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Group of Experts on Improving Safety at Level Crossings

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A summary of good practices including education

Submitted by Finland and India

This informal document submitted by Finland and India presents the outcomes of the actions requested by the Group of Experts of this subgroup:

- An analysis of national case studies and examples of evaluated good practices provided by GE.1 members to this subgroup;
- Research on evaluated good practices, to potentially be compiled into examples to be included in good practices related to safety at level crossings in the Consolidated Resolution on Road Traffic (RE.1); and
- A compilation of examples of good practices relating to items (a) to (g) provided by other GE.1 subgroups; and
- Proposed next steps.

I. Background

UNECE Working Party on Road Traffic Safety (WP.1) established in the year 2013 a Group of Experts on the safety at level crossings. The expert group on level crossing safety has seven subgroups. This is the report of the subgroup on the Good practices to improve level crossing safety, comprising of Finland (Finnish Transport Safety Agency Trafi, appointed by the Ministry of Transport and Communications) and India (Ministry of Railway).

The level crossing population varies considerably between different countries and also inside one country. Level crossings tend to be tailored to local conditions and even dividing them into different categories is challenging. Also the conditions at the same crossing can differ significantly when comparing it e.g. at different times of year. It is evident that there is no "one size fits all" solution to improve the safety of level crossings, except eliminating the crossing by closing it or by grade separation.

II. Working method

The UNECE secretariat of the Expert group on level crossing safety launched in summer 2014 a questionnaire on behalf of all the subgroups. The questionnaire included five questions on the good practices to improve level crossing safety.

(a) What do you consider to be the best/good practices in improving level crossing safety in your country?

(b) Why do you think they are the best/good measures to improve safety?

(c) How have the best/good practices been evaluated?

(d) Are there measures you have tried and which did not work even if these measures were successful or even best/good practices in other countries? Why did you think they did not work?

(e) Is there some additional information you would like to add on the best/good practices to improve level crossing safety?

After receiving the answers they were classified and grouped under the several categories: Elimination (including closure and grade separation), Education, Engineering, Enforcement, Evaluation and Endorsement.

Based on the cultural differences and different conditions in the countries responding to the questionnaire the results are presented for three groups: the countries applying to the European Union (EU) safety regime, India and other countries.

In the European Union the approach to railway safety (including the level crossing safety) is described in the Railway Safety Directive (2004/49/EC)[1]. The railway safety work and the different railway safety expert groups of the European Railway Agency (ERA) are also based on the Railway Safety Directive. The group of countries using the EU safety harmonization regime includes 16 countries (Belgium, Estonia, France, Germany, Greece, Hungary, Ireland, Italy, Lithuania, Norway, Poland, Portugal, Spain, Sweden, Switzerland and the UK).

[1] Directive 2004/49/EC of the European Parliament and of the Council of 29 April 2004 on safety on the Community's railways

The good practices to improve level crossing safety in India are described separately because the culture and especially the conditions in India differ greatly from the two other groups of countries. India has a huge number of level crossings, in total 30,348 of which 62% are manned and 38% unmanned. In India 69% of the inhabitants are living in rural area and due to this there are several associated problems like theft of devices at level crossings or tampering with them. The national average rate of literacy is 74% and because of that any structured education program cannot cover the entire population. In addition there are about 23 official languages and the number of regional languages spoken all across India is above 100.

The other countries include four former Soviet Union states: the Republic of Belarus, Georgia, the Republic of Moldova and Russia. This group includes also Turkey, in total five countries.

III. Data

We received the answers on good practices to improve level crossing safety from 22 countries. However, not all countries answered to all of the questions. The responses reflected the organisation of the respondent (e.g. railway company, railway infrastructure manager, ministry, police).

Most of the good practices represented the expert opinions without any other evaluation or the evaluation was based on changes in general accident statistics. In some countries the evaluation was based on the accident investigation reports (causes for level crossing accidents) or risk models. Sometimes the outcome of the evaluation was not yet available due to the early stage of the implementing of the measure or was not publicly available. Also the safety improving measures generally used in the country were often presented as good practices. We did not receive any information on e.g. impact assessments or before-after studies.

IV. Results

A. Good practices under European Union safety regime

We received the majority of answers (72%) from the countries applying the European Union safety regime (total 16 countries). Safety improvement measures have been sorted under Elimination, Engineering, Education, Enforcement and Endorsement. In general good practices should give appropriate information to user and encourage safe behaviour and put users in position to see approaching trains without being in danger.

B. Elimination

The elimination (closure and grade separation) of level crossings was mentioned in over half of the answers. In addition to that it was mentioned that new level crossings should not be built. If elimination is not possible the upgrading of the crossing was mentioned as a good practice. Also rerouting the traffic to the level crossing equipped with barriers was considered as a good practice.

When rerouting the traffic the network effect should also be considered to avoid just transferring the safety problem to some other location at the road network.

C. Engineering

Some type of engineering solution was seen as a good practice measure in almost all of the answers received from the countries applying the EU safety harmonization regime.

Upgrading the level crossings from passive to active with barriers was considered good practice. Also upgrading the crossings equipped with flashing lights and sound signals to crossings equipped with barriers (someroad users misunderstand the flashing red lights and interpret them as warning, not as a demand to stop). Crossings with barriers were suggested to be interlocked to signals and if there is a road junction with traffic lights nearby, also to that one. The good practice solution would be to make the barriers look fence-like with attaching chains or other structural solutions to the barriers. Upgrading the half barrier crossing to full barrier crossing (full barriers also for pedestrians and bicyclists) and equipping the signals and barriers with LED lights were seen as the good practice measure.

If it is not possible to upgrade the level crossing to active one, improving of sightings or use of rumble strips were seen as good practice solutions. From the stop point there should be an unobstructed sight along the railway.

Other measures estimated to be the good practice solutions included monitoring of the level crossing with CCTV, obstacle detection, an online form for reporting a fault with equipment and traffic lights some metres before the level crossing.

It is also important to inspect and maintain the existing equipment.

D. Education

Education and raising awareness was mentioned in about half of the answers. In addition to national awareness campaigns targeted or segmented awareness campaigns aimed at children, dog walkers, farmers, professional drivers or road users at harbours were considered to be the good practice measures. Rising of the awareness on the proper behaviour when trapped between the barriers is mentioned as good practice.

E. Enforcement

Five respondents considered the enforcement in general to be a good practice solution. Also mobile safety vehicles and uniform presence at the level crossings with a history of deliberate misuse were mentioned as well as well as the introduction of fixed red light safety cameras. In one answer it was considered that enforcement may create bad feelings, is expensive and may not change behaviour.

F. Evaluation

Different types of evaluation of level crossings were considered as good practices in four answers. These included level crossing inspections during which the technical condition of the level crossing is checked, and an impact assessment and an evaluation of legal framework/regulations based on risk monitoring and cost-benefit-analysis are carried out.

G. Endorsement

The endorsement measures include rail traffic improvement program, having all the level crossing issues under national law (technical issues, obligations of road and rail and the

consequences when the law is offended), knowledge on the exact number of level crossings and their type and frequent risk assessment.

H. Good practices in India

In India the good practices are different from the other responding countries because of the huge number of inhabitants and the languages spoken. The good practices include elimination, education, engineering and enforcement. The evaluation of measures is based on data collection.

I. Elimination

Elimination of unmanned level crossings within a time frame of five to seven years is the good practice measure as well as grade separation with over and under passes. The elimination is done e.g. by building over and under passes, closing of crossings and manning the unmanned crossings.

J. Education

Most of the level crossings are located on the rural and remote areas and the effective method to improve level crossing safety should be based on mass contact and bring out a behavioural change. Methods like education in school, street shows, mass contact in the Fares (Melas), etc. are found to be very helpful and cost-effective techniques.

At primary level education on railway safety (especially level crossing safety) is included in syllabus. For small children and illiterate adults there are street shows in their own language. Safety campaigns with SMS messages, printed safety bulletins in 23 official languages, leaflets are also amongst the best/good practices.

K. Engineering

The best/good practices for engineering include whistle boards 600 m before the crossing, rumble strips and speed humps and manual barriers interlocked with signals. There is a trial on repeated whistle board 300 m before the crossing. Cable Stayed Road Over Bridges are being provided at major busy railway yards. R&D is being promoted in collaboration with academic institutions and consultants.

L. Enforcement

The safety drives with regional and local police to enforce and remind on proper behaviour are found as the best/good practice as well as the road safety counsellors (employed by railways) warning and sensitizing road users. The latter will be extended.

M. Good practices in other countries

We received the answers from five other countries. In Moldova they are trying different solutions at 20 level crossings to improve safety. The good practices have not been identified yet.

N. Elimination

The grade separation and elimination of passive level crossings were considered to be the good practice measures because they improve safety, reduce maintenance costs and increase the capacity. If the over or under passes are built, the crossings within a five km area from the grade separated crossing should be eliminated.

O. Engineering

Equipping of the level crossing with barriers (including so called lying policeman) was seen a good practice measure as well as installing of technological protection measures not allowing the vehicle to enter to the private crossing (reduces the number of incidents).

Creating a communication system between train driver and level crossings was seen as the good practice because the train driver will be able to notice if the crossing is working properly.

P. Enforcement

The installation of video cameras to the level crossing is good practice because the cameras scare drivers and thus reduce the number of incidents. Good practice also comes about from increasing penalties and publishing the serious accidents.

Q. Endorsement

The national legislation including the measures to improve existing level crossings, the prohibited locations for level crossings, the distance between the level crossings and signing standards was considered to be the good practice measure.

V. Finnish study on the level crossing safety improvement measures[2]

As the result of the survey we did not receive information on any research with evaluation of the effects of the good practices to improve level crossing safety. In Finland a study on the Survey and assessment of measures aiming to improve the safety of level crossings was made as a part of the Traffic Safety 2025 research program at VTT Technical Research Centre of Finland. The study will be published shortly.

The study includes 37 measures to improve level crossing safety. Each measure is described and evaluated on their Excel sheet. The safety impact estimates are based on the Finnish and international research and partly on the Finnish expert estimations for the level crossing accident model. The safety impact was estimated in the study only if research or expert estimation (or both) were available.

The measures were evaluated based on 15 criteria. The most important for this study were the safety impacts and the costs of the measures. The measures estimated to decrease the number of accidents by at least 20% are listed in table 1. The table includes only the

[2] Survey and assessment of measures aiming to improve safety of level crossings, VTT Technical Research Centre of Finland, published by Finnish Transport Agency

measures for which the safety impact could be estimated. It is possible that the measures for which the safety impact could not be estimated are effective but for the present there is no research on their safety impact available. The estimated costs were classified in three categories: low (< EUR 5,000), intermediate (EUR 5,000-25,000) and high (> EUR 25,000).

Table1.
The measures which are estimated to decrease the number of accidents at level crossings by over 20% and the cost class of their implementation.

Measure	Impact	Costs
Preventing structurally going around the half barriers	20-50%	low/high
Fundamental improvement of level crossing	20-50%	high
Removal of level crossing	5-20%, 20-50%, >50%	high
Flashing lights and sound signals	20-50%	high
Safety models	no direct impact; 20-50%, >50%	not known per level crossing
Installing double barriers	>50%	high
Installing half-barriers	>50%	high
Obstacle detection system	>50%	high

The costs of preventing driving around the half-barriers depend on the way of implementing the measure and can be low (installing an extension to the barrier) or high (structural changes to the road). There is no research available per single level crossing on the costs of the modelling of level crossing accidents. The measure does not have direct impact on safety and the amount of indirect impact depends on what or which measures are decided to implement based on modelling.

Table 2 includes the measures that are estimated to be promising to be implemented in Finland but on which the safety impact is lacking. Those measures are estimated to have significant potential to decrease the number of level crossing accidents in the future and the recommendation of the report is to make research on their safety impact.

Table 2
The promising measures (safety impact not known) and the classification of costs for implementing the measure.

Measure	Impact	Costs
Clearing the sightings to comply with the requirements	Needs research	Depend on the crossing
Awareness campaigns and giving information	Needs research	Depend on the size of the target group
Mobile warning devices	Needs research	Not known
Enforcement with red light cameras	Needs research	Intermediate

In many crossings the sightings can be cleared by cutting the vegetation. Especially at the crossings without warning devices it is essential that the road user has good conditions to see the approaching train.

The proper evaluation is needed for the different types of awareness campaigns. At present we do not have enough research on the real safety impact of the awareness campaigns. The same concerns the mobile warning devices (e.g. in-vehicle warning devices).

VI. Conclusions and recommendations

The good practices identified with the survey were mostly based on expert opinion or they were the practices commonly used in the responding country (and also depending on the organization the respondent presented). We received hardly any knowledge on the research which is used to evaluate the safety impact of the measures used to improve the safety of the level crossings. In that respect it is difficult to identify the good practices evaluated to be good.

The measures considered to be good practice solutions to improve safety at level crossings were usually estimated to be that because they either offered engineering solutions to enhance the proper behaviour of road users and to make it clear on how to behave (e.g. physical separation) or the accident statistics show a decrease in the number of accidents. Education of children was deemed effective because they are the future drivers.

The recommendations given need to be considered taking into account that the exact measures need to be tailored to each country and sometimes to each crossing. The available diversity in perspectives, ideas and creativity is needed. Usually it is not possible to recommend one good practice measure.

A. Removal of level crossing and the use of safety models

The measure was mentioned almost in all of the answers to the survey and was also in the group of eight most effective measures to improve the safety. When closing the level crossing and directing the road traffic to another crossing the safety impact to roads and level crossings nearby should be considered. The challenge with this measure are naturally the costs.

It is important to try to close the crossings with the highest risks. For identifying the high risk level crossings some kind of accident or risk model should be used. Risk based approach is essential for identifying and evaluation of safety level, deciding the need of action, estimating and monitoring the impact of foreseen measures and evaluating of regulations / legal framework. In addition risk analyses (even simple ones) are essential for prioritising the investment and they should be done frequently. A good practice is to have an ongoing level crossing risk reduction programme in addition to the safety model. Also monitoring the risk levels frequently is essential.

Based on the review of risk / accident models most often the factors include the exposure (number of trains and road users) and the type of warning device. Other factors having effect on the safety are the speeds on road and rail, the number of lanes of the road, sight distances from the road to the rail and the surroundings of the crossing. It needs to be noted that the factors concerning the behaviour of the road users have an effect on the number and consequences of the accident.

Recommendation: Risk based approach should be used to identify the high risk level crossings.

In here possibly the recommendation on HF based on the HF subgroup results

B. Education

The need of awareness campaigns, information given to the road users and education at schools was recognised both in the results of the survey and in the Finnish study. Naturally to be able to behave properly at the level crossing the road users need to have enough knowledge on the proper behaviour.

The target groups of the awareness campaigns should be considered country by country. The awareness campaigns can be targeted to wide audience or to some identified group e.g. school bus drivers, emergency vehicle drivers, dog walkers, farmers, professional drivers in general, school children etc. More evaluation on the safety impact of awareness campaigns is needed.

Information on proper behaviour can also be given at mass gatherings by leaflets and having a stand, by SMS messages and on internet, also in social media.

The education needs to begin early at school, continue at driving schools and adults need to be regularly reminded about proper behaviour e.g. through campaigns.

Recommendation: Road users (vehicle drivers, bicyclists, pedestrians) need to be aware on the proper behaviour at level crossings. Target groups for the awareness campaigns should be considered country by country.

More evaluation of the safety awareness campaigns is needed.

C. Engineering solutions

Different engineering solutions at level crossings support the road users to understand how to behave. The measures have a variety from warning the road user on the approaching train to installing physical devices to the crossing or to the road leading to the crossing.

Upgrading the level crossings from passive to active with barriers was considered the good practice and has been evaluated to be effective. However, the upgrading is a long and costly process. More low cost measures (e.g. simple warning lights) to improve safety are needed.

Upgrading the crossings equipped with flashing lights and sound signals to crossings equipped with barriers to make it easier for the road user to behave properly at the crossing is seen as a good measure to improve safety.

Open crossings with warning only and crossings with automatic half-barrier systems are found to be particularly risky when installed on 'through roads', due to traffic speed, frequency of use, failure to see warnings, stop on crossing and avoiding barriers.

The introduction of new technologies offer new solutions to improve level crossing safety. Research on their safety impact is needed.

Recommendation: If possible considering the resources the passive crossings should be upgraded to active ones. The measures guiding the road users to correct behaviour could be used. Research on the new technologies is needed.

D. Enforcement

Already the uniform presence at level crossings with a history of deliberate misuse has effect on the behaviour of road users. Speed cameras and red light cameras have also been estimated to be a good practice.

The research on the safety impact of different enforcement measures is still needed.

Recommendation: Research on the safety impact of enforcement measures is needed.

VII. Next Steps

That the Expert Group considers this document and finalizes it based on the feedback received. The subgroup recommends that the work of the human factors subgroup be considered for the possible good practices found in their work.

Appendix 1[3]:

List of measures to improve safety and their safety impact

For some measures it was impossible to classify the costs to only one class. An example of such a measure is Improving to distinguish the barrier, which was estimated to decrease the number of vehicle accidents by <5% and the number of pedestrian and bicycle accidents by 5-20%. Another example is Removal of level crossing, the impact of which depends significantly on where the road traffic is directed.

Five measures were estimated to have the safety impact of less than 5% (e.g. portals and warning signs, see table 1). Typically it was estimated that the measure has 5-20% impact on decreasing the level crossing accidents (e.g. active warning sign speed humps and installing the low cost warning device. The safety impact of over 20% was estimated to 11 measures, 6 of them the decrease of 20-50% and four over 50% (e.g. installing the double or half barrier or obstacle detection. For 14 measures the safety impact was not known (no research on the topic found).

[3] Survey and assessment of measures aiming to improve safety of level crossings, VTT Technical Research Centre of Finland, published by Finnish Transport Agency

		Safety impact				
Impact mechanism	**Measure**	**<5 %**	**5-20 %**	**20-50%**	**>50 %**	**Not known**
Improves the distinguishing of the train	Improvement of distinguishing the engine front					X
	Level crossing mirror					X
	Clearing the sightings to comply with the requirements					X
Improves the distinguishing of the level crossing	Portal	X				
	Flashing light added to the level crossing warning sign	X				
	Active warning sign		X			
	Improving to distinguish the barrier	X	X			
Controls access to level crossing	STOP-sign		X			
	Emphasising the level crossing with markings	X				
	Preventing structurally going around the half barriers			X		
	Standardising the timing of barriers		X			
	Installing double barriers			X		
	Installing half barriers				X	
	Manual barriers and gates					X
	Driving prohibits for some types of vehicles		X			
Decreases the approaching speeds to level crossing	Warning sign	X				
	Speed humps		X			
	Lowering the speed limit at level crossing		X			
	Supporting lowering of speed by optical guidance					X
Increases the awareness on the dangers at levelcrossings and	Awareness campaigns and giving information					X

		Safety impact				
on the proper way to behave						
Improves the physical conditions of the level crossing	Repairing the flat part of road near the level crossing	X				
	Fundamental improvement of level crossing			X		
	Repairing the crossing angle		X			
	Removal of level crossing		X	X	X	
	More effective maintenance on the road to level crossing					X
Making it easier for pedestrians and bicyclists to cross	Adding railings for pedestrians to guide them looking to right direction					X
	Barriers for pedestrians and bicyclists					X
	Warning device at crossings from one platform to another					X
Informing on-time on the conditions at level crossing	Low cost warning lights		X			
	Flashing lights and sound signals			X		
	Mobile warning devices					X
	Red light cameras					X
	Obstacle detection system				X	
Supports the safety improvement measures at level crossing	Making good use of existing research					X
	Safety models		X	X	X	
	Maintaining the level crossing guidance					X