



# SafetyCube

## Design of the European Road Safety Decision Support System

**George Yannis and Eleonora Papadimitriou**

SafetyCube Workshop  
Brussels, 27 September 2016



Co-funded by the Horizon 2020  
Framework Programme of the European Union

9/27/2016

# SafetyCube DSS Objectives

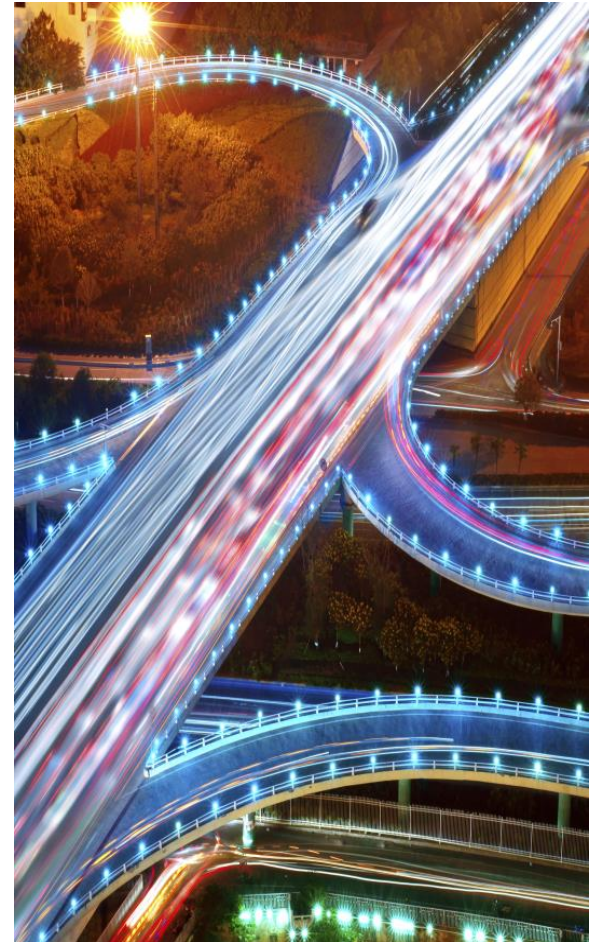


*The SafetyCube DSS objective is to provide the European and Global road safety community **a user friendly, web-based, interactive Decision Support Tool** to properly substantiate their road safety decisions for the actions, measures, programmes, policies and strategies to be implemented at local, regional,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

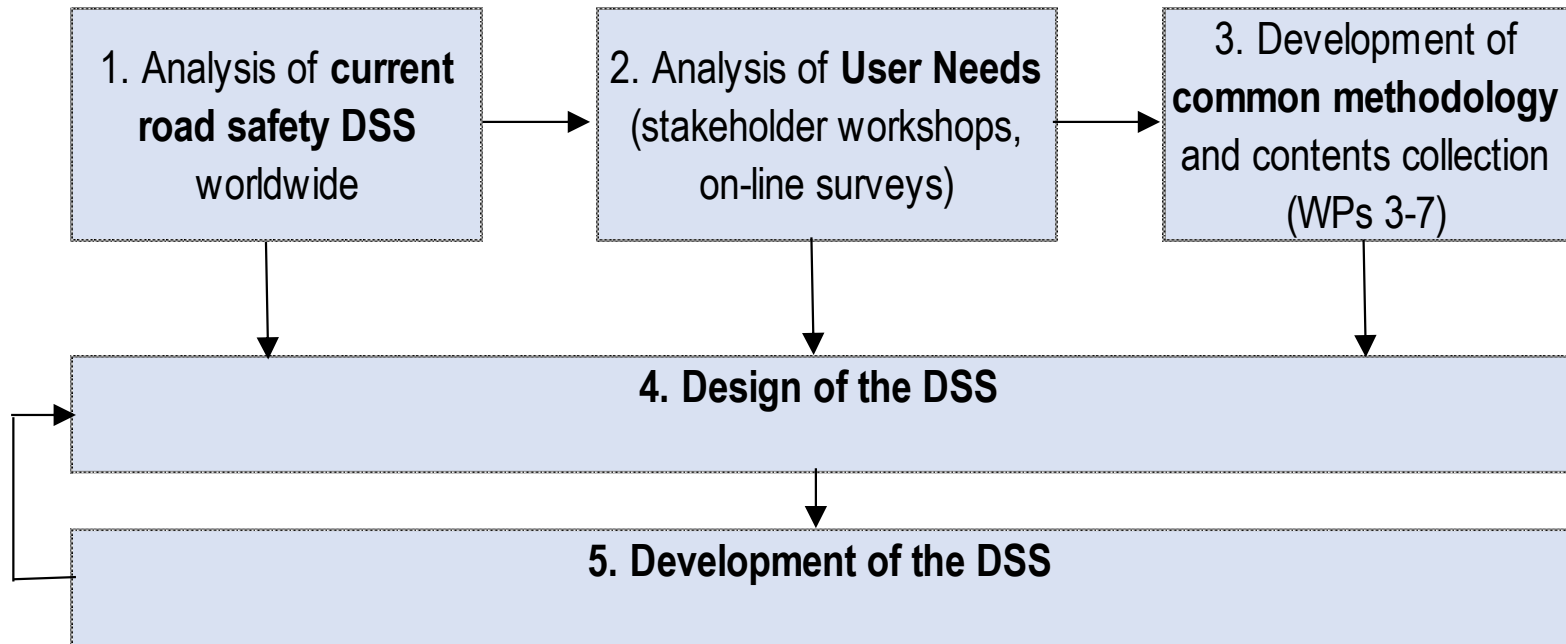
The main contents of the SafetyCube DSS concern:

- 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 Development Methodology



Testing, Pilot Operation, User Training and future continuous Maintenance will follow.

# Current Road Safety DSS Worldwide



- Crash Modification Factors Clearinghouse ([www.cmfclearinghouse.org](http://www.cmfclearinghouse.org))  
by NHTSA (USA) - **5.151 CMF** on infrastructure only - on going
- Road Safety Engineering Kit ([www.engtoolkit.com.au](http://www.engtoolkit.com.au))  
by Austroads (Australia) - **67 treatments** on infrastructure only
- PRACT Repository ([www.pract-repository.eu](http://www.pract-repository.eu))  
by CEDR (Europe) - **889 CMF and 273 APM** on infrastructure only – high quality
- iRAP toolkit ([toolkit.irap.org/](http://toolkit.irap.org/))  
by iRAP - **58 treatments** (43 on infrastructure)
- Safety Performance Factors Clearinghouse ([spfclearinghouse.org](http://spfclearinghouse.org))  
by Tatum Group LLC, Dr. Andrew Kwasniak (USA) - **few SPF** – subscribers only

# SafetyCube DSS Users



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

The SafetyCube DSS is intended to have **a life well beyond the end of the SafetyCube** research project. Furthermore, it will be developed in a form that can readily be incorporated within the existing European Road Safety Observatory of the European Commission DG-MOVE.



# SafetyCube DSS User Needs



- SafetyCube stakeholders' consultation Workshops
  - Brussels 2015,
  - Ljubljana 2015,
  - Brussels (WP5-Infrastructure) 2016,
  - Hague (WP7-Serious Injuries) 2016
- SafetyCube on-line survey
- Consolidated Table of user needs



# SafetyCube DSS Design Principles



- A **Modern** web-based tool
- High **Ergonomy** interface
- **Simple** structure
- Powerfull **Search** Engines
- Fully **Documented** information
- Easily **Updated**





# SafetyCube DSS Website Design Principles

- A strong **web address**  
e.g. [www.safetycube-dss.eu](http://www.safetycube-dss.eu)
- **Consistent design** throughout all tools  
(unique visual identity, colors, design, messages, etc.)
- Modern and **ergonomic** design  
[multimedia (photos and videos) wherever possible]
- Allow for **updates**
  - *feedback from the users*
  - *feedback from visits traffic monitoring*
- Develop a robust **promotion policy**, during and after the project (newsletter, twitter, etc.)





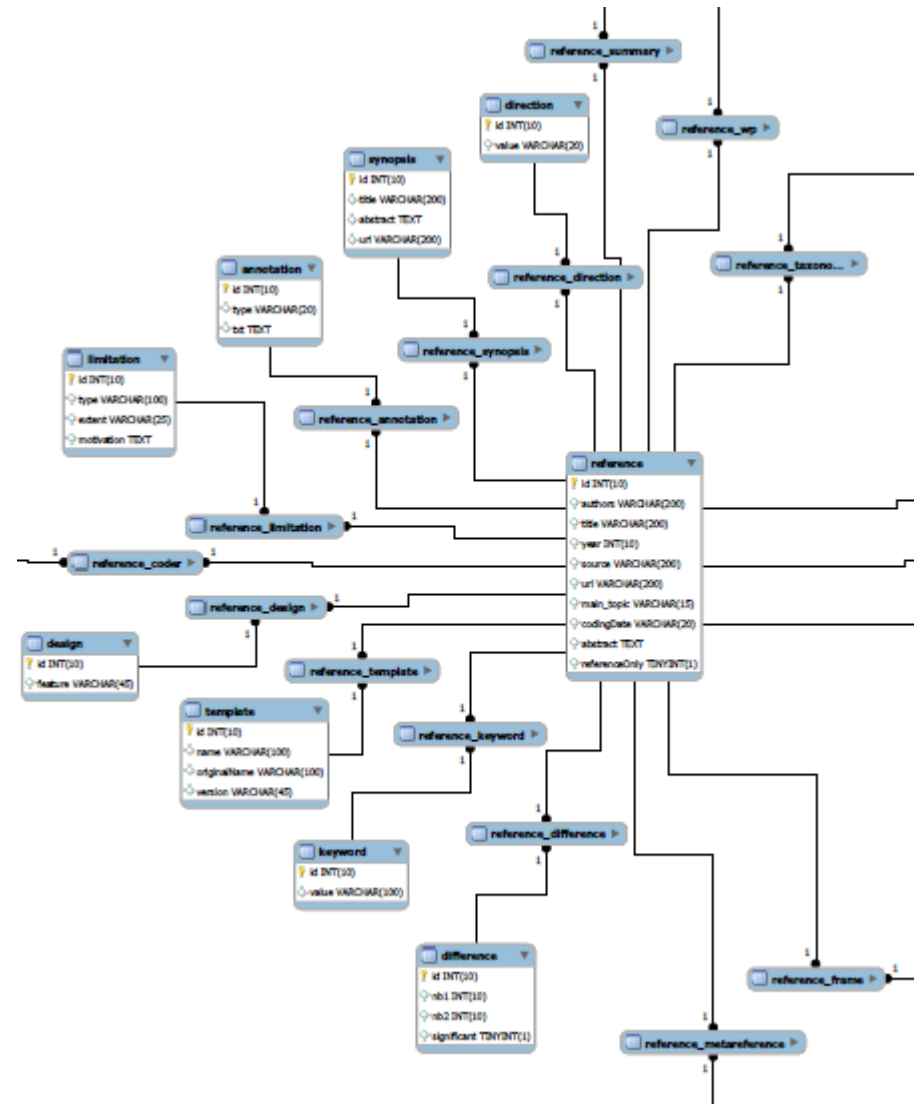
# SafetyCube DSS Search Engine

- — ○
- Fully **linked** search
  - *search a road safety problem alone or through the measures*
  - *search a measure alone or through the road safety problems*
  - *Search for risks and measures related to specific road user groups or crash types*
- Fully **detailed** search
  - *search by any parameter in each data table (road safety problems, measures)*
- Fully **flexible** search
  - *adjust and customize search according to results*
- Fully **documented** search
  - *access background information at any stage (links, etc.)*

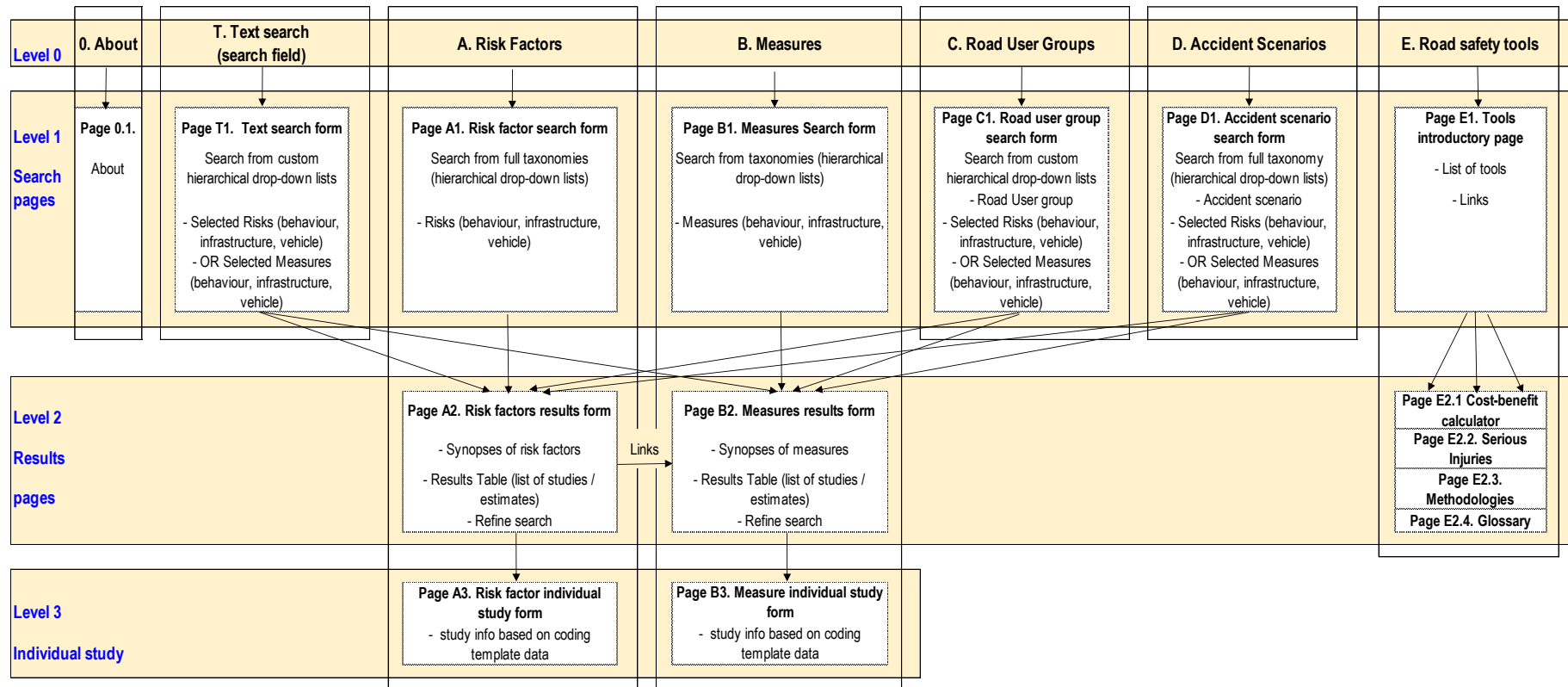


# Relational Data Base

- The templates of **coded studies** will undergo a thorough checking and debugging process
- The templates are eventually stored in a **relational database**, which will serve as the back-end of the DSS
- Front-end DSS results will be retrieved through **queries** on the back-end database (DSS search engine).



# 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 (Entry Points)



- **ABOUT** SafetyCube

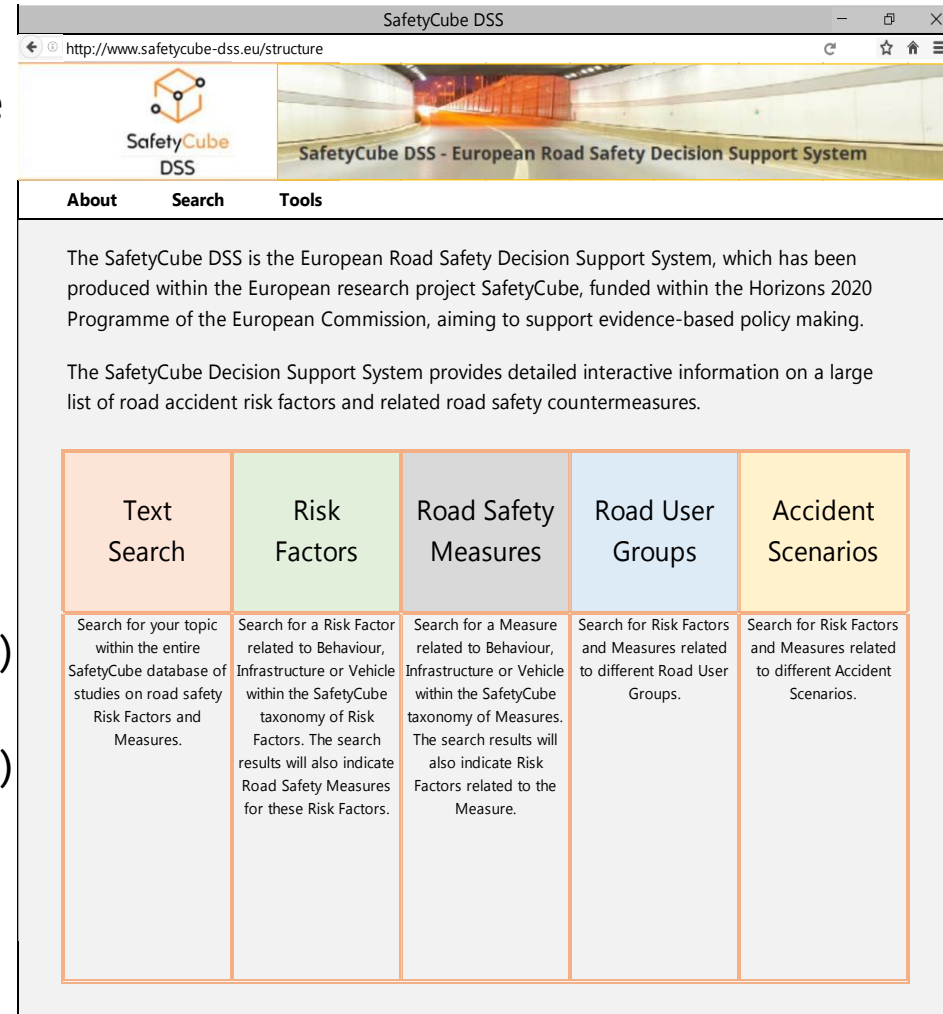
Basic Information about SafetyCube and the DSS

- **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)

- **TOOLS**

Background information, resources and methodology, including extensive glossary



The screenshot shows the homepage of the SafetyCube DSS. The browser address bar displays <http://www.safetycube-dss.eu/structure>. The page features a header with the SafetyCube DSS logo and a navigation menu with links for About, Search, and Tools. The main content area includes a descriptive paragraph about the system, followed by a table of search entry points.

| Text Search  | Risk Factors  | Road Safety Measures  | Road User Groups  | Accident Scenarios  |
|--|---|---|---|---|
| Search for your topic within the entire SafetyCube database of studies on road safety Risk Factors and Measures. | Search for a Risk Factor related to Behaviour, Infrastructure or Vehicle within the SafetyCube taxonomy of Risk Factors. The search results will also indicate Road Safety Measures for these Risk Factors. | Search for a Measure related to Behaviour, Infrastructure or Vehicle within the SafetyCube taxonomy of Measures. The search results will also indicate Risk Factors related to the Measure. | Search for Risk Factors and Measures related to different Road User Groups. | Search for Risk Factors and Measures related to different Accident Scenarios. |

# Risk Factors Search Parameters



## Three categories of taxonomy fields

- Category  
road user, infrastructure, vehicle
- Topic  
e.g. roadside deficiencies, distraction inside vehicle, inappropriate speed
- Specific risk factor  
e.g. no clear-zone, mobile phone, too fast / too slow

The screenshot shows the SafetyCube DSS website. The header includes the logo and the title "SafetyCube DSS - European Road Safety Decision Support System". The navigation menu has "About", "Search", and "Tools". The main content area describes the DSS as a key objective of the SafetyCube project. Below this, there are five colored boxes: "Text Search" (orange), "Risk Factors" (green), "Road Safety Measures" (grey), "Road User Groups" (blue), and "Accident Scenarios" (yellow). The "Risk Factors" box is highlighted, and a table is displayed below it.

| Risk Factors                 |  |   |
|------------------------------|--|---|
| Behaviour                    | Infrastructure                                       | Vehicle                                     |
| Speed choice                 | Traffic flow   | Prevalence of vehicle factors in crash data |
| Influenced driving - alcohol | Road functional class                                | Injury mechanism                            |
| Influenced driving - drugs   | Road surface deficiencies (risk of ran-off road)     | Crashworthiness                             |
| Risk taking                  | Poor visibility and lighting                         | Technical defects / Maintenance             |
| Fatigue                      | Adverse weather                                      | Protective equipment design                 |
| Distraction and inattention  | Workzones  | Visibility / conspicuity                    |
| Functional Impairment        | Horizontal/vertical alignment deficiencies           |   |
| Insufficient skills          | Superelevation / cross-slopes (risk of ran-off road) |   |
| Insufficient knowledge       | Lanes / ramps deficiencies                           |   |

# Measures Search Parameters



## Three categories of taxonomy fields

- Category  
road user, infrastructure, vehicle
- Topic  
e.g. formal tools to address road network deficiencies, speed regulation
- Specific measure  
e.g. road safety audits, lower speed limits

SafetyCube DSS

http://www.safetycube-dss.eu/structure

**SafetyCube DSS**  
European Road Safety Decision Support System

**About Search Tools**

The SafetyCube European Road Safety Decision Support System (DSS) is one of the key objectives of the SafetyCube project to better support evidence-based policy making. The SafetyCube results will be assembled in the form of a **Decision Support System** that will present for each suggested road safety measure: details of the risk factor tackled, the measure itself, the best estimate of casualty reduction effectiveness, the cost-benefit evaluation and the analytic background. While the development and evaluation of the measures will be developed into a format and structure that will enable industry, policy-makers and other stakeholders to access the information in an efficient manner within the DSS.

|             |              |                      |                  |                    |
|-------------|--------------|----------------------|------------------|--------------------|
| Text Search | Risk Factors | Road Safety Measures | Road User Groups | Accident Scenarios |
|-------------|--------------|----------------------|------------------|--------------------|

| Measures          |   |                          |
|-------------------|---|--------------------------|
| Behaviour         | Infrastructure                                    | Vehicle                  |
| Awareness raising | Traffic flow                                      | Frontal impact           |
| Information       | Formal tools to address road network deficiencies | Side impact              |
| Law               | Speed management                                  | Rear impact              |
| Enforcement       | Road functional class                             | Rollover                 |
| Education         | Road surface treatments                           | Injury mechanism         |
| Training          | Visibility / Lighting treatments                  | Maintenance - Visibility |
| Testing           | Workzones   | Technical defects        |
|                   | Horizontal & vertical alignment treatments        | Design - Visibility      |
|                   | Superelevation / cross-slopes treatment           | Special vehicle          |
|                   | Lanes / ramps treatments                          |                          |
|                   | Median / barrier treatments                       |                          |
|                   | Shoulder & roadside treatments                    |                          |
|                   | Sidewalks treatments                              |                          |
|                   | Cycle lanes                                       |                          |
|                   | Traffic signs treatments                          |                          |
|                   | Delineation and road markings                     |                          |

# Risk Factors results parameters

## Search results

- Short summaries of syntheses (meta-analyses) available
- Table listing the available synopses, meta-analyses and other studies
- Table columns concern main study characteristics (design, outcome variable, effect type and size, country, year etc.)

## Refine search

- Specific risk factor
- Search filters:
  - Road user types: All, car occupants, drivers, passengers, PTW riders, pedestrians, cyclists, HGV.
  - Road types: All, motorways, rural roads, urban roads
  - Region / Country: EU, EU countries (all names), US and Canada, Australia, Asia.
  - "Colour code": Risky, probably risky, unclear, probably not risky

## Links to related measures

- Go to measures search page, where the list of related measures is displayed as a pre-filled search

The screenshot shows the SafetyCube DSS website interface. The top navigation bar includes 'About', 'Search', and 'Tools'. The main content area is titled 'Risk Factors Search Results'. It displays two search results: 'Work Zone duration' and 'Work Zone length'. Each result includes a brief summary of the meta-analysis findings. Below the search results, there is a table titled 'Related Road Safety Measures' which lists various risk factors, their sources, outcome variables, effect estimators, effect sizes, and countries.

| Risk Factor        | Source                    | Outcome variable   | Effect estimator | Effect size     | Country |
|--------------------|---------------------------|--------------------|------------------|-----------------|---------|
| Work zone duration | SafetyCube Synopsis       | Accident frequency | Meta-analysis    | Non significant |         |
| Work zone length   | SafetyCube Synopsis       | Accident frequency | Meta-analysis    | Significant     |         |
| Work zone duration | Khattak et al., 2002      | Accident frequency | Slope            | Significant     | USA     |
| Work zone duration | Ozturk et al., 2013       | Accident frequency | Slope            | Significant     | USA     |
| Work zone duration | Pal and Sinha, 1996       | Accident frequency | Slope            | Significant     | USA     |
| Work zone duration | Venugopal and Tarko, 2000 | Accident frequency | Slope            | Significant     | USA     |
| Work zone duration | Yang et al. 2015          | Accident risk      | Slope            | Non significant | USA     |
| Work zone length   | Khattak et al., 2002      | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Ozturk et al., 2013       | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Ozturk et al., 2014       | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Chen and Tarko, 2012      | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Chen and Tarko, 2014      | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Yang et al., 2013         | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Venugopal and Tarko, 2000 | Accident frequency | Slope            | Significant     | USA     |
| Work zone length   | Yang et al. 2015          | Accident risk      | Slope            | Significant     | USA     |



## Study design info

- ## Study results:

- http://www.safetycube-dss.eu/structure



SafetyCube  
DSS

SafetyCube DSS - European Road Safety Decision Support System

About Search Tools

## Effects of work zone presence on injury and non-injury crashes

Khattak et al., 2002, Accident Analysis and Prevention, 34 pp 19-29

### Abstract

Work zones in the United States have approximately 700 traffic-related fatalities, 24 000 injury crashes, and 52 000 non-injury crashes every year. Due to future highway reconstruction needs, work zones are likely to increase in number, duration, and length. This study focuses on analyzing the effect of work zone duration mainly due to its policy-sensitivity. To do so, we created a unique dataset of California freeway work zones that included crash data (crash frequency and injury severity), road inventory data (average daily traffic (ADT) and urban/rural character), and work zone related data (duration, length, and location). Then, we investigated crash rates and crash frequencies in the pre-work zone and during-work zone periods. For the freeway work zones investigated in this study, the total crash rate in the during-work zone period was 21.5% higher (0.79 crashes per million vehicle kilometer (MVKM)) than the pre-work zone period (0.65 crashes per MVKM). Compared with the pre-work zone period, the increase in non-injury and injury crash rates in the during-work zone period was 23.8% and 17.3%, respectively. Next, crash frequencies were investigated using negative binomial models, which showed that frequencies increased with increasing work zone duration, length, and average daily traffic. The important finding is that after controlling for various factors, longer work zone duration significantly increases both injury and non-injury crash frequencies.

url: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.525.2933&rep=rep1&type=p>

### Study design

**Country:** USA  
**Research methods:** Negative Binomial Models  
**Design:** Observational study, Cross-sectional  
**Sample:** 2038 total accidents in 36 work zone sites in Indiana state, US, for the years 1992 a  
**Risk group:** Work zone  
**Control group:**  
**Modifying conditions:** AADT

The following effects on Work Zones are reported in this study:

| Risk factor             | Unit | Outcome variable              | Effect type | Effect size | Main outcome                               |
|-------------------------|------|-------------------------------|-------------|-------------|--|
| Ln of workzone duration | Days | Injury and non-injury crashes | Slope       | 1.1149      | Significant negative effect on road safety |
| Ln of workzone duration | Days | Non-injury crashes            | Slope       | 1.2317      | Significant negative effect on road safety |
| Ln of workzone duration | Days | Injury crashes                | Slope       | 1.2549      | Significant negative effect on road safety |
| Ln of workzone length   | Km   | Injury and non-injury crashes | Slope       | 0.6718      | Significant negative effect on road safety |
| Ln of workzone length   | Km   | Non-injury crashes            | Slope       | 0.6112      | Significant negative effect on road safety |
| Ln of workzone length   | Km   | Injury crashes                | Slope       | 0.7842      | Significant negative effect on road safety |

# SafetyCube synopses

## Syntheses on risk factors / measures

### Summary (2 pages)

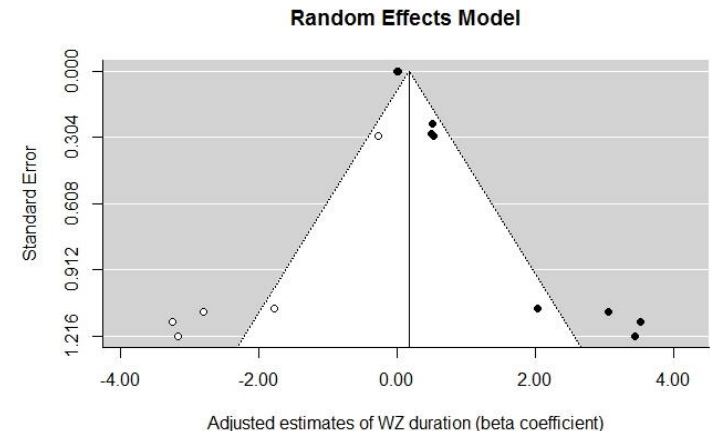
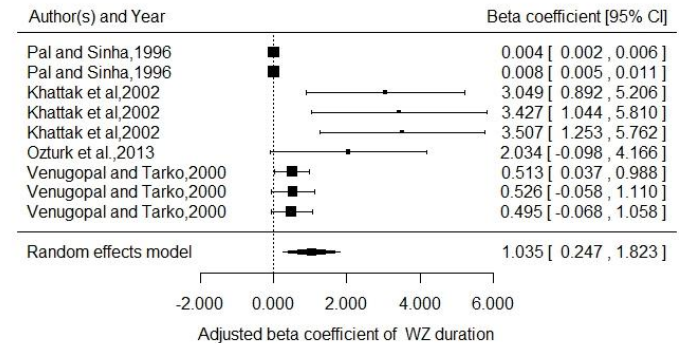
- Effect of risk factor / measure and ranking (colour code)
- Risk / safety effect mechanisms
- Risk / safety effects size, transferability of effects

### Scientific overview (4-5 pages)

- Comprehensive comparative analysis of available studies design and results
- Analysis results
  - *Meta-analysis*
  - *Vote-count analysis*
  - *Qualitative analysis*

### Supporting document (3-10 pages)

- Literature search strategy and study selection criteria
- Detailed analyses



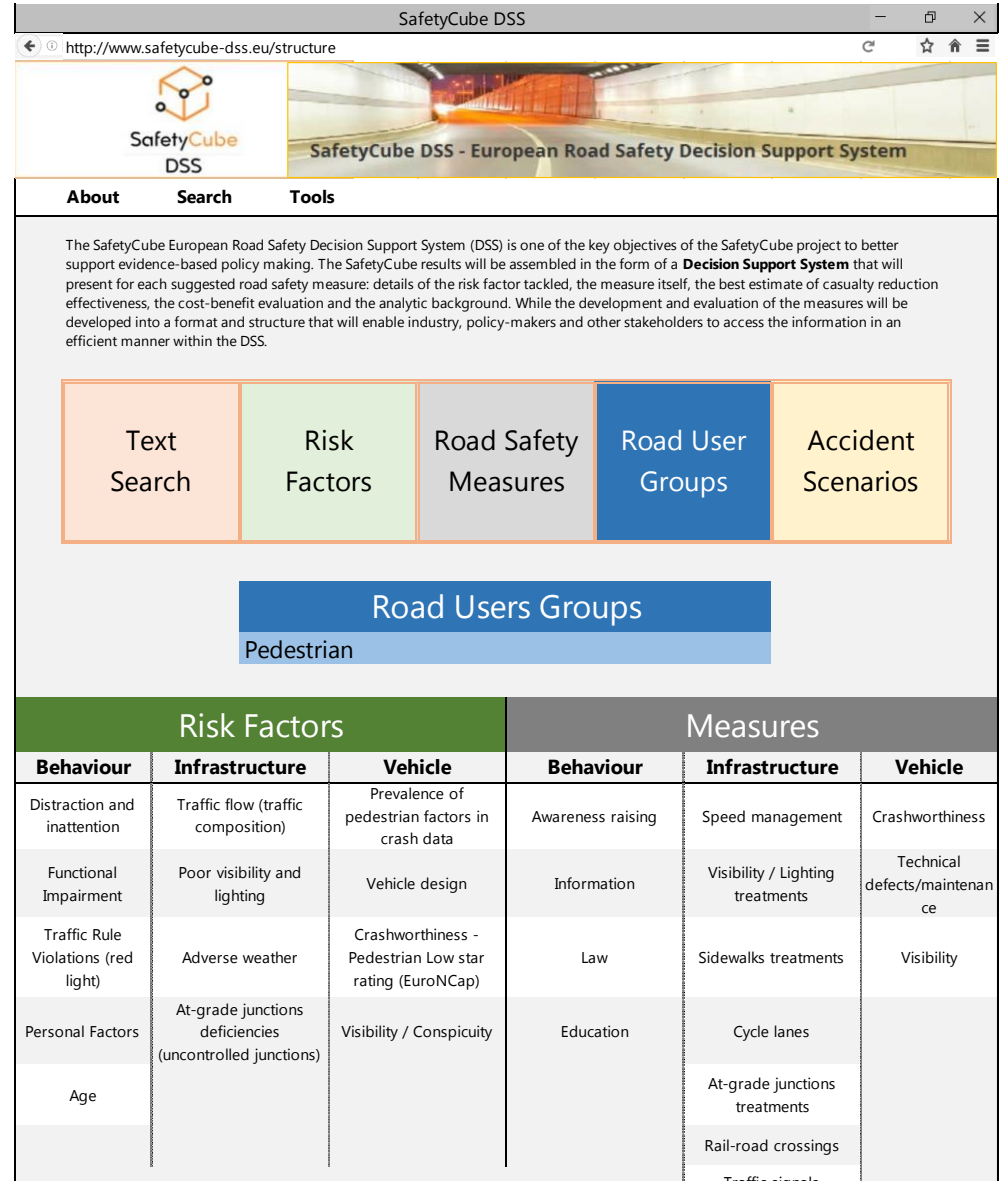
# Road User Group Search Parameters

## Road User Groups

- Pedestrian
- Bicycles
- Power Two Wheelers / ATV
- Passenger Cars
- Light Goods Vehicles
- Trucks / Bus

## For each group, 3+3 categories of taxonomy fields

- Risks: road user, infrastructure, vehicle
- Measures: road user, infrastructure, vehicle
- Topic
- Specific risk factor / measure



The screenshot shows the SafetyCube DSS website. The header includes the logo and the title "SafetyCube DSS - European Road Safety Decision Support System". The main navigation bar has links for "About", "Search", and "Tools". The "Search" section is active, displaying a grid of search categories: Text Search, Risk Factors, Road Safety Measures, Road User Groups (highlighted in blue), and Accident Scenarios. Below this grid, a dropdown menu for "Road Users Groups" is open, showing "Pedestrian" as the selected option. The bottom section of the page displays a table with two main columns: "Risk Factors" and "Measures". Each column has sub-columns for "Behaviour", "Infrastructure", and "Vehicle".

| Risk Factors                        |  |   | Measures          |                                  |                               |
|-------------------------------------|--|---|-------------------|----------------------------------|-------------------------------|
| Behaviour                           | Infrastructure   | Vehicle   | Behaviour         | Infrastructure                   | Vehicle                       |
| Distraction and inattention         | Traffic flow (traffic composition)                       | Prevalence of pedestrian factors in crash data          | Awareness raising | Speed management                 | Crashworthiness               |
| Functional Impairment               | Poor visibility and lighting                             | Vehicle design  | Information       | Visibility / Lighting treatments | Technical defects/maintenance |
| Traffic Rule Violations (red light) | Adverse weather  | Crashworthiness - Pedestrian Low star rating (EuroNCap) | Law               | Sidewalks treatments             | Visibility                    |
| Personal Factors                    | At-grade junctions deficiencies (uncontrolled junctions) | Visibility / Conspicuity                                | Education         | Cycle lanes                      |                               |
| Age                                 |  |   |                   | At-grade junctions treatments    |                               |
|                                     |  |   |                   | Rail-road crossings              |                               |
|                                     |  |   |                   | Traffic signals                  |                               |

# Accident Scenario Search Parameters

## Accident scenarios

- Pedestrian accident
- Bicycle accident
- Single vehicle accident
- Head-on collisions
- Rear end collisions
- Junction accident – no turning
- Junction accident – turning
- Railway level crossing

## For each scenario, 3+3 categories of taxonomy fields

- Related Risks: road user, infrastructure, vehicle
- Related Measures: road user, infrastructure, vehicle
- Topic
- Specific risk factor / measure

SafetyCube DSS

http://www.safetycube-dss.eu/structure

**SafetyCube DSS**

**SafetyCube DSS - European Road Safety Decision Support System**

**About Search Tools**

The SafetyCube European Road Safety Decision Support System (DSS) is one of the key objectives of the SafetyCube project to better support evidence-based policy making. The SafetyCube results will be assembled in the form of a **Decision Support System** that will present for each suggested road safety measure: details of the risk factor tackled, the measure itself, the best estimate of casualty reduction effectiveness, the cost-benefit evaluation and the analytic background. While the development and evaluation of the measures will be developed into a format and structure that will enable industry, policy-makers and other stakeholders to access the information in an efficient manner within the DSS.

**Text Search Risk Factors Road Safety Measures Road User Groups Accident Scenarios**

**Accident Scenarios**

Single vehicle accident

| Risk Factors                |  |                                 | Measures  |                |         |
|-----------------------------|--|---------------------------------|-----------|----------------|---------|
| Behaviour                   | Infrastructure                                       | Vehicle                         | Behaviour | Infrastructure | Vehicle |
| Speed choice                | Road surface deficiencies (risk of ran-off road)     | Injury mechanism                |           |                |         |
| Influenced driving alcohol  | Poor visibility and lighting                         | Crashworthiness                 |           |                |         |
| Influenced driving drugs    | Adverse weather                                      | Technical defects / Maintenance |           |                |         |
| Fatigue                     | Horizontal/vertical alignment deficiencies           |                                 |           |                |         |
| Distraction and inattention | Superelevation / cross-slopes (risk of ran-off road) |                                 |           |                |         |
| Personal Factors            | Lanes / ramps deficiencies                           |                                 |           |                |         |
|                             | Superelevation / cross-slopes (risk of ran-off road) |                                 |           |                |         |
|                             | Poor road readability                                |                                 |           |                |         |

# Text Search Parameters



## Key-word search

- Auto-complete field among all key-words in the database

## For each key-word, 3+3 categories of taxonomy fields

- Related Risks: road user, infrastructure, vehicle
- Related Measures: road user, infrastructure, vehicle
- Topic
- Specific risk factor / measure



| <input type="text" value="roundabouts"/> |                                      |                |                |   |                |
|--|--------------------------------------|----------------|----------------|---|----------------|
| Risk Factors                             |                                      |                | Measures       |   |                |
| Behaviour                                | Infrastructure                       | Vehicle        | Behaviour      | Infrastructure  | Vehicle        |
| not applicable                           | At-grade junctions deficiencies      | not applicable | not applicable | At grade junction treatments (conversion to roundabout) | not applicable |
|  | Junction readability - Traffic signs |                |                | Traffic signs treatments                                |                |
|  | Traffic control -                    |                |                | Road markings   |                |
|  |                                      |                |                |   |                |

# SafetyCube Tools pages



## Links to SafetyCube tools

- Cost Benefit Calculator
- Serious Injuries
- SafetyCube Methodology
- SafetyCube Glossary
- ...

SafetyCube DSS

http://www.safetycube-dss.eu/structure

SafetyCube DSS - European Road Safety Decision Support System

About Search **Tools**

### Road Safety Decision Support Tools

The following tools assist road safety decision making

**Cost Benefit Calculator**

The SafetyCube Cost Benefit Calculator allows you to perform Cost Benefit Analysis of a road safety measure, on the basis of its safety effects (number of crashes or casualties prevented), crash and casualties costs, implementation costs, implementation period etc.

**Serious Injuries**

The SafetyCube data and information on serious injuries include estimates of serious injuries in Europe, definitions of serious injuries etc.

**SafetyCube Methodology**

The SafetyCube Methodology for the analysis of risk factors and measures effects can be accessed through the SafetyCube reports, publications, and stakeholders' contributions.

**SafetyCube DSS glossary**

The glossary of the SafetyCube DSS includes all the definitions and meta-data of the DSS





# SafetyCube DSS Development

## Next steps

- Development of the **static DSS** (Wire Frames)
  - *Completed*
  - *[further improved incorporating comments from this Workshop]*
- SafetyCube DSS **Development phase**
  - *between September and December 2016*
  - *including all risk factors (~3.500 effects from 600 studies) and several measures*
- SafetyCube DSS **Pilot Operation**
  - *starting early 2017*
- SafetyCube DSS **Opening**
  - *Starting mid 2017*
- Continuous **Update**
  - *Starting on April 2018 (end of SafetyCube project)*







# SafetyCube

## Design of the European Road Safety Decision Support System

**George Yannis and Eleonora Papadimitriou**

SafetyCube Workshop  
Brussels, 27 September 2016



Co-funded by the Horizon 2020  
Framework Programme of the European Union

9/27/2016