SAFER-LC

SAFER LEVEL CROSSING BY INTEGRATING AND OPTIMIZING ROAD-RAIL INFRASTRUCTURE MANAGEMENT AND DESIGN

The SAFER-LC project

Workshop on
Railroad level-crossings safety improvement

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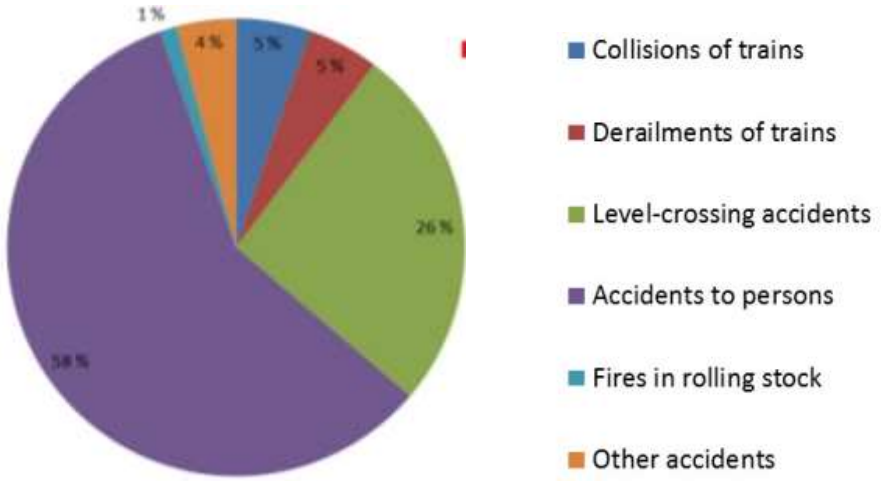
Summary

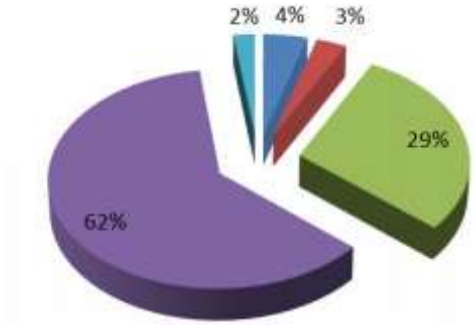
- Overview of SAFER-LC project
- Technical analysis about:
  - Analysis of LC safety systems
  - Human factors at LC
  - Smarter LC
  - Pilot tests in SAFER-LC
  - Main outputs of the project

Background

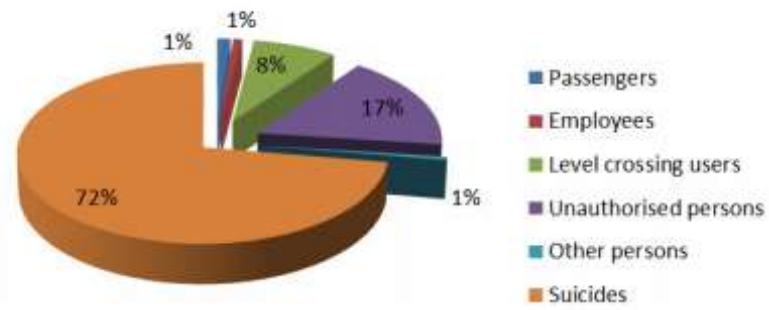
- Breakdown of significant accidents (2012-2014) – ERA Figures



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



Fatalities on railways disregarding railway suicides



Fatalities on railways including railway suicides

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 crossing
- 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

CONSORTIUM

COORDINATOR: 1-UIC - International Union of Railways

2-VTT - Technical Research Centre of Finland Ltd

3-NTNU - Norwegian University of Science and Technology

4-IFSTTAR - French institute of science and technology for transport, development and networks

5-FFE - Spanish Railways Foundation

6-CERTH-HIT - Centre for Research and Technology Hellas - Hellenic Institute of Transport

7-TRAINOSE - Trainose Transport – Passenger and Freight Transportation Services SA

8-INTADER - Intermodal Transportation and Logistics Research Association

9-CEREMA - Centre for Studies and Expertise on Risks, Environment, Mobility, and Urban and Country planning

10-GLS - Geoloc Systems

11-RWTH - Rheinisch-Westfaelische Technische Hochschule Aachen University

12-UNIROMA3 - University of Roma Tre

13-COMM - Commsignia Ltd

14-IRU - International Road Transport Union - Projects ASBL

15-SNCF - French Railways

16-DLR - German Aerospace Center - Institute of transportation Systems

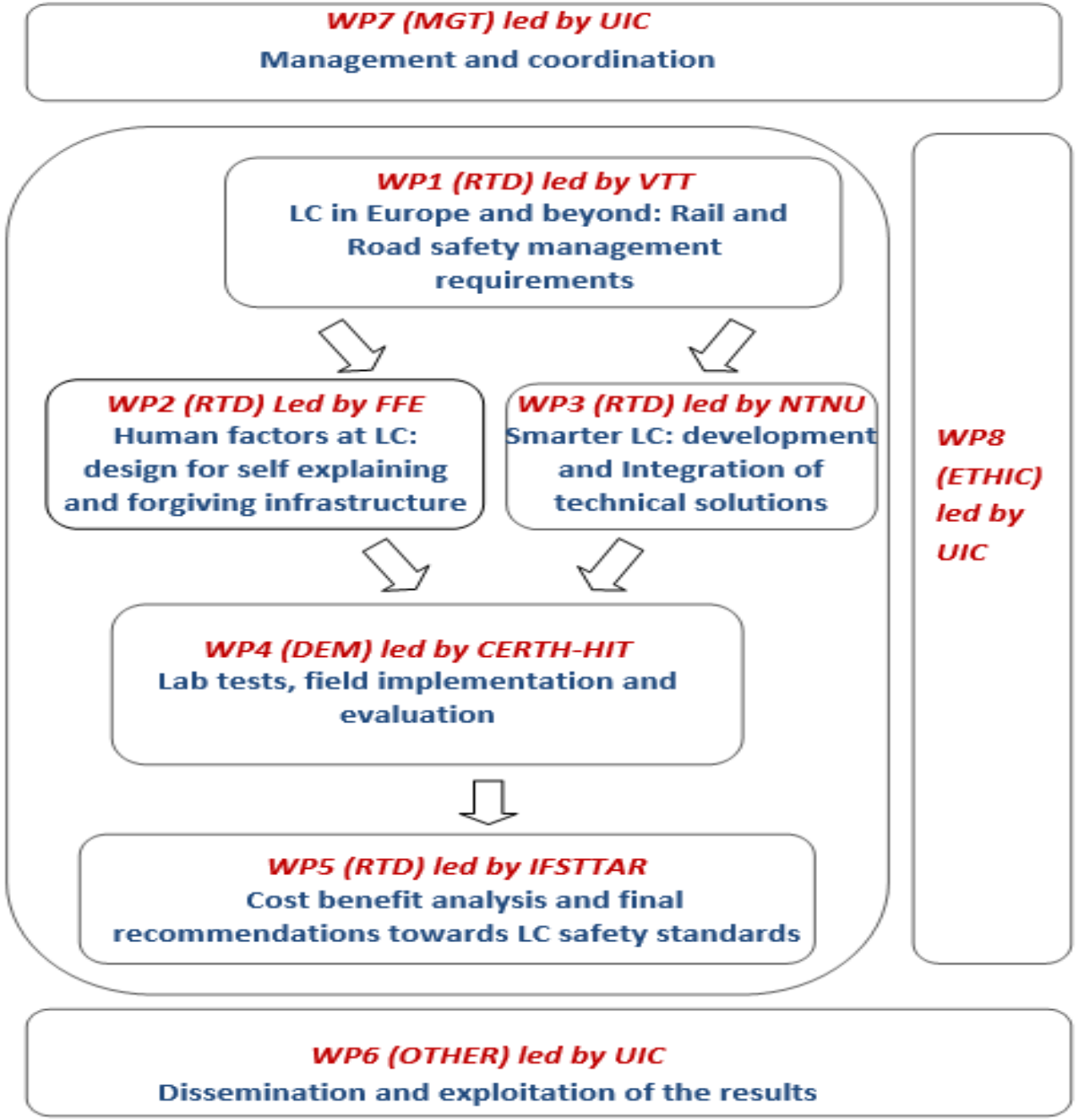
17-UTBM - University of Technology of Belfort-Montbéliard

- Coordinator : UIC
- 17 partners
- 8 European Union countries
- 2 associate countries

Approach

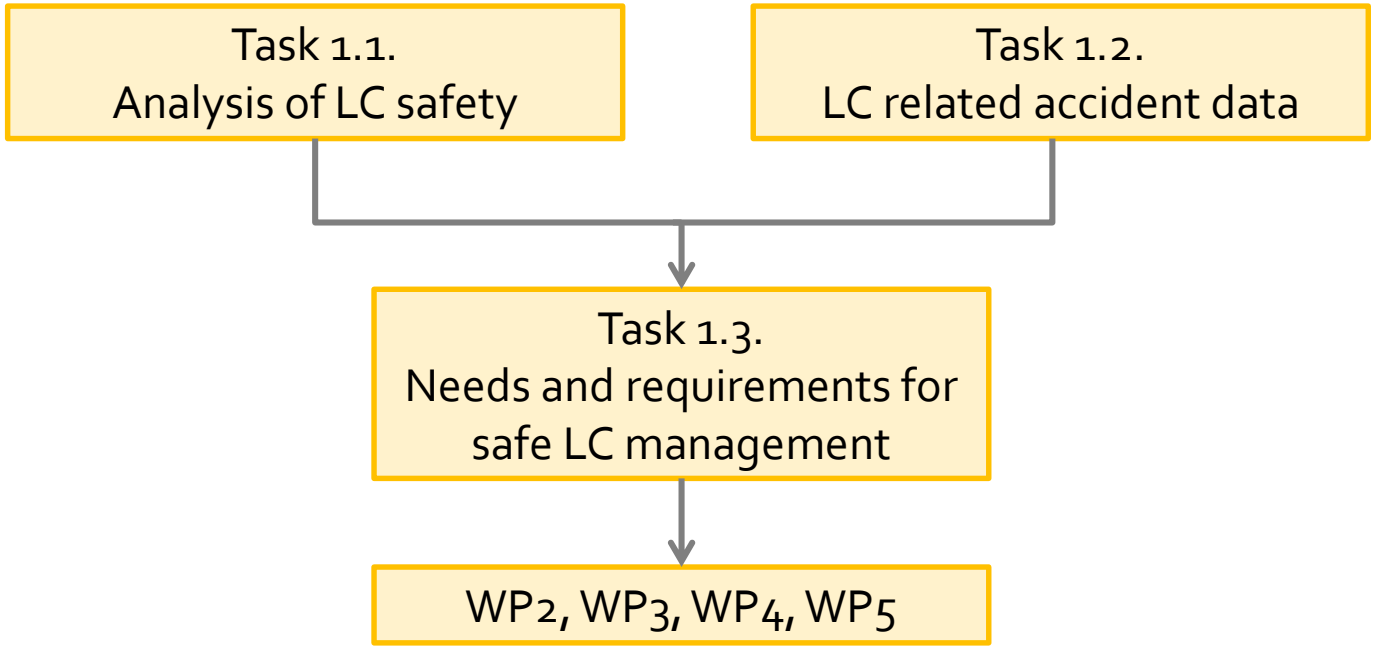
- Analysis of LC safety systems and definition of needs and requirements of the rail and road users for safer level crossings (WP1)
- Development of innovative measures (Wp2 and WP3)
  - Human centered low cost measures
  - Technical solutions
- Field-test and evaluation of the measures (WP4)
- Elaboration 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
WP8 (ETHIC) led by UIC
WP6 (OTHER) led by UIC
Dissemination and exploitation of the results

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 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

Strategic	• Cross-agency working • Political backing and investment • Evidence based decision making • Setting ambitious safety targets
Operational	• Investment in level crossing protection • Investment in level crossing removal • Effective programme of maintenance • System to report crossing failures
Educational	• Information and education
Enforcement	• Sanctioning level crossing misuse

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

Title	Variable	Country						
		Greece	Finland	France	Italy	Norway	Spain	Turkey
Collision	Outcome (choose the most severe consequence)	X	X	X	X	X	X	X
	Type of road vehicle	X	X	X	X	X	X	X
	Month	X	X	X	X	X	X	X
	Day of the week	X	X	X	X	X	X	X
	Hour	X	X	X	X	X	X	X
	Year	X	X	X	X	X	X	X
Victim	Type of victim	X	X	X	X	X	X	X
	Type of road user	X	X	X	X	NA	NA	X
	Outcome	X	X	X	X	X	NA	X
	Gender	(X)	X	X	(X)	NA	NA	X
	Age	NA	X	X	X	NA	NA	X
	Intentionality	(X)	X	NA	X	X	NA	X
	Involvement in secondary tasks	NA	X	NA	X	NA	NA	X
	Intoxication	(X)	X	(X)	(X)	NA	NA	(X)
Road environment	Road traffic volume (AADT)	X	X	X	X	X	NA	X
	Type of road	X	X	X	X	X	X	X
	Road speed limit	X	X	X	X	X	NA	X
	Number of lanes per direction	X	X	NA	X	X	NA	X
	Type or road surface	X	X	NA	X	X	X	X
	Existence of level crossing sign before LC	X	X	NA	X	X	(X)	X
	Inclination	X	X	NA	X	X	NA	X
	Crossing angle (between road and track)	X	X	X	X	X	NA	X
Railway environment	Daily train volume (passenger + freight)	X	X	X	X	X	X	X
	Speed limit for person trains (km/h)	X	X	X	X	X	NA	X
	Speed limit for freight trains (km/h)	X	X	X	X	X	NA	X
	Condition of wait platform	X	X	NA	X	NA	X	X
	Number of tracks	X	X	X	X	X	X	X
LC characteristics	Type of LC	X	X	X	X	X	X	X
	Location of LC	X	NA	X	X	X	X	X
	Sight distances (from the road)	NA	X	NA	X	X	NA	X
Circumstances	Weather	(X)	X	(X)	X	NA	NA	X
	Lighting conditions	(X)	X	NA	X	NA	NA	X
Train	Train	X	NA	NA	X	X	(X)	X
Effect	Delay (number of minutes)	(X)	NA	NA	X	NA	NA	X
	Delay (number of trains cancelled)	NA	NA	NA	NA	NA	NA	X
	Costs (euros)	NA	NA	NA	X	NA	NA	X
Main factors affecting the accident according to the accident report		X	NA	X	X	X	NA	X

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
- C ar violating the barriers
- Car abandoned in LC
- Excessive speed
- Distraction
- Loss of control (vehicles or bicycles)

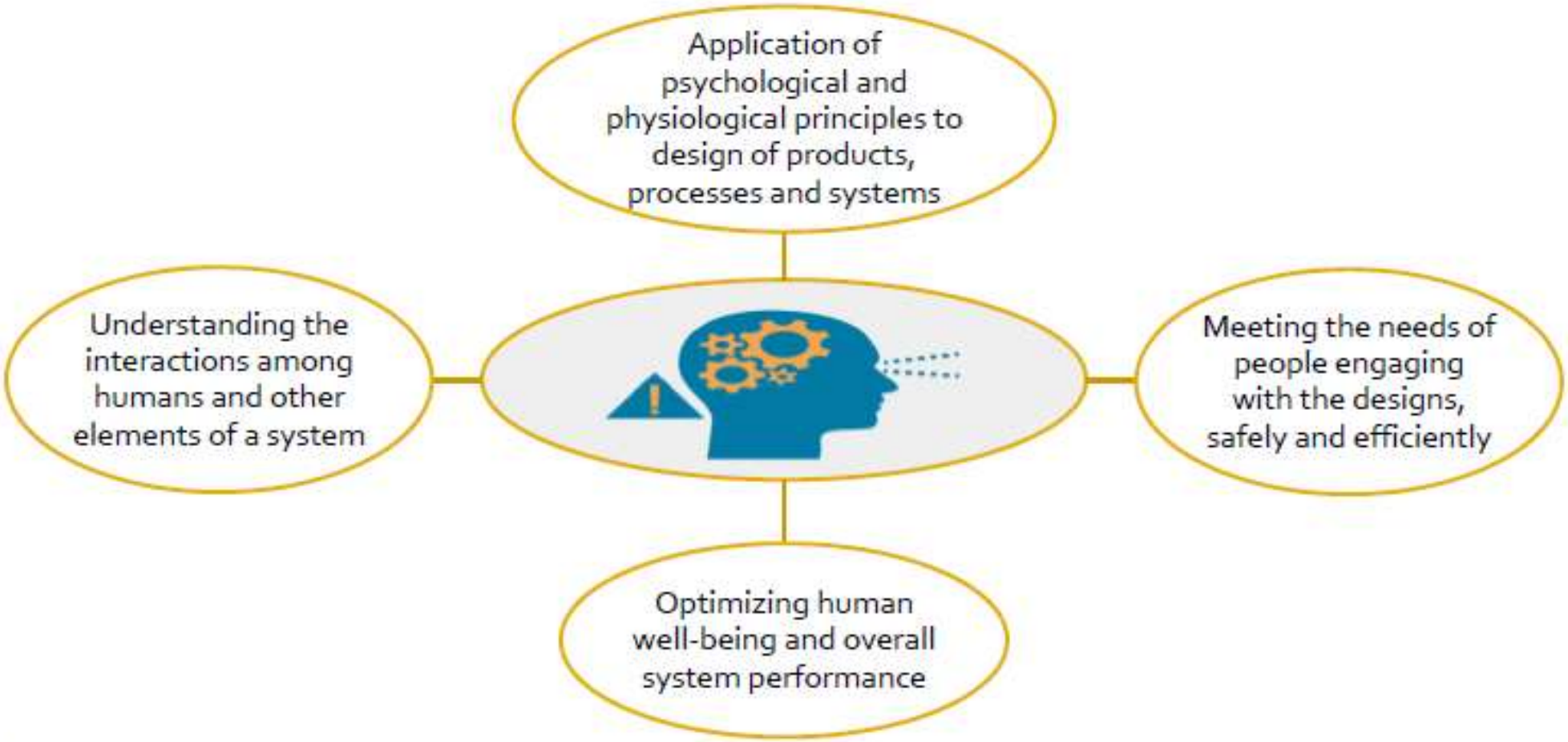
Human factors at LC (WP 2)

"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."

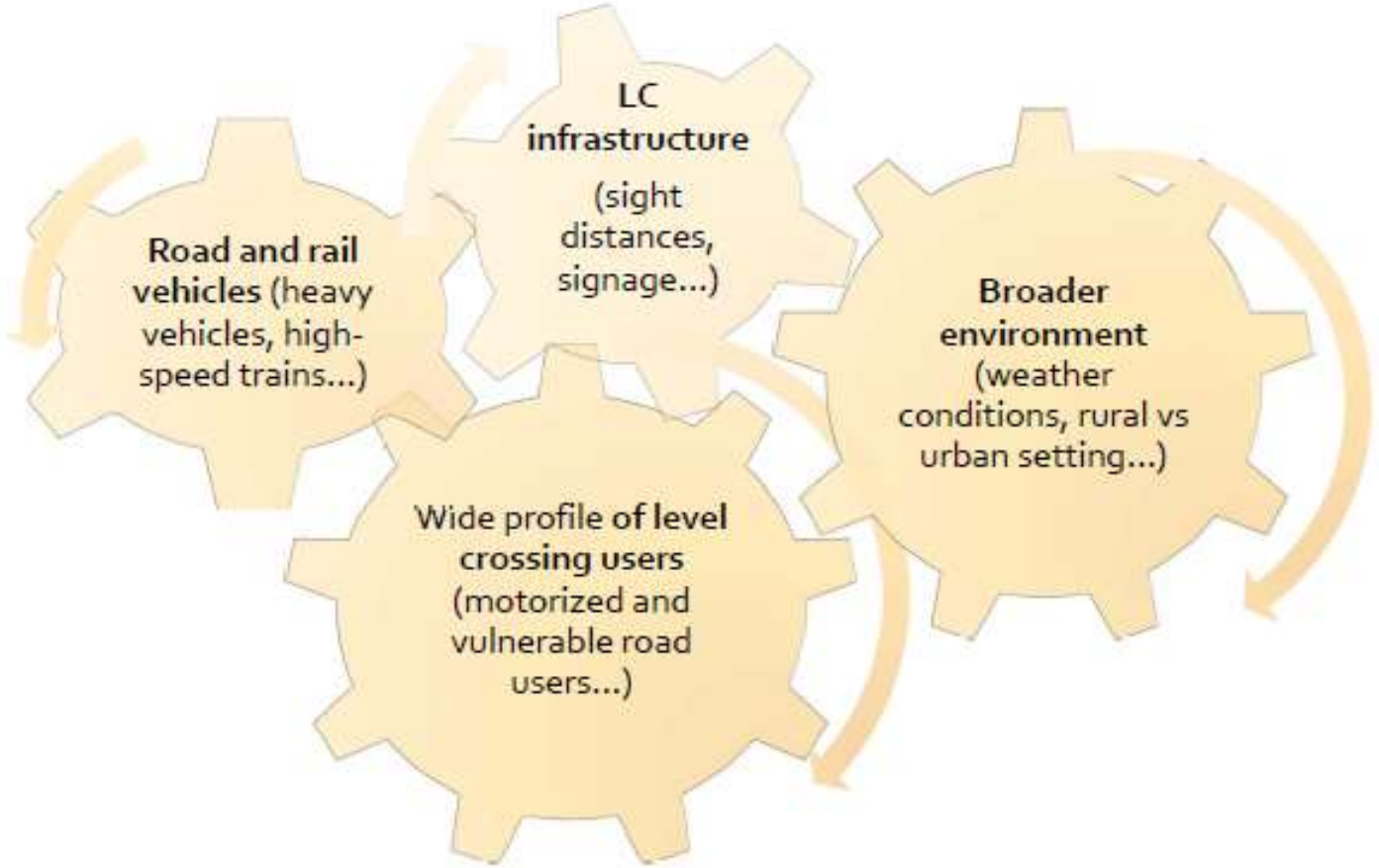
(United Nations Economic Commission for Europe [UNECE] Group of Experts on Improving Safety at Level Crossings, 2017)

"…**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



Level crossings as a complex system



Human behaviour = unpredictable variable

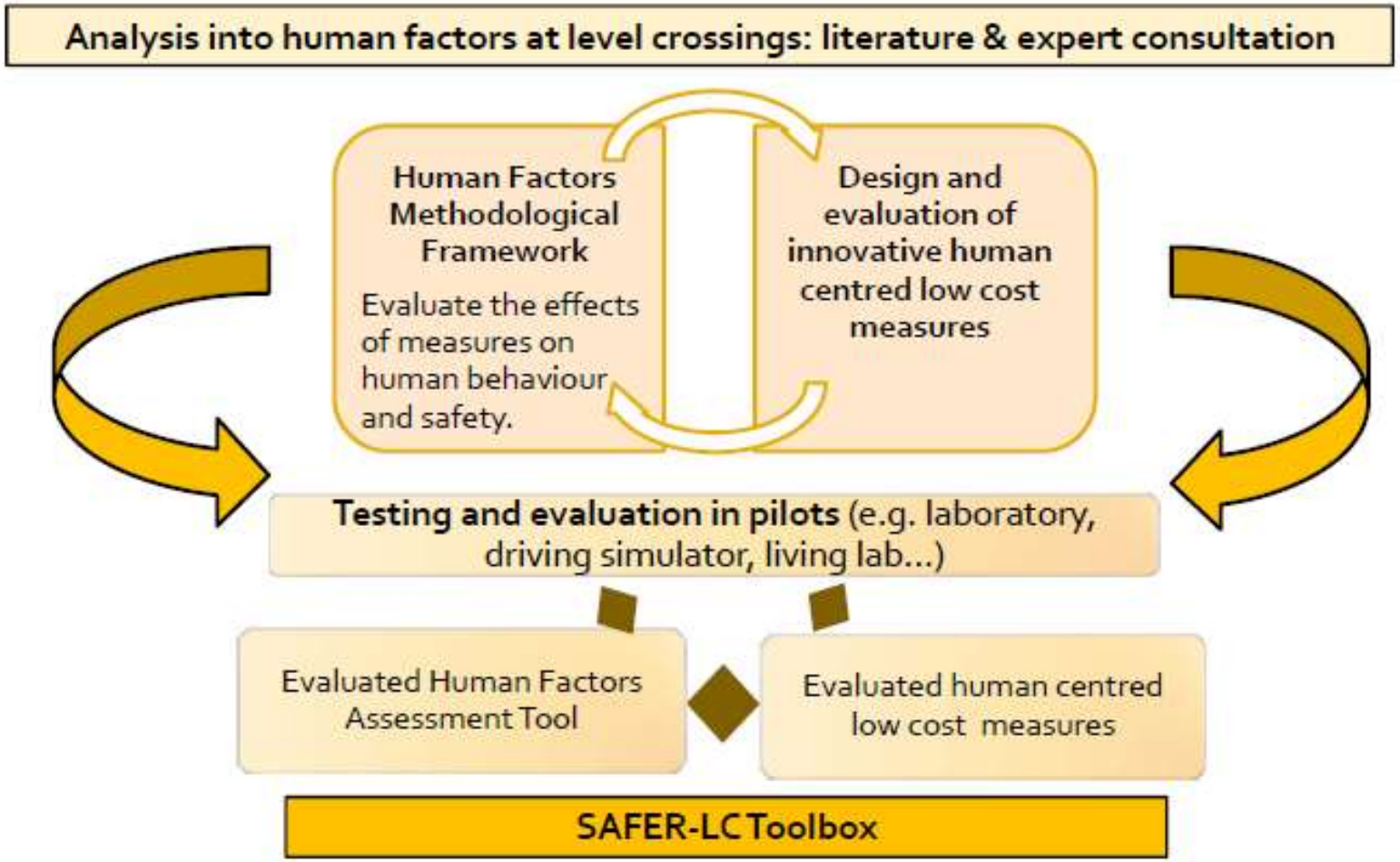
Human factors for LC design

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

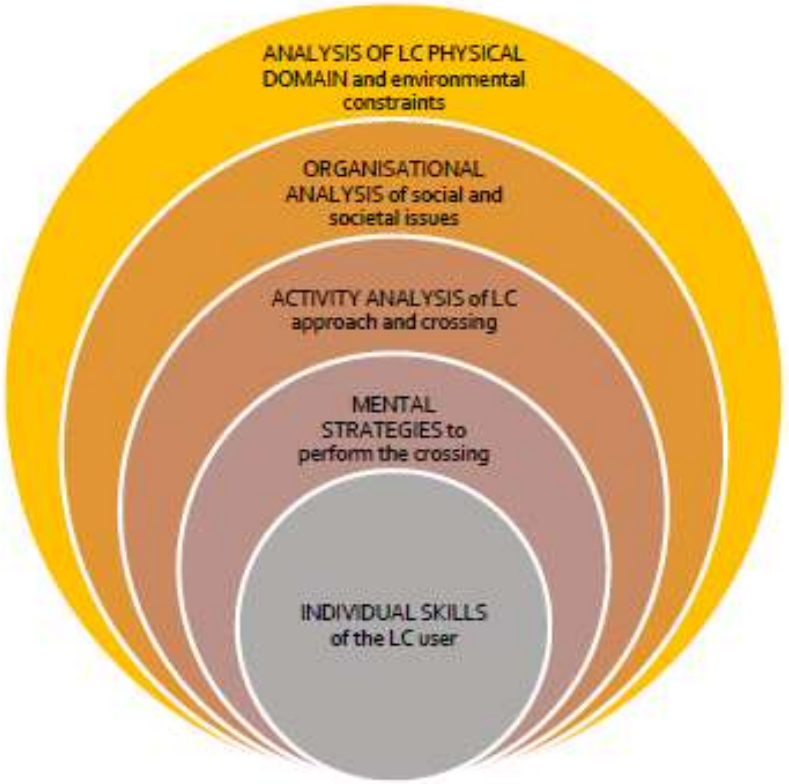
take into account the needs of different road and rail users, and especially

issues related to **vulnerable users**

Human factors at LC



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)

Criteria to assess the behavioural safety effects

- 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

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

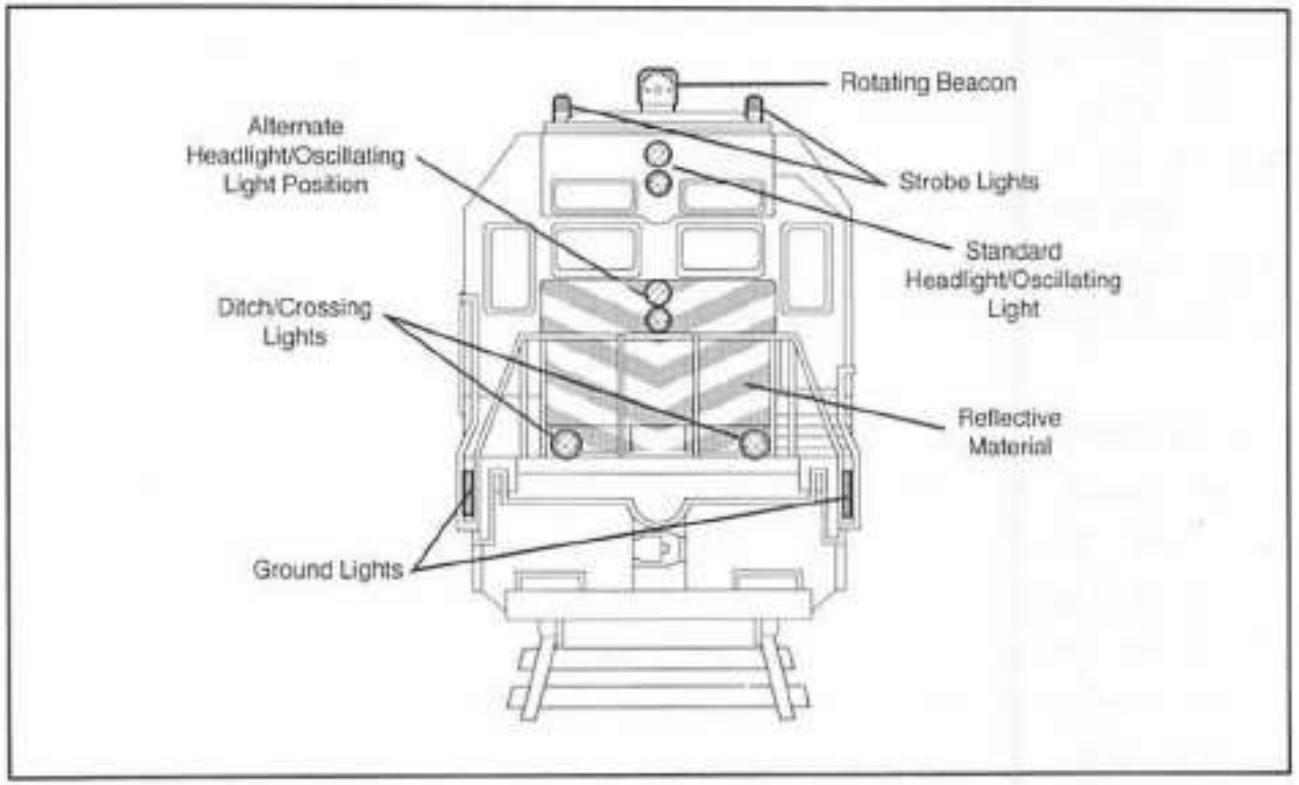
- 95 ideas for countermeasures
- expert ratings for 110 countermeasures on effectiveness, low-cost and innovativeness

Measures to enhance LC safety

Perceiving the level crossing

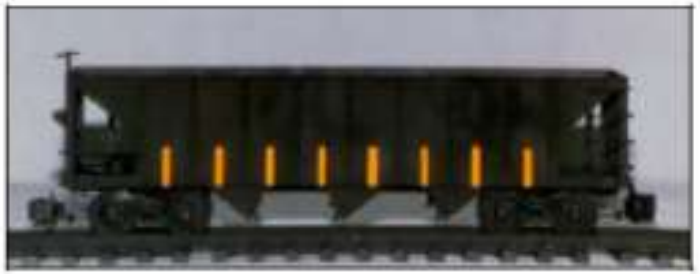
1. Enhance the visibility of the crossing

Measures to enhance LC safety



Perceiving the level crossing

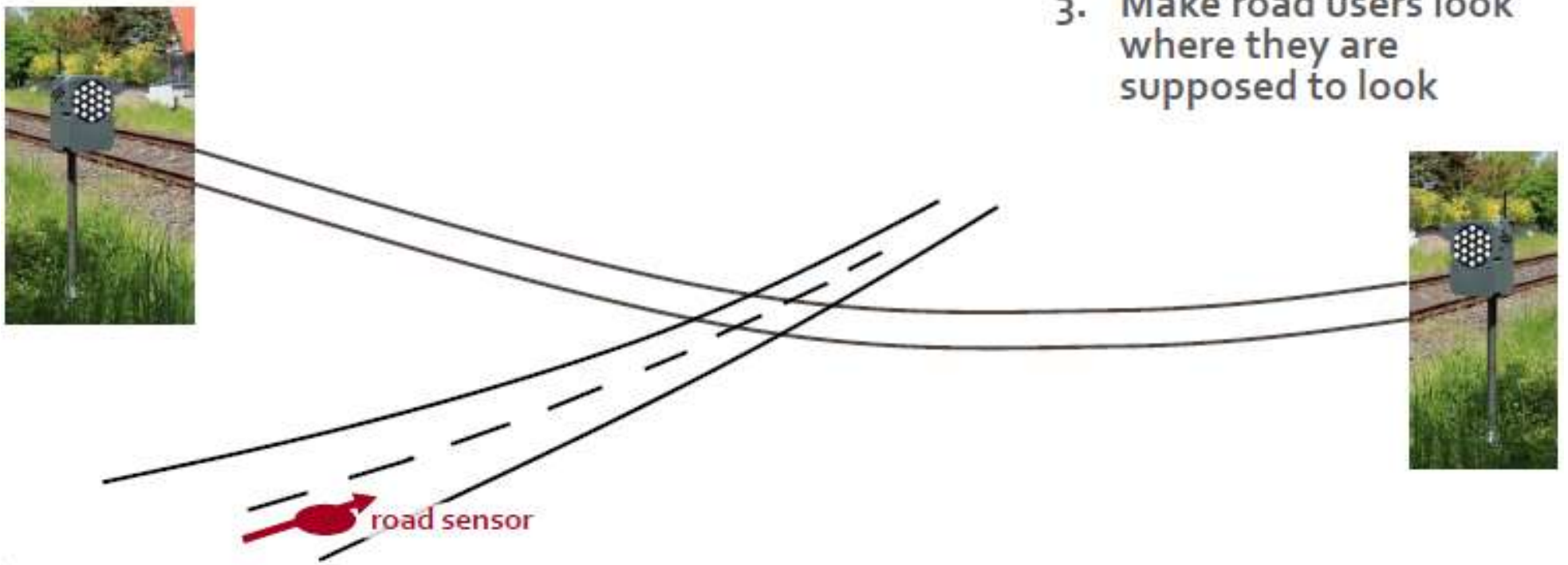
2. Enhance the visibility of the train



Measures to enhance LC safety

Perceiving the level crossing

3. Make road users look where they are supposed to look



Measures to enhance LC safety

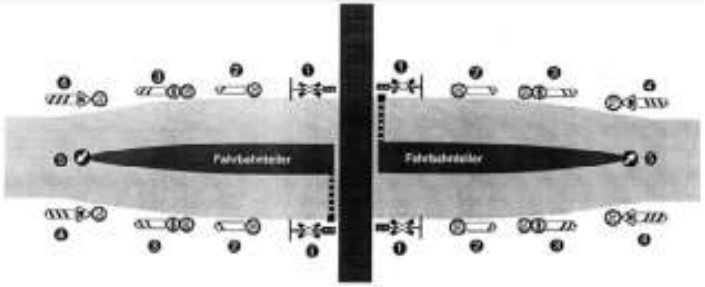
Retrieving relevant knowledge from long-term memory

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

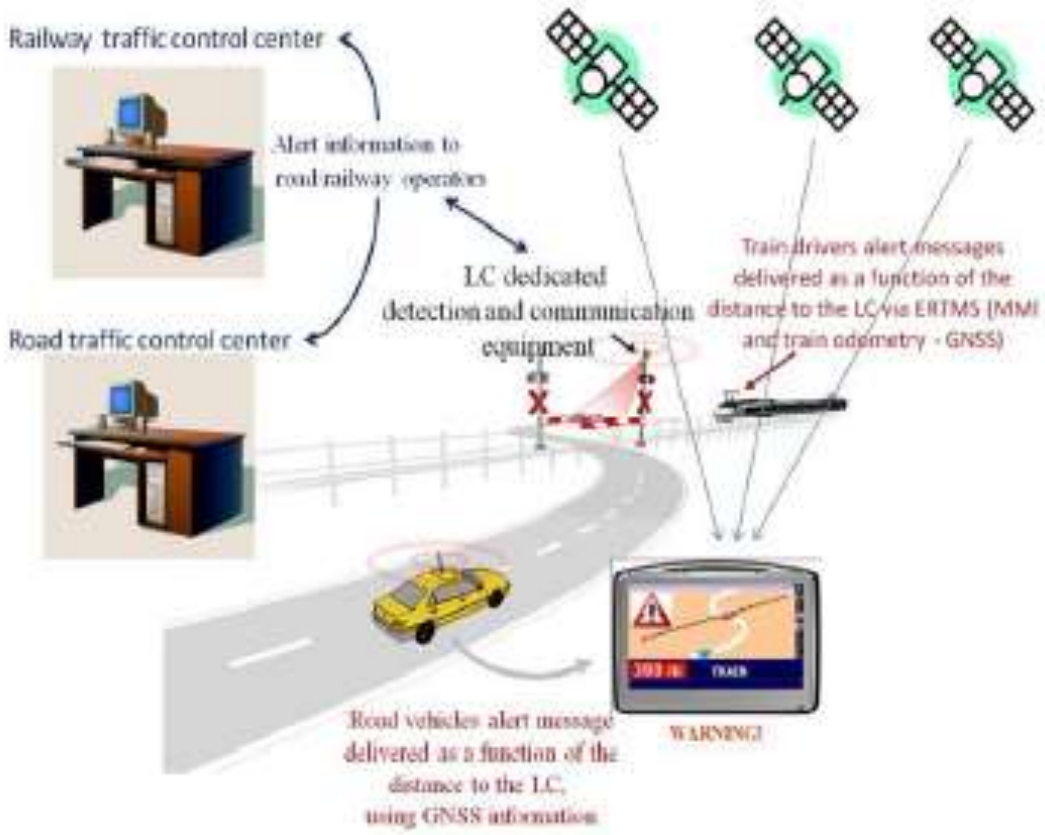
Choosing and executing appropriate actions

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

Finland (2)

Tampere

Sääksjärvi

Aachen

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

Braunschweig

Germany (3)

Rouen

France (2)

Chalon-sur-Saône

Karabük

Thessaloniki

Turkey (1)

Greece (1)

Activity Type

- Simulation
- Test-track
- Real-world pilot

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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