SafetyCube – the European Road Safety Decision Support System

The webinar will start at 11:00 CET

www.roadsafety-dss.eu

#roadsafetydss

SafetyCube - the European Road Safety Decision Support System

Presenters: **Pete Thomas**, Loughborough University
Stijn Daniels, VIAS Institute
Eleonora Papadimitriou, NTUA
Wendy Weijermars, SWOV
George Yannis, NTUA
Susanne Kaiser, KFV

Delivering a long awaited powerful tool

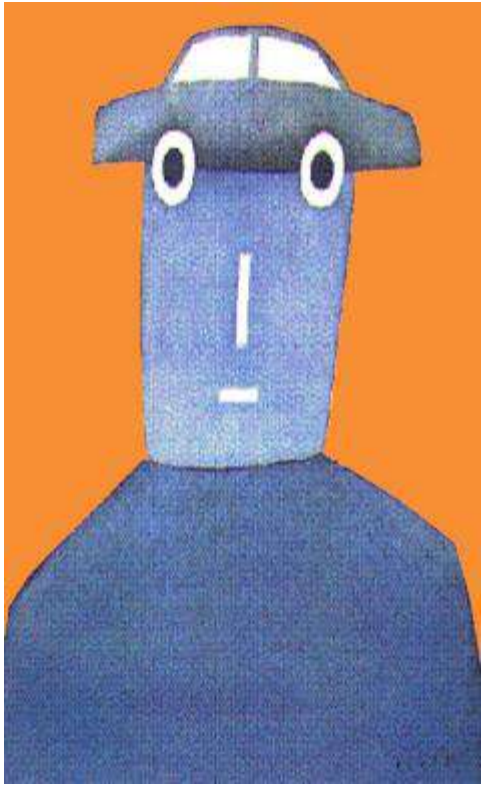
- SafetyCube DSS is the first integrated road safety support system **developed in Europe**

- SafetyCube DSS **offers for the first time** scientific evidence on:
  - risks and not only measures
  - risks and measures not only on infrastructure
  - a very large number of estimates of risks and measures effects
  - links between risks factors and measures

- SafetyCube DSS aims to be **a reference system** for road safety in Europe, constantly improved and enhanced

SafetyCube concept and vision

- Problem
  - ***Evidence based road safety policies*** *are becoming more usual and there is much better availability of national data and state of the art knowledge*
  - *Effective road safety policies need good information about accident risk factors and about measures*
- SafetyCube will meet this need by generating **new knowledge about accident risk factors and the effectiveness of measures** relevant to Europe, to be integrated in a European Road Safety Decision Support System (DSS)



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 effectiveness
- cost-benefit evaluation
- Serious injuries
- all related analytic background

Example questions addressed

- how important is my road safety problem?
- what is the nature of that problem?
- what solutions are usually proposed for my problem?
- how efficient are the solutions proposed?
- which is the most efficient solution?
- and if I have a combination of problems …

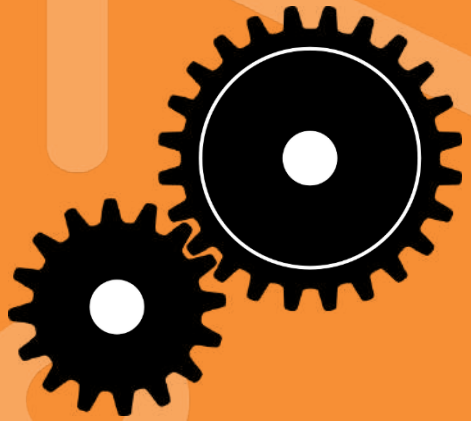
… then use SafetyCube DSS to have the answers

SafetyCube DSS Users

- **Public Authorities**
  local, regional, national, European and international
- **Industry**
  Infrastructure, Vehicle, Insurance, Technology
- **Research Institutes, Experts**
- **Non Governmental Organisations**
- **Mass Media**
- **Everyone**

The SafetyCube DSS is intended to have **a life well beyond the end of the SafetyCube** research project.

Methodology

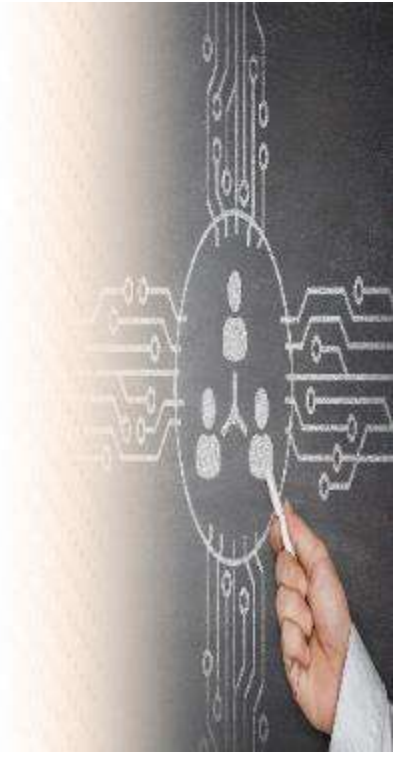


Stijn Daniels, VIAS Institute

SafetyCube Methodology

1. Consulting **stakeholders** to understand needs
2. Creating **taxonomies** of risk factors and measures
3. Exhaustive literature review and rigorous study selection criteria
4. Use of a template for **coding studies**, to be introduced in the DSS back-end database
5. Carrying out **meta-analyses** to estimate the effects of risk factors / measures.
6. Drafting **Synopses** summarising results of risk factors / measures.

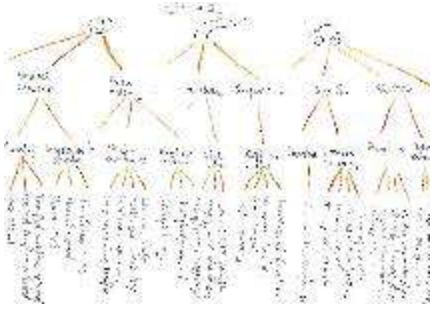
- **Systems approach**: **links** between infrastructure, user and vehicle risks & measures
- Emphasis on risk factors and measures of **priority issues** (VRUs, ADAS, speed management, distraction, etc.)
- Rigorous assessment of the **quality of the data / study methods**



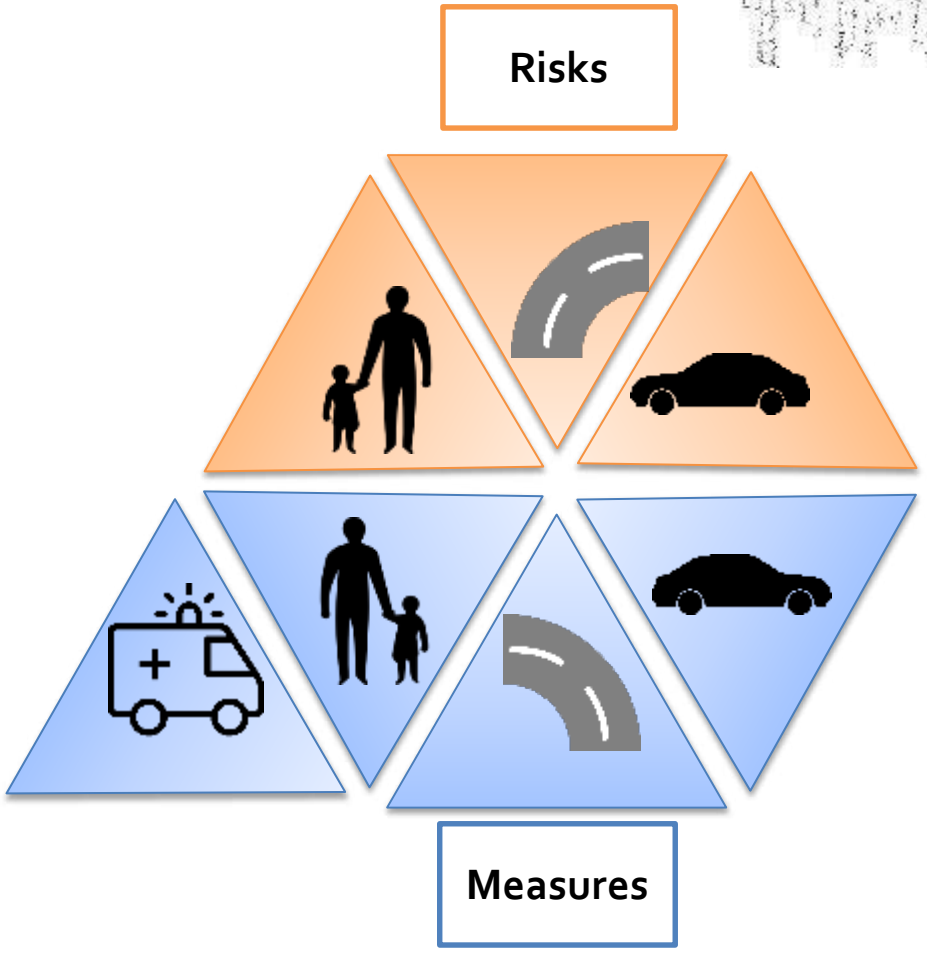
SafetyCube Taxonomy

Stijn Daniels, VIAS Institute

Taxonomy



- Risks & Measures
- main AREAS
  - *Behaviour*
  - *Infrastructure*
  - *Vehicle*
  - *(Trauma care)*
- Hierarchical



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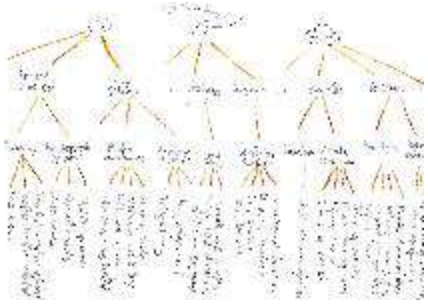
Taxonomy - DSS



- Backbone of DSS
- Finding risks & measures
- Linking risks to measures

- Additional entry points:
  - *Road user groups*
  - *Accident categories*

SafetyCube Repository

Stijn Daniels, VIAS Institute

Repository
Evaluation of Studies

- Methodology
  - *Design*
  - *Type of results*
- Conditions
  - *Country*
  - *Road user type*
  - *Road type*
  - *Traffic conditions*
  - *Crash severity*
- Transferability

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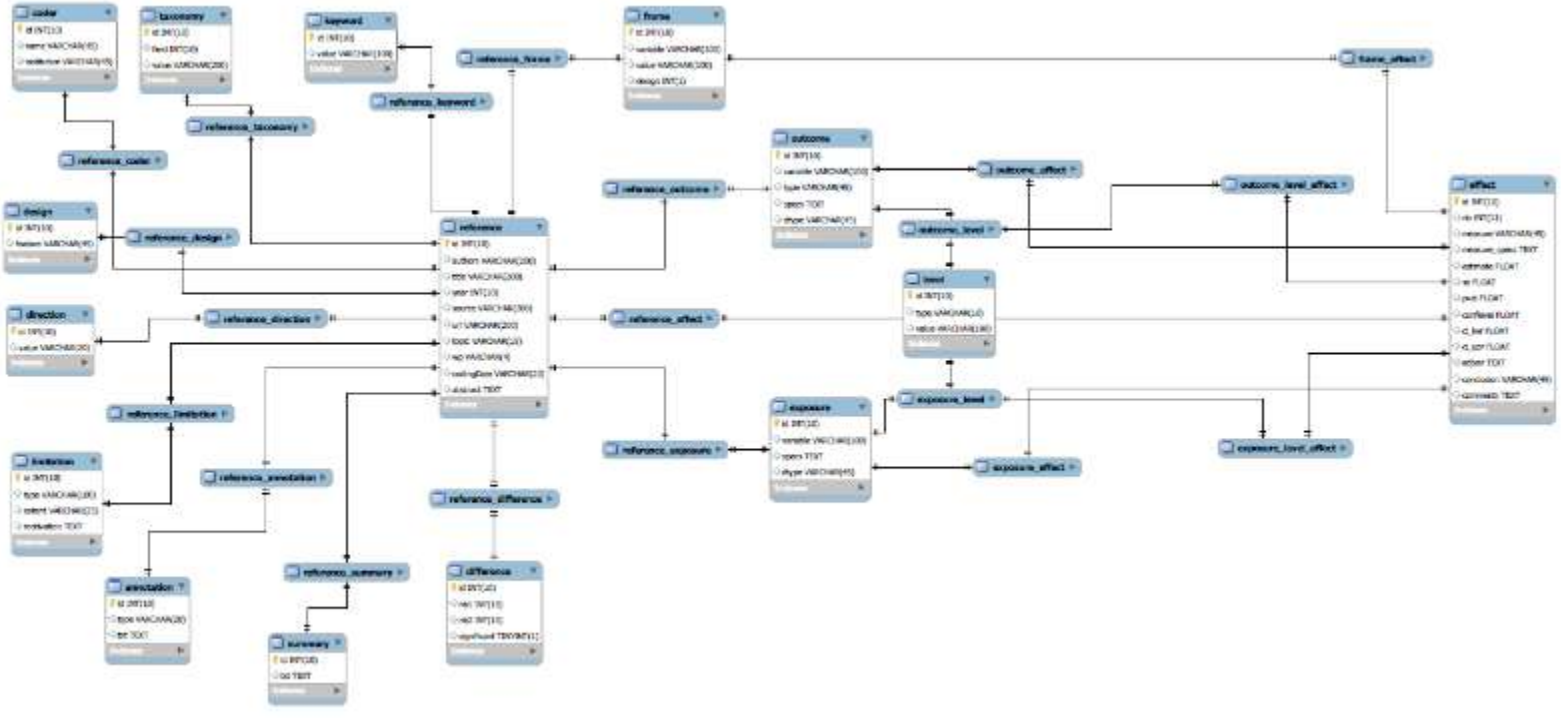
Repository
Coding template

Core info

Coder	*Name*	Focant Nathalie				
	Institution	BRSI				
	Date (dd/mm/yyyy)	20/05/2016				
Reference	*Authors*	Nathalie Focant, Martensen Heike				
	Title	Are there more accidents in the rain? Exploratory analysis of the influence of weather conditions on the number of road accidents in E				
	Year	2014				
	Source	BRSI report				
	URL					
Topic	*Risk factor or Countermeasure?*	Risk factor				
☐	*IyP*	WP5				
☐	*Header 5 - Infrastructure element*	Road environment				
☐	*Header 6 - Risk factor*	Adverse weather				
☐	*Header 7 - Specific risk factor*	rain	snow / ice / low temperatu	wind		
☐						
☐						
	Abstract	Its purpose is to determine how "weather" conditions do or do not influence the daily occurrence of "injury" - and "fatal" "accidents" in E				
	Keywords	mean comparison				
Sampling frame	☐ *Countries*	Belgium				
☐	*Administrative Level*	National				
☑	*Road user profile - Modes*	Pedestrian	Cyclist	Car	LGV	HGV
☐	*Road user profile - Type*	All				
☐	*Road user profile - Subgroup*					
☐	*Road user profile - Age*	All				
☐	*Road user profile - Gender*	All				
☐	*Road network profile - Area*	All				
☐	*Road network profile - Segments*	All				
☐	*Accident severities*	Injury	fatal			
☐	*Injury severities*	All				
	Comments					
Design	*Features*	Observational				
	Direction	≠ Exposure -> ≠ Outcome				
	EXPOSURE DEFINITION	Rain	Snow	High winds	Cold	
	OUTCOME DEFINITION	Injury accidents	Fatal accidents			
	Total number of effects	56				
	Comments	Mean comparison				
Limitations / Potential sources of bias		*Extent*	*Motivation*			
	Experiments: Pre-trial group differences	Maybe a problem	Days with rain might differ from days without on characteristics other than the weather.			

Repository Database



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SafetyCube Synopses

Stijn Daniels, VIAS Institute

Synopsis

- Key conclusion
- Overview
- Scientific summary
- Supporting background

- For risk-factors and counter-measures

Effect of traffic volume on road safety: ● *RED (RISKY)*

Most of the reviewed studies find higher traffic volumes to be associated with a net increase in crashes. However, the crash increase is less than proportional to traffic volume increases, indicating a lower risk for each road user. The effect of traffic volume on crash occurrence appears to differ between crash types. The studies reviewed concern motorways.

Congestion as a risk factor: ● *YELLOW (PROBABLY RISKY)*

Some studies find congestion to be associated with adverse road safety outcomes, but this finding is not consistent across studies and conditions investigated. The effects might differ based on the crash types and/or congestion indicators considered. All reviewed studies concern motorways.

Absence of access control: ● *RED (RISKY)*

Absence of access control seems to have negative effects on road safety. More access points on road segments is mostly negatively associated with road safety, and a greater distance between an intersection and the nearest driveway (corner clearance) has positive effects on road safety.

Occurrence of Secondary crashes: ● *YELLOW (PROBABLY RISKY)*

The presence of a crash or an incident can contribute to the occurrence of additional (secondary) incidents or crashes. The prevalence of secondary crashes, and the factors contributing to their occurrence is unclear, as this varies between studies. The available literature concerns motorways in the United States.

Risks associated with the distribution of traffic flow over arms at junctions: ● *GREY (UNCLEAR RESULTS)*

There was an adequate number of studies investigating the risk factor 'distribution of traffic flow over arms at junctions', but it was rarely the main variable of interest included in the crash models. Furthermore, the risk factor was not expressed in a consistent way across the studies, resulting in an unclear picture of its overall effect.

Synopsis: colour code

Risk factor		Countermeasure	
Red	Results consistently show an increased risk when exposed to the risk factor concerned.	Green	Results consistently show that the countermeasure reduces road safety risk.
Yellow	There is some indication that exposure to the risk factor increases risk, but results are not consistent.	Light green	There is some indication that the counter measure reduces road safety risk, but results are not consistent.
Grey	No conclusion possible because of few studies with inconsistent results, or few studies with weak indicators, or an equal amount of studies with no (or opposite) effect.	Grey	No conclusion possible because of few studies with inconsistent results, or few studies with weak indicators, or an equal amount of studies with no (or opposite) effect.
Green	Results consistently show that exposure to the presumed risk factor does not increase risk.	Red	Results consistently show that this measure does NOT reduce road safety risk and may even increase it.

SafetyCube Tools for Prioritisation

Stijn Daniels, VIAS Institute

Prioritisation
Economic Efficiency Evaluation (E^3)

User input **Info on measures**	*Output E^3-calculator*	*SafetyCube input* **Info per country**
Effectiveness Saved crashes per unit *(fatal, serious, slight, pdo)*	*Cost Effectiveness Analysis* • *Costs per crash prevented (fatal, serious, slight, pdo)*	**Crash & casualty costs** *(fatal, serious, slight, pdo)*
Time horizon	*Cost Benefit Analysis* • *Net present value (benefits – costs)* • *Benefit-cost ratio (benefit / costs)*	Discount rate
Costs of measures		

E3-calculator
Economic efficiency evaluation

- SafetyCube examples
- User adapts SafetyCube example for own purposes
- Users' analysis starts from scratch.

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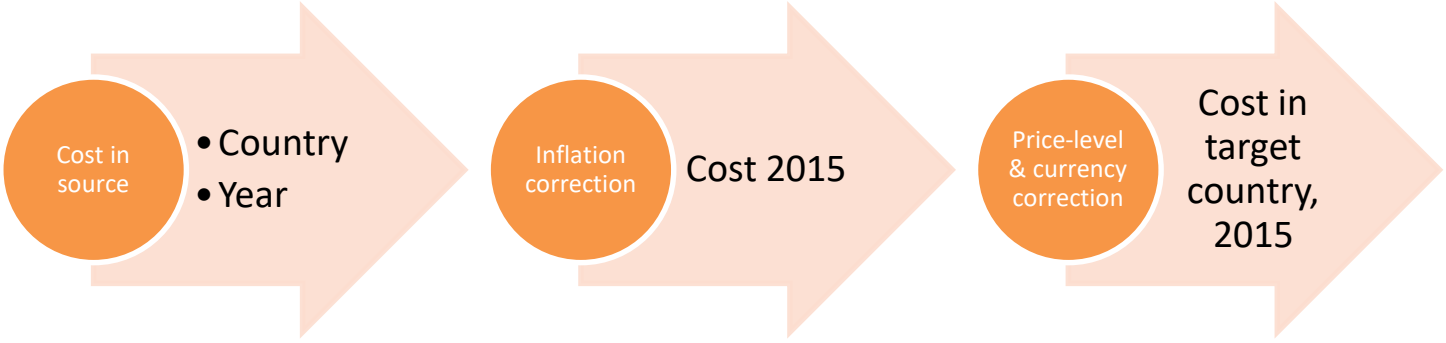
E3-calculator
Crash costs

- Based on SafetyCube crash-cost collection
  - *Countries' own reported values*
  - *Common methodology estimates per country*
  - *EU standardized cost*

E3-calculator
Costs of counter-measures

- Costs for counter-measures can be adjusted from one country to another, by means of *value transfer*.



SafetyCube E3 examples
Sensitivity analysis

- Low / high measure effect
  - *Lower CI*
  - *Upper CI*
- Low / high measure costs
  - *- 50%*
  - *+ 100%*
- Combined scenarios
  - *Worst case*
  - *Ideal case*

Table 1: Input values and BCR for the 'best estimate' scenario

Scenario	Input values	BCR
Best estimate	Crash reduction: 14% Implementation cost: €3,284,143 /100,000 tests Annual cost: €0.00 Affected nr. of casualties per year: Crashes: 304	7.3

Table 2: Sensitivity analyses

Scenario	Input values	BCR
Low measure effect	Crash reduction: 11%	5.7
High measure effect	Crash reduction: 18%	9.4
Low measure cost (-50%)	Implementation cost: €1,642,072 /100,000 tests Annual cost: €0.00	14.6
High measure cost (+100%)	Implementation cost: €6,568,287 /100,000 tests Annual cost: €0.00	3.7

Table 3: CBA for worst case and ideal case scenarios

Combined Scenario	Input values	BCR
Worst case	Crash reduction: 11% PDO only crashes reduction: 13% Implementation cost: €6,568,287 /100,000 tests Annual cost: €0.00	2.9
Ideal case	Crash reduction: 18% Implementation cost: €1,642,072 /100,000 tests Annual cost: €0.00	18.8

Linking between risks and measures

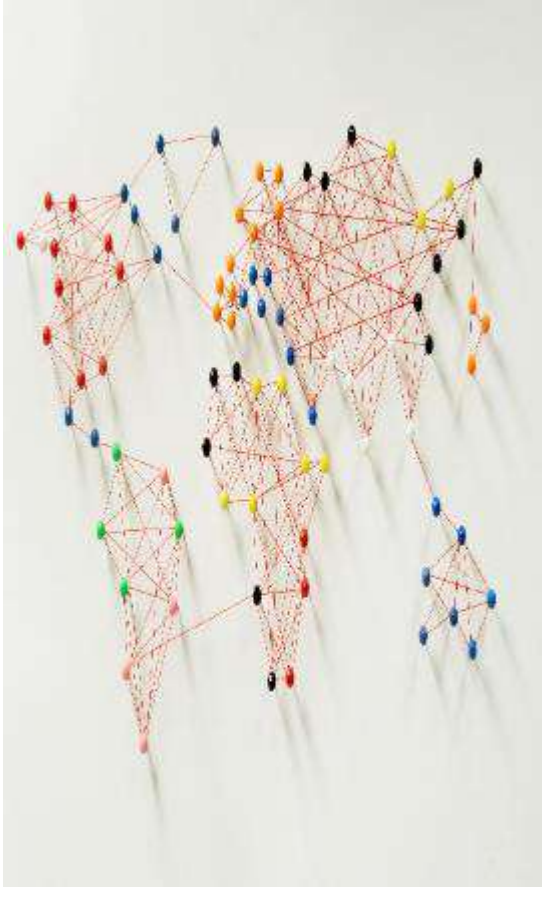
Eleonora Papadimitriou, NTUA

Linking between risks and measures

- A **theoretical framework** for linking risk factors and measures
  - *based on a crash chain model*
  - *applied through existing expert knowledge*

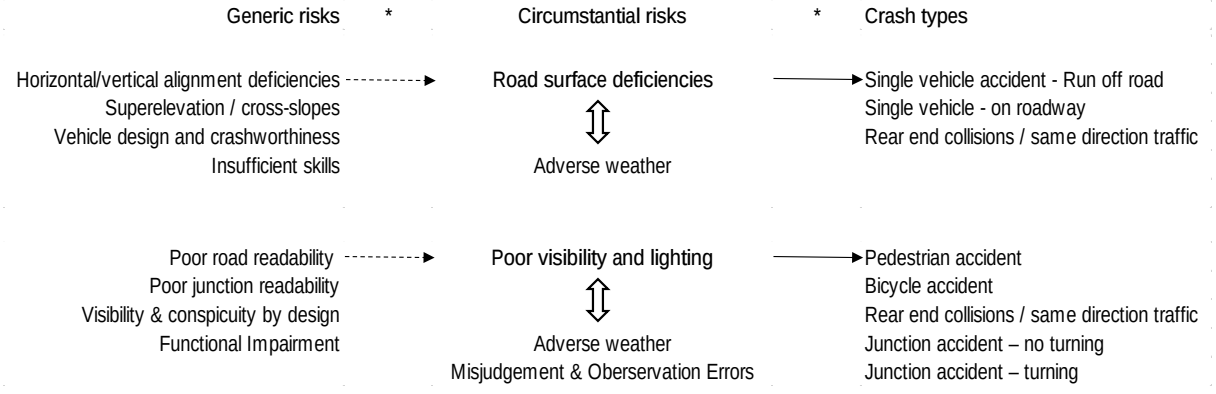
- Links are **integrated in the DSS** to explore and identify a range of solutions with potential of addressing road safety problems

- The DSS contents (individual studies, synopses and meta-analyses) "validate" or "conditionalize" the links, assist to **understand the conditions of measures effectiveness** and flag the sources of uncertainty.

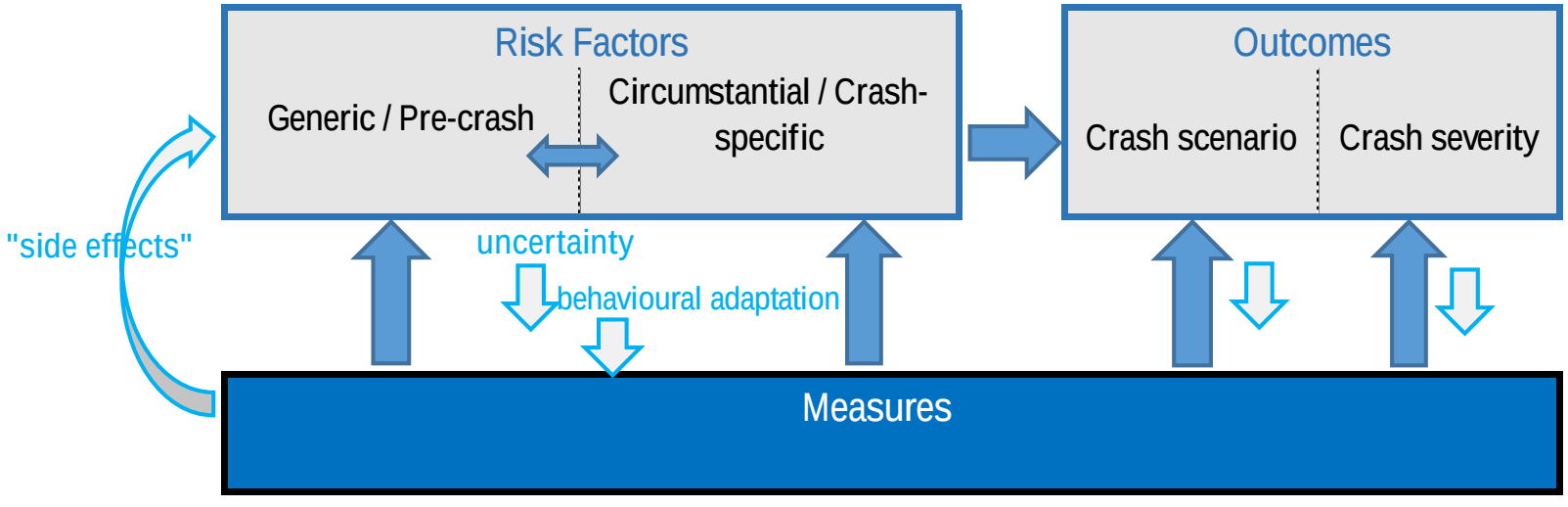


Chains of risk factors and outcomes

- **Each crash type is caused by a (combination of) circumstantial risk(s), which are due to or strengthened by pre-existing generic risks.**
- The combination of risk factors then may result to specific crash types and related crash consequences.



Proposed SafetyCube model



DSS links from risks to related measures

- **Measures for "Fatigue - not enough sleep"**

The following measures are related to the risk factor you selected. Select a measure from the table below to see the available SafetyCube results.

Behavior	Infrastructure	Vehicle	Post Impact Care
Fitness to drive, medical referrals	installation of median	Electronic Stability Control (ESC)	Not Applicable
Campaigns on fatigue	increase median width	Lane Departure Warning (LDW), Lane Keeping Assist (LKA) & Lane Centering System	
	change median type	Drowsiness and Distraction Recognition	
	implementation of rumble strips at centerline		
	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		
	implementation of edgeline rumble strips		

Countries

☐ GREECE

SafetyCube Synopses

Effectiveness of Road Safety Campaigns: *LIGHT GREEN (PROBABLY EFFECTIVE)*

There is some indication that campaigns are beneficial for road safety on various levels. Meta-analyses show an association with accident reduction, increased safe behaviours and risk awareness. However, for other outcome variables such as drink-driving or safety relevant attitudes, no such effect was found. Furthermore, meta-analysed studies vary strongly, mainly regarding the design of the evaluated campaigns.

ID	Title	Source	Year	Design	Countries
49	Do Road Safety Communication Campaigns Work? How to Assess the Impact of a National Fatigue Campaign on Driving Behavior	TRANSPORTATION RESEARCH RECORD: JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, NO. 2364, TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES, WASHINGTON, D.C., 2013, PP. 62-70.	2013	BEFORE-AFTER	GREECE

DSS links from measures to related risks

- **Risks addressed by "Emergency Braking Assistance Systems"**

The following risk factors are related to the measure you selected. Select a risk factor from the table below to see the available SafetyCube results.

Behavior	Infrastructure	Vehicle
Headway distance	secondary crashes	Risk to be injured in rear impact
Insufficient skills and operating errors		
Observation errors		
Elderly (65+)		

Road User Group

- ☐ ALL
- ☐ CAR
- ☐ LGV

Road Type

- ☐ ALL
- ☐ RURAL ROAD
- ☐ SUBURBAN ROAD
- ☐ URBAN ROAD

Countries

- ☐ FINLAND
- ☐ UNITED KINGDOM
- ☐ UNITED STATES

SafetyCube Synopses

Risk taking - Close Following Behaviour *YELLOW (PROBABLY RISKY)*

Although following too closely is seen as one of the main reasons for rear end crashes, studies that evaluate the risk of this behaviour in connection to accidents are rare. However, if headway distances are so short that it is no longer possible to stop in time in the case of an emergency stop, it can be presumed as risky. Quite a proportion of drivers engage in such a behaviour. Results of one study indicate a higher crash risk for short headways.

ID	Title	Source	Year	Design	Countries
765	Driver crash risk factors and prevalence evaluation using naturalistic driving data	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA PNAS, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES	2016	CASE-CONTROL	UNITED STATES
772	Close-following drivers on two-lane highways	ACCID. ANAL. AND PREV., VOL 29, NO. 6, PP. 723-729	1997	QUASI-EXPERIMENTAL	FINLAND
840	Car following decisions under three visibility	ACCIDENT ANALYSIS AND PREVENTION, 39(1), 106-116	2007	EXPERIMENTAL	UNITED STATES

Serious injuries

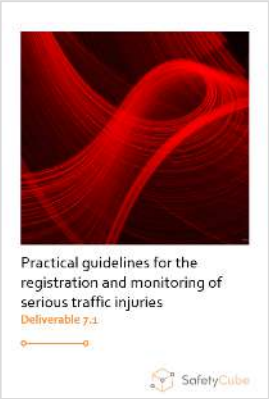
Wendy Weijermars, SWOV

Serious injuries

- Serious road injuries are increasingly being adopted as an additional road safety performance indicator
- EU definition (2013): non-fatal road traffic casualty with an injury severity level of **MAIS3+**
- All EU member states are asked to provide data from 2014 on, by:
  1. *Applying correction factors to police data*
  2. *Using hospital data*
  3. *Using linked police and hospital data*

Serious injuries in SafetyCube

- Estimation of the number of MAIS3+ casualties
- Consequences of serious road injuries
- Costs related to serious road injuries
- Risk factors associated with serious road injuries



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Serious injuries in the DSS

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Presenting the DSS

Prof. George Yannis, NTUA

SafetyCube DSS Design Principles

- A **Modern** web-based tool
- Highly **Ergonomic** interface
- **Simple** structure
- Powerful **Search** Engines
- Fully **Documented** information
- Easily **Updated**

SafetyCube DSS Knowledge Wealth

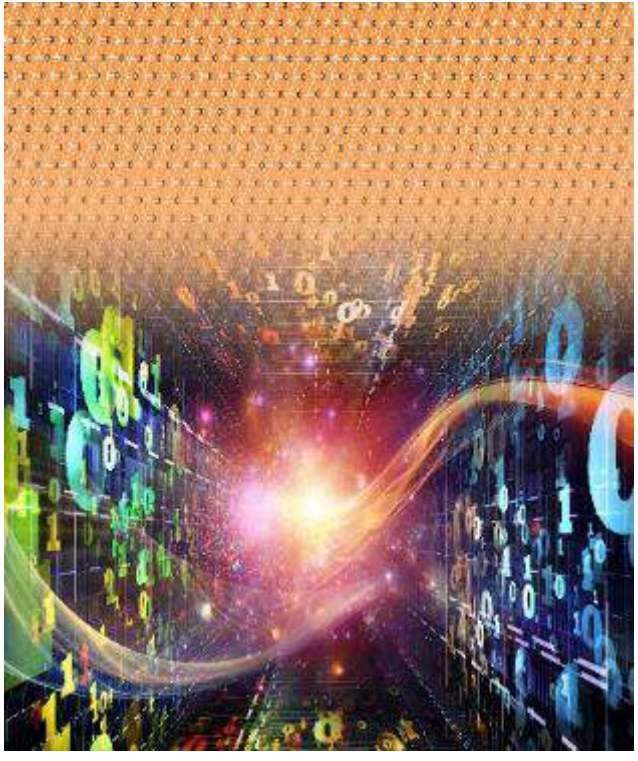
SafetyCube DSS will eventually include
by April 2018:

- more than **1,250 studies,**

- with more than **7,500 estimates** of risks/measures effects on:
  - behaviour,
  - infrastructure,
  - vehicle, and
  - post impact care

- **211 Synopses**

- **36 cost-benefit analyses**



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SafetyCube DSS Menu

- **Search**
  Risk Factors & Measures
- **Knowledge**
  211 Synopses, Serious Injuries, Accident Scenarios
- **Calculator**
  Economic Efficiency Evaluation
- **Methodology**
  System documentation
- **Support**
  Contact, help, feedback

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SafetyCube DSS Search Pages

DSS Search through five entry points:

- **Keyword** search (all database keywords)
- **Risk factor** search (taxonomy)
- **Measures** search (taxonomy)
- **Road User Groups** (database keywords related to each group)
- **Accident Categories** (under development)

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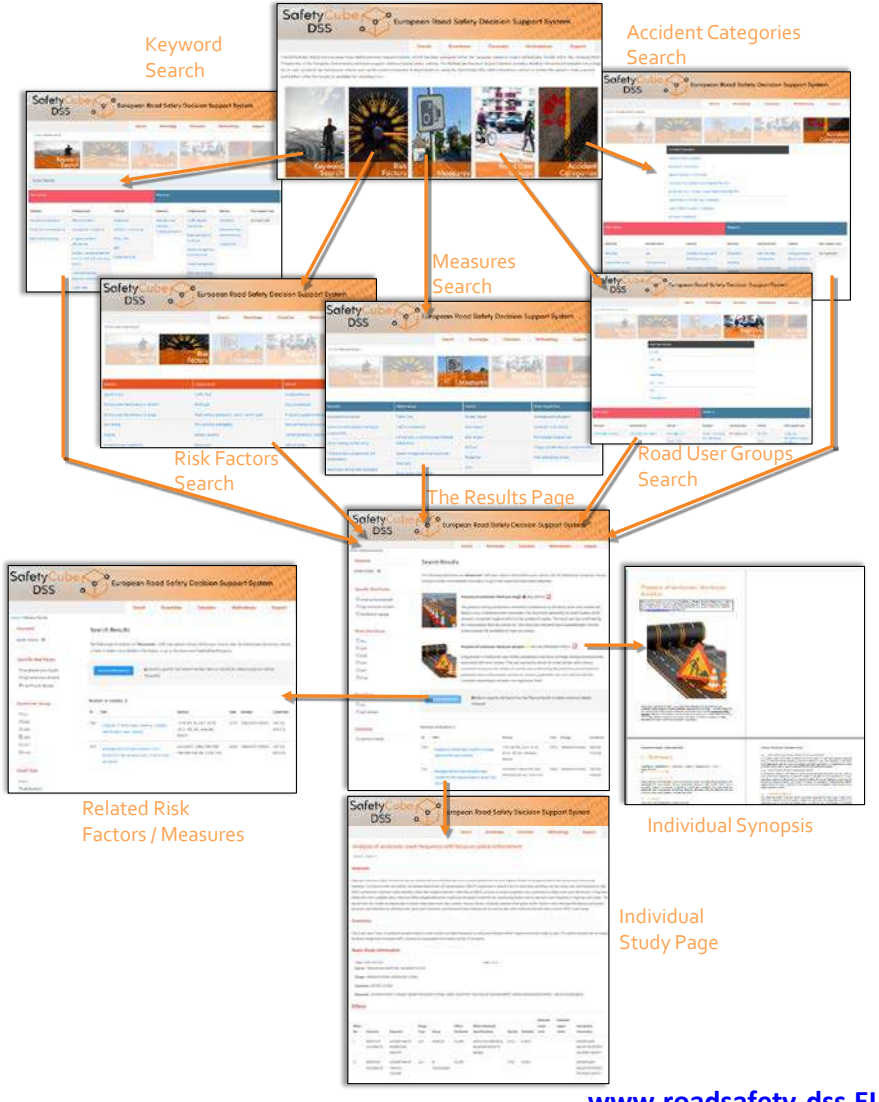
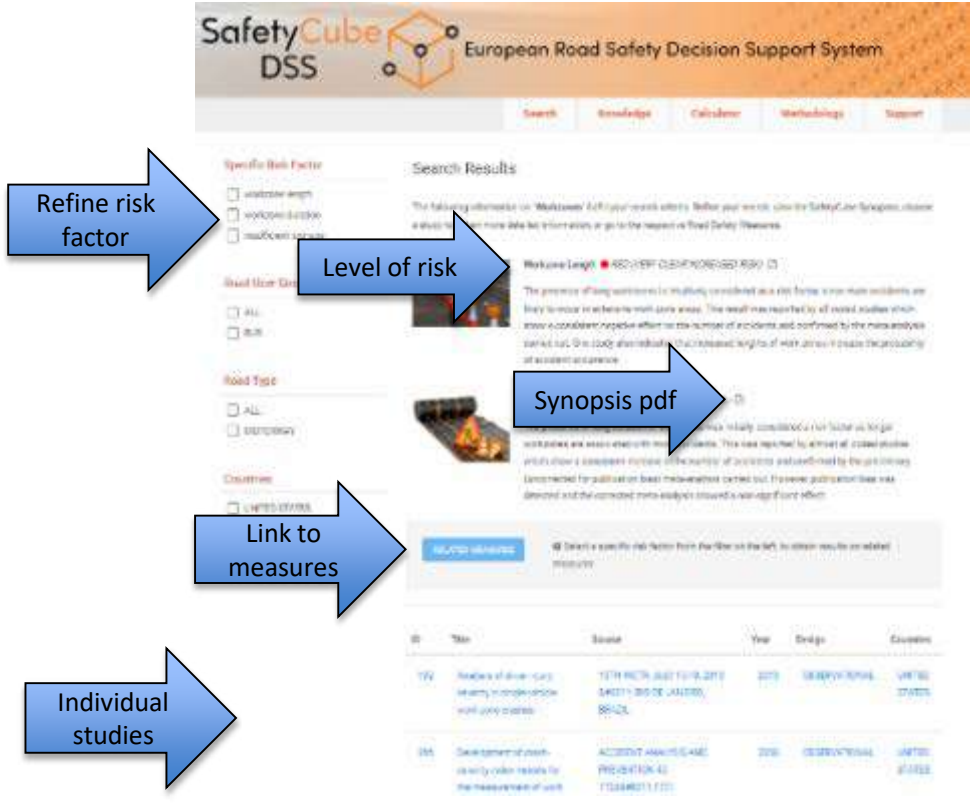
The Search Structure

- **Search**
  (5 entry points)
- **Results pages**
  (Introduction, Colour codes, Synopses, Coded studies)
- Individual **Studies** pages
  (Disaggregate level, detailed effects listed, some studies not in synopses)

- **Links** between Risk Factors
  Information about which risks can be remedied by which types of measures



SafetyCube DSS Results Pages



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SafetyCube Synopses

211 Syntheses on risk factors / measures

Summary (2 pages)

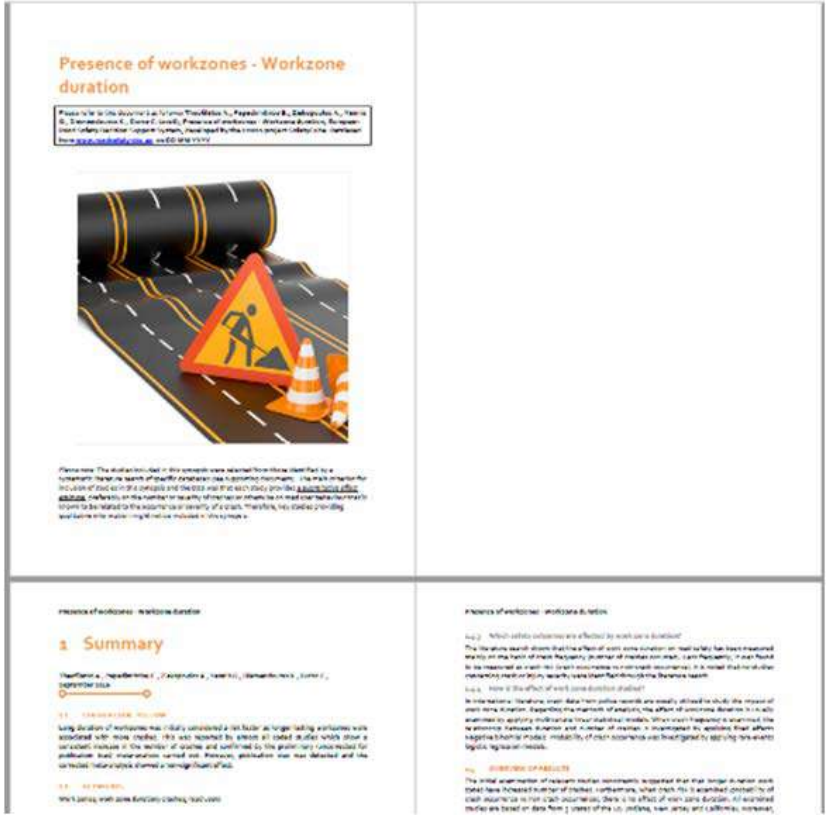
– Effect of risk factor / measure and ranking (colour code)
– Risk / safety effect mechanisms
– Risk / safety effects size, transferability of effects

Scientific overview (4-5 pages)

– Comparative analysis of available studies
– Analysis results: Meta-analysis/Vote-count analysis/Qualitative analysis

Supporting document (3-10 pages)

– Literature search strategy and study selection criteria
– Detailed analyses



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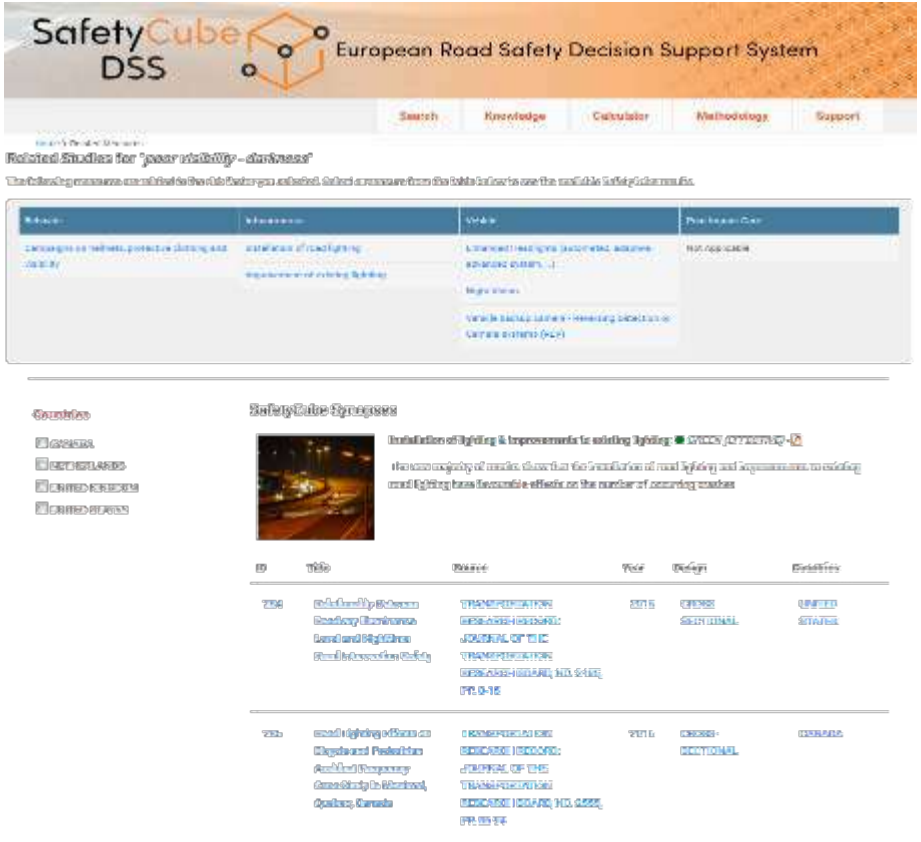
SafetyCube Related Risks / Measures

- Linking based on a **dedicated model** categorizing risks
- Every Risk Factor (88) is **linked** to one or more Road Safety Measure(s) (175)
- Every Road Safety Measure (175) is **linked** to one or more Risk Factor(s) (88)
- A total of **762 links** between risk factors and measures



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SafetyCube DSS Individual Study Pages

Title, author, source, abstract

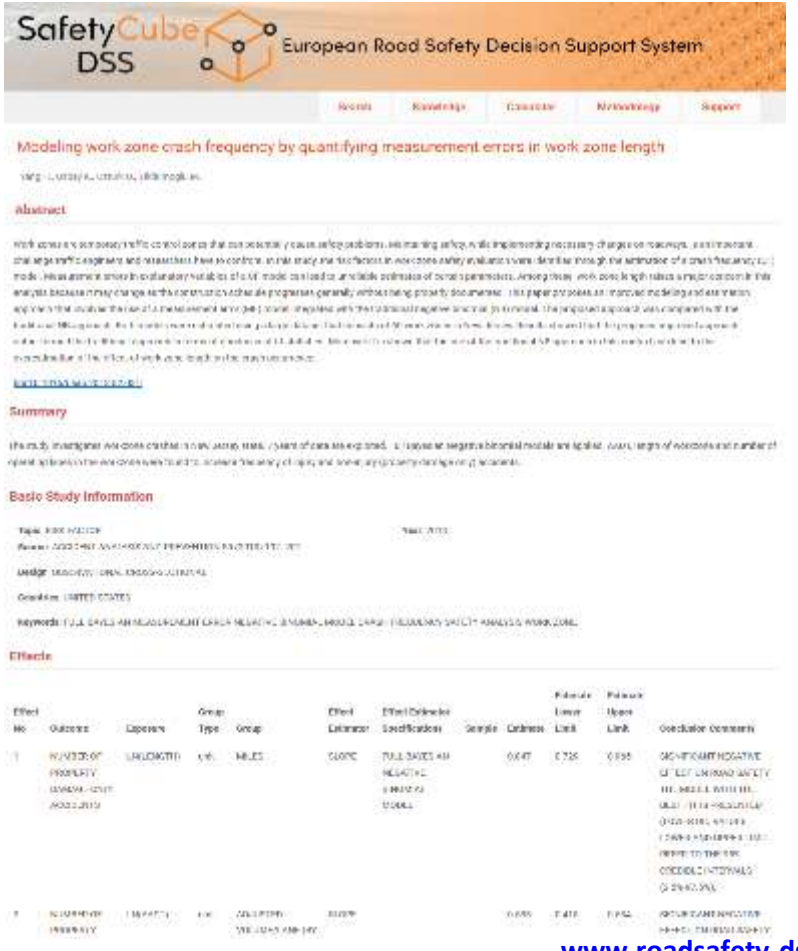
- Link to URL for full-text download (depending on Institute permissions)

Study design info:

- Country
- Research Method, Design, Sample
- Exposure/Control group
- Risk/Outcome Group
- Modifying Conditions
- Potential limitations

Study results:

- Table **listing the detailed effects** reported in the study



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SafetyCube DSS Calculator

- Combines information about the **effectiveness of a measure** (i.e. the percentage of crashes or casualties prevented) with the **costs** of this measure
- Integrates updated information of **crash costs in the European countries**
- Allows to express all costs and benefits of a measure in monetary values and conduct **cost benefit analysis**

Main Functions

- Perform cost-benefit analysis with **own input data**.
- Select one of the **SafetyCube examples** of cost benefit analyses
  – Measures with high effectiveness
  – For which reliable cost information could be found

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… hands-on examples for querying the DSS

Eleonora Papadimitriou, NTUA
Susanne Kaiser, KFV

The next steps …

Prof. Pete Thomas, Loughborough University

SafetyCube Next Steps

The **future operation** of the SafetyCube DSS concerns:

1. the uninterrupted operation of the current SafetyCube DSS
2. updates of the risk factors, measures and cost-benefit analyses (recent studies but also older ones)
3. addition of studies in more languages
4. translation of the contents in other languages
5. possibility to receive, check and incorporate studies submitted by external experts and organizations and the respective quality control
6. incorporation of additional data and knowledge sections
7. A partnership of public and private organisations is being assembled to enable the DSS to continue

SafetyCube - the European Road Safety Decision Support System

A recording of this webinar and all deliverables of the project will be available at

www.Safetycube-project.eu

You are welcome to use the DSS at

www.roadsafety-dss.eu