The SAFER-LC project

Workshop on
Railroad level-crossings safety improvement

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Summary

- Overview of SAFER-LC project
- Technical analysis about:
  - Analysis of LC safety systems
  - Human factors at LC
  - Smarter LC
  - Pilot tests in SAFER-LC
  - Main outputs of the project
Background

▲ Breakdown of significant accidents (2012-2014) – ERA Figures

▲ Relative share of victims per category of persons (2012-2014) - ERA Figures
Objectives

▲ Improve safety and minimize risks at and around level crossings (LCs)
  • by developing innovative solutions and tools to detect as early as possible potentially dangerous situations leading to collisions at LCs and to prevent incidents at level crossings

▲ Focus both on technical solutions and on human processes
  • to adapt infrastructure design to end-users
  • to enhance coordination and cooperation between different stakeholders from different transportation modes.

▲ Develop a toolbox which will integrate all the project results and solutions to help both rail and road managers to improve safety at level crossings.
Key facts

▲ Framework: H2020 Call 2016-2017 Mobility for Growth
  • Topic: MG-3.4-2016: Transport infrastructure innovation to increase the transport system safety at modal and intermodal level (including nodes and interchanges)

▲ Project submitted in September 2016 and selected in January 2017

▲ Starting date
  • 1st May 2017 for 3 years

▲ Budget
  • 4,888,927 €

▲ Total effort
  • 487,75 MM
Consortium

▲ Coordinator: UIC
▲ 17 partners
▲ 8 European Union countries
▲ 2 associate countries
Approach

- Analysis of LC safety systems and definition of needs and requirements of the rail and road users for safer level crossings (WP1)
- Development of innovative measures (WP2 and WP3)
  - Human centered low cost measures
  - Technical solutions
- Field-test and evaluation of the measures (WP4)
- Elaboration of recommendations and guidelines (WP5)
- Collection of all results in a toolbox
Structure

WP7 (MGT) led by UIC
Management and coordination

WP1 (RTD) led by VTT
LC in Europe and beyond: Rail and Road safety management requirements

WP2 (RTD) Led by FFE
Human factors at LC: design for self explaining and forgiving infrastructure

WP3 (RTD) led by NTNU
Smarter LC: development and Integration of technical solutions

WP4 (DEM) led by CERTH-HIT
Lab tests, field implementation and evaluation

WP5 (RTD) led by IFSTTAR
Cost benefit analysis and final recommendations towards LC safety standards

WP6 (OTHER) led by UIC
Dissemination and exploitation of the results

WP8 (ETHIC) led by UIC
Analysis of LC safety systems (WP1)

To provide requirements and recommendations to be taken into account in development and evaluation work packages (WP2, WP3 and WP4)

- Needs and requirements for improving level crossing safety available for the technical WPs
- Definition of selected scenarios to be tested and evaluated in WP4

- Task 1.1. Analysis of LC safety
- Task 1.2. LC related accident data
- Task 1.3. Needs and requirements for safe LC management

WP2, WP3, WP4, WP5
Task 1.1: Analysis of LC safety in Europe and beyond

▲ Objective: to identify and analyze the regional disparities in LC environments between countries in Europe and beyond
▲ Collection of information on different aspects of LC safety
▲ Information was received from 24 countries in Europe and beyond

Lessons learnt regarding level crossing safety
▲ Factors that facilitate the successful implementation of safety at level crossings
▲ Factors that act as barriers to improving level crossing safety
Results of Task 1.1: factors **facilitating** LC safety

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<th>Strategic</th>
<th>Operational</th>
<th>Educational</th>
<th>Enforcement</th>
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<td>• Cross-agency working</td>
<td>• Investment in level crossing protection</td>
<td>• Information and education</td>
<td>• Sanctioning level crossing misuse</td>
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<td>• Political backing and investment</td>
<td>• Investment in level crossing removal</td>
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<td>• Evidence based decision making</td>
<td>• Effective programme of maintenance</td>
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<td>• Setting ambitious safety targets</td>
<td>• System to report crossing failures</td>
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Results of Task 1.1: **barriers** to LC safety

**Strategic**
- Securing political acceptance and public investment
- Lack of cross-agency working

**Operational**
- Cost and complexity of LC removal and upgrade process
- Limitations of current protection arrangements
- Meeting maintenance requirements

**Human factors**
- Gaining public acceptance
- Level crossing misuse
- Lack of public awareness around safety
Task 1.2: Identification of typical factors behind LC accidents

▲ Objective: To produce an in-depth review of LC accident data
▲ In-depth review covered railway accident databases from 7 countries, namely Greece, Finland, France, Italy, Norway, Spain and Turkey
Results of Task 1.2

Large differences among countries

Main factors affecting the realization of the accident:

- Breakdown of the car at the LC
- Non-observation of road signage
- Overtaking the queueing traffic
- Visibility: glare from the sun
- Car violating the barriers
- Car abandoned in LC
- Excessive speed
- Distraction
- Loss of control (vehicles or bicycles)
"Human factors must be identified as a major issue in improving level crossing safety. (...) Human factors which cause or contribute to accidents must be put at the heart of actions for improving safety at level crossings."


"...better understanding of the root causes and human factors of this misuse could support improved management of this significant railway risk."

(European Union Agency for Railways, 2017)
Human factors: key concepts

- Application of psychological and physiological principles to design of products, processes and systems
- Understanding the interactions among humans and other elements of a system
- Optimizing human well-being and overall system performance
- Meeting the needs of people engaging with the designs, safely and efficiently
Level crossings as a complex system

- Road and rail vehicles (heavy vehicles, high-speed trains...)
- LC infrastructure (sight distances, signage...)
- Wide profile of level crossing users (motorized and vulnerable road users...)
- Broader environment (weather conditions, rural vs urban setting...)
Human behaviour = unpredictable variable

Human errors
- Lack of knowledge of LC rules
- Poor lighting
- Limited sight distance
- Distraction and inattention
- Fatigue
- Decision making
- Perception

Subjective risk estimates
- Personal characteristics
- Time pressure
- Mood
- Influence of drugs or alcohol
- Social pressure (peers or other drivers)
- Risk seeking personality
- Individual motivation
Human factors for LC design

A dedicated human factors work package which aims to enhance the safety performance of level crossing infrastructures from a human factors perspective, making them more self-explaining and forgiving, designed to take into account the needs of different road and rail users, and especially issues related to vulnerable users.
Analysis into human factors at level crossings: literature & expert consultation

Human Factors Methodological Framework
Evaluate the effects of measures on human behaviour and safety.

Design and evaluation of innovative human centred low cost measures

Testing and evaluation in pilots (e.g. laboratory, driving simulator, living lab...)

Evaluated Human Factors Assessment Tool
Evaluated human centred low cost measures

SAFER-LCToolbox
Adaptation of Cognitive Work Analysis (CWA) approach

For each level, there are sets of criteria which apply

The levels help to:

a) establish the context and identify the purpose of the new measure (intended effect mechanism)

b) estimate the measure effectiveness from a LC user perspective
Criteria selected for the Human Factors Assessment Tool

Classification criteria
- Applicability to different LCs
- Feasibility under different environmental conditions
- Applicability to different types of user
- Adaptation to individual characteristics and conditions of users
- Intended effect mechanism

Estimation of short-term safety effects on road user behaviour (direct, immediate reactions)
- Detectability
- Identification
- Rule knowledge
- Decision-making
- Behavioural execution

Estimation of long-term safety effects on road user behaviour (learning processes and behavioural adaptation)

Criteria to assess the user experience and social perception
- Acceptance
- Reliability (Trust)
- Usability (Level of self-explaining nature)
Challenges with user behaviour

Active LC with full barriers
- Circumventing closed barriers (climbing over / below)
- Passing the LC after pre-signaling has begun / while barriers are closing
- Getting caught between the barriers
- Getting stuck on the rails

Active LC with half-barriers / light protection
- Circumventing closed half-barriers (swerving around, climbing over / below)
- Passing the LC in spite of active light signals (e.g. flashing red light)
- Passing the LC after pre-signaling has begun / while barriers are closing
- Getting stuck on the rails

Passive LC
- Insufficient visual scanning of tracks for train
- Insufficient adaption of approach speed to scanning needs

Number of participants scanning the tracks for a train

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Expert Design Workshop Paris

- 38 road and rail systems experts
- 12 countries
- 2 groups per LC type
  - full barrier
  - half-barrier / light protection,
  - passive)
- Using design-thinking methods

- 95 ideas for countermeasures
- Expert ratings for 110 countermeasures on effectiveness, low-cost and innovativeness
Measures to enhance LC safety

1. Enhance the visibility of the crossing
Measures to enhance LC safety

2. Enhance the visibility of the train
Measures to enhance LC safety

3. Make road users look where they are supposed to look
Measures to enhance LC safety

1. Make LCs as self-explaining as possible.
2. Use signs and symbols that road users are familiar with.
3. Convey relevant messages via onboard systems.
Measures to enhance LC safety

1. Create barriers
2. Violations should be difficult
3. Demotivate road users from breaking the law
Smarter LC (WP3)

To develop **technological solutions** to **improve safety** at level crossings through **sharing information** and **giving warnings** to trains/vehicles approaching/arriving to level crossings.
Specific technological solutions

△ Advanced video surveillance system for modeling and analyzing LC users’ behaviour
△ Evaluate various safety enhancement techniques
△ Develop Optimized Automatic/Smart Incident Detection (AID) system
△ Develop smart sensor technologies for monitoring of LC infrastructure
△ Develop systems to transmit and share the risks and hazard information detected at LCs
△ V2X-based sensing, actuation and information sharing techniques to detect and forecast train arrivals and broadcast
△ Automatic closure of level crossing triggered by the train geolocalisation
Pilot tests in SAFER-LC

To evaluate the positive and negative impacts of lab test and field implementations executed within SAFER-LC project

Simulation

- Driving simulators (DLR, SNCF)
- Two simulation environments (VTT)
- Test-track pilot activities (RWTH, CEREMA)
- Self-driving vehicles (VTT)
- Test track under real rail environment (VTT)
- Real-world pilot activities (DLR, TRAINNOSE, CERTH, INTADER)

Field tests
SAFER-LC test sites

Activity Type
- Simulation
- Test-track
- Real-world pilot

Integration of multiple measures led by: CEREMA, COMMSIGNIA, GLS, IFSTTAR
Outputs of the project

▲ Human Factors Assessment Tool (WP2)

▲ Definition of new human centred low cost countermeasures (WP2)

▲ Toolbox which will integrate all the project results and solutions to help both rail and road managers to improve safety at level crossings

▲ Recommendations and guidelines (WP5)
Thank you very much for your attention

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