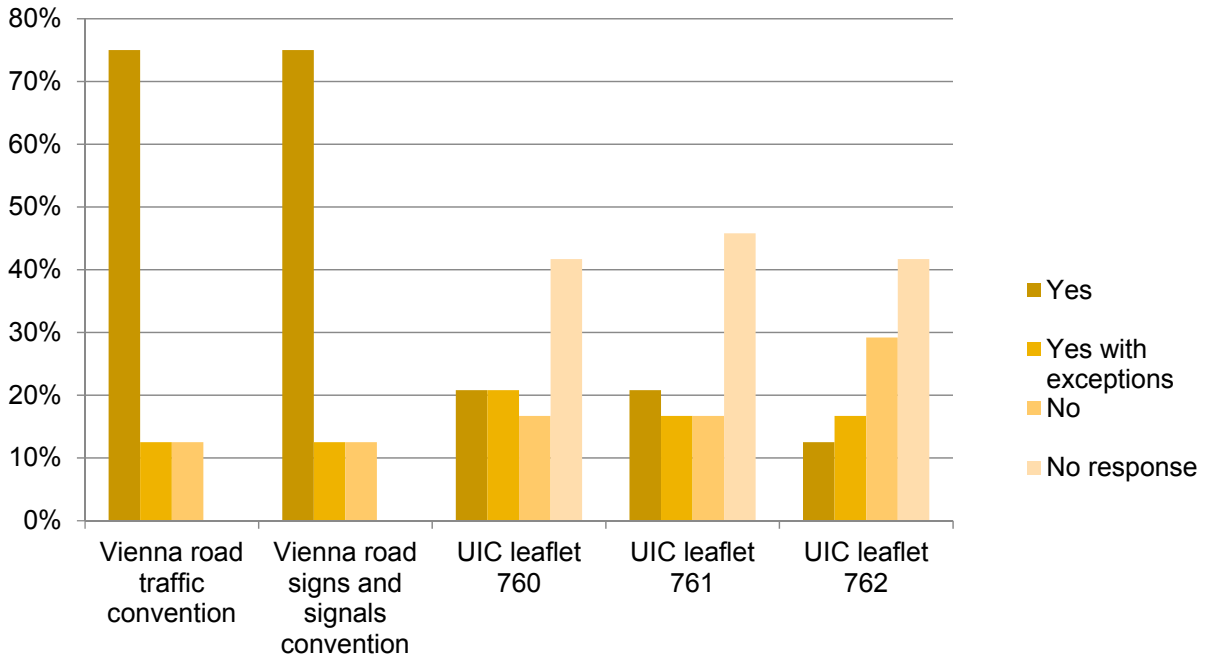


Figure 9. Application of international level crossing safety regulations by surveyed countries (24 countries) (%)

4.2.3. National Policy on Level Crossing Safety

Some clear themes emerged regarding level crossing safety policy across the different countries, most notably the existence of level crossing removal and improvement programmes. A number of the policy actions are related and have been grouped under wider policy headings (see Table 19): Please note that responses to this question were given by 23 countries (excluding Russia). For a breakdown of the policies by country see Annex F.

Table 19. Level crossing safety policy areas and associated actions (n=23)

Level crossing safety policy areas	Associated actions
Level crossing removal (n=22)	▪ Speed related removal criteria ▪ Construction grade separated crossings ▪ No new level crossing construction ▪ Concentrating road use to a reduced number of level crossings
Level crossing protection (n=16)	▪ Upgrading and enhancing level crossing protection ▪ Replacement of passive level crossings with active crossings ▪ Upgrading active level crossing protection (to cover user and rail side warning and protection) ▪ Technological development towards a more cost effectiveness, energy efficiency, preventative maintenance etc. ▪ Safe system approach (towards forgiving infrastructure)
Organisational and strategic development (n=8)	▪ Cross sector collaboration towards improved level crossing safety ▪ Level crossing safety strategy and action plan ▪ Focus on accident reduction (e.g. targeting accident hotspots) ▪ Use of safety evaluation and risk management tools ▪ Ongoing level crossing monitoring and reporting
Education and enforcement (n=5)	▪ Level crossing safety awareness campaigns ▪ Increased education and enforcement

Level crossing removal policy

The most important safety policy across all responding countries is removal or reduction of level crossings. With the exception of Lithuania (and Russia who gave no response), all of the responding countries have a level crossing removal programme which in all cases is the principal policy for improving level crossing safety. This policy action is implemented with varying degrees of stringency, taking into account operational and cost benefit issues. For example, the Netherlands has set a specific long term target of zero level crossings whereas for other countries, such as the United Kingdom, the decision to close a crossing is based on an assessment of risk reduction benefit in agreement between the rail and road the infrastructure manager.

Policy actions associated with level crossing reduction or removal include the replacement of level crossings with grade separated crossings (over/underpasses). This was mentioned specifically by seven countries (Albania, Montenegro, Romania, Serbia, Slovakia, Sweden and Turkey) (see Annex F). Three countries specify a level crossing removal policy related to the maximum line speed, whereby level crossings are not permitted on sections where the train travels at or above a certain speed. The maximum speed varies from 160 km/h in Slovakia and Switzerland to 120 km/h in Greece. Only two countries report having a no-new build policy for level crossings (Spain and Latvia).

Level crossing protection policy

The second most common safety policy, shared by 16 of the countries, is to improve the protection of existing level crossings. Six of these countries (Romania, Slovakia, Norway, Austria Ireland and Switzerland) focus this improvement on installing active protection measures at passive level crossings. Two countries (Romania and Slovakia) also seek to upgrade the protection of active crossings so that they encompass both user-side and rail-side warning and protection, not just user-side warning. In Finland and Canada, the focus of the improvement is to further develop existing protection systems to be more cost effective and energy efficient.

A further action under this policy area is the adoption of a safe systems approach. This is only present in two countries (Sweden and Lithuania). Sweden has a policy to adopt a safe systems approach to tackling level crossing safety with a focus on forgiving infrastructure rather than an onus on the user behaviour and correct usage as a way of ensuring safety. Similarly Lithuania was classified as promoting a safe systems approach as they stated a policy of making level crossings user friendly.

Organisational and strategic development policy

A third of the countries (n=8) have a policy to improve level crossing safety based on some sort of organisational and strategic development. Of the eight countries with this type of policy, Finland is the country that has reported the most areas of action. The most common strategic or organisational related policies are adoption of evaluation and risk management practices (Finland, Greece, United Kingdom) and development of level crossing safety strategy and action plans (Finland, the Netherlands, Slovakia).

Specifically, safety evaluation and risk management tools are used by countries to support decision making regarding the actions to be taken at level crossings (removal or improvement) within a cost benefit framework. In Finland and the United Kingdom this appears to be integrated practice whereas in Greece a process of evaluation is currently taking place in the framework of a project to rationalise level crossings, taking into account different user and rail side operational and safety issues.

In terms of the countries that report to have a strategy or long term action plan, in Slovakia this plan forms part of a wider road safety strategy and in Finland the Finnish Transport Agency has defined a long term level crossing strategy (2016) for the elimination and improvement of level crossings. In the Netherlands they have a clearly defined set of time scaled objectives for achieving level crossing safety, including a long term policy for reducing level crossings to zero, a medium term policy to protect all level crossings and a short term policy towards education and enforcement.

To a small degree the focus of strategic actions also encompasses operational planning both on the rail and road side with systematic level crossing monitoring taking place in Finland and Sweden. Specifically, Finland is developing a public level crossing register into a continuously updated Geographic Information System which supports regional traffic planning.

The policy to target accident reduction, particularly in identified accident hotspots takes place in France and Lithuania. In just one country, Finland, there is a policy related to cross sector working to tackle safety at level crossings. They have a group formed across administrative boundaries that meet regularly to discuss annual operational and financial planning of level crossing safety issues.

Education and enforcement policy

Just over one fifth of the countries (n=5) have a policy to raise public awareness around safety at level crossings. This takes the form of inclusion within road traffic safety campaigns (Finland); public awareness and educational outreach activities and tools (Norway, United Kingdom, the Netherlands) and paper based publications through booklets to promote awareness of rules and risks (Ireland). The Netherlands is the only country that specifically states having a policy of enforcement together with education.

4.2.4. National legal framework on Level Crossing Safety

Survey respondents were asked to briefly describe the legal framework applied to the design, operation and management of level crossings in their country, including details of the government department(s) and/or ministry responsible for the content and compliance of the law; current legislation regarding safety at level crossings and the existence of regional variation in the application of rules. The analysis is based on information provided by all countries except Norway, the Netherlands and Finland. In the case of Finland, no information is available due to the fact that level crossing related safety laws are currently undergoing a process of amendment, anticipated for completion by summer 2019.

Legal responsibility for level crossing safety

In all cases responsibility for level crossing safety legislation falls on ministries or government departments responsible for transport, encompassing both road and rail and in many cases also infrastructure. In some cases more than one entity was cited with responsibility for different aspects of the legal framework. For example, in four countries (France, Spain, Romania, Slovakia) the Interior Ministry also has responsibility for level crossing legislation, as the ministry accountable for road safety, national security and law enforcement (police).

In four out of the twenty four countries (Italy, Norway, Ireland and United Kingdom) there are also independent regulatory bodies responsible for assuring compliance with railway safety legislation and in some cases (Ireland and United Kingdom) also the interface with public roads. In the case of Italy, Norway and Ireland this independent body, in line with European legislation, is the national railway safety authority. In the United Kingdom this falls on the Office of Rail and Road (ORR), an independent economic and safety regulator for Britain's railways.

In Norway and Ireland the infrastructure manager has legal responsibility for technical regulations and addressing misuse of private level crossings, respectively. In Turkey and Ireland the national police force is also reported to be involved, to enforce the correct public use of level crossings.

It is interesting to observe a greater onus on railway safety agencies than their equivalent within road, with the exceptions of Turkey which cited the General Directorate of Highways and the United Kingdom, whose regulatory body encompasses both road and rail. This relationship can also be observed in the division of legal responsibility between road and rail as reflected in the laws.

A breakdown of the specific institutions cited by survey respondents is presented in Table 20. Where specific mention of legal roles by entity was mentioned this has been included in the table within brackets next to the country code.

Table 20. Body responsible for level crossing legislation (24 countries)

Type of body	Specific entity	Country
Government department or ministry	Ministry of Transport and Communications	FI; NO (responsible for law); TR; LT; CH; MK
	Ministry of Transport	FR; RO; AT; IE; LV; RU; ME
	Ministry of Transport and Infrastructure	EL; AL
	Ministry of Transport and Construction	SK
	Ministry of Construction, Transport and Infrastructure	RS
	Ministry of Public Works	ES
	Federal Government Department for Mobility and Traffic	BE
	Ministry of Infrastructure and environment	NL
	Ministry of Interior	FR; RO; SK; ES
	Transport agency (Ministry of Enterprise and Innovation)	SE
	Transport Canada (Government Department under Transportation, Infrastructure and Communities)	CA
	Department for Transport	UK (high level transport policy and legislation)
	Department of Transport, Tourism and Sport	IE (legislation)
Infrastructure manager and operator	Rail Infrastructure Manager	NO (technical regulations); IE (misuse of private LCs); TR
	Highways	TR
Independent regulatory bodies	Commission for Railway Regulation	IE (IM compliance with statutory duty)
	National railway safety agency	IT; NO (national regulations)
	Office rail and road	UK (economic and safety regulation)
Other gov bodies	National police force	IE (misuse of public LCs); TR

Overview of legal responsibility for level crossings across administrative areas

Before entering into a more in-depth examination of the content of the legal frameworks, a first analysis of the legal documents was carried out in order to obtain an overview of how level crossings are dealt with by the different transport (rail and road) or other sectors, as an indication of the distribution of legal responsibility for level crossings across administrative areas. For example, are level crossing regulations gathered within wider railway legislation and/or road laws and how is it distributed between the two? Or is there a law dedicated specifically to level crossings, independent of rail and road?

The distribution of legal responsibility for level crossings as reflected in the laws is represented in the pie chart below (see Figure 10). The classification of the legal documents (69 in total) as rail; road; level crossing specific; or other is based on the title of the legal document and review of its content. As can be observed, the rules regarding level crossing safety are given slightly more coverage (10% more) within railway legislation than road legislation. The rules contained within railway legislation appear to deal with a wider range of issues, from level crossing classification, rules regarding safeguarding and modifications to level crossings to the legal obligations and duties of responsible parties and rail side level crossing usage, amongst others. Level crossing related content within road laws almost exclusively deal with road side rules on use and protection of level crossings.

Of all the documents cited, 29% are regulations or decrees dedicated specifically to level crossings as opposed to being an article or clause within a wider rail or road law. In only two cases, Canada and the United Kingdom, safety at level crossings is dealt with from a cross agency perspective (rail, road, private and public authorities). In the United Kingdom, no single government department controls all level crossing legislation, rather, laws relating to the highways, railways and health and safety apply (Office of Rail Regulation, 2011). In Canada there is a law that clarifies roles and responsibilities for level crossings (between railway, road, and private authorities) and requirements to facilitate information sharing.

The fact that the United Kingdom and Canada have a set of standalone level crossing laws and regulations may reflect the particular and complex nature of level crossings in their countries. In the case of the United Kingdom, the elevated number and range of crossing types (including a high number of user operated crossings), density and length of the national railway network are all factors that raise safety concerns and call for an adequate response. In the case of Canada the accident rate, extension of the rail network and number of crossings may have led to the development of specific laws to deal with level crossings.

In one case there is a non-level crossing law that belongs to neither road nor rail, the United Kingdom´s Health and Safety at Work Act.

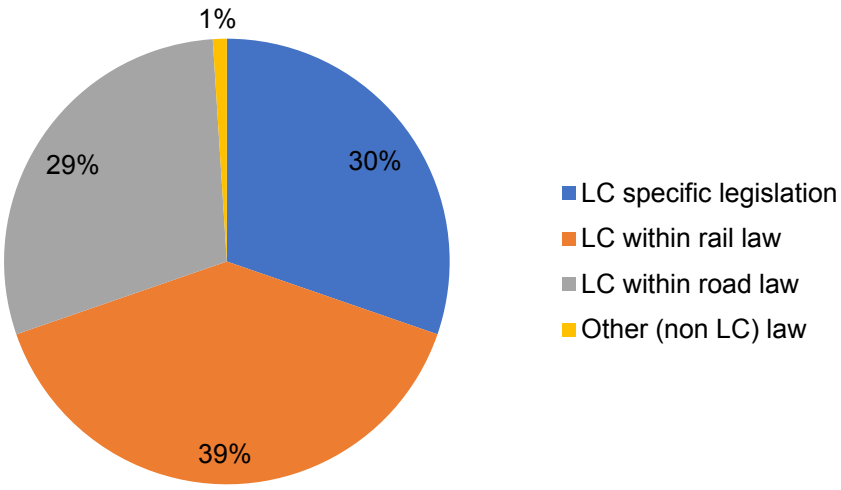


Figure 10. Division of legal responsibilities for level crossings as reflected in the laws (69 legal documents)

Thematic analysis of legal framework content

A range of legal instruments have been cited as forming the legal framework applied to level crossing safety in the different countries (ministerial decrees, legal acts, orders, ordinances and regulations). In general, the responses given describe the contents of the law, rather than specific details of the rules. Where more detailed information is available and considered to add value to the analysis, it has been included. In relation to the contents of the laws, some clear themes appear across the different countries, summarised in Table 21 below.

Table 21. Thematic overview of legal framework content (n=24)

Legal framework themes	Content of legal framework	Countries applied
LCs safeguarding (n=20)	Application of protection systems	BE; FR; EL; RO; ES; IT; AT; IE; LV; LT; UK; CH; RU; AL; MK; ME; RS (n=17)
	Signalling (road or rail side)	FR; RO; SK; SE; UK; CH; AL; ME; RS (n=9)
	Technical standards of level crossing protection	BE; IT; TR; MK; ME; RS (n=6)
LC usage (rail and road side) (n=14)	Rules governing road side rights and obligations	RO; SK; ES; SE; AT; LT; CH; RU; FR; RS (n=10)
	Railway safety rules and train traffic management	SE; ES; IE; LT; RU; CA; MK; ME; RS (n=9)
	Operational priority at level crossing (road versus rail)	SK; RS (n=2)
	EU harmonized railway safety rules	AL; ES (n=2)
	Safety rules regarding special road user requirements	SE; RS (n=2)
Responsible bodies (n=9)	Financial obligations of responsible stakeholders	AL; IE; RS; SK; ES; TR; CH (n=7)
	Legal obligations and duties of responsible stakeholders	AL; ME; RO; ES; EL (n=5)
Modifications to LC and removal (n=9)	Rules applied to level crossing removal	EL; ES; LV; LT; CH; ME; RS (n=7)
	Rules governing grade separated crossings	SK; ES; CH; AL; ME (n=5)
	Orders to modify or improve existing level crossings	EL; ES; IE (n=3)
LC infrastructure and construction related issues (n=8)	Rules applied to construction of new level crossings	EL; SK; ES; RU; RS (n=5)
	Maintenance and repair of level crossings	LV; LT; RU; ME; RS (n=5)
	Costs of works to level crossings	RU; RS (n=2)
Organisational/ procedural (n=3)	Cross sector road management	SE; CA (n=2)
	Standardise engineering best practice	CA (n=1)
	Health and safety at work	UK (n=1)
	Rules on LC accident/incident reporting	SE (n=1)
Enforcement of LC safety (n=2)	Measures for sanctioning level crossing misuse	IE (n=1)
	Rules regarding sanctioning of level crossing misuse	UK (n=1)

The most significant aspect covered by the legal frameworks are rules regulating the **safeguarding of level crossings** which appear twenty countries. Most notably this includes rules regarding the application of systems of level crossing protection which is present in seventeen countries. Just over

a third of countries (n=9) highlighted regulations dictating road and rail side signalling. In a quarter of the countries (n=6) the framework defines the technical standards of level crossings.

A further legal theme that appears frequently (n=14) are rules concerning **level crossing usage**, covering a number of different aspects both from the rail and road side. The most important of these relates to the rights and obligations of the road side users (n=11), particularly rules for movement of road vehicles at level crossings, Highway Code and road traffic safety. Just two countries (Sweden and Serbia) have rules setting out special road user safety requirements. In Sweden this covers special transport vehicles with a length longer than 35 metres. In Serbia their Railway Safety and Interoperability Law defines conditions for level crossing of railway lines and road, pedestrian and biking trails together with a rulebook on the method of level crossing, pedestrian or bicycle trail prescribing the way of using a level crossing by these types of users.

From the rail side nine countries cited rules regarding **railway safety and train traffic management**. In the case of Ireland this includes a Railway Clauses Act (1863) that allows the Commission for Railway Regulation to make regulations concerning level crossings on public roads and with regard to the speed at which trains may pass at the crossing. In Lithuania there are regulations of technical usage of railways which defines the main use of 1520mm gauge track, main structures (constructions), devices and rolling stock dimensions, requirements and standards for them and the principals of train traffic organization and signalling. In Canada the Railway Safety Act ensures the safe operation of railways, in a similar way to the Regulation for all traffic (rulebook for tracks and road level crossing for safe railway traffic) in Macedonia and the rules determining measures to ensure safe traffic in Montenegro. In Serbia the Railway Safety and Interoperability Law (2015) covers this aspect.

Only two countries (Serbia and Slovakia) cited rules regarding **operational priority or right of way at level crossing** (road versus rail), although this is also likely to be gathered within rules governing the rights and obligations of the road side users. Details of this rule were given in the case of Slovakia where it is the railroad operation that has priority over road traffic. It is understood that for those countries signed up to the Vienna Conventions on road traffic and road signs and signals trains have priority at all level crossings.

Also on the rail side, two countries (Spain and Albania) cited reference to EU railway safety legislation, with specific reference made to the **EU reporting requirements of Common Safety Indicators** concerning level crossings, in the case of Spain.

Just over a third of countries (N=9) have laws covering **the roles and responsibilities for level crossing safety**. In seven countries these laws cover the **financial obligations of stakeholders**, particularly in reference to costs incurred by modifications made to existing level crossings (be it removal, replacement with grade separated crossing or protection of the crossing). In the case of Serbia this also encompasses the distribution of costs for installing and maintaining level crossings.

In terms of the sharing of costs between the two main stakeholders, rail and road, there are some slight variations between the countries. In Spain the financial obligation regarding elimination and/or protection is determined by the modal share (road and rail) of the traffic moment (with responsibility falling on the road administrator when the road vehicle factor is equal or greater than 250 vehicles circulating on the road per day and on the rail administrator if train traffic factor is equal or greater than 6 trains circulating on the track per day). In a similar way, in Albania the costs are assumed

proportionally to the requests made for modification. In Ireland there is a provision to allow the infrastructure to recoup 50% of the costs of improving a level crossing on a minor public road from the road authority. A different situation can be currently found in Turkey where the rail infrastructure manager has taken on full responsibility for level crossings, including financial obligations until November 2018.

Just over one fifth of countries (n=5) cited legislation that regulates the **division of responsibilities for level crossings between rail and road infrastructure managers** in relation to various aspects including the setting up, modifying, removing or protection of level crossings.

A further legal theme present just over one third (n=9) of the surveyed countries relates to **modifications to crossings** in the form of rules regarding the removal of existing crossings (n=7) and the construction of grade separated crossings (n=5). In many of these countries these laws relate to the government's plan for the elimination and prohibition of the establishment of new level crossings and determines the principal that the intersection of railway lines with roads should be constructed at a different level to the track, as an over or underpass (Slovakia, Spain and Switzerland).

In a third of the countries (n=8) there are laws regarding **level crossing infrastructure and construction related issues**. Specifically in five countries there are **rules governing the construction of new crossings**. This in most cases states that no new level crossing should be built on new lines except in exceptional circumstances, with the authorization of the relevant authorities and often only as a provisional and temporary measure, (which is the case in Slovakia and Spain).

Rules governing the maintenance and repair of level crossings exist in five countries. In general terms these rules define the requirements of level crossing maintenance and repair (Lithuania, Russia and Montenegro) and also in Russia the procedure for organising the work and duties of employees who maintain level crossings. In Serbia it also includes the distribution of costs for maintaining road crossings between infrastructure managers and other entities (road infrastructure manager).

In two countries (Russia, Serbia) there are regulations regarding the **costs of different types of works done at level crossings**. As mentioned above, in Serbia the distribution of costs for installing or maintaining road crossings and in Russia there are rules regulating the cost of installing and disassembling level crossings and covers at approaches to level crossings.

In just three countries there is legislation that has been classified under the **organisational and procedural** theme. In some cases these laws only exist in one surveyed country. This includes **rules regulating the cross sector management of roads** present in Canada and Sweden. Given the focus of the SAFER-LC project it is interesting to explore this aspect a little further. In Canada there is a Grade Crossing Regulation which introduces several requirements to improve safety standards, clarify roles and responsibilities (railways, road authorities, private authorities) and facilitate information sharing. In Sweden there is a law aimed at managing different roads and the collaboration with other authorities.

A further procedural related piece of legislation present in one country (Canada) relates to introducing standards based on the current best practices in engineering and making these standards into law.

A **law concerning health and safety at work** exists in the United Kingdom and provides a goal setting objective for risk reduction based on cost benefit criteria.

Finally, in Sweden there is a law setting out the **reporting requirements in the event of level crossing accident and incidents**.

The final legal theme is **enforcement of level crossing safety** which only appears to exist in two of the responding countries (Ireland and the United Kingdom). In Ireland there is a Railway safety Act (2005) which includes a provision for railway to prosecute persons who fail to close the gate of a level crossing or passage after use. In the United Kingdom there is a Private crossings (signs and notices regulations) which defines signs for which penalties can be applied for failure to obey.

Existence of regional variations to level crossing safety rules

Survey respondents were asked whether there are regional variations to the rules concerning level crossing safety applied in the country. In 18 countries the rules are applied equally throughout the country, with the exception of six countries: Albania, Canada, France, Italy, Spain and the United Kingdom where there are some regional variations.

A common factor in at least three of these countries (Italy, Spain and United Kingdom) is the existence of regional based rail and/or road infrastructure managers. In Spain, the railway infrastructure is managed by regional public companies in four of the country´s autonomous communities. In these regions the level crossing architecture and products are similar but circulation rules and signs differ slightly from those used by Adif (national state owned IM) and the protocols regarding substitution of level crossings are also different. The signalling control is the same throughout the country (using interlocking) in line with railway operating rules. In the United Kingdom there is some variation in legislation in respect of roads and highways in Scotland and Northern Ireland compared to England and Wales. In France there are variations in terms of level crossing layout and the surrounding environment and in the case of Canada, the provincial crossings are not regulated by Transport Canada although the Provincial regulator requests that Transport Canada inspectors perform Safety Assessments and make recommendations.

Future legislative steps to promote safety at level crossings

In terms of what surveyed countries consider to be the next legislative steps to improve level crossing safety, the following themes emerged (country specific details provided in Table 22):

Table 22. Overview of future legislative steps to improve level crossing safety (n=24)

Future legal themes	Future actions
Level crossing reduction (n=7)	Legislation that facilitates level crossing removal and grade separation (AT; BE; CA; EL; LV; LT; SK)
Education and enforcement (n=7)	Greater information, education and public awareness work with national government backing (EL; IT; MK)
	Consider awareness measures (e.g. to ban use of mobile devices in traffic areas) (NO)
	Enforce regulations and sanctions (AT; CA; SK)
Cross agency working (n=5)	Coordination and cooperation between road and rail managers (EL; IT; MK)
	Legal commitment of road authorities (NL)
	The more equitable sharing of responsibility between rail authority and road authorities especially financial responsibility (UK)
Strategic & legal (n=5)	Review relevant level crossing legislation (IE)
	Approval on new law of safety, interoperability and National Safety Authority (AL)
	Incorporate level safety targets within wider traffic safety strategy (RU)
	Greater public and political support (AT)
	Systematic research into human factors (AT)
	Develop national level crossing database (SE)
	Approval on new law of safety, interoperability and NSA (AL)
Revision of technical rules (n=5)	Consider mandating upper speed limits for various types of level crossing (IE)
	Consider whether train always must be able to stop in front of level crossing if it is not secured (NO)
	The current visibility specifications do not apply to all level crossings (FI)
	Amend regulations on level crossings and railway transition data and parameters specifications (LV)
	Introduce single emergency contact number (FR)
Level crossing protection (n=4)	Provision of funding to railways and road authorities to upgrade and maintain crossings to standards (CA; EL; RS; ES)

4.3. Division of responsibilities regarding level crossings

In legal terms, level crossings cut across different administrative boundaries and involve the interests of a wide range of stakeholders. To effectively manage safety at this intersection it is important to understand how the roles and responsibilities for level crossing safety are organised. In this sense survey respondents were asked to indicate who is responsible for the design, operation, management and enforcement of safety at level crossing in their country and any other additional roles not gathered within these categories. In addition the survey sought to assess the level of cross agency working that exists in the different countries to deal with level crossing safety and whether there is an independent or specific government body dedicated to promoting safety at level crossings.

4.3.1. Division of responsibility for level crossing safety

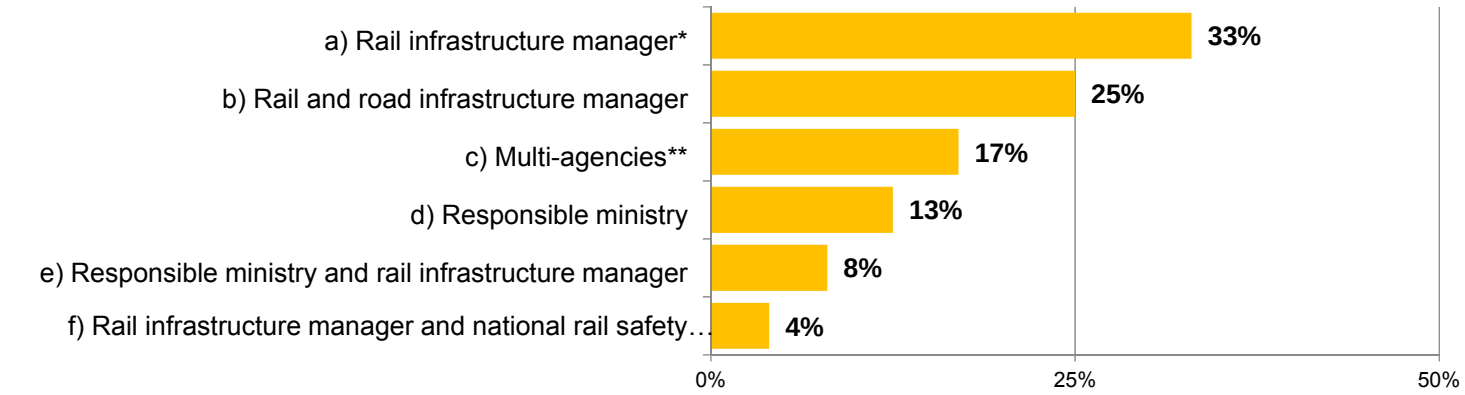
Division of stakeholder responsibility for level crossing safety: design, operation, management and enforcement

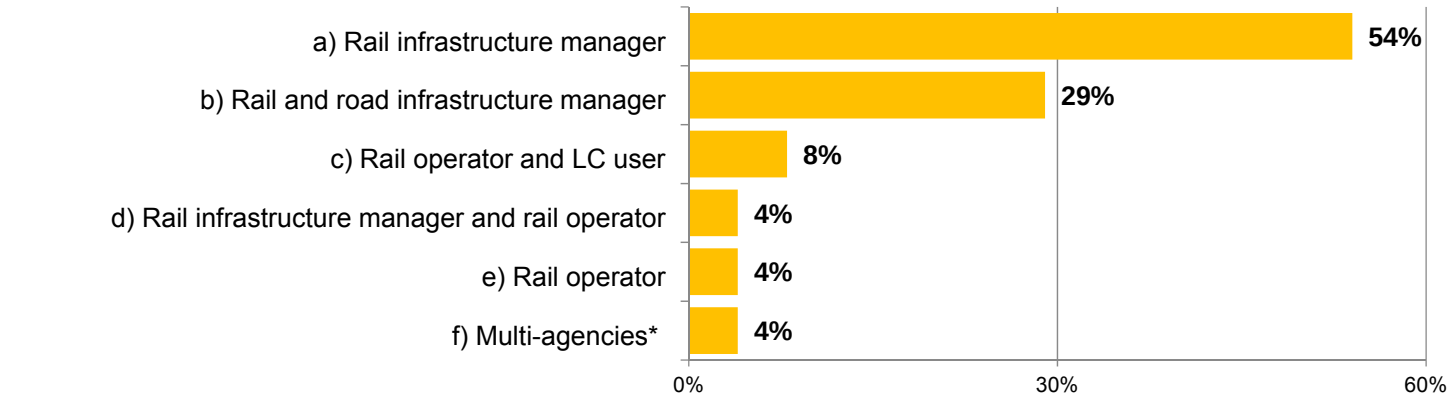
As can be observed in Table 23[3] the rail infrastructure manager holds the greatest level of responsibility for the **design of level crossing safety** being the sole duty holder for this aspect in 33% of countries (n=8). In 25% of countries (n=6) this role is shared with the administrator of road infrastructure and in 17% of countries (n=4) responsibility is assigned between various actors. In Romania this includes the road and rail infrastructure manager, police, land owners and government authorities. In Slovakia this role is performed by the project designer, building authority, road authority, local authority, responsible ministry and the police. In Spain the road and rail infrastructure manager, responsible ministries, national railway safety authority and urban planning administration holds responsibility for the design of safety. Finally, in Serbia, the road and rail infrastructure manager together with local government bodies are responsible.

In terms of responsibility for the **safe operation of level crossings** this falls most heavily on rail, with 58% of countries (n=14) citing that the rail infrastructure manager is responsible for ensuring safe operation of level crossings. This is closely followed by joint rail and road responsibility. The **management of level crossing safety** falls within the remit of various stakeholders, principally the rail infrastructure manager (n=13) but also the rail administrator together with the road infrastructure manager, rail operator and police. There is a large degree of variation in terms of the distribution of roles and responsibilities for the **enforcement of level crossing safety** with different compositions of stakeholders. The rail infrastructure manager continues to have the greatest level of responsibility across the countries (n=5) closely followed by the police, transport authority, and rail infrastructure manager together with the police (n=4 respectively).

[3] Table 18 contains information regarding the share of responsibility between stakeholders for different aspects of level crossing safety. The information provided is expressed in both absolute terms (number of countries indicating a response out of 24 countries) and percentage terms (% of countries indicating a response out of 24 countries).

Table 23. Division of stakeholder responsibility for level crossing safety (n=24)

AREA OF RESPONSIBILITY: **DESIGN**	**COUNTRIES**
 * In Russia and Montenegro the rail infrastructure manager works alongside a project designers/ executor. ** Category encompasses entities such as responsible ministry, road and rail authorities, police, local authorities…	a) IT; LT; NL; UK; CH; MK; RU; ME (n=8) b) FI; NO; SE; LV; CA; AL (n=6) c) RO; SK; ES; RS (n=4) d) BE; TR; AT (n=3) e) FR; EL (n=2) f) IE (n=1)
AREA OF RESPONSIBILITY: **OPERATION**	



* Category encompasses rail operator and infrastructure manager, road users and land owners.

COUNTRIES

a) BE; FR; EL; RO; AT; IE; NL; UK; CA; AL; MK; ME; RS (n=13)

b) IT; LT; SE; ES; SK; FI; RU (n=7)

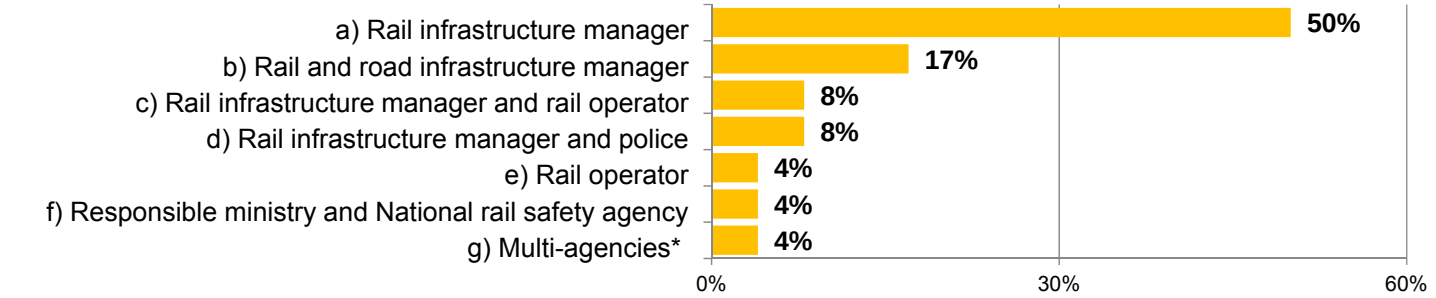
c) LV; CH (n=2)

d) IT (n=1)

e) TR (n=1)

f) NO (n=1)

AREA OF RESPONSIBILITY: **MANAGEMENT**



* Category encompasses level crossing owner, road authority and responsible ministry.

COUNTRIES

a) FI; FR; EL; RO; IT; AT; IE; LT; UK; AL; MK; ME (n=12)

b) NO; SE; LV; RS (n=4)

c) BE; CH (n=2)

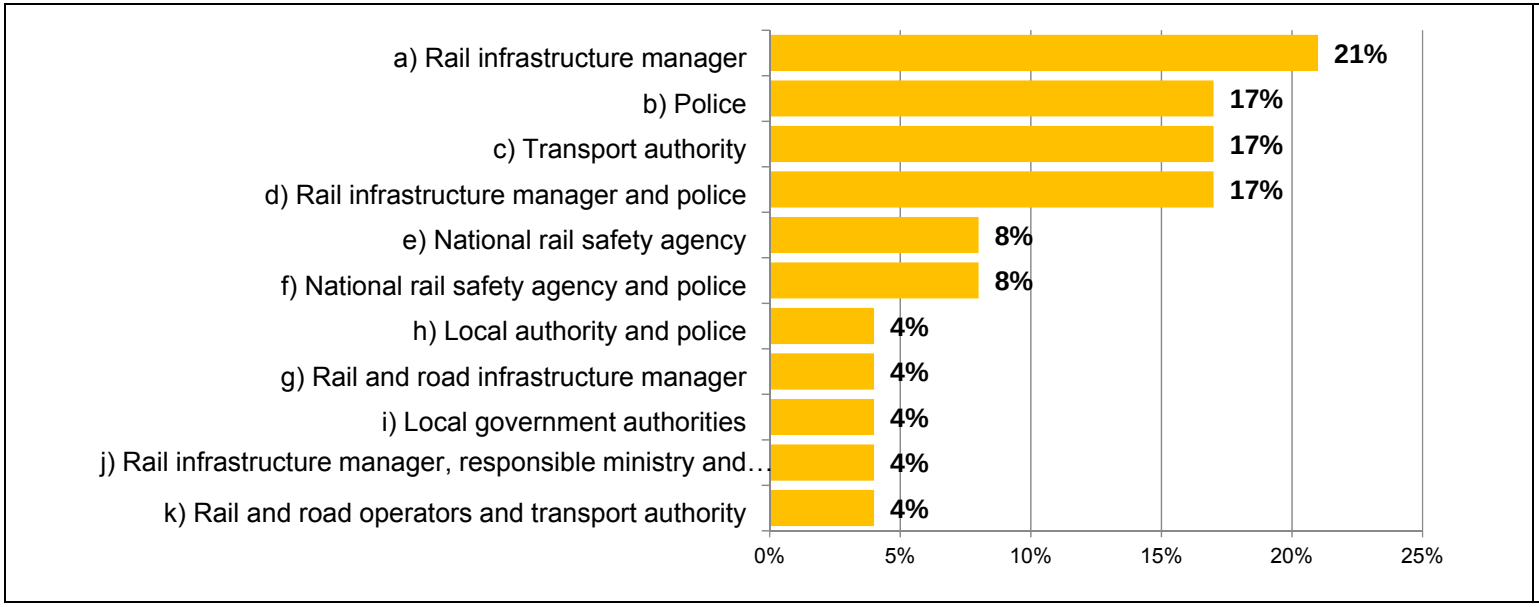
d) SK; NL (n=2)

e) TR (n=1)

f) ES (n=1)

g) RU (n=1)

AREA OF RESPONSIBILITY: **ENFORCEMENT**



COUNTRIES

a) RO; LT; RU; ME; RS (n=5)

b) FI; NO; TR; MK (n=4)

c) SK; CH; CA; AL (n=4)

d) EL; IE; NL (n=3)

e) ES; LV (n=2)

f) IT; UK (n=2)

g) SE (n=1)

h) AT (n=1)

i) FR (n=1)

j) BE (n=1)

k) AL (n=1)

Scope of stakeholder responsibility for level crossing safety: design, operation, management, enforcement and other aspects

Please note that not all 24 countries provided details on the scope of stakeholder responsibility (i.e. what the stakeholder responsibilities entail). Furthermore, given that this part of the question was open-ended, respondents were free to specify as many items as desired and therefore the results presented on continuation are based on the responses received. These have been grouped under themes, presented in Table 24 to Table 28 below.

Responsibility for the design of level crossing safety

Based on the responses given by fifteen of the surveyed countries[4], responsibility for the design of safety at level crossings can be summarised under four key areas (see Table 24). The responses indicate the different stages involved in the design and implementation of safety and protection measures (particularly signalling and signs), in compliance with legal regulations. Responsibility is concentrated at the design stage, involving decision making and planning processes but also including roles related to safety authorisation, procurement and installation. In general terms the elements on the road side of the level crossing fall within the domain of the road administrator, particularly design of road signs, whilst the elements making up the level crossing itself is responsibility of the rail administrator.Table 24. Areas of responsibility and associated stakeholders related to the design of safety at level crossings (n=15)

Area of responsibility: Design	Associated stakeholders
Establishment of rules concerning LC protection	- Responsible ministry in consultation with rail infrastructure manager: *ES*
Design of LC and approach (including LC signalling and road design) *Underpinned by planning processes; provision of data (e.g. road speed, gradient, daily traffic etc), stakeholder consultation etc.*	- Rail and road infrastructure manager: *AL; CA; LV; NO* - Rail infrastructure manager: *IE; UK; LT* - Rail infrastructure manager and designer: *ME* - Rail and road infrastructure manager and local government bodies: *RS* - Responsible ministry: *EL* - Building authority and project designer: *SK*
Safety approval and authorisation *Aligned with legal, technical, environmental, health and safety requirements and public interest.*	- National safety authority: *IE* - Rail infrastructure manager and urban planning administration: *ES*
Procurement and installation	- Rail infrastructure manager: *IE* - Rail and road infrastructure manager: *ES*

[4] Whilst all 24 countries indicated the responsible stakeholder for level crossing safety design, only fifteen of these countries provided detail regarding the scope of stakeholder responsibility.

Responsibility for the safe operation of level crossings

Based on the responses given by thirteen of the surveyed countries[5], the responsibility for the operation of safety at level crossings can be summarised under eight key areas, as presented in Table 25. These responses indicate that there is a clear division of responsibility for road-side and rail-side elements of the level crossing. The road infrastructure manager appears to have sole responsibility for the road and road traffic signs whilst the level crossing itself is responsibility of the rail infrastructure manager (in all cases). For example, in Finland the road manager is in charge of maintaining road signage, excluding the Andrew´s Cross[6] which falls to the rail administrator.

Table 25. Areas of responsibility and associated stakeholders related to the operation of safety at level crossings (n=13)

Area of responsibility: Operation	Associated stakeholders
Road side level crossing maintenance and repair (road, protection devices, warning signs)	- Road infrastructure manager: *FI; ES* - Rail infrastructure manager: *CA; TR*
Rail side level crossing maintenance and repair (tracks, protection devices, warning signs)	- Rail infrastructure manager: *AT; FI; CA; ES; TR*
Rail side level crossing users to follow railway operating rules	- Rail operator: LV; CH; UK (also IM in UK)
Road side level crossing users to follow road traffic regulations	- Road and other crossing users: LV; CH
Traffic management (road and rail)	- Rail infrastructure manager: *FI*
Operation and surveillance	- Rail infrastructure manager: *IE*
Ensuring safe public access to level crossings (LC installation and approach road)	- Rail and road infrastructure manager: *LT*
Preparation of rulebook for handling level crossing devices	- Rail infrastructure manager: *RS*

Responsibility for management of safety at level crossings

Based on the responses given by twelve of the surveyed countries[7], the responsibility for the management of safety at level crossings can be summarised under five key roles as presented in Table 26. These results indicate that the tasks associated with managing level crossing safety are, in general terms, performance related, from ensuring the efficient and safe operation of level crossings and monitoring the achievement of objectives to maintenance of the crossing.

[5] Whilst all 24 countries indicated the responsible stakeholder for level crossing safety operation, only thirteen of these countries provided detail regarding the scope of stakeholder responsibility.

[6] St Andrew's cross or a cross buck is a traffic sign used to indicate a level crossing which is often used at crossings where there are no gates or barriers.

[7] Whilst all 24 countries indicated the responsible stakeholder for level crossing safety management, only twelve of these countries provided detail regarding the scope of stakeholder responsibility.

Table 26. Areas of responsibility and associated stakeholders related to the management of safety at level crossings (n=12)

Area of responsibility: Management	Associated stakeholders
Ensure efficient and safe operation of level crossings	- Railway infrastructure manager: *EL; CH; TR; UK** - Rail operator: *CH*
Manage and maintain level crossings	- Railway infrastructure manager: *AL; IE; TR* - Rail and road infrastructure manager: *RS*
Create and monitor safety management system	- Railway infrastructure manager: *AL; MK*
Performance of safety at level crossings (setting and monitoring achievement of objectives)	- National safety authority: *ES*
Installation of protection systems (road and rail)	- Rail and road infrastructure managers: *LV*

** The UK´s actual response was "full accountability" which is understood to mean overall responsibility for the safe and efficient operation of the LC.*

Responsibility for enforcement of safety at level crossings

Based on the responses given by fifteen of the surveyed countries[8] the scope of responsibility for the enforcement of safety at level crossings can be summarised under six key areas (presented in Table 27). Enforcement of safety is principally performed through the supervision of rail infrastructure activities (by national safety authorities or similar) on the one hand and the enforcement of road side user rules (by the police) on the other. Another important aspect of safety enforcement (established in 3 countries), is monitoring of the application of related legislation by relevant authorities and police.

[8] Whilst all 24 countries indicated the responsible stakeholder for level crossing safety enforcement, only fifteen of these countries provided detail regarding the scope of stakeholder responsibility.

Table 27. Areas of responsibility and associated stakeholders related to the enforcement of safety at level crossings (n=15)

Area of responsibility: Enforcement	Associated stakeholders
Supervise activities of rail infrastructure manager and operators (issue and supervise safety authorizations; safety certificates etc.)	- National safety authority: *IT; ES; LV* - Transport authority: *SK; CH* - Rail inspection authority: *AL* - Rail infrastructure manager: *CA; TR*
Ensure all users respect level crossing safety rules (impose sanction; speed enforcement; level crossing surveillance)	- Police (local and traffic): *EL; IT; MK* - Police and rail infrastructure manager: *TR; IE* (impose sanctions) - Police: *FI* (speed enforcement) - Police: *TR* (surveillance
Monitor application and enforcement of relevant legislation (railway safety law; level crossing specific law; health and safety law; road traffic law)	- Police and local authority: *AT* - Transport authority: *SK* - National safety agency, police, railway authority: *UK*
Accident reporting	- Police, railway staff: *EL*
Analyse and propose measure to improve safety	- Rail infrastructure manager: *MK*
Management of level crossing devices	- Rail infrastructure manager: *RS*

Responsibility for other areas of safety at level crossings

Survey respondents were asked to indicate other areas of responsibility for level crossing safety, not gathered within the previous categories (design, operation, management and enforcement) (see Table 28). The responses provided by thirteen countries indicate the importance of education and awareness raising actions (n=7) including work in schools and other outreach locations (on the street, driver licence schools). In Turkey there are training activities and certification directed at level crossing personnel. At a strategic level there are stakeholders from government or ministerial bodies (road and rail safety authorities and local public administration) that perform advisory roles (recommendations and consultation) as well as approving and authorizing level crossing infrastructure, in addition to tasks associated with the Safety Management System.

Table 28. Other areas of stakeholder responsibility

AREA OF RESPONSIBILITY: OTHER		
COUNTRIES	**STAKEHOLDER(S)**	**SCOPE OF RESPONSIBILITY**
ALBANIA	Municipalities, schools and education centres	Cooperation to raise awareness on level crossings safety.
AUSTRIA	Driver licence schools, Ministry for Transport (BMVIT)	No information given
BELGIUM	Road and traffic authorities; train and freight operators; local government authorities.	Advisory role
FINLAND	The Finnish Transport Safety Agency	Provides authorisations related to railway infrastructure and oversees railway safety via Safety Management System.
IRELAND	Infrastructure manager	Liaison with users
	Garda Síochána (police)	Road safety visits to schools
	Road Safety Authority	Promotion of road safety
LITHUANIA	Infrastructure manager, local government authorities, highway, road and traffic authorities.	Organization of educational programmes in schools, on the street or other places.
MONTENEGRO	Ministry of Transport and Maritime Affairs	Laws and by-laws
	Railway Directorate (NSA)	Safety Reports
	National Commission for Accident Research	Provide recommendations
SLOVAK REPUBLIC	Ministry of Education, Science, Research and Sport	Road safety courses as part of the teaching programs
SPAIN	Regional and local government authorities and land owners	Consultation and approval for the elimination and/or modification to level crossings on private land and administrative territory.
SWEDEN	Other infrastructure managers (with LCs e.g. on industry property)	No information given
SWITZERLAND	SBB (Swiss rail operator) education train; school	Delivery of education program and road safety education
TURKEY	TCDD Traffic Department	Training and certification of level crossing personnel who control the level crossing barriers
UNITED KINGDOM	Railway Authority	Voluntary operation of education campaigns.

4.3.2. Cross agency working for level crossings safety

In 88%[9] (n=21) of the countries there is some form of cross agency working for the management and operation of safety at level crossings. Four countries (Italy, Spain, Macedonia, Slovakia) report limited or no cross sector working which in the case of Slovakia consists of rail and road inspections carried out every 5 years. In four countries (Albania, Lithuania, Norway and Romania) there is evidence of cooperation between stakeholders, considered by the respondents to be either satisfactory or sufficient, although no details have been given regarding the relationship in practice.

Specific examples of cross agency working can be summarised as follows and is explained in greater detail on continuation:

- Working groups (multi-stakeholder)
- Rail and road level crossing inspections
- Cooperative arrangements

Multi-stakeholder working groups

There are working groups established and operating in six of the responding countries (Austria; Belgium; Finland; Ireland; Switzerland; United Kingdom) brought together to identify and select actions and measures to improve level crossing safety. The composition of these groups differs according to the country, with groups composed of stakeholders from one sector (rail) to groups made up of different administrative entities, ranging from rail and road to multiple agencies, encompassing rail, road, safety, police, local authorities. Some details of these groups, summarised by country, are presented on continuation with reflections made by the survey respondents regarding issues or barriers to effective collaboration.

- In Austria regular coordination meetings are held between concerned stakeholders.
- Each year the Belgian rail infrastructure manger (Infrabel) organizes working groups with different stakeholders (road and traffic authorities; train and freight operators; local government authorities; police authorities; local safety agencies) to select new measures to improve LC safety.
- In Finland there is a Railway Stakeholder Working Group comprising the Finnish Transport Agency, the Finnish Transport Safety, railway undertakings, other infrastructure managers and maintenance companies meet to discuss railway safety (no specific for level crossing safety).
- A Road Rail Safety Working Group meets in Ireland, with representation from main stakeholders.
- In Switzerland the Federal Office of Transport and the Swiss Federal Office for Roads have implemented a working group with the aim to identify options for actions, inter alia education of road users. The Association for Public Transport has attempted to initiate a (prevention) campaign, but there has been limited interest from road side stakeholders. Accident statistics for the road network show clearly that the risks at level crossings are not the most relevant ones.
- Formal Road Rail partnership groups exist in the United Kingdom to solve mutual problems and provide support. Participation is mostly voluntary and a good level of co-operation is generally

[9] This figure excludes those countries that report limited collaboration.

achieved although some local authorities see railway safety as low priority for them and consider it ultimately is a 'Railway issue'. Co-operation becomes more difficult when funding is required.

Level crossing inspections performed by rail and road

A further cross agency practice that takes place in five of the countries (Belgium; France; Slovakia; Latvia; the Netherlands) is the inspection of level crossings in order to analyze and diagnose the safety situation at level crossing in the country. These inspections involve different partners and take place with a different degree of frequency depending on the country. Some details of this practice, summarised by country, are presented on continuation.

- In Belgium, the rail infrastructure manager (Infrabel) and the "Federal government- Mobility and traffic" inspect level crossing on a regular basis.
- The French rail company (SNCF) in collaboration with the highway manager conduct safety diagnoses on some level crossings, the aim of which is to analyse the current situation and check various criteria (visibility, sighting, tendency for tailbacks to form road profile, pedestrian crossings).
- In Slovakia level crossing inspections involving road and rail are carried out every five years.
- In Latvia yearly commissioning of every single level crossing takes place. The act contains all detected flaws, period of fixing and responsible stakeholders. The inspection is performed by the infrastructure manager, local government authorities and road owner as well as the National Safety Authority.
- In the Netherlands the initiator of new risks is responsible for making a risk assessment, which the infrastructure manager must approve.

Cooperative arrangements

In more general terms four of the survey respondents (Ireland; Montenegro; Sweden; Russia) cited the existence of some sort of cooperative arrangements between different stakeholders involved.

- In Ireland there is a cooperative arrangement between safety authority, infrastructure manager and road safety authority.
- In Sweden there is cooperation within the Government Transport Administration (Trafikverket) which includes both road and rail together with land owners and local and private authorities for the management and technical maintenance of level crossings.
- In Montenegro local government and rail authorities work together to provide the necessary safety measures on the road approach (road signalling) and protection of crossing (equipping level crossing with safety devices).
- In Serbia the rail infrastructure manager has signed contracts with individual road infrastructure managers for the joint maintenance of level crossings.

4.3.3. Existence of dedicated government or independent level crossing safety body

Half of the countries (n=12) report not to have a government body or independent organization dedicated to promoting safety at level crossings operating in their country. Of the twelve other countries affirming to have an organisation(s) working in this field, only one, Canada, has a specific and independent organisation set up with this objective, named Operation Lifesaver. Operation Lifesaver is a non-profit public safety education and awareness organization dedicated to reducing collisions, fatalities and injuries at highway-rail crossings and trespassing on or near railroad tracks.

In the case of Russia there is an Interdepartmental Working Group on Traffic Safety at Level Crossings which comprises a wide range of ministries and governmental road and rail agencies. In the other cases, existing government or non-government entities carry out some functions or activities as part of wider road safety or railway safety work.

For example, in Finland and France there is no single organisation dedicated to promoting level crossing safety but rather existing entities (public and private road and rail entities) who join efforts to run specific level crossing safety activities, such as safety campaigns or a dedicated awareness day.

In Finland the level crossing safety campaigns are typically organised by the Finnish Transport Agency in cooperation with the Finnish Transport Safety Agency, VR-Group Ltd, the Central Organisation for Traffic Safety in Finland (*Liikenneturva*) and the Police).

In France every year the SNCF organises a nation-wide accident-prevention day in conjunction with the Road Safety Directorate, professional haulage and motoring organisations, mayors' associations, the administrative Departments and Regions of France, and the French association for the prevention of road accidents.

In Sweden the Transport Administration is responsible for continuously managing level crossing safety while in Austria, Italy and Lithuania, different government or ministerial bodies with accountability for transport and safety also cover level crossing safety.

In the case of Albania a specific body was not cited but rather actions from public and private road and rail related organisations. From the road side, level crossing safety is promoted through subjects delivered at auto schools and from the rail side the subject is dealt with at vocational training centres for railway safety posts.

Level crossing safety is also gathered within the activities of non-profit road safety organisations, such as in Greece. In a similar way in Macedonia and Slovakia level crossing safety may be dealt with as part of the activities of public bodies (e.g. road traffic safety unit) that have been set up to promote road safety.

4.4. User requirements in level crossings

The design of innovative solutions and tools for promoting level crossing safety should take into account that level crossings are used by a wide-spectrum of users (e.g. car drivers, professional drivers, pedestrians, cyclists etc.,) and that the requirements of these users are not homogenous. For this reason a key element of the SAFER-LC project is to analyse the user requirements for safe access and use of level crossings. In order to gather information on the national safety arrangements and features related to user requirements at level crossings, specific measures for different user groups were investigated.

Specifically, the analysis of user requirements presented in this section focused on:

- Motorized road users: transport professionals; heavy vehicles; and farm vehicles.
- Vulnerable road users: cyclist; pedestrians; ramblers; horse riders; persons with reduced mobility; users with vision loss and blindness; users with hearing loss and deafness; and users with different cultural and language background.

The survey tool also sought to understand how level crossing user needs are identified and whether legislation exists in the different countries targeting equal access and use of level crossing
In general terms users can be divided into two key groups: motorised and non-motorised road users who can be further distinguished as vulnerable or non-vulnerable users. According to the European Commission (2011), vulnerable road users are defined as *"non-motorised road users, such as pedestrians and cyclists as well as motor-cyclists and persons with disabilities or reduced mobility and orientation"*.

ERTRAC (2011) define vulnerable road users (VRU) as "*those participants in traffic that are not protected by any mechanical system: pedestrians, motorcyclists, bicyclists, and users of mopeds. This includes road users with impairment, e.g. using a mobility aid, or children playing on the road. Car occupants, even when this refers to impaired people, senior people or children do not belong to the category of VRU according to this definition*".

The SAFER-LC project goes further with its definition. For SAFER-LC, the situation of vulnerability is not limited to the use or not of a vehicle, rather can encompass other circumstances, such as age, culture, nationality, language, physical limitations, etc. (e.g. older persons, foreigners/ refugees, children, ramblers, horse riders, etc.).

In general terms users can be divided into two key groups: motorised and non-motorised road users who can be further distinguished as vulnerable or non-vulnerable users. According to the European Commission (2011), vulnerable road users are defined as "*non-motorised road users, such as pedestrians and cyclists as well as motor-cyclists and persons with disabilities or reduced mobility and orientation"*.

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culture, nationality, language, physical limitations, etc. (e.g. older persons, foreigners/ refugees, children, ramblers, horse riders, etc.).

4.4.1. User requirements at level crossings

Albania and United Kingdom are the only countries that indicated to have safety arrangements and features that address the specific requirements of all different LC user groups: All three user groups for motorized road users and all eight user groups for vulnerable road users are covered. Other countries covering a large number of different user groups are Switzerland (9 out of 11; 82%), Sweden (6 out of 11; 55%), Montenegro (5 out of 11; 46%) and Lithuania (6 out of 11; 55%). Greece and Romania do not indicate to have any safety arrangements that address specific requirements of different user groups at level crossings (see Figure 11 below).

Results indicate that safety arrangements related to motorized road users at level crossings are more frequent than those related to vulnerable road users (see Table 29):

- 59% of countries (n=13) have cited more examples of safety measures that target motorized user than measures aimed at pedestrian users (Austria, Canada, France, Greece, Italy, Lithuania, Macedonia, Montenegro, Norway, Russia, Slovakia, Sweden and Switzerland).
- 32% of countries (n=7) have reported more safety arrangements addressing vulnerable road users than measures for motorized road users (Belgium, Finland, Latvia, the Netherlands, Serbia, Spain and Turkey).
- 9% of countries (n=2) have the same number of measures for each type of user (Albania and United Kingdom).

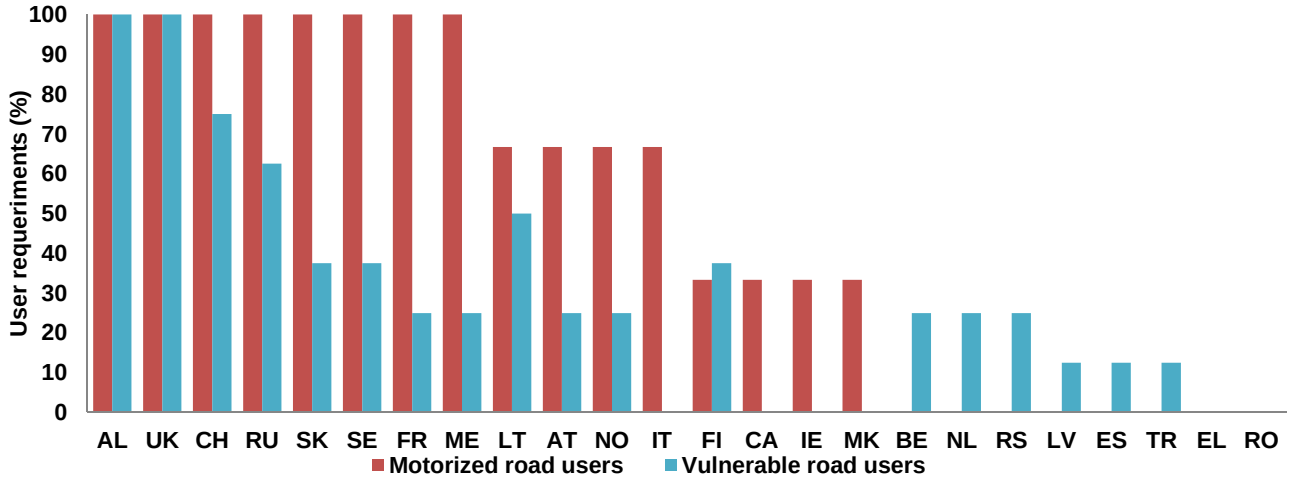

Figure 11. Level crossing user requirements covered, by type of users and country (%)

Although these are the general trends there are **specific requirements of different motorized road user groups** depending on the country:

- In Albania, for example, there are safety arrangements focused on transport professionals, heavy vehicles and farm vehicles in level crossings.
- In Austria, Italy and Lithuania measures are focused on transport professionals and heavy vehicles.
- In Norway measures are focused on heavy vehicles and farm vehicles in level crossings (see Table 29 below).

There are specific **measures taken to protect vulnerable road users** depending on the country:

- Albania and United Kingdom have safety arrangements for all groups of vulnerable road users.
- Switzerland is another country with a high rate of coverage: cyclist, pedestrians, horse riders, persons with reduced mobility, users with vision loss and blindness, and users with hearing loss and deafness.
- In Russia, there are specific requirements for cyclists, pedestrians, persons with reduced mobility, users with vision loss and blindness, and users with hearing loss and deafness (see Table 29 below).

These results indicate the difference in political strategies regarding user requirements of countries participating in the SAFER-LC survey. It should be noted that with the exception of Albania and the United Kingdom, which claim to have safety arrangements in level crossings for all user groups, other countries do not take into account users with different cultural and language backgrounds.

Some countries consider other additional safety arrangements and features related to user requirements at level crossings. These measures focus on other groups at risk, such as children and animals. Italy and the United Kingdom develop education safety campaigns for children and students. In Albania, Ireland and Russia their focus is on animals. In the case of Albania, animals that accompany persons, such as guide dogs, are addressed. Ireland and Russia have measures to protect cattle at level crossings.

Table 29. Share (%) of user categories considered in each country.

	AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU	RS	SK	ES	SE	CH	TR
Motorized road users	100	67	0	33	33	100	0	33	67	0	67	3	100	0	67	0	100	0	100	0	100	100	0
Transport professionals	x	x			x				x		x	x	x				x		x		x	x	
Heavy vehicles	x	x							x		x		x		x		x		x		x	x	
Farm vehicles	x			x				x					x		x		x		x		x	x	
Vulnerable road users	100	25	25	0	38	25	0	0	0	13	50	0	25	25	25	0	63	25	38	13	38	75	13
Cyclist	x		x		x	x					x		x	x	x		x	x	x		x	x	
Pedestrians	x		x		x	x				x			x	x	x		x	x	x	x	x	x	x
Ramblers	x				x																x		
Horse riders	x																					x	
Persons with reduced mobility	x	x									x						x		x			x	
Users with vision loss and blindness	x	x									x				x		x					x	
Users with hearing loss and deafness	x										x						x					x	
Users with different cultural and language background	x																						
TOTAL	100	36	18	9	36	36	0	9	36	9	55	9	46	36	46	0	73	36	55	9	55	82	9

4.4.2. Actions to address the requirements of level crossing user groups

The 24 countries provided examples of how safety at level crossings has been addressed in order to meet the requirements of different user groups. According to these results five types of strategies could be established depending on the thematic focus of safety (see Table 30):

- **PHYSICAL AND TECHNOLOGICAL ARRANGEMENTS**
  These type of safety strategies have focused, on the one hand, on physical arrangements, i.e. on different types of barriers and systems of protection of roads and level crossings. In particular:
  - **Barriers for cyclists and pedestrians**.
    For example, in Latvia, there are special safety fences for pedestrians that permit to control their movement flow through the level crossing.
  - **Protective barriers for heavy duty vehicle**.
    For example, in Norway, there are barriers used as obstacle detector for heavy vehicles.
  - **Protective barriers for the cattle**.
    In Ireland, there are special arrangements made to facilitate the crossing of herds, including corrals.
  - **Manual or mechanical protection for workers**.
    For example, in Canada, there is manual protection of private crossing during farm work by railway workers.

  On the other hand, technological arrangements for vulnerable users have been developed:
  - **Technological developments.**
    For example, various technological measures have been developed in the United Kingdom to improve the safety of different groups of users: signage and telephones to enable contact with railway authority for drivers of abnormal vehicles (motorised users); flange way infill strips at high-risk crossings (cyclists); decks at high use crossings (pedestrians and ramblers); additional warning time, signs to dismount, bridle gates with extended handles (horse riders); extended warning times, decks, anti-slip surfaces (persons with reduced mobility), etc.
- **INFRASTRUCTURE ARRANGEMENTS**
  Some countries that participated in the SAFER-LC project survey provided examples on how safety at level crossings has been addressed through infrastructure arrangements. In particular:
  - **Level crossings (or level crossings devices) for pedestrian and cyclist lanes**.
    In Spain there is a demarcated area for the crossing which is for the exclusive use of pedestrians, separated from the road traffic.
  - **Widen level crossings for heavy vehicles**.
    In France, the level crossings are expanded to make crossing easier for heavy vehicles.

- **EDUCATIONAL CAMPAIGNS**
  Some countries also emphasized the importance of including educational and informative campaigns to improve safety at the level crossings:
  - **Educational safety campaigns**.
    In Austria, for example, there is training at schools for children and young people. FYROM has developed posters and school safety campaigns.
- **SAFETY SIGNS**
  Other countries provided examples on how safety strategies at level crossings have been addressed through safety signs. To be more specific:
  - **Pedestrian signalling**.
    In Russia, for example, there are traffic warning signs, horizontal surface marking and stop line on the road.
  - **Signalling for heavy vehicles**.
    In Slovakia, there are road signs with the pictogram "no entry for trucks" pictogram and others which limits the length of road vehicles.
- **PROCEDURAL MEASURES**
  Strategies of this type have focused on legal procedural measures about safety at level crossings:
  - **Legal procedural**.
    In Switzerland, for example, legal regulations and standards take into account the different user groups.

Table 30. Examples of actions to address the requirements of different users at level crossings

Type of measure	Actions taken by country
Physical and technological arrangements	▪ Barriers for cyclists and pedestrians: BE; LV; ME; NL; NO; RS. ▪ Manual or mechanical protection for workers: CA; SK ▪ Protective barriers for heavy duty vehicle: LT; NO ▪ Protective barriers for the cattle: IE. ▪ Technological developments for vulnerable users: UK; SK.
Infrastructure arrangements	▪ LCs (or LC devices) for pedestrian and cyclist lanes: FI; LT; TR; ES; FR; SK ▪ Expand level crossings for heavy vehicles: FR.
Educational campaigns	▪ Educational safety campaigns: AT; IT; MK; RO.
Safety signs	▪ Pedestrian signalling: IE; ES; BE; LV; LT; RU; UK. ▪ Signalling for heavy vehicles: FI; NO; SE; SK.
Procedural measures	▪ Legal procedural: AL; CH.

4.4.3. Identification of user requirements

In order to gain knowledge on level crossing safety and develop effective countermeasures, it is necessary to know more about high-risk users and other human factors that contribute to level crossing misuse (voluntary or involuntary). For this reason survey respondents were asked to indicate how the needs of level crossing users are taken into account when designing safety arrangements at level crossings. Results show that the main source of information is gathered from accident investigation, with safety assessments, expert opinion and other kind of information (e.g. company standards or contextual information) (see Figure 12).

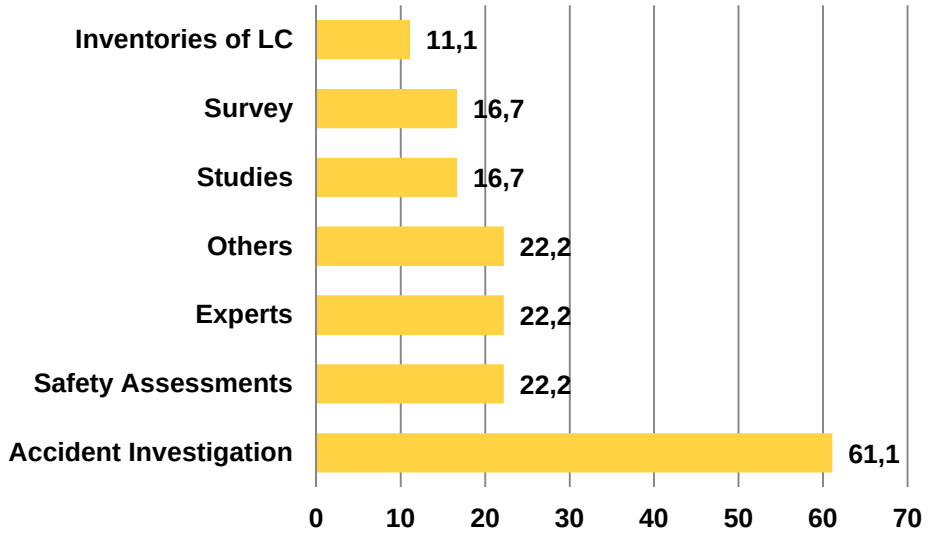

Figure 12. Actions to identify user requirements (%)

According to the results, there are countries that follow a more complex procedure to identify user requirements (see Table 31). For example, in Sweden, in the first place, all accident and incident reports and investigation are added to a database that registers all occurrences at the railway. In a next step, the accident databases are linked to the Plk-web The Plk web is a national database that includes comprehensive information about all the level crossings in the country, leading to a situation where every single level crossing has got a list of the accidents and incidents registered. It is searchable and possible to aggregate data to find out and study the frequency of different occurrences in both Plk-web and the database for accidents and incidents. There is an additional advantage in Plk-web, as it links the data with information of a specific level crossing and it gives a more detailed picture of the problem.

In Slovakia, before the reconstruction of a level crossing, the needs of different users are discussed in advance within the preparation of project documentation with all parties (municipalities, road manager, and police). A public consultation is developed in Macedonia and Montenegro to identify the needs of users.

The United Kingdom collects information from Census data to identify numbers and types of users, adoption of findings from accident and incident reports, analysis of accident and incident statistics, risk, assessment of use, application of research findings, application of professional safety and engineering judgements.

Table 31. Actions to identify user requirements by country

	AL	AT	CA	FI	FR	EL	IE	IT	MK	NL	NO	RU	RS	SK	SE	CH	TR	UK
Accident Investigation			X		X	X	X	X	X	X		X			X	X		X
Safety Assessments			X								X						X	X
Experts							X							X			X	X
Others						X	X			X								X
Studies	X	X											X					
Survey									X			X		X				
Inventories of LC				X			X											

4.4.4. Equality legislation for level crossing usage

According to the results, nine countries have legislation promoting equal access and use of level crossings by all user groups whereas 15 countries have no specific legislation covering this topic (see Figure 13).

Figure 13. Existence of legislation promoting equal access and use of level crossings by all user groups (n=24).

Legislation on equal access and use of level crossings by all user groups in the countries present many international differences:

- Albania includes legislation of equal access in the new railway code and provisions related to ability, access and availability conditions and equipment for people with disabilities and limited mobility, and any person accompanying them.
- Canada applies the Grade Crossings Standards, article 10.3 (Departure Time), particularly 10.3.3 dealing with Pedestrians, Cyclist and Persons Using Assistive Devices).

- Finland applies PRM TSI (Technical specifications for interoperability relating to accessibility of the Union's rail system for persons with disabilities and persons with reduced mobility).
- In France, this is foreseen by regulation, and SNCF is developing new equipment which will be trialled before being rolled out across the network.
- In Norway, there is legislation on equal access and use of level crossings by all user groups though no details were given in the survey.
- Russia applies the Order No. 237 of the Ministry of Transport of the Russian Federation dated 31 July 2015 “On the Approval of the Level Crossing Operating Conditions”.
- Sweden follows the EU-legislation at platform crossings that especially includes those with disabilities.
- In Switzerland, there is an act setting requirements for the equality of disabled persons. The act is comprehensive, not specific to level crossings.
- In the United Kingdom, the Railway Authority applies the Equality Act 2010. Further is required periodically a proactive demonstration of compliance.

4.5. Lessons learnt regarding level crossing safety

Survey respondents were asked to share lessons that have been learnt regarding delivering effective safety at level crossings, specifically highlighting factors that have facilitated the successful implementation of safety measures and those issues that act as barriers to improving level crossing safety. All countries provided a response to this question with some clear themes emerging, along with country-specific issues highlighted in some cases.

4.5.1. Factors that facilitate level crossing safety

The factors that have been identified as supporting safety at level crossings can be grouped under three key headings: strategic; operational; educational and enforcement, summarised in Table 32. This illustrates the importance attributed to cross-agency working and obtaining political backing and investment in level crossing safety. On continuation a more detailed analysis of each factor is carried out.

Table 32. Factors reported by countries to facilitate level crossing safety (n=24)

Factors facilitating LC safety	
Strategic	– Cross-agency working (n=16) – Political backing and investment (n=10) – Evidence based decision making (n=2) – Setting ambitious safety targets (n=1)
Operational	– Investment in level crossing protection (n=5) – Effective programme of maintenance (n=4) – Investment in level crossing removal (n=3)
Educational and enforcement	– Information and education and sanctioning level crossing misuse (n=4)

Cross-agency working

Countries reporting factor: AL; AT; BE; CA; FI; EL; IE; LV; MK; NO; RO; SK; SE; CH; TR; UK (n=16)

Sixteen countries reported cross-agency working[10] as an important factor for the delivery of safety at level crossings, with an emphasis on road and rail collaboration. Specifically, countries reported the need for joint participation in investment projects with the sharing of costs of level crossing construction, operation and maintenance (highlighted by Slovakia and Albania). Respondents also indicated the value of making a clear division of roles and responsibilities, including identification of primary responsible stakeholder and definition of responsibilities to be assumed by road authorities.

[10] The terminology varied slightly between countries, with reference to cooperation (UK; Finland; Ireland) partnership working (Austria; Norway; Switzerland) collaboration (Sweden; Belgium) and coordination (Italy; Macedonia).

Tools to support cross sector participation, include regular cross agency meetings (a practice that currently takes place in Finland, Sweden and Turkey) and protocols for joint decision making, costs and responsibilities.

Responses point to the importance of political and legal backing in order to achieve a multi-agency approach, with the UK specifically highlighting the challenge of gaining voluntary co-operation without political backing or the force of law and examples, such as in France, of national regulations which establish the responsibilities to be assumed by highway authorities. It is interesting to note that the examples of more developed cross agency working often coincide with those countries where there is fusion between the road and rail administrations.

In terms of the actors that should be involved in working together for level crossing safety, the surveyed countries highlighted the following:

- Rail (government agencies, IM, RU)
- Road (IM, government agencies)
- Local authorities
- Law enforcement
- Individual level crossing users (motorised and non-motorised)
- Other involved stakeholders

Political backing and investment

Countries reporting factor: NL; UK; NO; IE; LV; RO; EL; FR; MK; RS (n=10)

Ten countries reported the importance of political backing and investment as a factor that facilitates safety at level crossings, including in the case of Macedonia, support from local government bodies to invest in level crossing safety. This is a cross-cutting factor that underpins other level crossing safety actions in terms of both funding as well as support of processes and operational issues that promote level crossing safety (e.g. division of stakeholder roles and responsibilities as established by law).

Level crossing protection

Countries reporting factor: ES; RU; NL; LT; IT (n=5)

Five countries consider that expanding the coverage of level crossing protection systems contributes to improving safety. This encompasses the upgrade of unprotected crossings, as a minimum, by equipping all level crossings with a primary means of technical protection (Russia). The idea is echoed in Spain as they report the need to set realistic targets for level crossing protection, not committing to implementing the highest level of safety measures on all level crossings. These two approaches are related and seem to be in contradiction with the idea of setting ambitious targets (proposed in the Netherlands) which may indicate some differences in the operational, economic and cultural conditions of the countries which of course influences national policy and practice.

Education and enforcement

Countries reporting factor: IT; RU; FR; RS (n=4)

sanctions against misuse as positive influencers towards level crossing safety. Specifically, France reports the effectiveness of penalising road users for misuse in order to incentive correct use of crossings. The importance of sanctioning level crossing misuse alongside education is also recognised in Italy and Russia.

Maintenance

Countries reporting factor: NO; CA; IT; MK (n=4)

An effective programme of maintenance is considered to support level crossing safety by four countries, with Canada specifically noting the value of applying a system to report crossing failures.

Investment in level crossing removal

Countries reporting factor: ES; RU; NL (n=3)

Three countries report that investment in eliminating level crossings is important to improving safety. There is evidence of different removal philosophies between the respondents with the Netherlands setting ambitious safety targets (long-term vision zero for level crossings) whilst Spain expresses the need to set realistic targets, specifically indicating non application of the vision zero policy. Russia focuses attention on constructing grade separated crossing (overpasses).

Evidence based decision making

Countries reporting factor: FI; SE (n=2)

Factors classified as evidence based decision making were cited by two countries. This encompasses systematic monitoring activities including: level crossing safety database and inventory; dedicated level crossing e-mail box managed by group of experts; open weekly meetings to discuss level crossing issues with regional stakeholders; integrated and systematic approach to addressing level crossing safety and budget decisions, taking into consideration different factors: infrastructure and operation, legislation, human behaviour.

Setting ambitious safety targets

Country reporting factor: NL (n=1)

Just one country identified the setting of ambitious safety targets by the infrastructure manager as a factor that facilitates safety at level crossings.

4.5.2. Barriers to level crossing safety

The factors that have been identified as barriers to achieving safety at level crossings can be grouped under three key headings: strategic; operational; and human factors summarised in Table 33. These results highlight the importance of securing political acceptance and public investment and impact of human factor related issues on achieving level crossing safety. On continuation a more detailed analysis of each factor is carried out. Please note that although individual barriers have been grouped together thematically, more barriers than facilitators were identified by survey respondents.

Table 33. Factors that act as barriers to achieving level crossing safety (n=24)

	Barriers to LC safety
Strategic	– Securing political acceptance and public investment (n=16) – Lack of cross-agency working (n=5)
Operational	– Cost and complexity of LC removal and upgrade process (n=7) – Limitations of current protection arrangements (n=5) – Maintenance (n=1)
Human factors	– Public acceptance (n=3) – Level crossing misuse (n=5) – Public awareness (n=4)

Securing political acceptance and public investment

Countries reporting factor: ES; TR; UK; LT; CH; LV; BE; RO; EL; CA; SE; FI; SK; ME; MK; AL (n=16)

Political acceptance and public investment is an issue highlighted by sixteen countries. Some responses grouped these two issues together whilst others pointed to one or the other, however, given that public investment priorities and allocation of funding to support level crossing safety are underpinned by political will and interest in the issue, they have been considered together.

Specifically, limited resources and budgetary restrictions was a barrier highlighted by half of the countries (n=8) whilst a lack of political will was highlighted by five countries. Another issue indicated by one country relates to the public financing of issues that lack public appeal influencing budgetary allocation. The example given was the announcement of new line opening versus the announcement of the closure of a level crossing with the former likely to have greater appeal than the latter. Another issue related specifically to political involvement and commitment to the issue is a lack of coordination and overview from the government to ensure safety standards which was highlighted in Slovakia.

Human factors

There are three key issues that have been classified as human factor related, namely:

- **Level crossing misuse**
  Countries reporting factor: AL; FR; EL; SK; CH (n=5)

This issue was identified by five countries and encompasses non-compliance with road traffic legislation (identified in FR; EL; CH; SK), crossing misuse (identified in CH; SK; EL; FR), vandalism of protection devices (identified in SK) and issues around enforcing legislation (identified in Albania).

- **Lack of public awareness on level crossing safety**
  Countries reporting factor: FR; NL; RS; ES (n=4)

A lack of safety awareness amongst level crossing users was emphasised by four countries, underlining the need for education and enforcement for the correct and safe use of level crossings.

- **Public acceptance**
  Countries reporting factor: ME; NL; ES (n=3)

The public´s lack of acceptance of safety measures at level crossings was indicated to be a barrier by three countries. Examples included the resistance from action groups against the closure of

crossings or building of grade separated crossings (the Netherlands and Spain) and Montenegro reports a lack of understanding from the public about the need to reduce the number of crossings.

Cost and complexity of level crossing removal and upgrade process

Countries reporting factor: AT; BE; IE; IT; SE; SK; TR (n=7)

Seven countries raised a variety of issues related to the cost and complexity of level crossing removal and upgrade processes which act as barriers to ensuring safety at level crossings. The following problems were identified by respondents:

- High costs and technical complexity involved in removing level crossings and constructing grade separated crossings (over or underpasses), including costs of compulsory land purchase (identified in IE; IT);
- Long and complex (planning) process which entails reaching multilateral agreements on the safety measures to be taken; obtaining the consent of interested parties and planning permission to remove a level crossing or upgrade (identified in SE, AT, IE, SK).
- Construction related issues including problems with construction plans, including disregard of planning approvals leading to unauthorised constructions and failure to comply with building conditions leading to LC safety problems (identified in SK, TR).
- Legal requirements and restrictions (identified in BE)

Lack of cross agency working and collaboration

Countries reporting factor: LV; SK; BE; RO; UK (n=5)

Just as this point was highlighted as facilitating level crossing safety, in its absence it acts as a barrier. Specifically, the responding countries emphasised lack of collaboration and coordination between rail (IM), road (IM), road police and local authorities which impacts the planning of road repairs and level crossing constructions and implementation of technical measures on roadside (identified in LV, SK, BE, RO).

One of the issues appears to be the differing priorities of rail, road and local authorities which leads to a contrasting perception on the problem of safety at level crossings. For example, in the UK crossings are viewed as safer than roads and are therefore lower in the hierarchy for investment. Perhaps this calls for the establishment of a multi-stakeholder vision which brings together the concerns of road and rail in order to facilitate their working together for safety at level crossings.

Another factor related to the division of roles and responsibilities of involved stakeholder is the need for a more equitable share of responsibility between rail, road and local authorities (as indicated by the United Kingdom). A number of the responses pointed towards reallocating greater level of responsibility to road authorities and local authorities, including financial commitment from local authorities for the installation of road side technical measures and contribution towards maintenance costs. In Slovakia there can be problems in gaining the collaboration of municipal government in contributing towards maintenance costs, perhaps linked to the fact that there are many level crossings in a municipality that are only used seasonally.

Slovakia also points out the lack of government coordination and overview in relation to procedures regarding level crossing replacement with grade separated crossing.

Limitations of current protection arrangements

Countries reporting factor: ES; RU; IE; EL; SK (n=5)

Five countries indicated that the technical limitations of current protection systems are a barrier to level crossing safety. Specifically, due to the inflexible and relatively unchanged nature of the current protection systems (that are linked to railway signalling) it is necessary to develop technological solutions that are more cost effective and easy to install and maintain, in this way also facilitating their application at crossings that are currently unprotected (identified in ES).

Furthermore, installing and maintaining protection equipment entails high costs, particularly technical equipment (video, photo recording equipment) (identified in RU).

Two countries indicated the problem of inadequate or insufficient levels of current level crossing protection in their country. For example in Ireland current protection arrangements have become obsolete due to changing circumstances of the roads across passive crossings where these have been upgraded and there is an increase in traffic. Greece reported “useless” level crossings that contribute heavily towards accidents and do not facilitate rail and road operations.

4.6. Best practice on level crossing safety

This section of the report explores the experiences and best practice regarding level crossing safety in different countries. Task participants provided information regarding different types of measures: organisational and procedural; physical and/or technological; educational and other measures. In order to explore the transferability of the reported measures, survey respondents were asked to perform a brief evaluation exercise, rating the safety arrangements in terms of different criteria: organizational and procedural; technological; safety; human factors; and economic. A summary of the measures and the results of the evaluation are presented on continuation.

4.6.1. Case studies and project results

Twenty case studies and/or project results at a European and international level were reported. In some cases, the measures are already implemented but in others they are only at a design phase. These examples represent a diverse spread of safety arrangements, including two organisational/ procedural measures, seventeen physical and technological and only one educational intervention (Table 34).

The organisational and procedural measures encompass a level crossing safety manual and level crossing safety analysis tool used for the allocation of safety measures. Just one educational measure was cited, a Safety at Level Crossings rule book directed for use by railway staff, schools and railway police. Under the physical and technological category a wide range of examples were reported, from low cost measures to more sophisticated technological solutions. Examples include:

- Physical elements applied to the road approach that act as a warning and/or facilitate road user crossing (e.g. road markings; rumble strips; rubber/plastic cattle grids) (n=3);
- Technologies (e.g. video, satellite etc) that detect and communicate LC risk between rail and road vehicles and between infrastructure and road vehicles (n=3).
- Low cost measures to improve visibility of the roadside user (e.g. traffic mirrors;“V” Boards for management of vegetation overgrowth) (n=2)

- Flashing yellow light warnings at passive LCs (n=2)
- In-vehicle warning systems and protection device (in concept/design phase) (e.g. TEDS-Train Early Detection System; Junavaro project; wheel detector sensor technology) (n=3)
- Viaduct over level crossing (n=1)
- Camera for enforcement of red light violation (n=1).

More detailed information, case studies and project results are included in Annex G.

Table 34. Summary of case study and project results

Type of measure	Case studies/project results	Country
Organisational and procedural measures	MANEUVER. Development of avoidance measures for misconduct on railway crossings with the aid of the traffic psychology	Austria
	Tarva Level Crossing tool. Level Crossing safety analysis tool	Finland
Physical and/or technological measures	RÜTTLEX project	Austria
	TEDS-Train Early Detection System	Canada
	JUNAVARO project. In-vehicle warning system for railway level crossings	Finland
	LeCross study. Improving Safety at Rail Crossings	Finland
	Level Crossing Attention Device	Finland
	Radar camera to detect drivers running red lights at level crossings	France
	Lattice road markings	France
	Traffic Mirrors for Level Crossings	Ireland
	White Stop Lines. Passive and Manual Road Crossings	Ireland
	Cattle Grids Alternatives. Rubber pyramid and Recycled Plastic	Ireland
	Vegetation 'V' Boards	Ireland
	Level crossing of Railway section Marijampole-Sestokai 26+440 km reconstruction installing viaduct over Arminas street	Lithuania
	Level Crossing Safety Systems	Serbia
	ADIF type Level Crossing Protection System (SPN-900)	Spain
	BEGICROSSING	Spain
	MICRO	Switzerland
	Design of Automated Unmanned Railway Level Crossing System Using Wheel Detector (Sensor) Technology	Turkey
Educational measures	Rules of the Road. 'Safety at Level Crossings'	Ireland

4.6.2. Evaluation of case studies and project results

In order to extract useful lessons from the best practice examples provided and explore cross-national circumstances, a follow-on task was included which required the survey respondent to evaluate the measure in terms of different criteria. Specifically survey respondents were asked assess the measure, assigning a “low”, “medium” or “high” score rating to the following set of criteria:

- Level of cross-modal cooperation required
- Procedural complexity
- Level of technological development required
- Effect on safety
- Level of social impact/acceptance of measure
- Level of physical access to the level crossing all types of users (including people with reduced mobility)
- Level of self-explaining nature
- Economic cost of measure
- Cost-effectiveness of measure

Essentially, this brief evaluation exercise sought to identify some of the factors that should be taken into account when considering the feasibility of implementing the measure in different country contexts. The results of this assessment have been interpreted by FFE in terms of difficulty and/or complexity for the implementation of said measure. Two of the criteria also judged the level of impact, in terms of effect on safety and cost-effectiveness of the measure. Whilst these criteria are not directly related to implementation they are also important factors to be taken into account when considering whether to implement a measure or not. The level of difficulty and/or complexity has been represented using the colours of a traffic light, as a more visually symbolic way of presenting the results, as follows:

- Red refers to a high level of difficulty or complexity in the aspect of implementation assessed;
- Yellow refers to medium level of difficulty or complexity in the aspect of implementation assessed;
- Green refers to low level of difficulty or complexity in the aspect of implementation assessed.

Please note that the results of this evaluation exercise are indicative and highlight only some of the issues to be aware of when considering the feasibility of implementing a measure. Furthermore, in order to understand the results in greater depth, more aspects should be taken into account, such as the extension of the rail and road network; public investment in level crossing safety; the degree of technological development in the country; historical, socio-cultural and political factors, etc.

Sixteen evaluations of the case studies or project results have been explored[11]. These are described below:

[11] There are not evaluations of all case studies.

4.6.2.1. Organisational and procedural measures

An overview of the results of the evaluation of organisational and procedural case studies and project is presented in Table 35. On continuation a more detailed description of the assessment of each measure is provided.

Table 35. Results of the evaluation of organisational and procedural case studies and project results

	1. Maneuver project	2. Tarva tool
Organisational and procedural		
Level of cross-modal cooperation required		
Procedural complexity		
Technology		
Level of technological development required		
Safety		
Effect on safety		
Human factors		
Level of social impact/acceptance of measure		
Level of physical access to the LC by all types of users		
Level of self-explaining nature		
Economic		
Economic cost of measure		
Cost-effectiveness of measure		

Note: Red: high level of difficulty or complexity. Yellow: medium level of difficulty or complexity. Green: low level of difficulty or complexity.

1. **Maneuver project** is a manual of measures: education, awareness raising and roadside infrastructure which draws on traffic psychology. The measure is at a conceptual/ design phase (Austria).
   - At an organizational and procedural level, the procedural complexity of the measure and the required level of cross-modal cooperation have been estimated as medium (Table 35).
   - The level of technological development required is low.
   - In terms of safety, the safety effects of Maneuver have been estimated as high.
   - As regards to human factors, measure has social impact. However, with regard to physical access to the level crossing by all types of users and self-explaining nature of the measure it has been assigned a medium level rating.
   - Finally, as regards to economic factors, it is rated positively due to being evaluated a low-cost system with a high level of cost-effectiveness.

2. **Tarva Level Crossing tool** is safety analysis tool used to estimate the current safety situation on all level crossings to allocate safety measures optimally. The measure has been tested in real conditions and implemented (Finland).
   - At an organizational and procedural level, the procedural complexity of the measure and the required level of cross-modal cooperation were estimated as low (Table 35).
   - At a technological level, the tool does not require complex developments.
   - In terms of safety, Tarva tool has no direct safety effects. The safety effects can potentially be high but they will be realised only after the results of the tool are applied in practice.
   - According to the assessment, the social impact and acceptance of the measure were considered as high though has a medium rating in terms of self-explanatory nature.
   - Finally, regarding economic factors, Tarva tool has been assessed as a medium cost measure. It has a high cost-effectiveness rating.

4.6.2.2. Physical and/or technological measures

An overview of the results of the evaluation of physical and/or technological case studies and projects is set out in Table 36 overleaf. Please note the TEDS project was not evaluated. On continuation a more detailed description of the assessment of each measure is presented.

Table 36. Results of the evaluation of physical and/or technological case studies and project results

	1. Ruttlex	2. Junavaro	3. LeCross	4. Attention	5. Radar	6. Lattice	7. Mirrors	8. White lines	9. Catlle	10. Vegetation	11. Viaduct	12. LC Safety	13. Adif	14. Begicrossing	15. Micro	16. Sensor
Organisational and procedural																
Level of cross-modal cooperation required																
Procedural complexity																
Technology																
Level of technological development required																
Safety																
Effect on safety																
Human factors																
Level of social impact/ acceptance of measure																
Level of physical access to the LC by all types of users																
Level of self-explaining nature																
Economic																
Economic cost of measure																
Cost-effectiveness of measure																

Note: Red: high level of difficulty or complexity. Yellow: medium level of difficulty or complexity. Green: low level of difficulty or complexity.

1. **Rüttlex project** developed a series of rumble strips applied to road zones of level crossings. The measure has been tested in real conditions (Austria).
   - At an organizational and procedural level, the Ruttlex project is classified to have a medium difficulty level.
   - At a technological level, it does not require complex developments.
   - In terms of safety, the safety effects of Ruttlex have been estimated as high.
   - Regarding human factors the results are disparate. It should be noted that it is a measure with a high level of social impact and self-explaining nature, however, the survey respondent highlighted the low level of physical access to the level crossing by all types of users.
   - At an economic level, the Ruttlex project is low-cost and cost-effective.

2. **Junavaro project** studied the technical functioning, reliability and socioeconomic cost-benefit of an in-vehicle warning system for railway level crossings. The measure has been tested in real conditions (Finland).
   - At an organizational and procedural level, Junavaro systems is favourable because it does not require complex procedures and the level of cross-modal cooperation required for its implementation is low.
   - The level of technological development required however, is high.
   - In terms of safety, the safety effects of Junavaro have been estimated as medium.
   - According to the assessment, the social impact and acceptance of the measure were considered as high though has a medium rating in terms of self-explanatory nature.
   - Finally, as regards to economic factors, it is rated positively due to being evaluated a low-cost system with a high level of cost-effectiveness.

3. **LeCross** study assessed a new satellite-enabled the system that allows railway infrastructure managers to deliver up-to-date reliable information of approaching trains to road users at currently unprotected passive level crossings. The measure has been laboratory tested (Finland).
   - At an organizational and procedural level, LeCross is a measure that requires a low level of cross-modal cooperation and the procedural complexity is low.
   - At a technological level, the level of technological development required was estimated as high.
   - In safety terms, the safety effects of the Ruttlex project is low-cost and cost-effective.
   - An average level of technological development was underlined.
   - According to the assessment, the social impact of the measure were considered as medium and level of physical access to the level crossing by all types of users and self-explanatory nature of the measure were considered as medium.
   - At an economic level, LeCross project is low-cost and cost-effective.

4. **Level Crossing Attention Device** comprises a transmitter installed in a train/railway vehicle sends GPS based information about the location of the train/railway vehicle to the attention device, which warns the road users by yellow blinking LED light when a train/railway vehicle is sufficiently close to passive crossing level LC. The measure has been implemented (Finland).
   - LC attention device requires a low degree of cooperation and complexity in the procedures.
   - An average level of technological development was underlined.
   - The safety effect of this measure was classified as medium.

- Regarding human factors the results were disparate. It should be noted that it is a measure with a high level of social acceptance and it has no effect on physical access to the level crossing. The level of self-explaining nature of the measure on the other hand was estimated as medium.
- At an economic level, it is a low-cost safety solution for passive level crossings but with a medium level of cost-effectiveness.

5. **Radar camera to detect drivers running red lights at level crossings** to detect drivers running red lights at level crossings developed to impose penalties for drivers. The measure has been implemented (France).
   - At an organizational and procedural level, Radar camera is a technological development that requires complex procedures and a medium level of cross-modal cooperation**Erreur ! Aucun nom n'a été donné au signet.**.
   - At technological level, the system requires an average level of development.
   - In terms of safety, the radar camera to detect drivers running red lights at level crossings has obtained average results.
   - Regarding human factors the results were disparate. The measure had positive results on social impact but a lower rating in terms of physical access to the level crossing and level of self-explaining nature.
   - Finally, as regards to economic factors, a medium score was assigned.

6. **Lattice road markings** to remind road users that it is prohibited to stop on any part of the level crossing bearing road markings. The measure has been tested in real conditions (France).
   - Results show that at organizational and procedural level, Lattice road markings have an average difficulty level of implementation.
   - The level of technological development required is low.
   - However, the measure in terms of safety has not been evaluated positively, with effects on safety considered to be low.
   - In terms of human factors, the results of the measure were somewhat negative with low social acceptance, physical access and self-explaining nature.
   - It is rated to be a low-cost measure although its cost-effectiveness is evaluated as low.

7. **Durable Ice-Free Stainless Steel Traffic Mirror** as an additional sighting aid at Level Crossings where view(s) are restricted. No information was provided on its stage of development (Ireland).
   - According to the assessment, at the organizational and procedural level, the procedural complexity of the measure and the required level of cross-modal cooperation have been estimated as low.
   - In terms of technological development required it received a medium score rating.
   - In terms of safety, measure has obtained average results.
   - It received a rather score rating in terms of human factors with a medium social impact and level of physical access to the level crossing and low level self-explaining nature.
   - At an economic level, the Durable Ice-Free Stainless Steel Traffic Mirror is a medium-cost measure and the cost-effectiveness of measure is also intermediate.

8. **White Stop Lines (Passive and Manual Road Crossings)**: white stop line that indicates safety position for road vehicle on approach to level crossing. No information was provided on its stage of development (Ireland).
   - At an organizational and procedural level, is a project which requires a medium level of cross-modal cooperation but the procedures have a low level of complexity.
   - In technological terms, the system does not require complex developments.
   - In terms of safety impact, White Stop Lines has obtained medium results.
   - With regard to human factors, this technological development has a high level of social acceptance and is a measure that is self-explanatory, but physical access to the level crossings is evaluated as intermediate.
   - The White Stop Lines is a medium-cost measure with intermediate cost-effectiveness.

9. **Cattle Grids Alternatives (Rubber pyramid and Recycled Plastic)** project is a cost-effective, durable alternatives to cattle grid using rubber pyramid and recycled plastic to avoid trips and falls in these locations. No information was provided on its stage of development (Ireland).
   - At organizational and procedural level, the Cattle Grids Alternatives project requires a low degree of cooperation and complexity in the procedures.
   - This measure requires an intermediate level of technological development.
   - In terms of safety impact, the project has obtained medium results.
   - Regarding human factors the results are intermediate.
   - At an economic level, the project has an intermediate rating.

10. **Vegetation 'V' Boards** project is a low cost measure aimed at management of vegetation overgrowth in line with compliant sighting distances. No information was provided on its stage of development (Ireland).
   - At an organizational and procedural level, the Vegetation 'V' Boards project has a medium difficulty level.
   - Technologically speaking, the measure not requires complex developments.
   - In terms of safety, this measure allows managing risks and improving safety.
   - Regarding human factors, the results were not positive, particularly because it is not considered an accessible measure for all types of users (people with disabilities, elderly, etc.). It should be noted that it is a measure with a medium level of social impact and self-explaining nature.
   - At an economic level, the measure has an intermediate cost and medium cost-effectiveness.

11. **Viaduct project**: level crossing of railway section Marijampole-Sestokai 26+440 km reconstruction installing viaduct over Arminas street. The measure has been implemented (Lithuania).
   - At an organizational and procedural level, the Viaduct project has a high difficulty level.
   - At a technological level, this measure requires a high degree of technological development.
   - At a safety level it is a measure that is rated positively.
   - Regarding human factors, it is a measure with a high level of social acceptance and it has no effect on physical access to the level crossing. The level of self-explaining nature of the measure on the other hand was estimated as medium.
   - It is rated to be a high-cost measure although its cost-effectiveness is evaluated as high.

12. **Level Crossing Safety Systems** compares technical solutions of level crossings using technical and financial costs of different types of level crossings. This measure is at the design/conceptual stage (Serbia).
    - At an organizational and procedural level, the LC safety systems has a high difficulty level.
    - At technological level, this measure requires an intermediate level of development. In safety terms, it is a measure considered to have medium level benefits.
    - Regarding human factors, measure had negative results in terms of social impact and acceptance as well as physical access, although a high level of self-explaining nature.
    - At an economic level, the system is a low-cost measure with intermediate cost-effectiveness.

13. **ADIF type Level Crossing Protection System** (SPN- 900) is a new level crossing protection system. This measure has been implemented (Spain).
    - Measure has an intermediate difficulty level in terms of cooperation and procedural implementation.
    - At a technological level, the measure requires complex technological development, but very efficient in safety terms.
    - Regarding human factors, it is a measure with high social acceptance as well as physical access. It is a measure with high level self-explaining nature.
    - At an economic level, its implementation has a medium cost. The cost-effectiveness of the measure is high.

14. **BEGICROSSING** refers to a video camera providing real-time information to detect and alert risks regarding obstacles on the line and/or level crossing malfunctions. This measure has been implemented (Spain).
    - At an organizational and procedural level, the Begicrossing system is based on a model that requires a medium level of cooperation and procedural complexity.
    - At technological level, this measure requires an intermediate level of development.
    - The measure has good effects on level crossing safety.
    - This innovative solution has a high level of social impact/acceptance, physical access by all types of users and self-explaining nature.
    - In economic terms is a low-cost measure and has high cost-effectiveness.

15. **MICRO project** is a low cost measure to upgrade safety warning at passive crossings using flashing yellow lights. This measure has been implemented (Switzerland).
    - At organizational and procedural level, the MICRO project has a high difficulty level.
    - At a technological level it has been assessed that its implementation would have an average difficulty.
    - In safety terms, results were intermediate.
    - Regarding human factors, the results indicate an overall medium score.
    - At an economic level, its implementation would have a medium difficulty (in terms of economic cost and cost-effectiveness of measure).

16. **Wheel Detector (Sensor) Technology** proposed with the aim to stop road users at a level crossing before the train passes. No information was provided on its stage of development (Turkey).
    - At organizational and procedural level, it is a project which requires an intermediate level of cross-modal cooperation and procedural complexity.

- At a technological level, the level of development required is medium.
- In safety terms, Sensor project has obtained an intermediate evaluation.
- Regarding human factor level, results are also intermediate.
- At economic level, the technological development is a medium-cost measure. Cost-effectiveness of measure is high.

4.6.2.3. Educational measures

An overview of the results of the evaluation of educational case studies and projects is presented in Table 37. On continuation a more detailed description of the assessment of the measure is provided.

Table 37. Results of the evaluation of educational case studies and project results

	1. Rules of the Road-Safety at Level Crossings
Organisational and procedural	
Level of cross-modal cooperation required	
Procedural complexity	
Technology	
Level of technological development required	
Safety	
Effect on safety	
Human factors	
Level of social impact/acceptance of measure	
Level of physical access to the LC by all types of users	
Level of self-explaining nature	
Economic	
Economic cost of measure	
Cost-effectiveness of measure	

Note: Red: high level of difficulty or complexity. Yellow: medium level of difficulty or complexity. Green: low level of difficulty or complexity.

1. **'Safety at Level Crossings' Rules of the Road booklet** presents instructions for safe use of level crossings used by railway staff, schools and railway police (an educational tool to train the trainers). This measure has been implemented (Ireland).

- At an organizational and procedural level, the booklet has a medium-high implementation difficulty.
- At a technological level, it does not require complex developments.
- In terms of safety, its effects on safety are considered low.
- Regarding human factors, it is an accessible measure for all types of users. However, the survey respondent has highlighted the low level of social impact or acceptance and a medium level of self-explaining nature.
- At an economic level, the booklet is a low-cost measure. Cost-effectiveness of measure is intermediate.

5. CONCLUSIONS AND PROPOSALS

The aim of this Deliverable was to analyse level crossing safety in Europe and beyond, identifying where possible the differences in level crossing environments between countries. The study has covered level crossing safety arrangements; legal aspects related to level crossings; division of stakeholder responsibilities; the requirements of different user groups for safe access and use of crossings; and lessons learnt regarding factors influencing effective level crossing safety. The analysis also sought to identify examples of good practice and innovations related to level crossing safety arrangements.

Methodological reflection

Through a survey tool designed ad-hoc (Country Information Collection Form), nominated partners and UIC collaborators were responsible for collecting information from relevant experts and operational staff from their country, together with other relevant sources of secondary information. Information was received from twenty-four countries: Albania, Austria, Belgium, Canada, Finland, France, Greece, Ireland, Italy, Latvia, Lithuania, Macedonia, Montenegro, the Netherlands, Norway, Romania, Russia, Serbia, Slovakia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

The volume and wide geographic spread of participating countries has contributed to the representativeness of the results of this Deliverable. Nevertheless, some challenges were experienced in analysing the data, mainly due to the disparity in the quality of information received, both between countries and between sections and questions. Furthermore, not all countries cited the sources of information that had been used in completing the form and, in some cases, the sources of information were not in English which proved a challenge especially when needing to follow up certain pieces of information.

A further limitation of the study which has influenced the ability to analyse the differences between countries has been the lack of a common framework regarding the issues examined. Whilst a general review of common legislation (non-mandatory) was carried examining international rules and regulations covering basic protection arrangements and roadside rules on level crossing usage (UIC Codes; Vienna Conventions; and Consolidated Resolution on Road Traffic and Road Signs and Signals), in terms of more organisational issues (e.g. division of responsibilities or user requirements) no common framework exists.

At a methodological level, limitations related to the design of the questionnaire were observed. Given the breadth, depth and complexity of the information required for the analysis, a semi-structured information collection tool was developed, composing open as well as closed questions. Open questions were used to facilitate the collection of rich information, covering complex issues, as well as capturing unexpected findings, such as cultural differences. Whilst open questions enabled the collection of more qualitative information, the different degree of detail provided by respondents and the open nature of the answers has made comparisons somewhat difficult.

The quality and detail of the answers may also have been conditioned by the respondent´s level of English. Furthermore, open questions also require a greater amount of respondent time, thought,

and effort which together with the length of the survey tool and the time available to complete the task may have proved a challenge for some.

Finally, due to the need to obtain such a wide range of information the tool was not designed as a straight forward self-completion questionnaire, rather it needed to be completed drawing on a variety of information sources. In this way, potential knowledge gaps may have limited an individual respondent's capacity to complete the entire form to a consistent level of depth and detail.

The results presented in the report are based on the information provided by survey respondents which at the same time is conditioned by the factors highlighted above. In this way it is possible that in some cases there are results that may apply for some countries that are not gathered in the results simply because the information was not reported in the country´s information collection form.

Level crossing safety arrangements

In general terms the basic protection arrangements used at level crossings between countries do not differ greatly, with a common move towards more active (automatic) forms of protection, albeit passive crossings still exist in almost all countries. The protective arrangements applied are decided based on a combined set of criteria, most commonly the volume of road and rail traffic and the maximum train speed and to a slightly lesser degree the conditions of the road and rail (i.e. type of road and number of railway tracks). In most countries some local circumstances are also considered when deciding the protective arrangements, particularly previous accidents and the proximity of the crossing to amenities that generate a high volume of level crossing users (including vehicles and pedestrians).

The average level crossing warning time is 32.7 seconds, except for Austria, Italy, Macedonia and Russia who have higher warning times than other countries. In some countries, the warning time is determined by the type of level crossing and/ or road, with other factors including types of users; distance to the crossing; and speed of the train.

Most countries employ some form of additional safety arrangement, most commonly physical and technological measures such as cameras, rubber panels and warning lights. Public awareness and educational measures are also used with particular emphasis on general and school safety campaigns. A smaller number of countries have additional organizational and procedural safety arrangements, most notably the use of risk management tools, safety management information systems and specific rail and road arrangements at level crossings.

Legal aspects of level crossing safety

A common legal framework regarding safety at level crossings exists in the form of treaties and recommended guidelines (non-mandatory) from international organizations including the United Nations Economic Commission for Europe (UNECE) and the International Railway Union (UIC). The aforementioned UNECE treaty, *Vienna Conventions on Road Traffic and Road Signs and Signals,* deals with basic roadside rules on the safe use of level crossings as part of wider road traffic regulation to which most countries report adherence. Specific level crossing rules, developed by the UIC (*UIC Codes 760; 761; 762*), relate to more technical aspects of level crossing protection and are not as widely reported. In this way there appears to be a greater level of harmonization with road side rules than those applied specifically to the operation and management of level crossings. Indeed responses indicate that the operation and safety management of level crossings are governed more by national laws and regulations, reflecting, perhaps, the need to account for national factors such

as the extension of the rail network, public investment, historical factors, socio-cultural factors, number of accidents, etc. Please note that the high level of “no response” to the question of adoption of UIC leaflets may indicate a lack of knowledge regarding these rules and their application in the surveyed country.

Some common themes were found in terms of level crossing safety policy, most notably the presence of level crossing removal as the primary safety policy, followed by improved protection (particularly upgrading to active protection). It is interesting to observe that whilst level crossing removal is the most commonly reported safety policy shared by all countries, its actual implementation appears to depend largely on operational and cost benefit issues. In just one case, the Netherlands, there is a long term commitment to achieve zero level crossings, though other countries expressed a more tentative approach to realising absolute level crossing removal. A further challenge to level crossing removal, highlighted by a small number of the countries, is resistance from the public to level crossing closure, indicating the need to take into account the individual end user (road side) when making decisions on actions to improve safety at level crossings.

In most countries the legal framework applied to safety at level crossing covers rules regulating the safeguarding of level crossings and rules governing level crossing usage with these being applied equally throughout the country. As existing legislation does not necessarily address all current and future safety needs, countries were asked to indicate the future legislative steps to improve level crossing safety. The results express a continued priority to reduce level crossings and also some more strategic actions, such as improved cross-agency working; greater level of education and enforcement for correct level crossing usage; and a review of technical rules. These legal guidelines and the ability to invest long term in safety programmes strongly depend on the political interest and commitment to level crossing safety in the country.

Division of responsibilities regarding level crossing safety

In legal terms, level crossings cut across different administrative boundaries and as such need to balance the interests of the different parties involved: road, rail, private and public authorities and individual users. To a larger or lesser degree, these aforementioned stakeholders are involved in the management of level crossing safety in the surveyed countries. However, by far the greatest level of accountability is held by the rail infrastructure manager, with the responsibility of the road administrator generally concentrated on more specific roadside elements.

Indeed a lack of cross agency working has been highlighted as a potential barrier to achieving level crossing safety, with the need for a more equitable share of responsibility between rail, road and local authorities being emphasized by a number of respondents. A challenge lies in reconciling the different stakeholder priorities, at the same time as achieving effective safeguarding of level crossings. The value of making a clear division of roles and responsibilities, including identification of primary responsible stakeholder and definition of responsibilities to be assumed by road authorities in a legally recognized framework, was proposed, backed up by tools to support joint working (e.g. regular multi-agency meetings, protocols for joint decision making, etc.). Despite challenges around joint working having been highlighted, most countries do in fact report some form of cross agency working for the management and operation of safety at level crossings, most notably through multi-stakeholder working groups.

User requirements at level crossings

Most countries report to have some form of safety arrangement that takes into account the needs of specific user groups. In general terms though, these measures account more for motorized road users than vulnerable road users, with the UK providing the most complete set of examples of measures targeting a wide range of level crossing users.

In terms of reaching the end user, survey responses indicate a strong focus on education and awareness raising actions and to some extent increased enforcement. Research, together with expert opinion, point to the need for infrastructures and safety measures that address level crossing user requirements and at the same time improved understanding from the public about the need for them to exercise caution and act safety at level crossings. It is curious to note, given the focus of the SAFER-LC project, that there appear to be few examples of work or policies towards developing forgiving and self-explaining infrastructures amongst the surveyed countries, with just one notable example of this taking place in Sweden. Specifically, Sweden report to have a safety policy that focuses efforts on making the railway system safe as possible, making it easy for travellers on the road to do the right thing beyond just informing them.

Designing infrastructures from a human factors´ perspective is a complex process given the breadth of potential users and calls for a level crossing safety strategy underpinned by a research programme. Indeed the literature indicates an increasing recognition and move towards understanding the behaviour of different types of users and the many factors that impact upon the safe use of level crossings, applying this learning to the design of infrastructures, amongst other measures.

The trend towards research-based action, whereby decisions on how to improve level crossing safety are based on evidence of the issues to be addressed, has also been reported by some countries in the survey. Specifically Greece, Finland, Sweden and the UK report the use of safety evaluation and risk management tools to support decision making regarding the actions to be taken at level crossings, together with systematic level crossing monitoring and reporting taking place in Finland and Sweden. In general though, most countries reported the use of accident reports as a way of identifying user requirements, indicating a more reactive rather than proactive response to addressing level crossing safety from the user perspective.

Best practice on level crossing safety

In this report a selection of experiences and best practices regarding level crossing safety in different countries have been presented. Twenty case studies and/or project results at a European and international level were reported. In some cases, the measures are already implemented but in others, they are only at a design or conceptual stage. These examples represent a diverse spread of safety arrangements, including two organisational and procedural actions, seventeen physical and technological measures and one educational intervention. The organisational and procedural measures encompassed a level crossing safety manual and level crossing safety analysis tool used for the allocation of safety measures. Just one educational measure was cited, a Safety at Level Crossings rule book directed for use by railway staff, schools and railway police. Under the physical and technological category a wide range of examples were reported, from low cost measures, to more sophisticated technological solutions. Examples ranged from physical elements applied to the road approach as warnings to facilitate road user crossing (e.g. road markings; rumble strips;

rubber/plastic cattle grids) to technologies (e.g. video, satellite etc) that detect and communicate LC risk between rail and road vehicles and between infrastructure and road vehicles.

In order to extract useful lessons from the best practice examples provided and explore cross-national circumstances, an evaluation exercise was developed. The evaluation sought to identify some of the factors that should be taken into account when considering the feasibility of implementing the measure in different country contexts. This is conceived as a preliminary exercise to highlight some best practices. For example, this brief assessment exercise found that under the organisational and procedural category, the Austrian Maneuver project (manual of safety measures) has been assessed as a low cost measure with a high effect on level crossing safety and high rating in terms of cost-effectiveness. A further technological measure, currently implemented in Spain, is BEGICROSSING. This measure reported to be low cost and with a high impact on safety, uses a video camera to provide real-time information to detect and alert risks regarding obstacles on the line and/or level crossing malfunctions.

Information reported by partners is very useful to identify innovative experiences carried out by railway infrastructure managers, universities, technological centres and companies; to disseminate this information at an international level; and generate shared knowledge and experience. Nevertheless, these experiences and best practices are just a sample of what is being developed to address level crossing safety in Europe and internationally. Moreover, in order to deepen the lessons to be learnt from the best practice examples cited, further information on national factors such as the extension of the rail network, public investment, historical factors, socio-cultural factors, etc. should be taken into account.

Challenges and proposals

Based on the report findings, the following challenges for improving level crossing safety and corresponding proposals have been identified (see Table 38). These issues should be taken into account in the development of subsequent SAFER-LC work packages.

Table 38. Challenges and proposals to achieving level crossing safety

Challenges	Proposals
Strengthen cross-agency working	– Work towards creating a shared vision and commitment to level crossing safety between road, rail, local authorities and individual level crossing users based on the identification of common priorities.
Secure political interest to address investment and long term support of LC safety programmes	– Identify and draw on successful experiences of gaining political commitment to LC safety; Highlight problems to be addressed using critical safety statistics and data.
Address cost and complexity of LC safety improvements, accounting for multiple factors (economic, operational, political, human factors)	– Apply data fed risk management models to inform decisions regarding safety at specific level crossings
Address technical limitations of LC protection, including high costs and complexity of installation and maintenance	– Identify examples of low cost low impact safety solutions that have been successfully implemented
Account for human factors at level crossings to address public acceptance of LC safety measures; LC misuse; design of forgiving infrastructures	– Research into human factors at LC; Identify examples of successful community involvement in similar initiatives.

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ANNEXES

1. ANNEX A. COUNTRY INFORMATION COLLECTION FORM

1.1. Introduction to the tool

The data collection tool presented herein has been developed to respond to the research objectives of **Task 1.1. Analysis of LC safety in Europe and beyond.**
The aim of this Task is to identify the differences in level crossing environments between countries, in relation to the following aspects:

- Level crossing legislation in selected countries.
- Division of responsibilities between stakeholders involved in safety at level crossings in selected countries.
- User requirements for safe access and use of level crossings in selected countries; e.g. age groups, cultures, nationalities, languages and physical limitations.
- Level crossing safety arrangements in selected countries: organizational and procedural; physical and technological; public awareness and educational; others.
- Examples of good practice and innovations related to level crossing safety arrangements with an emphasis on identifying breakthroughs in terms of: organizational and procedural aspects, physical measures, new technologies, public awareness and educational measures.

This analysis will create a knowledge base that will allow the proposal of trans-modal (road-rail) security solutions at level crossings, focused on human processes and aimed at better coordination and cooperation between the managers of different transport modes.
To this end, Task partners are asked to respond to the following **Country Information Collection Form** which is structured around the following themes:

- Section I. General Information on Level Crossings and Safety Arrangements
- Section II. Legal Aspects on Level Crossings
- Section III. Division of Responsibilities between the Stakeholders Involved
- Section IV. User Requirements at Level Crossings
- Section V. Lessons Learnt Regarding Safety at Level Crossings
- Section VI. Experiences and Best Practice Regarding Level Crossing Safety

Another objective of the SAFER-LC project is to discover experiences and best practice regarding level crossing safety. In order to capture this information task participants will be asked, in Section VI, to share their knowledge of project results, case studies and technological developments, both from their own and/or other countries. In order to extract useful lessons from the best practice examples given and explore cross-national circumstances, task partners will be asked to rate the safety arrangements in terms of different factors: organizational and procedural, technology, human factors, economic and social impact. For example, the level of cross-modal cooperation required.

Task 1.1 partners will be responsible for collecting the associated information for their country, completing to the fullest extent possible this Country Information Collection Form and returning this to FFE by **21st July 2017**.

Partners will obtain the information requested using the methods and information sources they consider most appropriate, always citing the information source in their completed Country Information Collection Form within the Background Details Section.

1.2. Country Information Tool

Background Details

Country:

Institutions consulted in the information collection process:

Information source (bibliography, webography):

Section I. General Information on Level Crossings and Safety Arrangements

1. There are different types of level crossings. Could you indicate in the table below:
   - The system(s) of protection employed at each type of level crossing;
   - The criteria followed in the selection of the level crossing type:

TYPE OF LEVEL CROSSING (ERA classification)	**SYSTEM(S) OF PROTECTION USED** E.g. barrier, road traffic light signals, railway signals, audible warning	**SELECTION PARAMETERS** E.g. Location; traffic moment; actual daily road vehicle usage; sighting distance and conditions; maximum speed, number of tracks; road width…
Passive level crossing		
Automatic user side warning		
Automatic user side protection		
Automatic user side protection and warning		
Automatic user side protection and warning and rail-side protection		
Manual user-side warning		
Manual user-side protection		
Manual user-side protection and warning		

2. What entity is responsible for deciding the form of level crossing protection employed?

3. Does the selection of protective arrangements take into account the local circumstances at individual crossings (i.e. previous accidents, vicinity of schools, etc...)? If so, please specify which circumstances.

4. What is the average level crossing warning time in your country[12]?

i. What factors are taken into account when determining the level crossing warning time (e.g. location, type and use of the level crossing…)?

5. What additional or complementary safety arrangements are attached to level crossings? Please specify, in the table below:

- The safety arrangement, in line with the following categories: organizational and procedural; physical and/or technological (*those not already noted in the previous table*); public awareness and educational; other;
- The type of level crossing to which the safety arrangement is attached;
- The circumstances addressed by the safety arrangement.

CATEGORY OF SAFETY ARRANGEMENT	SAFETY ARRANGEMENT	LC TYPE TO WHICH ARRANGEMENT IS ATTACHED	CIRCUMSTANCES ADDRESSED
Organizational and procedural E.g. risk management tools, Road – Rail safety management guidance…			
Physical and/or technological E.g. obstacle detector, level crossing rubber panels, GPS technology			

[12] The length of time between the start of the warning sequence provided for users and the arrival of the first train at the level crossing (RSSB, 2012).

to communicate train position …)			
Public awareness and educational E.g. posters, safety campaign in schools…)			
Other			

Section II. Legal Aspects on Level Crossings

6. Please indicate adherence to the following international regulations regarding safety at level crossings, ticking as appropriate the application or otherwise of the following regulations:

   - **Vienna Convention on road traffic, of 1968**

   ☐ *Applied* ☐ *Applied with Exceptions* ☐ *Not Applied*

   - **Vienna Convention on Road Signs and Signals, of 8 November 1968**

   ☐ *Applied* ☐ *Applied with Exceptions* ☐ *Not Applied*

   - **UIC leaflet 760: Road signs and signals**

   ☐ *Applied* ☐ *Applied with Exceptions* ☐ *Not Applied*

   - **UIC leaflet 761: Guidance on the automatic operation of level crossings**

   ☐ *Applied* ☐ *Applied with Exceptions* ☐ *Not Applied*

   - **UIC leaflet 762: Safety measures to be taken at level crossings on lines operated from 120 to 200 km/h**

   ☐ *Applied* ☐ *Applied with Exceptions* ☐ *Not Applied*

   - **Others:**

7. What is the key policy regarding level crossing safety in your country (E.g. level crossing removal programme, public investment, level crossing safety programmes and initiatives…)?

8. Which government department(s) and/or ministry is responsible for level crossing legislation, in terms of content and compliance?

9. Briefly describe the legal framework applied to the design, operation and management of level crossings.
   Provide your answer in the following table, naming the legislation and briefly summarizing said legislation (an example has been provided from the United Kingdom as an indication of the level of detail required):

LEVEL CROSSING LEGISLATION	BRIEF SUMMARY OF LEGISLATION
E.g. Level Crossings Act 1983	Enables the Secretary of State for Transport to make orders that take account of both safety and convenience aspects of crossings. The order can specify the protection arrangements required at certain types of crossing.

10. Are there any regional variations to the rules or are they applied equally throughout the country? (briefly describe)

11. In accordance with your expert vision, what should be the next legislative steps your country should take with regard to promoting safety at level crossings?

Section III. Division of Responsibilities between the Stakeholders Involved

12. Who is responsible for the design, operation, management and enforcement of safety at level crossings? Please indicate in the following table:

- The stakeholders involved in each aspect (e.g. infrastructure manager; highway, road and traffic authorities; train and freight operators; land owners; local government authorities; other stakeholders from the community; road users and other crossing users …)
- The scope of the stakeholders´ responsibility.

AREA OF RESPONSIBILITY	STAKEHOLDER(S) INVOLVED	SCOPE OF RESPONSIBILITY
Design		
Operation		
Management		
Enforcement		
Other (stakeholders involved in other aspects of LC safety, e.g. educational programmes…)		

13. Can you describe the level of cooperation and partnership working between the different stakeholders involved in the management and operation of safety at level crossings (e.g. cross road and rail cooperation)

14. Is there a government body or independent organization dedicated to promoting safety at level crossings? (E.g. RSSB, Operation Lifesaver…)

Section IV. User Requirements at Level Crossings

15. Do the level crossings have safety arrangements and features that address the specific requirements of different user groups?
    If so, please mark as appropriate the user groups targeted:

- ☐ **Motorized road users**
  - ☐ Transport professionals
  - ☐ Heavy vehicles
  - ☐ Farm vehicles
- ☐ **Vulnerable road users**
  - ☐ Cyclist
  - ☐ Pedestrians
  - ☐ Ramblers
  - ☐ Horse riders
  - ☐ Persons with reduced mobility
  - ☐ Users with vision loss and blindness
  - ☐ Users with hearing loss and deafness
  - ☐ Users with different cultural and language background
- ☐ **Other** (add user category as required)

16. Please give examples of how safety at level crossings has been addressed in order to meet the requirements of different users groups (i.e. what measures or actions have been taken).

17. In the event that the needs of level crossing users are taken into account when designing safety arrangements at level crossings, can you explain how these needs are identified (for example, through research studies, surveys, public consultation, accident investigation…) ?

18. Is there legislation that targets the equal access and use of level crossings by all user groups (including those with disabilities)?

Section V. Lessons Learnt Regarding Safety at Level Crossings

19. What factors facilitate the successful implementation of safety measures at LC (for example, effective partnership working between road, rail and other involved stakeholders, supported by protocols for joint decision making, costs and responsibilities; political backing and investment in level crossing safety; community based support and participation in safety initiatives; an effective programme of maintenance)?

20. What are the main barriers to improving level crossing safety?

Section VI. Experiences and Best Practice Regarding Level Crossing Safety

The analysis of level crossing safety in Europe also encompasses experiences of innovation and best practice in level crossing safety. In order to capture the latest breakthroughs in level crossing safety, you are asked to **complete the following Innovation and Best Practice Form with an example(s) from your own or another country**. This includes various fields to be completed each containing key questions to be addressed.

We are seeking examples that will include **organisational and procedural practice, technological and physical solutions, public awareness and educational campaigns and programmes** as well as **other measures** that have been developed to improve safety at level crossings. The information provided can be based on different published sources: project results, case studies, evaluation reports… You are asked to provide bibliographical details of the information sources used in the following Innovation and Best Practice Form.

Please fill in one form for each innovative experience and best practice that you report. You can copy and paste the table as many times as necessary.

Do not forget to also do this with the last table that evaluates the innovative safety arrangement reported.

LEVEL CROSSING SAFETY INNOVATIONS AND BEST PRACTICE		
NAME OF INNOVATIVE SAFETY ARRANGEMENT *Name of the project, case study or technological development*		
COUNTRY *Country*	**PUBLICATION DATE** *When (month/year) has good practice been published/ documented?*	**AUTHOR (S) / ENTITY** *Who has written the good practice document? If applicable*

TYPE OF SAFETY MEASURE ☐ Organisational and procedural ☐ Physical and/ or technological ☐ Educational ☐ Others:……	**TYPE OF LC TO WHICH MEASURE IS ATTACHED** ☐ Passive level crossing ☐ Automatic user side warning ☐ Automatic user side protection ☐ Automatic user side protection and warning ☐ Automatic user side protection and warning and rail-side protection ☐ Manual user-side warning ☐ Manual user-side protection ☐ Manual user-side protection and warning
CURRENT STATE OF IMPLEMENTATION ☐ *Valid* ☐ *Not in force*	
TIME FRAME OF DEVELOPMENT ☐ Currently ☐ Other:……	**LEVEL OF DEVELOPMENT** ☐ Conceptual design ☐ Tested in real conditions ☐ Laboratory tested ☐ Implemented

ELEMENTS	KEY QUESTIONS
Information Source	Specify the type of document and to whom the document is addressed (E.g. European Commission, universities…): best practice sheet, technological development, experience sheet, research project results, information sheet, methodological sheet, fact sheet case study, guidelines, etc.
Objective	What is the objective of the innovative safety arrangement presented?
Location / geographical coverage	What is the geographic area where the innovative safety arrangement has been developed? Specify the country, region, province, district, and village. When possible, also add a map to show the place where the practice has been carried out.
Context	What is the context, risk detected, problem addressed? Provide a brief description of the experience and indicate the period during which it was developed or is being developed. In situations of risk, explain how this measure helps reduce risk and crisis management.
Parties involved	Who are the beneficiaries or target group of the safety arrangement? Who does the measure target?

	What stakeholders are involved (road, rail, both, local authority…)? Who is responsible for its implementation?
Methodological approach	How was the safety arrangement developed? What methodology was used to deal with the initial topic? How long did it take to learn from it and identify the key success factors of the practice?
Validation process	Confirmation by the beneficiaries that the practice responds correctly to the initial problem. Has good practice been validated with stakeholders/end users? A brief description of the validation process of good practice.
Scientific evaluation	Briefly, describe the scientific evaluation of the measure and provide, if possible, evaluation results.
Impact	What has been the impact (positive or negative) of this innovative safety arrangement?
Innovation	In what sense can the experience be considered an innovation in terms of level crossings?
Success factors	What are the conditions (organisational, economic, social and environmental) that have to be given so that good practice can be successfully reproduced (in a similar context)?
Lessons learned	What are the key messages and lessons learned from this experience?
URL	Where can you find good practice on the Internet?
Related Web Site (s)	What are the Internet sites of projects where the good practice has been identified and reproduced?
Related Resources	What training manuals, guidelines, fact sheets, posters, photographs, video and audio documents, and/or internet sites have been developed and developed from the identification of good practice?
Contact person	In case we need additional information you could provide the name and email of a contact person

In order to extract useful lessons from the experiences of innovation and best practice in level crossing given and explore cross-national circumstances, please rate the innovative safety arrangement in the terms included in the following table (NB: please complete this table for each measure reported in the above Innovation and Best Practice Form):

	LOW	MEDIUM	HIGH
Organisational and procedural	☐	☐	☐
Level of cross-modal cooperation required	☐	☐	☐
Procedural complexity	☐	☐	☐
Technology	☐	☐	☐
Level of technological development required	☐	☐	☐
Safety	☐	☐	☐
Effect on safety	☐	☐	☐
Human factors	☐	☐	☐
Level of social impact/acceptance of measure	☐	☐	☐
Level of physical access to the LC by all types of users (including people with reduced mobility)	☐	☐	☐
Level of self-explaining nature	☐	☐	☐
Economic	☐	☐	☐
Economic cost of measure	☐	☐	☐
Cost-effectiveness of measure	☐	☐	☐

2. ANNEX B. RESPONSE RATE BY COUNTRY AND QUESTION

		AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU	RS	SK	ES	SE	CH	TR	UK*	REPONSES RATE (question)
Section I. General Information on LCs and Safety Arrangements																										
1.	**Different types of LCs**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
2.	**What entity is responsible for deciding the form of LC protection employed?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
3.	**Does the selection of protective arrangements take into account the local circumstances at individual crossings?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
4.	**What is the average LC warning time in your country?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
i.	**What factors are taken into account when determining the LC warning time?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
5.	**What additional or complementary safety**	X	X	X		X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	**92**

	arrangements are attached to LCs?																								
Section II. Legal Aspects on LCs																									
6.	**Please indicate adherence to the following international regulations regarding safety at LCs.**	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X	**92**
7.	**What is the key policy regarding LC safety in your country?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	**96**
8.	**Which government department(s) and/or ministry is responsible for LC legislation, in terms of content and compliance?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
9.	**Briefly describe the legal framework applied to the design, operation and management of LCs.**	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	**96**
10.	**Are there any regional variations to the rules or are they applied equally throughout the country?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
11.	**What should be the next legislative steps your country should take with regard to promoting safety at LCs?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**

Section III. Division of Responsibilities between the Stakeholders Involved																											
12.	**Who is responsible for the design, operation, management and enforcement of safety at LCs?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
13.	**Can you describe the level of cooperation and partnership working between the different stakeholders?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
14.	**Is there a government body or independent organization dedicated to promoting safety at LCs?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
Section IV. User Requirements at LCs																											
15.	**Does the LCs have safety arrangements and features that address the specific requirements of different user groups?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
16.	**Please give examples of how safety at LCs has been addressed in order to meet the requirements of different users groups.**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
17.	**Can you explain how the needs of**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**

	LC users are identified?																										
18.	**Is there legislation that targets the equal access and use of LCs by all user groups?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
Section V. Lessons Learnt Regarding Safety at LCs																											
19.	**What factors facilitate the successful implementation of safety measures at LC?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
20.	**What are the main barriers to improving LC safety?**	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	**100**
Section VI. Experiences and Best Practice Regarding LC Safety																											
21.	**LC Safety Innovations and Best Practice.**		2		1	4	2		5			1								1		1		1	1		**42**
22.	**Rate. LC Safety Innovations and Best Practice.**		2			4	2		5			1								1		1		1	1		**38**
REPONSES RATE (country)		**91**	**100**	**91**	**91**	**100**	**100**	**91**	**100**	**91**	**91**	**100**	**91**	**82**	**82**	**91**	**91**	**86**	**100**	**91**	**100**	**91**	**100**	**100**	**91**		

* The United Kingdom completed two questionnaires. This table contains the data of the most complete form: the one answered by Network Rail. The response rate to Highways England questions was 64%

3. ANNEX C. Additional safety arrangements attached to level crossings

Table I. Additional safety arrangements: organizational and procedural

COUNTRIES	SAFETY ARRANGEMENT	LC TYPE TO WHICH ARRANGEMENT IS ATTACHED	CIRCUMSTANCES ADDRESSED
Albania	yes	Passive and active L-C	Vicinity etc
	For passive L-C it is valid the rules and requirements of safety in L-C according to Road Code		
	For active L-Cs they are in force the rules of Guideline for safety working position in railways(still in force) until new safety regulation shall be produced accruing from the new railway code approved.		
Belgium	risk management tools	Only for public LC (Except in the harbour)	
Canada	Safety Assessments every 5 years		
Finland	Tarva LC tool (see detailed description at the end of the template)		
France	Guidance setting out recommendations on how to organise the area surrounding the level crossing.		Various guides for highway managers have been produced in collaboration with the Ministry.
Ireland	Level crossing risk model	All types	Risk evaluation and prioritisation
Latvia	informative plates	attached to each LC (train track and road crossing) type	plates includes level crossing specific number and phone number to call if any accident happened
Lithuania	Inspection of level crossing	All types	Every year (April-June) inspection of level crossings must be done by committee of various authorities
	Inspection of specific level crossing	All types	If there is need for specific level crossing inspection then committee of various authorities are formed and LC is inspected
	Risk management, inspection of level crossing	All types	Railroad employees constantly monitors and controls level crossings
Netherlands	Risk tool		On passenger lines

	Train camera's to analyse incidents and behaviour		On passenger lines
Norway	risk management tools	All level crossings	To reduce risk
Russia	Level crossing operating conditions, Code on Administrative Offences, Traffic Rules	on all	compliance with level crossing rules, compliance with rules for level crossing maintenance and operation
Slovakia	Decree-Law of The Slovak Republic	All level crossings	On ŽSR part, in case of active level crossings, there is a command of careful (so called "OP rozkaz"), which contains necessary arrangements, for example speed reduction of rolling stock. Eventually warning of the driver with traffic signboard, that the level crossing device is not working.
	Law and Regulations of The Slovak Republic		On Passive level crossings - Marked with road traffic signboards
	Regulations of ŽSR		
Spain	Annual monitoring for the official level crossings register	All	Ensure correct LC protection systems employed.
Sweden	There are different warning signs on the road for the road users when approaching the LC, to make them more aware of the LC		
Switzerland	SMS (operator)	All LC	High risk LC, legal compliance
	FOT risk management (net wide)	All LC	Net wide safety level, effectiveness of legal regulations
United Kingdom	Risk management tool kit, All Level Crossings Risk Model	All	Best practice for managing specific risks identified through research and ergonomic studies.
	Safety Management Information system	All	Accident and incident data including near miss reports
	Public education campaigns, national and local	All	General and specific user groups, eg dog walkers, road vehicle drivers, mobile phone users
	Targeted campaigns	All	Eg. School children, Authorised users,
		Private crossings	

Table II. Additional safety arrangements: physical and technological

COUNTRIES	SAFETY ARRANGEMENT	LC TYPE TO WHICH ARRANGEMENT IS ATTACHED	CIRCUMSTANCES ADDRESSED
Albania	yes	Passive and active L-C	
Austria	Electronic ring device	Technical secures LC	Not safe in the sense of signal technic
	à none at the moment	à none at the moment	-
Belgium	obstacle detector	Automatic user side protection and warning (full barriers)	
	Traffic sign 41 	LC with barriers	
	Traffic Sign 43 	LC without barriers	
Canada	Emergency stickers to identify the location and emergency member to report (mileage, subdivision)		
	Light to advise locomotive engineers about Crossing Power failure or other failures (short warning time, etc.)		
Finland	Junavaro and LC attention device (see detailed descriptions at the end of the template)		
France	Speed cameras/crossing cameras (detect drivers running red lights)	Based on local analysis of crossing	Crossings identified following an inspection or due to high accident rates.
	Rumble strips, speed cushions		
	Additional traffic lights and gantry lights		
	Synchronisation of three-aspect traffic lights with crossing warning and/or with in-road detection loop		
	Trials underway		
Greece	GSM and cameras are used in only 3 LCs in Northern Greece		
Ireland	Rubber panels	All types	Road surface conformity
	Cattle grids at either side of LC	All types of LC	Trespass prevention
	Warning signs	Passive LC	Crossing procedure;
			Stop signs for road vehicles
	Warning signs	Active LC	Stop when red lights show
Latvia	video supervision including recording	3rd part of all LC with automatic user side protection and warning are equipped with video supervision	video files helps with any accident investigation or to inform about any trespassers etc.
Lithuania	Level crossing illumination	All types	If there is train traffic at night then level crossing must be illuminated

	Level crossing surveillance system (security cameras)	All types	If there is need
	Road restraints	All types	When new level crossing is installed or when old is modernized
	Level crossing rubber panels	All types	If there is need for rubber panels
	Level crossing embedded Rail system (ERS)	All types	If there is need for ballastless concrete pavement with embedded rail system
Norway	Full barriers work as obstacle detectors	Full barrier crossings	If there is need for ballastless concrete pavement with embedded rail system
	Strail element, wood element and similar	All	
Romania	CCTV (closed circuit television)	- Automatic user side protection and warning and rail-side protection with 4 barriers	If there is need for ballastless concrete pavement with embedded rail system
	Automatic Train Protection equipment (INDUSI for Romania)	- Automatic user side warning	
		- Automatic user side protection and warning and rail-side protection	
Russia	GLONASS technology, dividing posts, road surface markings, automatic train driver notification about an obstacle at a crossing (barrier signals)	on all	decrease in traffic accidents at level crossings
	Video cameras	Automatic user side warning and protection	decrease in traffic accidents at level crossings
Serbia	Rulebook for delivery, installation and maintenance of rubber panels of Kraiburg system for arrangement of level crossing on JR ralway network (2003)	All	Technicall conditions for instalation of rubber panels
Slovakia	The roadway of the level crossing must fullfil the conditions for safe passage of the motorised road vehicle	All level crossings	Division of the lanes with road islands, Light signalling installations at level crossings on the ground, road traffic signboards, road markings on the road
Spain	Level Crossing event log and advice management system	Class B level crossing.	Detection and resolution of possible incidents and preventive maintenance at level crossings. Reduction of corrective maintenance times.
		Class C	
		Class F	
	Road obstacle detector	Class B, C and F level crossing	Detection of unauthorised objects on the rail that could be precursor to an accident or incident.

	Lights signals on the gate/barrier arms	Class C level crossing.	Used in conditions of poor visibility.
	Anti-skid rubber road surface over level crossing (STRAIL system)	All	Optimise the good working order of the road surface over the level crossing to avoid accidents caused by vehicles becoming trapped on the level crossing.
	The SPN- 900 system offers an integrated	Class B, C, F.	Cost effective solution to level crossing improvement. Elimination of construction works and cabling between
Sweden	We have a pilot test of anti-trespass panels in LC last winter to assess if it works in Swedish winter circumstances. The results and conclusion of this project is not available yet.		
	There has also been test of a new kind of rail side protection but it is not used in a common way yet.		
Switzerland	Area monitoring (obstacle detector)	T-junctions where roads are parallel to rail track	Clearance of LC difficult
Turkey	Level Crossing rubber panels	Automatic user side protection and warning; Automatic user side protection and warning and rail-side protection	Daily avg. number of train times daily avg. number of vehicle in a year
	Track circuit,	Automatic user side protection and warning; Automatic user side protection and warning and rail-side protection	Daily avg. number of train times daily avg. number of vehicle in a year
	Axle counter		
United Kingdom	Obstacle detection	Public road crossings	Multi user types at public roads
	Barrier protection management	Public road crossings	Public roads with high level of user misuse
	Rubber/concrete deck	Vehicle crossings	Public roads
	Wooden sleeper deck	Older vehicle crossings	Private crossings, agricultural crossings
	Rubber flangeway strips		Cyclists
		High levels of cyclists at skew crossings	
	CCTV	Manual controlled crossings	Remotely controlled crossings
	Red Light Enforcement cameras, Automatic Number plate recognition cameras	Public road crossings	Crossings with high levels of misuse

Table III. Additional safety arrangements: public awareness and educational

COUNTRIES	SAFETY ARRANGEMENT	LC TYPE TO WHICH ARRANGEMENT IS ATTACHED	CIRCUMSTANCES ADDRESSED
Albania	yes	The a-m	
Austria	Trainings in schools	All types of LC	Behaviour of road users
	ILCAD	All types of LC	Behaviour of road users
Belgium	Schoolkit & school calendar		
	The box by Infrabel (VR Experience)		
	Ad hoc campaigning (based on actualities and opportunities), ad hoc communication via social media (Facebook, YouTubem instagram, Linkedin)		
Finland	In summer 2017, the Finnish Transport Agency together with the Finnish Transport Safety Agency, VR-Group Ltd, the Central Organisation for Traffic Safety in Finland (Liikenneturva) and the Police started a campaign for level crossing safety to remind people that the train always wins at level crossing.		
	The current campaign is on-going at national radio channels and in social media.		
	In addition, there are some videos about LC safety produced by the Finnish Transport Safety Agency in their website and in youtube:		
France	Schools education and outreach		At crossings near schools where an accident has occurred, or following reports of misbehaviour by pupils.
	Nationwide prevention campaign		Same day as ILCAD.
	Posters, flyers		Topics chosen based on current events, e.g. reopening of a line, partnership with road federations.
Greece	Rarely, awareness raising campaigns take place in regards to safety at LCs. Also, some of the leaflets distributed at schools in regards to road safety include info on LCs.	All	All
Ireland	Rules of Road special booklet for LC safety	All LCs	Crossing procedure
	Booklet for farmers and private users	Passive LCs	Crossing procedure
Italy	Posters		

	Safety campaigns		
	Safety campaigns in schools		
Latvia	safety campaign 3 times per year via mass media	attached to each LC type	public education in terms of safety in LC area
	safety campaign in schools during all studying period	attached to each LC type	public education in terms of safety in LC area
	safety public campaign via web page made by Latvian Railway	attached to each LC type	public education in terms of safety in LC area
Lithuania	Safety campaign for public education	Near dangerous level crossings	Periodically, every year
	Video material for level crossing safety promotion on television and internet	All types	Periodically
	Educational visits to schools, promoting level crossing safety	All types	Periodically
Macedonia	Posters		
	Safety campaigns		
	Safety campaigns in schools		
Netherlands	Education at schools, national campaigns, enforcement.		
Norway	Visit schools and kindergartens in the vicinity of level crossings with high amount of registered transgressions		
	Arrange International Level Crossing Awareness Day (ILCAD) during a whole week (Bane NORs sikkerhetsuke – Rail safety week) with 50 + initiatives nationwide. Distribute images and press briefs to local and regional press.		
	Visit children's festivals with Lukas the Lion, our safety mascot, to promote safe behaviour at railway tracks.		
	Distribute activity booklets about Lukas the Lion and a safe train travel to schools and on trains		
	Develop and distribute safety materials like videos, posters, brochures at key locations to promote safe use of private and public crossings.		
	Arrange winter campaigns during winter and easter holidays.		
	Cooperate with train companies.		
	Raise awareness among drivers through driving schools.		

Romania	Pilot-project "A Different Approach School at CFR S.A."	All	Annual educational initiative of CFR S.A. in order to implement for the young people an awareness programme to realize the hazard in the railway area.
			The pilot-project has a chapter dedicated to the signaling at level crossings and to the meaning of the signs.
Russia	Posters, social campaigns, meetings with vehicle owners, Safety Days for schoolchildren	on all	compliance with level crossing rules, decrease in traffic accidents at level crossings
Slovakia	Safety activities of Police of The Slovak Republic		
	Education – driving schools		
	Posters, leaflets, publications, ...		
Spain	Rail infrastructure manager run railway safety education programme, targeting railway trespass and unsafe use of level crossings through different awareness raising activities (posters, workshops and talks…) (2016).	Class C	Intervention targeting specific problem with railway trespassing and misuse of level crossings.
Sweden	Not any educational efforts just now.		
Switzerland	SBB education train	All	Children
	Driving schools	All	Motorised road users
	Traffic education at schools	Only 3 basic types: St. Andrew's cross, Flashing light, Barriers	Children
Turkey	Student drivers take the traffic lessons at driving courses including LCs	Automatic user side protection and warning; Automatic user side protection and warning and rail-side protection Passive LC	Related Instruction Of Ministry Of National Education
	Traffic classes at Primary school	Automatic user side protection and warning; Automatic user side protection and warning and rail-side protection, Passive LC	Related Instruction Of Ministry Of National Education
	TCDD traffic department personnel visit schools which are close to LCs for educating students on LCs.	Automatic user side protection and warning; Automatic user side protection and warning and rail-side protection, Passive LC	If there is a LCs close to primary schools and if any accident happened at the LCs close to schools.
United Kingdom	School visits	All public crossing types	Crossings used by children
	Public events, shows,	All public crossing types	All types
	Television broadcasts	All public crossing types	All types used by public users especially specialist groups, ramblers, dog walkers, children, professional drivers,

Table IV. Additional safety arrangements: others

COUNTRIES	SAFETY ARRANGEMENT	LC TYPE TO WHICH ARRANGEMENT IS ATTACHED	CIRCUMSTANCES ADDRESSED

Austria	Trainings in the driver schools for driving instructors and also for the owners	All types of LC	Behaviour of road users triggered by the instructors
Netherlands	Test phase for several new concepts.		
	Use of colour and leds on the crossing floor,		
	Pre warning for slow or disabled pedestrians		
Slovakia	Unique identification number ("Jedinečné Identifikačné Číslo" - JIČ)	On all level crossings	Unique identification number – Labelling of the level crossing with identification number, for enabling fast orientation on the number „112" in case of emergency
United Kingdom	Mobile phone aps, conversion of text to voice for blind users (Signly)	All public crossing types	

4. ANNEX D. Level Crossing Safety Flyer


SAFETY TIPS FOR
TAXI DRIVERS
IN CASE OF EMERGENCY:
ACTIONS TO BE TAKEN
If the crossing lights start flashing, while crossing, keep going
If your vehicle is stuck between the barriers, drive through, breaking them
Evacuate all passengers from the broken-down vehicle and move quickly away
SOS
Make emergency call
INTERNATIONAL UNION OF RAILWAYS
OPERATION LIFESAVER
www.iru.org/
www.uic.org/
www.ole.ee/en
TAXI
AT GRADE/
LEVEL CROSSINGS
CROSSING SAFELY: GENERAL CONDITIONS TO BE OBSERVED
Be prepared to encounter a level/ grade crossing
Slow down
Obey the road signs and signals
Where there is a STOP sign: STOP, look both ways and listen carefully
Stop well before LC markings and signs
Be aware of traffic jams
Never stop on tracks
Expect a train from either direction
Do not zigzag between barriers
Wait for all the warnings to stop and the barriers to open completely
CROSSING SAFELY: OTHER CONDITIONS TO BE OBSERVED
Adapt your driving to weather conditions
Be aware of the length of your vehicle
Observe the relevant height clearance
Observe the relevant width clearance
Observe the topo-graphy of level/ grade crossings
SPECIAL TIPS FOR COMMERCIAL VEHICLES
Turn off the radio
800 m
56 m
Be aware that a train can't stop immediately
Be aware that a train weighs much more than a taxi
Be aware that a train extends over the rails

5. ANNEX E. Adherence to international level crossing safety regulations by surveyed countries (N=24)

		AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU	RS	SK	ES	SE	CH	TR	UK	%
Vienna Convention on road traffic	YES	X	X	X		X	X	X		X	X	X	X	X			X	X		X	X	X	X	X		75.0
	EXCEPTIONS															X			X						X	12.5
	NO				X				X						X											12.5
	NO ANSWER																									0.0
Vienna Convention: Road Signs & Signals	YES	X	X	X		X	X	X		X	X	X	X	X			X	X		X	X	X	X	X		75.0
	EXCEPTIONS															X			X						X	12.5
	NO				X				X						X											12.5
	NO ANSWER																									0.0
UIC leaflet 760	YES																X	X			X		X	X		20.8
	EXCEPTIONS								X	X			X			X			X							20.8
	NO							X			X	X													X	16.7
	NO ANSWER	X	X	X	X	X	X							X	X					X		X				41.7
UIC leaflet 761	YES																X	X			X		X	X		20.8
	EXCEPTIONS								X	X			X						X							16.7
	NO							X			X	X													X	16.7
	NO ANSWER	X	X	X	X	X	X							X	X	X				X		X				45.8
UIC leaflet 762	YES																X	X			X			X		12.5
	EXCEPTIONS								X	X									X							16.7
	NO			X				X			X	X	X										X		X	29.2
	NO ANSWER	X	X		X	X	X							X	X	X				X		X				41.7

Note: Responses regarding application of the two Vienna Conventions have been modified for Canada (CA), Greece (EL), Montenegro (ME), the Netherlands (NL) and Romania (RO) in line with the official list of contracting parties to the two conventions as published by United Nations (United Nations 2006; 2007). In the case of Greece the response provided in the Country Information Collection Form stated non application of the two Vienna Conventions whilst the other countries had left the answer field blank.

6. ANNEX F. Level crossing safety policy by country (N=24)

LEVEL CROSSING REMOVAL POLICY: (22 OUT OF 24 COUNTRIES) 92%																										
	AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU*	RS	SK	ES	SE	CH	TR	UK	Nº	%
LC removal reduction	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X			X	X	X		X	X	20	83.0
Speed related removal criteria							X												X			X			3	12.5
Grade-separated crossings	X												X			X		X	X		X		X		7	29.0
No new LC construction										X										X					2	8.0
LEVEL CROSSING PROTECTION POLICY (16 OUT OF 24 COUNTRIES) 67%																										
	AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU	RS	SK	ES	SE	CH	TR	UK		%
Upgrading LC protection			X		X		X				X			X	X			X		X				X	9	37.5
Replacement of passive for active LCs		X						X							X	X			X			X			6	25.0
Upgrading active LC protection																X			X						2	8.0
Technological development/ improvement				X	X																				2	8.0
Safe systems approach											X										X				2	8.0
ORGANISATIONAL AND STRATEGIC DEVELOPMENT POLICY (8 OUT OF 24 COUNTRIES) 33%																										
	AL	AT	BE	CA	FI	FR	EL	IE	IT	LV	LT	MK	ME	NL	NO	RO	RU	RS	SK	ES	SE	CH	TR	UK		%
Evaluation and risk management					X		X																	X	3	12.5

LC safety strategy and action plan					**X**									**X**					**X**						**3**	**12.5**
Focus on accident reduction						**X**					**X**														**2**	**8.0**
On-going LC monitoring and reporting					**X**																**X**				**2**	**8.0**
Cross sector collaboration					**X**																				**1**	**4.0**
EDUCATION AND ENFORCEMENT POLICY (5 OUT OF 24 COUNTRIES) 21%																										
	AL	**AT**	**BE**	**CA**	**FI**	**FR**	**EL**	**IE**	**IT**	**LV**	**LT**	**MK**	**ME**	**NL**	**NO**	**RO**	**RU**	**RS**	**SK**	**ES**	**SE**	**CH**	**TR**	**UK**		**%**
LC safety awareness campaigns					**X**			**X**						**X**	**X**									**X**	**5**	**21.0**
Increased enforcement														**X**											**1**	**4.0**

* No response to this question was provided by Russia.

7. ANNEX G. Results of case studies and projects

I. Organisational and procedural measures

MANEUVER. Development of avoidance measures for misconduct on railway crossings with the aid of the traffic psychology
COUNTRY Austria
PUBLICATION DATE 2013
AUTHOR (S) / ENTITY Kuratorium für Verkehrsssicherheit, Vienna /AT
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ Passive level crossing ☒ Automatic user side protection ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT ☒ Conceptual design
ABSTRACT The objective of the **MANEUVER project** was to develop cost-effective measures (education, awareness-raising, roadside infrastructure) with the help of experts and road traffic participants to reduce misdemeanour at level crossings. Austria proposed this conceptual design due to the associated high financial and technical costs to level crossings and because is necessary cost-effective alternative solutions that complement the existing level crossing safety systems. Methods used in traffic psychology will help to develop such additional safety measures tailored to the specific level crossing safety system. The result of the project is an Austrian-specific manual with validated measures. In addition, a performance profile for a mobile detection tool is developed to measure misdemeanour on specific level crossings. This measure is not in use but could be applied to passive level crossings and level crossings with automatic user side protection.

Tarva Level Crossing tool. Level Crossing safety analysis tool
COUNTRY Finland
PUBLICATION DATE 2013
AUTHOR (S) / ENTITY VTT
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ All types of LC ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT

☒ Tested in real conditions ☒ Implemented

ABSTRACT

The main objective of the **Tarva Level Crossing tool** (**Level Crossing safety analysis tool**) was to estimate the safety of the level crossings in Finland and the potential to enhance safety with different safety measures.
This tool implemented since 2011 to conduct consistent analyses throughout the whole country to estimate:
- The current safety situation on all level crossings to allocate safety measures optimally.
- The safety effects and implementation costs of improvements to estimating the cost-effectiveness of alternative measures at level crossings.
A key success factor is that the measure was tested in real conditions and the constant follow-up of the functioning of the estimation tool has been arranged.
According to the predictions, almost half of the future accidents occurred in the 10% of level crossings that had the highest predictions for accidents. But the removal of the level crossings not based only on the high accident expectations, there are other factors.
Safety measures at level crossings have been allocated based on the expected accident outcomes and traffic safety work has been enhanced.
This measure is applied to all types of level crossings.

II. Physical and/or technological measures

RÜTTLEX project

COUNTRY

Austria

PUBLICATION DATE

2016

AUTHOR (S) / ENTITY

Centrum dopravního výzkumu, v.v.i., Brno/CZ

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Passive level crossing
☒ Automatic user side protection
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Tested in real conditions

ABSTRACT

The objective of the **RÜTTLEX project** was to develop a series of rumble strips that are suitable and effective for application in the approximation (road) zones of certain level crossings in Austria.
The results of the project were positive and the implementation of the measure has a low cost.
The safety measure was tested in real conditions.
This measure is not in use but could be applied to passive level crossings and level crossings with automatic user side protection.

TEDS-Train Early Detection System

COUNTRY
Canada

PUBLICATION DATE
2017

AUTHOR (S) / ENTITY
……..

TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Automatic user side protection and warning
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT
☒ Conceptual design

ABSTRACT
TEDS-Train Early Detection System was a conceptual design from Canada. The main objective of TEDS is to improve safety in the level crossings using a technological development to announce to road users the proximity of crossings by cell phones. It is planned to test the measure under real conditions in two level crossings but the locations are not yet determined.
This measure is not in use but could be applied to level crossings with automatic user side protection and warning.

JUNAVARO project. In-vehicle warning system for railway level crossings

COUNTRY
Finland

PUBLICATION DATE
2011

AUTHOR (S) / ENTITY
Risto Öörni, Marita Hietikko, Kimmo Kauvo, Ali Lattunen & Ari Virtanen

TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Passive level crossing
☒ Automatic user side warning
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT
☒ Tested in real conditions

ABSTRACT
The main objective of the **JUNAVARO project** (**In-vehicle warning system for railway level crossings**) was to facilitate the development and deployment of in-vehicle warning system for railway level crossings by studying the technical functioning, reliability and dependability and socioeconomic benefits and costs of the system as well as user experience, potential other application areas and business models related to the system.
For this, the study focused on providing warnings of an approaching train to professional drivers (taxi drivers, bus drivers, truck drivers, etc.) and neighbours in level crossings at low-density lines. Pilot site was a railway section between Hanko and Karjaa (Finland).
VTT (Technical Research Centre of Finland) developed a pilot in real conditions focused on the accuracy of the arrival time estimation and reliability figures.
The results of the project indicated that in a full-scale implementation of the system, the number of level crossing accidents involving injury or death could reduce annually in four accidents less in Finland, in a situation in which a half of the vehicle fleet is equipped with an in-vehicle unit connected

to the system. The key to success for these results is the digitalisation of the rail environment: train location data, wireless communication services, timetable data and rail network database.
This measure is not in use but could be applied to passive level crossings and level crossings with automatic level crossings.

LeCross study. Improving Safety at Rail Crossings
COUNTRY Finland
PUBLICATION DATE 2014
AUTHOR (S) / ENTITY Ari Virtanen & Omar Iqbal
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ Passive level crossing ☒ Automatic user side warning ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT ☒ Conceptual design ☒ Laboratory tested
ABSTRACT The **LeCross study** (**Improving Safety at Rail Crossings**) assessed and proved the concept of a new satellite-enabled the system that enables railway infrastructure managers to deliver up-to-date reliable information of approaching trains to road users at currently unprotected passive level crossings. The main objective was to provide warnings of approaching train to road users via LeCross installation at low-density line level crossings using satellite technologies. The technology was a self-powered low-cost warning equipment, which does not require the installation of railway infrastructure. But the cost of the use of the satellite communication is high compared to a cellular network. However, for the moment it is only a conceptual model and tested in the laboratory. Also is fundamental the digitalisation of the rail environment: train location data, wireless communication services, timetable data and rail network database. The study was funded by European Space Agency and participated Finland, United Kingdom and the Czech Republic. This measure is not in use but could be applied to passive level crossings and level crossings with automatic level crossings.

Level Crossing Attention Device
COUNTRY Finland
PUBLICATION DATE 2014
AUTHOR (S) / ENTITY

The Finnish Transport Agency

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Passive level crossing
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

The **Level Crossing Attention Device** was developed in Finland as a low-cost safety solution. The level crossing attention device is estimated to be ten times cheaper than traditional half barrier solution. The device, which is already implemented, works with solar energy and no changes to railway infrastructure are needed.
The level crossing attention device consists of two parts: i) transmitter installed in a train/railway vehicle and ii) attention device (which provides the warning) located near the level crossing. The transmitter installed in a train/railway vehicle sends GPS based information about the location of the train/railway vehicle to the attention device, which warns the road users by yellow blinking LED light when a train/railway vehicle is sufficiently close to level crossing. The blinking continues until the train/railway vehicle has passed the level crossing. However, the level crossing attention device is not failsafe.
The Finnish Transport Agency and the Finnish Transport Safety Agency conducted a small scale internet survey (n=33) to investigate the road users' perceptions of the safety of these devices. In general, most of the road users felt that the level crossing attention devices improve the safety of passive level crossings. The negative comments were related to the non-functioning of the device in unexpected situations.
This measure is applied to passive level crossings.

Radar camera to detect drivers running red lights at level crossings

COUNTRY

France

PUBLICATION DATE

2010

AUTHOR (S) / ENTITY

CEREMA

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Automatic user side protection and warning
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

The objective of **Radar camera to detect drivers running red lights at level crossings** developed by CEREMA (France) wa to impose penalties for drivers who do not stop in front of the red lights of the level crossings and they continue their way.
To date, cameras have been installed at 80 automatic level crossings with two or four half-barriers across France. The results show fewer traffic offences, fewer barrier breakages and red lights being run.
This measure is applied to level crossings with automatic user side protection and warning.

Lattice road markings

COUNTRY
France

PUBLICATION DATE
2010

AUTHOR (S) / ENTITY
CEREMA

TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Automatic user side protection and warning
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT
☒ Tested in real conditions

ABSTRACT
The objective of **Lattice road markings** developed by CEREMA (France) was to remind road users that it is prohibited to stop on any part of the level crossing bearing road markings.
For this, CEREMA conducted trials in eastern France (Dieulouard, la Patrotte and La Cluse et Mijoux), that consisted of applied various types of road markings (yellow, white and red) and road users had to complete questionnaires about the road markings.
The trials were inconclusive, but road users did not understand the markings.
This measure is not in use but could be applied to level crossings with automatic user side protection and warning.

Traffic Mirrors for Level Crossings. Durable Ice-Free Stainless Steel Traffic Mirror

COUNTRY
Ireland

PUBLICATION DATE
2013

AUTHOR (S) / ENTITY
Iarnrod Eireann-Infrastructure Manager-Senior Track and Structures Engineer

TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Passive level crossing
☒ Manual user-side protection
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT
☒ No Information

ABSTRACT
Ireland proposed **Traffic Mirrors for Level Crossings** (**Durable Ice-Free Stainless Steel Traffic Mirror**) a project which objective was to place in strategic locations convex traffic mirror(s) as an additional user aid at Level Crossings where view(s) are restricted due to cuttings, structures etc. The mirrors would be positioned so that the user can see the image of an approaching train from the direction of the offending view.
The mirror chosen used a thermo-active material to resist ice, condensation and rain. All components must be made from stainless steel. The mirror surface must be a highly polished robust stainless steel (vandal proof).
This measure is applied to passive level crossings and level crossings with manual user-side protection.

White Stop Lines. Passive and Manual Road Crossings
COUNTRY
Ireland
PUBLICATION DATE
2011
AUTHOR (S) / ENTITY
Iarnrod Eireann-Infrastructure Manager-Senior Track and Structures Engineer
TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Passive level crossing ☒ Manual user-side protection ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT
☒ No information
ABSTRACT
The objective of **White Stop Lines** (**Passive and Manual Road Crossings**) was to indicate the position in advance of which a vehicle must be brought to a complete halt (placed 2.0m back from the running edge). The advantage of this measure is that train drivers now have a defined line that they can use to determine if a vehicle was in a position of safety when they were approaching and if a near-miss incident occurred. The level crossing user uses the same white line to stop behind so they can stop, look and listen for an approaching train in a position of safety. This measure is applied in Ireland to passive level crossings and level crossings with manual user-side protection.

Cattle Grids Alternatives. Rubber pyramid and Recycled Plastic
COUNTRY
Ireland
PUBLICATION DATE
2011
AUTHOR (S) / ENTITY
Iarnrod Eireann-Infrastructure Manager-Senior Track and Structures Engineer
TYPE OF LC TO WHICH MEASURE IS ATTACHED
☒ Passive level crossing ☒ Manual user-side protection ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT
☒ No information
ABSTRACT
The aim of **Cattle Grids Alternatives** (**Rubber pyramid and Recycled Plastic**) was to review the layout of existing cattle grids and provide cost-effective, durable alternatives to timber cattle grids in Ireland. Initially, the layout, orientation and gap of existing grids reviewed. In this measure, there were two alternatives to improve the cattle grids: recycled plastic; and rubber pyramid type mats. Their introduction has reduced slips trips and falls in these locations and in the crossings that provide access for RRV have eliminated the need to regularly replace damaged timber cattle grids.

Initial cost is high to the organisation at installation, but longer-term benefits in terms of life-cycle costs, durability and reusability. This measure is applied in Ireland to passive level crossings and level crossings with manual user-side protection.

Vegetation 'V' Boards
COUNTRY Ireland
PUBLICATION DATE 2011
AUTHOR (S) / ENTITY Iarnrod Eireann-Infrastructure Manager-Senior Track and Structures Engineer
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ Passive level crossing ☒ Manual user-side protection ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT ☒ No information
ABSTRACT The **Vegetation 'V' Boards** are boards placed at the sighting distance set out in IÉ standards that allow safe traversing of a level crossing in Ireland. They allow a quicker appraisal of the available views at the crossing, which can then assist in focusing on vegetation management at the crossing. There are four 'V' Boards per crossing located on poles in the cess 2m from the running edge and facing the level crossing. 'V' Boards are for Permanent Way staff only in relation to sighting distances and have no relevance to train-drivers. It is a low-cost measure and by adding these simple boards they are now able to manage compliant views better/manage risk better and they have made cost savings by only cutting vegetation where and when we need to. This measure is applied in Ireland since 2011 to passive level crossings and level crossings with manual user-side protection.

Level crossing of Railway section Marijampole-Sestokai 26+440 km reconstruction installing viaduct over Arminas street
COUNTRY Lithuania
PUBLICATION DATE 2017
AUTHOR (S) / ENTITY Algirdas Jonas Notkus, Paulius Ptašinskas, Saulius Anusas & Justina Genytė
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ Automatic user side warning ☒ Pedestrian crossing
LEVEL OF DEVELOPMENT ☒ Implemented
ABSTRACT

Lithuania presented a project developed in 2012 that consisted to eliminate accidents (train and road transport or pedestrian collisions) by **installing viaduct over Arminas street in Marijampole (section Marijampole-Sestokai 26+440 km)**.
There was a high risk of railway and road transport accident and there was a need to make railway and road transport more efficient. When the level crossing was reconstructed also installed a viaduct and risk was eliminated.
Usually, railway infrastructure manager is responsible for project implementation as well as stakeholders that have signed the contract with the railway infrastructure manager or government authority.
Installing viaduct is expensive, time-consuming but very effective for making railway and roads safer and more convenient for all infrastructure users.
This viaduct is applied in an automatic user side warning level crossings.

Level Crossing Safety Systems

COUNTRY

Serbia

PUBLICATION DATE

2007

AUTHOR (S) / ENTITY

Ivan Ristić

TYPE OF LC TO WHICH MEASURE IS ATTACHED

- ☒ Automatic user side warning
- ☒ Automatic user side protection
- ☒ Automatic user side protection and warning
- ☒ Automatic user side protection and warning and rail-side protection
- ☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

- ☒ Conceptual design

ABSTRACT

Serbia proposed a **Level Crossing Safety Systems**. The aim of this conceptual design was to develop a transparent system that compares technical solutions of level crossings using technical and financial costs of different types of level crossings. Database of level crossings, technical documentation for reconstruction and upgrading the level of insurance at level crossings was made in the period 2005-2007. A security solution was developed using a simplified multicriterial analysis tailored for a specific application.
This measure is not in use but some elements of the innovative solutions were implemented in the later technical documentation of the reconstruction of level crossings which was designed for the needs of the railway infrastructure manager.
This measure could be applied to level crossings with automatic user side warning, level crossings with automatic user side protection, level crossings with automatic user side protection and warning and level crossings with automatic user side protections and warning and rail-side protection.

ADIF type Level Crossing Protection System (SPN- 900)

COUNTRY

Spain

PUBLICATION DATE

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AUTHOR (S) / ENTITY

ADIF & ICF

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Automatic user side warning
☒ Automatic user side protection
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

Spain proposed a new level crossing protection system the **ADIF type Level Crossing Protection System** (**SPN- 900**). The SPN- 900 system aims to offer an integrated solution for the automatic protection of level crossings that uses light and audible signalling (Class B), automatic/interlocked half-barrier (Cass c) and pedestrian light signalling (Class F). The system can be powered using solar energy and works using radio communication between its different elements.
Signage is directed at the train driver to warn of the protection status of the crossing and protection devices are activated to protect the road users on the approach of a train.
The advantages of this protection system applied in urban and rural areas are:
- Cost reductions in terms of energy, costs and time involved in construction.
- Improved safety in terms of responsive maintenance system and fail-safe technology.
- Reduced environmental impact.
This measure is applied in Spain to level crossings with automatic user side warning, level crossings with automatic user side protection and pedestrian crossing.

BEGICROSSING

COUNTRY

Spain

PUBLICATION DATE

2017

AUTHOR (S) / ENTITY

BEGIRALE

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Passive level crossing
☒ Automatic user side warning
☒ Automatic user side protection
☒ Automatic user side protection and warning
☒ Automatic user side protection and warning and rail-side protection
☒ Manual user-side warning
☒ Manual user-side protection
☒ Manual user-side protection and warning

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

The objective of **BEGICROSSING** is to increase security and control over level crossings by having real-time information regarding the state of the level crossings, from both the point of view of the railway and the road (people and vehicles). A video camera is installed to have the vision of the level crossings and a software system based on Computer Vision and Computer Intelligence that does a real-time analysis of the scenario detecting and alerting on every possible risk situation. Those situations normally are both problems with obstacles on the railway (persons, vehicles, etc.) and malfunctions of one of the protection element of the level crossings.
The system was tested in 2015 and 2016 in real conditions. It has been installed in 7 level crossings of the Basque network railway situated in the province of Bizkaia (Spain).
The advantage of this measure is that benefits all parties: infrastructure manager, train operator and users of the road.
BEGICROSSING system has a positive impact on security. Also, the innovative solution permit a control over the level crossings from the point of view of the operator/infrastructure manager; normally they have control over all the elements of the level crossings but now the control also the external elements (cars, people, animals, …). The system is providing visual proof and statistical data of the problems and malfunctions of the level crossings. The video is recorded with the risk situations; this is useful for educational purposes and for complaints.
This measure can be applied to all types of level crossings.

MICRO

COUNTRY

Switzerland

PUBLICATION DATE

2010

AUTHOR (S) / ENTITY

Association for Public Transport and FOT

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Automatic user side warning
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

Due to the high acquisition costs, many level crossings on secondary lines remain equipped only with passive level crossing signs like the St. Andrew cross. This project wanted to implement Low-cost Level Crossing System (LCS) **MICRO** (flashing yellow light), to warn the road users against the railway traffic.

From 2006 to 2009 the industry in Switzerland tested 4 different pilot systems in level crossings with very low road traffic in rural regions. Test mainly investigated behaviour/reactions of road users in the event of problems with the MICRO system.
This measure is not in use but could be applied to level crossings side warning.

Design of Automated Unmanned Railway Level Crossing System Using Wheel Detector (Sensor) Technology
COUNTRY Turkey
PUBLICATION DATE 2017
AUTHOR (S) / ENTITY Ipinge David & Rituraj Rituraj
TYPE OF LC TO WHICH MEASURE IS ATTACHED ☒ No information
LEVEL OF DEVELOPMENT ☒ No information
ABSTRACT Turkey proposed a thesis work wrote in Hungary. The main aim of the **Design of Automated Unmanned Railway Level Crossing System Using Wheel Detector (Sensor) Technology** was to develop an automated level crossing system that would prevent accidents between trains and road users. From the railway level crossing point of view, the requirement to be met by such protections is quite simple: it has to stop road users before the train passes. Two wheel sensor are used located before (Strike-in point) and also after (Strike-out point) the level crossing. On the other hand, the proposed system comprises of other warning devices such as automatic barrier, LED flashing lights and the alarm device. MicroLok II is used as the controller to execute all the signals and programs. Barrier closing time will be optimized based on the type train and their speed. Implementation of new technology will significantly improve safety at the level crossing without building the capacity of road infrastructure. This measure is not in use. But this proposed system has the advantage that is cost-effective, convenient, efficient, secure and tailor-made level crossing protection system that is best suited to be implemented in the future of railway industry. However, education and safety campaign awareness should be carried out regularly to inform road users about the danger of misbehaving and ignoring road rules.

III. Educational measures

Rules of the Road. 'Safety at Level Crossings'
COUNTRY Ireland
PUBLICATION DATE 2016
AUTHOR (S) / ENTITY

Road Safety Authority; Commission for Railway Regulation; Iarnród Éireann - Infrastructure Manager.

TYPE OF LC TO WHICH MEASURE IS ATTACHED

☒ Passive level crossing
☒ Automatic user side warning
☒ Automatic user side protection and warning and rail-side protection
☒ Pedestrian crossing

LEVEL OF DEVELOPMENT

☒ Implemented

ABSTRACT

The objective of the **Rules of the Road** booklet called **'Safety at Level Crossings'** was to present the instructions for safe use of level crossings. This booklet is used in Ireland by railway staff to inform users, and by schools and the community police when teaching road safety to young people. The target group is regular users and young people.
Three videos were produced, a long one for instructions and education, and two brief videos for social media.
Success depends on the distribution of the booklet as part of an educational programme but a scientific evaluation has not been performed.
This education measure is applied and is useful in passive level crossings, level crossings with automatic user side warning and level crossings with automatic user side protection and warning and rail-side protection.

8. ANNEX H. OVERVIEW OF SELECTION CRITERIA BY LC TYPE, FREQUENCY OF RESPONSE AND COUNTRY

Selection criteria	Passive	Active automatically controlled				Active manually controlled		
		User side warning	User side protection	User side protection & warning	User side protection & warning & rail protection	User-side warning	User-side protection	User-side protection & warning
Traffic moment	6 (AL, FR, ES, TK, UK, AT)	5 (SK, ES, LV, LT, AT)	1 (SK)	2 (FR, TK)	2 (ES, TK)		1 (TK)	1 (ES)
Road traffic volume*	10 (AL, FI, FR, LV, LT, CH, AT, IE, ME, RS)	9 (AL, LV, LT, CH, AT, RU, IE, ME, RS)	4 (AL, LT, RU, RS)	9 (AL, FR, EL, LV, LT, UK, CH, RU, RS)	6 (EL, LV, LT, RU, IE, RS)	3 (LV, LT, RS)	4 (LV, LT, IE, RS)	3 (EL, LT, RS)
Rail traffic volume	5 (RO, LV, LT, SE, FI)	3 (FI, RO, RU)	2 (LT, RU)	4 (EL, LV, LT, RU)	5 (EL, RO, LV, LT, RU)	3 (RO, LV, LT)	3 (RO, LV, LT)	3 (EL, RO, LT)

Sighting distance/ conditions	13 (AL, FR, RO, SK, ES, LV, UK, CH, AT, IE, SE, ME, RS)	7 (FI, ES, LV, AT, RU, SE, ME)	1 (RU)	3 (FR, LV, RU)	2 (LV, RU)	2 (LV, RU)	2 (LV, RU)	1 (RU)
Maximum train speed	11 (AL, RO, TK, LV, UK, CH, CA, AT, SE,MK, RS)	7 (RO, LV, AT, IE, SE, ME, RS)	1 (RS)	7 (FR, TK, LV, CA, IE, MK, RS)	9 (RO, ES, TK, LV, CA, RU, SE, MK, RS)	2 (RO, LV)	4 (RO, TK, LV, IE)	1 (RO, ES)
Line category	1 (IE)	3 (SK, IE, NL)	1 (SK)		1 (IE)		1 (IE)	
Number of tracks	7 (AL, RO, CA, IE, SE, ME, MK)	3 (RU, IE, ME)	1 (RU)	3 (CA, RU, MK)	4 (CA, RU, IE, MK)		1 (IE)	
Intersection (incl. angle)	2 (RO, CA)			1 (CA)	1 (CA)			
LC category	3 (LT, IE, NL)	2 (LT, NL)	1 (LT)	1 (LT)	1 (LT)	1 (LT)	3 (FI, LT, IE)	1 (LT)
Proximity to station					1 (UK)			
Type of road	5 (RO, CA, IE, SE, FI)	4 (AL, FI, RO, IE)	1 (AL)	2 (AL, CA)	4 (RO, CH, CA, IE)	1 (RO)	3 (RO, UK, IE)	2 (RO, UK)
Type of area: rural, urban		1 (RU)	1 (RU)	4 (FI, UK, RU, SE)	1 (RU)	1 (RU)	1 (RU)	1 (RU)
Accident rate		1 (SK)	1 (SK)					
Type of LC user				2 (SE, NL)	1 (SE)			
Road width	3 (AL, IE, MK)	1 (AL)	1 (AL)	2 (AL, MK)	1 (MK)			
Location	1 (AL)						1 (AL)	
Train timetable						1 (AL)		
Other		2 (IE, FI)						