Infrastructure risks and measures at the SafetyCube project

Safety CaUsation, Benefits and Efficiency

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SafetyCube Vision

- To create **an inventory of evaluated road safety risks measures related to the road infrastructure**, with results from accident risk factors analysis and measures cost-efficiency assessment, to be integrated in the **European Road Safety Decision Support System (DSS)**

Infrastructure analysis objectives

- The in-depth understanding of infrastructure related **accident causation factors** and the identification and evaluation of the most appropriate related **measures**.
  - *to identify and rank risk factors related to the road infrastructure,*
  - *to identify measures for addressing these risk factors,*
  - *to assess the safety effects and the cost-effectiveness of measures.*

Nearly 60 risk factors and 100 measures in more than 15 infrastructure areas

- motorways, rural and urban roads -

- road segments and junctions -

Infrastructure 'hot topics'

1. **Self-explaining and forgiving roads**: Removing obstacles, Introduce shoulder, Alignment (horizontal / vertical), Sight distance, Traffic signs, Raised crossings / intersections

2. **Urban road safety measures**: Pedestrians / cyclists, Upgrade of Crossings, New crossings, Junctions / roundabouts treatments for VRU, Visibility

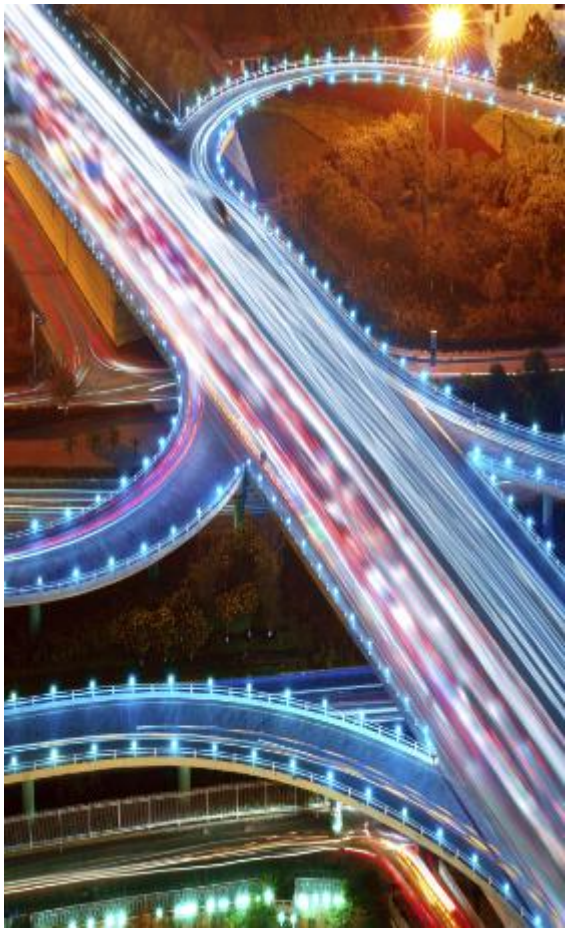
3. **Road safety management**: Quality of measures implementation, Appropriate speed limits, Enforcement, Availability of cost-effectiveness data, Workzones

4. **ITS applications**: ISA, Dynamic speed warning, ADAS and active safety with V2I, VMS

Identified after several stakeholders' consultations

Methodological approach

- **SafetyCube common methodology**
  - ***Taxonomy*** *of infrastructure risk factors*
  - *Exhaustive literature review and rigorous study selection criteria*
  - *Template for* ***coding studies***
  - *Studies analysed for carrying out meta-analyses to estimate the effects of risk factors and measures.*
  - ***Synopses summarising results*** */ meta-analysing risk factors*
- **Systems approach**: links between infrastructure, user and vehicle risks / measures
- Assessment of the **quality of the data / study methods**



Risks taxonomy (1/2)

Traffic flow	Traffic volume congestion secondary accidents traffic composition (share of pedestrians, cyclists, PTW, HGV) distribution of flow over arms at junctions
Road type	Road type
Road surface deficiencies (risk of ran-off road)	inadequate friction uneven surface ice, snow oil, leaves, etc.
Poor visibility and lighting	poor visibility - darkness poor visibility - fog
Adverse weather	rain snow / ice / low temperatures wind
Workzones	small workzone length high workzone duration insufficient signage
Horizontal/vertical alignment deficiencies	low curve radius absence of transition curves frequent curves densely spaced junctions poor sight distance - horizontal curves high grade vertical curve radius

Risks taxonomy (2/2)

Superelevation / cross-slopes (risk of ran-off road)	superelevetion at curve
	cross-slope
Lanes / ramps deficiencies	number of lanes
	narrow lane
Median / barrier deficiencies (risk of crash with oncoming traffic)	undivided road
	narrow median
Shoulder and roadside deficiencies (risk of ran-off road or crash with obstacle)	absence of shoulder
	narrow shoulder
	absence of guardrails or crash cushions
	absence of clear-zone
	roadside obstacles (per type of obstacle e.g. trees)
	sight obstructions
Poor road readability	absence of traffic signs
	misleading or unreadable traffic signs
	absence of road markings
	absence of rumble strips
Interchange deficiencies	inadequate ramp capacity
	insufficient ramp length
	insufficient acceleration / deceleration lane length
	absence of channelisation
	absence of access control
	poor sight distance
At-grade junctions deficiencies	high number of conflict points
	type of junction
	skewness / junction angle
	poor sight distance
	gradient
Rail-road crossings (risk of collision with train)	uncontrolled rail-road crossing
Poor junction readability	uncontrolled junction
	misleading or unreadable traffic sign
	absence of road markings
	absence of marked crosswalks

Results of analyses on risks

- **Wealth of studies** related to road infrastructure risk aspects

- Analysed approx. **300 studies on risks**
- Selection criteria:
  - *Meta-analyses*
  - *Recent studies*
  - *High quality studies with quantitative results*

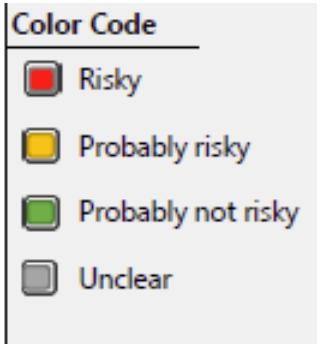
- Authored **38 risk factor synopses**
- Carried out **7 original meta-analyses of risk factors**

- **Ranking of risk factors**: Colour Code

Analysis is completed and outcomes are already integrated in the DSS

Synthesis of results (1/2)

- **Ranking of risk factors**



Red (Risky)	Yellow (Probably risky)	Grey (Unclear)
! Traffic Volume	! Occurrence of Secondary crashes	? Congestion as a risk factor
! Risks associated with Traffic Composition	! Absence of Transition curves	? Risks associated with the distribution of traffic flow over arms at junctions
! Road Surface - Inadequate Friction	! Risk of Different Road Types	? Adverse weather - Frost and snow
! Workzone length	! Adverse weather - Rain	? Workzone duration
! Low Curve Radius	! Poor Visibility - Darkness	? Frequent curves
! Number of Lanes	! Cross-section deficiencies - Superelevation	? Densely spaced junctions
! Absence of paved shoulders	! High grade	? Interchanges - Acceleration / deceleration lane length
! Narrow Shoulders	! Presence of Tunnels	
	! Narrow lanes	
	! Undivided road	
	! Narrow median	
	! Risks associated with Safety Barriers and Obstacles	
	! Sight Obstructions (Landscape, Obstacles and Vegetation)	
	! Interchange deficiencies - Ramp Length	
	! At-grade junctions - Number of conflict points	
	! Risk of different junction types	
	! At-grade junctions - Skewness / Junction angle	
	! At-grade junctions - Poor sight distance	
	! At-grade junctions - Gradient	
	! Uncontrolled rail-road crossing	
	! Absence of road markings and crosswalks	
	! Uncontrolled junction	

Synthesis of results (2/2)

- **Detailed ranking of risk factors**

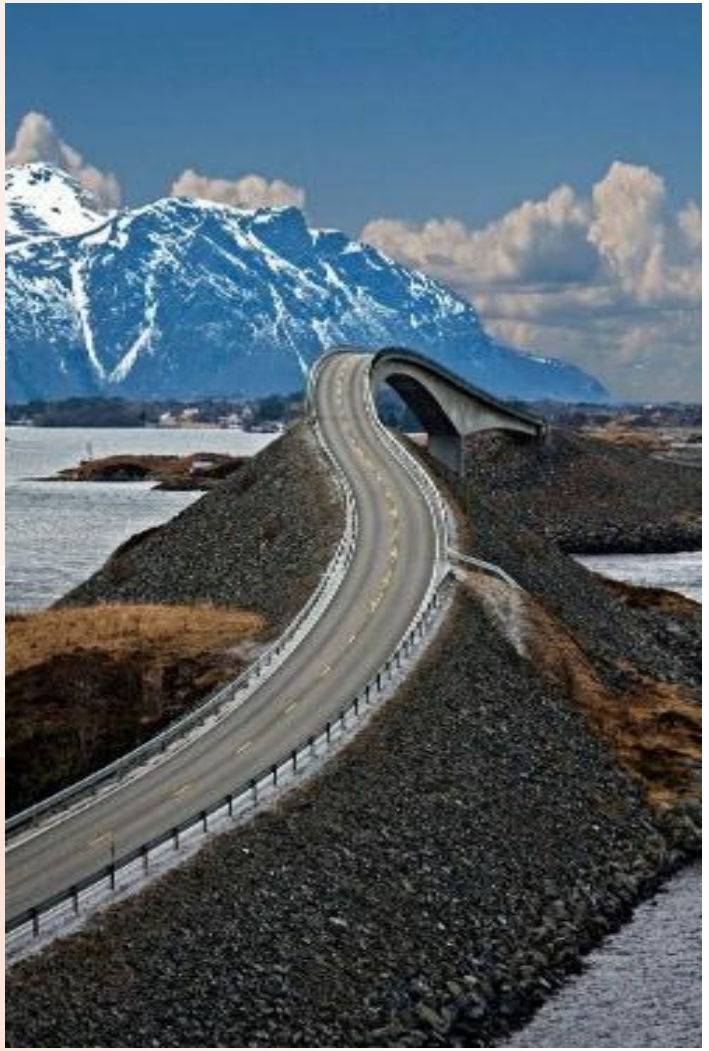
Infrastructure Element	Specific Risk Factor	Colour code	Crash risk	Crash frequency	Crash severity	Hot topic (Yes/No)
Exposure	Effect of Traffic Volume on safety	**Red**	↓	↑	-	N
	Risks associated with Traffic Composition	**Red**	↓	↑	-	N
	Occurrence of Secondary crashes	**Yellow**	↑	-	-	N
	Congestion as a risk factor	**Grey**	-	↑	-	N
	Risks associated with the distribution of traffic flow over arms at junctions	**Grey**	-	-	↑	N
Road Surface	Inadequate Friction	**Red**	↑	-	↑	N
Road Type	Risk of Different Road Types	**Yellow**	-	↑	↑	N
Road environment	Adverse weather - Rain	**Yellow**	-	↑	-	N
	Adverse weather - Frost and Snow	**Grey**	-	-	-	N
	Poor Visibility - Darkness	**Yellow**	↑	-	↑	N
Presence of workzones	Workzone Length	**Red**	↑	↑	-	**Y**
	Workzone Duration	**Grey**	-	-	-	**Y**

Measures taxonomy 1/3

Traffic flow	Flow diversion 2+1 roads Reversible lanes One-way traffic Ramp metering
Traffic composition	HGV traffic restrictions Creation of HGV lanes
Formal tools to address road network deficiencies	Road safety audits implementation Road safety inspections implementation High risk sites identification Land use regulations improvement
Speed management & enforcement	Reduction of speed limit Dynamic (weather-variant) speed limits Individual dynamic speed warning Speed cameras Section control Speed humps Woonerf implementation Narrowings School zones 30-zones implementation Traffic calming schemes
Road type	Upgrade/downgrade road class Upgrade road to motorway Creation of by-pass road
Road surface treatments	Improve friction (type of surface) Road re-surfacing to improve evenness Ice prevention/winter maintenance
Visibility / Lighting treatments	Installation of road lighting Improvement of existing lighting

Measures taxonomy 2/3

Workzones	Workzone length treatment Workzone duration decrease Workzone signage installation Workzone signage improvement
Horizontal & vertical alignment treatments	Creation of weaving area Increase horizontal curve radius Implement transition curves Reduce number of curves (re-alignment) Reduce tangent length Sight distance treatments Reduce gradient (re-alignment) Increase vertical curve radius Sight distance treatments
Superelevation / cross-slopes treatment	Superelevation improvement Cross-slope improvement
Lanes / ramps treatments	Increase number of lanes Increase lane width Create speed change lane
Median / barrier treatments	Installation of median Increase median width Change median type Implementation of rumble strips at centerline
Shoulder & roadside treatments	shoulder implementation (shoulder type) increase shoulder width change shoulder type safety barriers installation change type of safety barriers create clear-zone / remove obstacles increase width of clear-zone removal of sight obstructions



Measures taxonomy 3/3

Delineation and road markings	Road markings implementation Installation of chevron signs Implementation of edgeline rumble strips Transverse rumble strips Implementation of marked crosswalk
Sidewalks treatments	Sidewalk installation Increase of sidewalk width
Cycle lanes	Cycle lane treatments Cycle lane treatments Increase of cycle lane width
Traffic signs treatments	Traffic sign installation Traffic sign maintenance STOP / YIELD signs installation STOP / YIELD signs maintenance
Traffic signals treatments	Traffic signals installation Improve traffic signals timing Implementation of pedestrian signal phase
Driver information and alert	Variable message signs: incident/accident warning Variable message signs: congestion/queue warning V2I schemes
Interchanges treatments	Convert at-grade junction to interchange Increasing ramp width Increasing ramp curve radius (ramp re-alignment) Increasing acceleration/deceleration lane length Increasing lane width
At-grade junctions treatments	Channelization Sight distance treatments Convert junction to roundabout Convert 4-leg junction to staggered junctions Improve skewness / junction angle
Rail-road crossings	Rail-road crossing traffic sign Automatic barriers installation

Progress on measures analysis

- **Several measures** related to road infrastructure, but less focus on heavy engineering changes

- Already analysed more than **200 studies on infrastructure measures**
- Selection criteria as per risks

- **38 synopses** on measures effects are planned
- More than **35 meta-analyses** available from the literature, and several original ones planned
- **Cost Benefit analysis** of selected measures planned

- **Ranking of measures**: Colour Code

Measures analysis is in progress and outcomes will be available to be integrated in the DSS by July 2017

SafetyCube DSS Objectives

The SafetyCube DSS objective
is to provide the European and Global road safety community
a user friendly, web-based, interactive Decision Support Tool
to properly substantiate their road safety decisions
for the actions, measures, programmes, policies and strategies
to be implemented at local, regional, national,
European and international level.

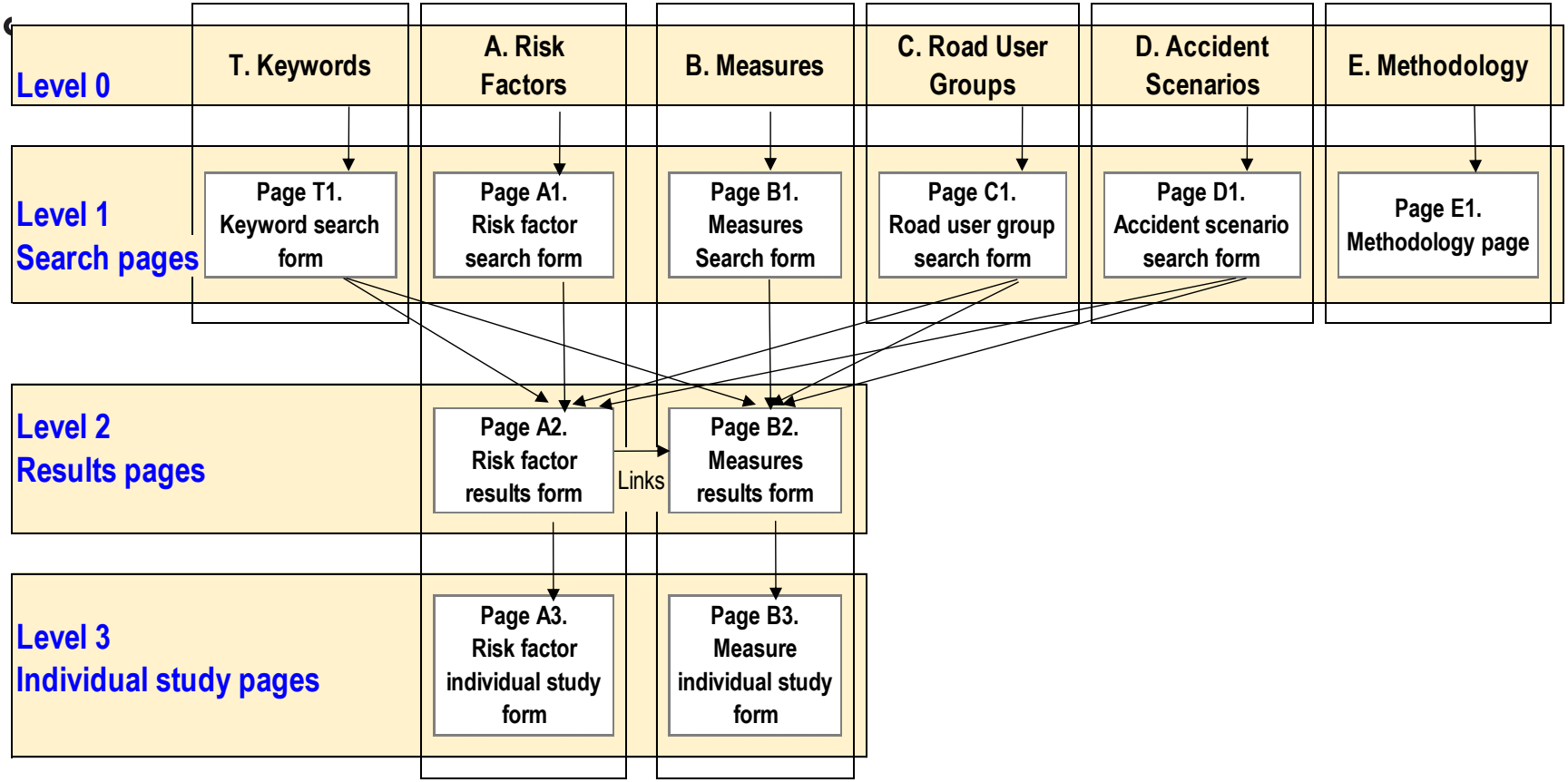
The main contents of the SafetyCube DSS concern:

- road accident risk factors and problems
- road safety measures

- best estimate of casualty reduction effectiveness
- cost-benefit evaluation
- all related analytic background

Special focus is given to linking road safety problems with related countermeasures.

SafetyCube DSS Structure



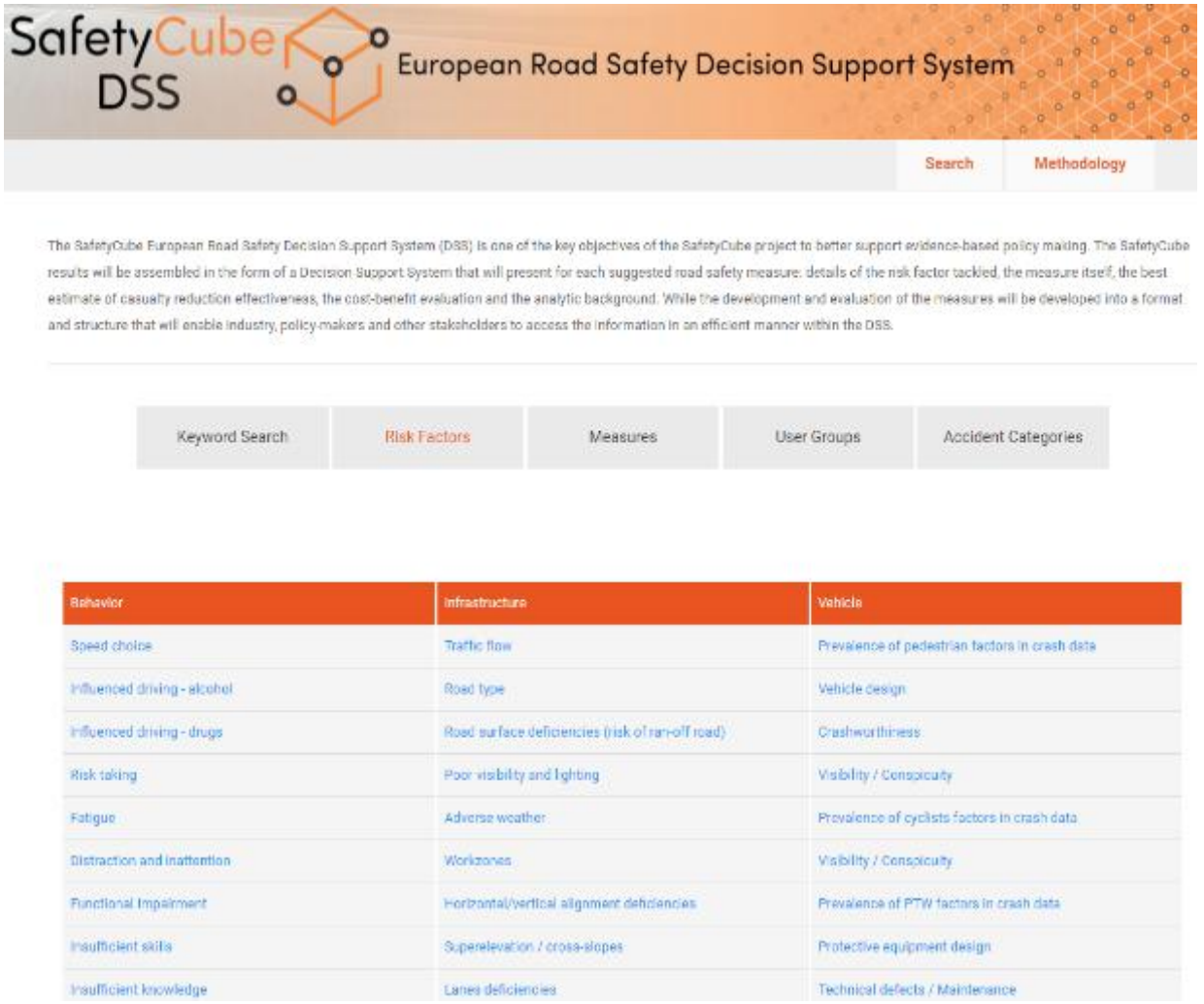
Home Page Main Menu (About - Search - Tools)

Three Levels of Search (Search - Results pages - Individual study pages)

Two Interlinked Search Streams (Risk Factors – Road Safety Measures)

SafetyCube DSS Homepage

- **Methodology**
  Basic Information about SafetyCube and the DSS
- **Search**
  - **Text** search (key-words)
  - **Risk Factors**
    (Risk factors search engine)
  - **Road Safety Measures**
    (Measures search engine)
  - **Road User Groups**
    (Risk factors and Measures search engines)
  - **Accident Scenarios**
    (Risk factors and Measures search engines)



SafetyCube DSS Development Next steps

- Development of the **static DSS** (Wire Frames)
  - *Completed*
- SafetyCube DSS **Development phase**
  - *conducted between September and December 2016*
  - *including all risk factors (~3.500 effects from 600 studies) and several measures*
  - *linking of risks and measures also nearly completed*
- SafetyCube DSS **Pilot Operation**
  - *starting July 2017*
- SafetyCube DSS **Opening**
  - *Starting September 2017*
- Continuous **Enhancement and Update**
  - *Starting on April 2018 (end of SafetyCube project)*

www.roadsafety-dss.eu

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