

SafetyCube



European Road
Infrastructure Congress

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Development of a road safety Decision Support System for road infrastructure

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SafetyCube project

Funded by the European Commission under the Horizon 2020 research framework programme

Coordinator: Pete Thomas, Loughborough University

Start: May 2015

Finish: April 2018

17 partners from 12 EU countries



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 casualty reduction effectiveness
- cost-benefit evaluation
- all related analytic background

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



Road infrastructure topics in the SafetyCube DSS

Nearly 60 risk factors and 100 measures in more than 15 infrastructure areas - motorways, rural and urban roads - road segments and junctions -



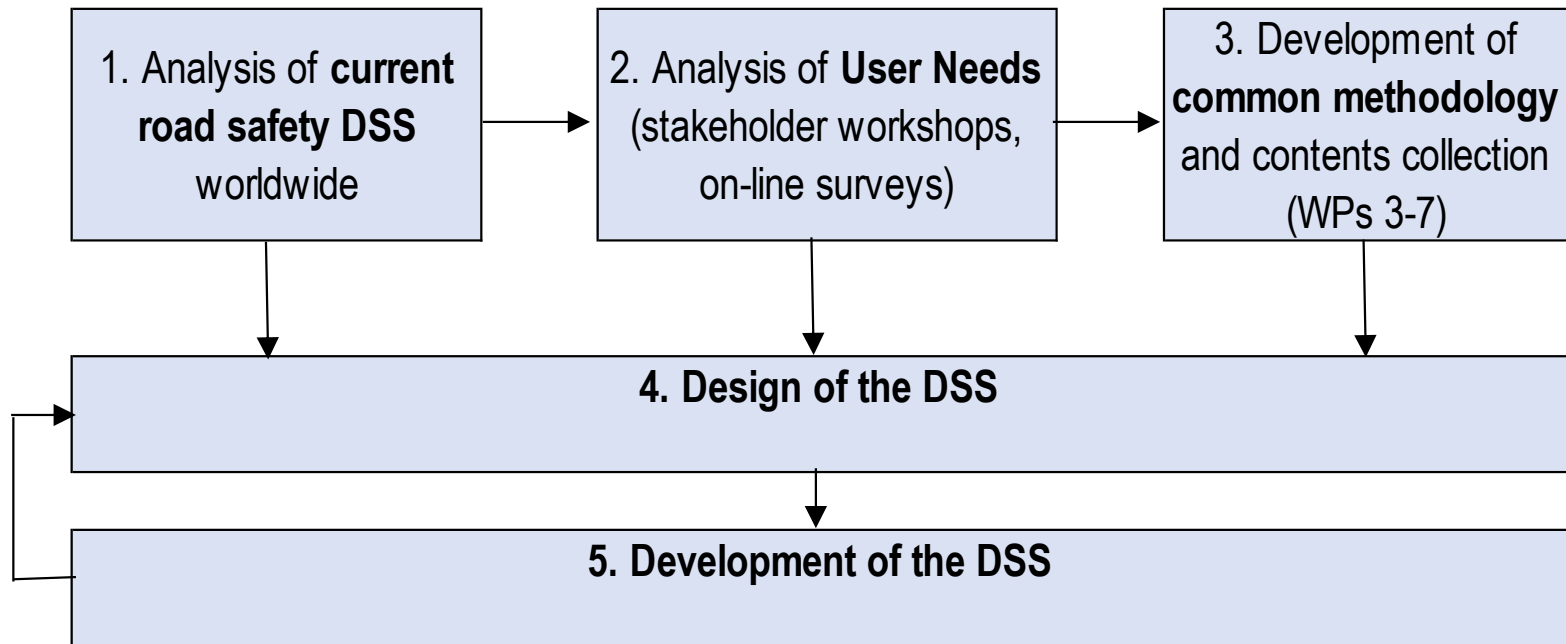
Road infrastructure 'hot topics'



- 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



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)
by NHTSA (USA) - **5.151 CMF** on infrastructure only - on going
- Road Safety Engineering Kit (www.engtoolkit.com.au)
by Austroads (Australia) - **67 treatments** on infrastructure only
- PRACT Repository (www.pract-repository.eu)
by CEDR (Europe) - **889 CMF and 273 APM** on infrastructure only – high quality
- iRAP toolkit (toolkit.irap.org/)
by iRAP - **58 treatments** (43 on infrastructure)
- Safety Performance Factors Clearinghouse (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, Jun 2015
 - Ljubljana, Oct 2015
 - Brussels (WP5-Infrastructure), Feb 2016
 - Hague (WP7-Serious Injuries), May 2016
 - Brussels, Sep 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
- **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.)



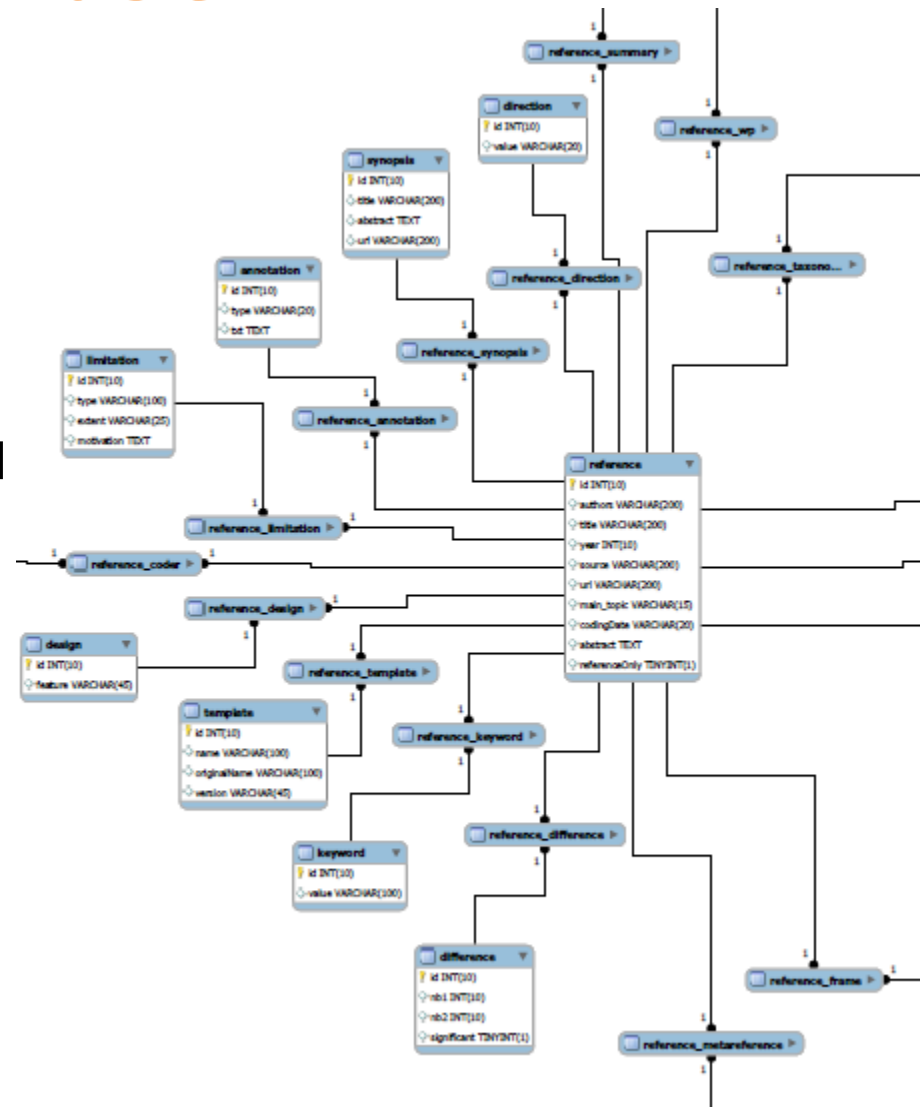
SafetyCube DSS Search Engine

- — ○
- **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 (accident scenaria)*
- **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.)*

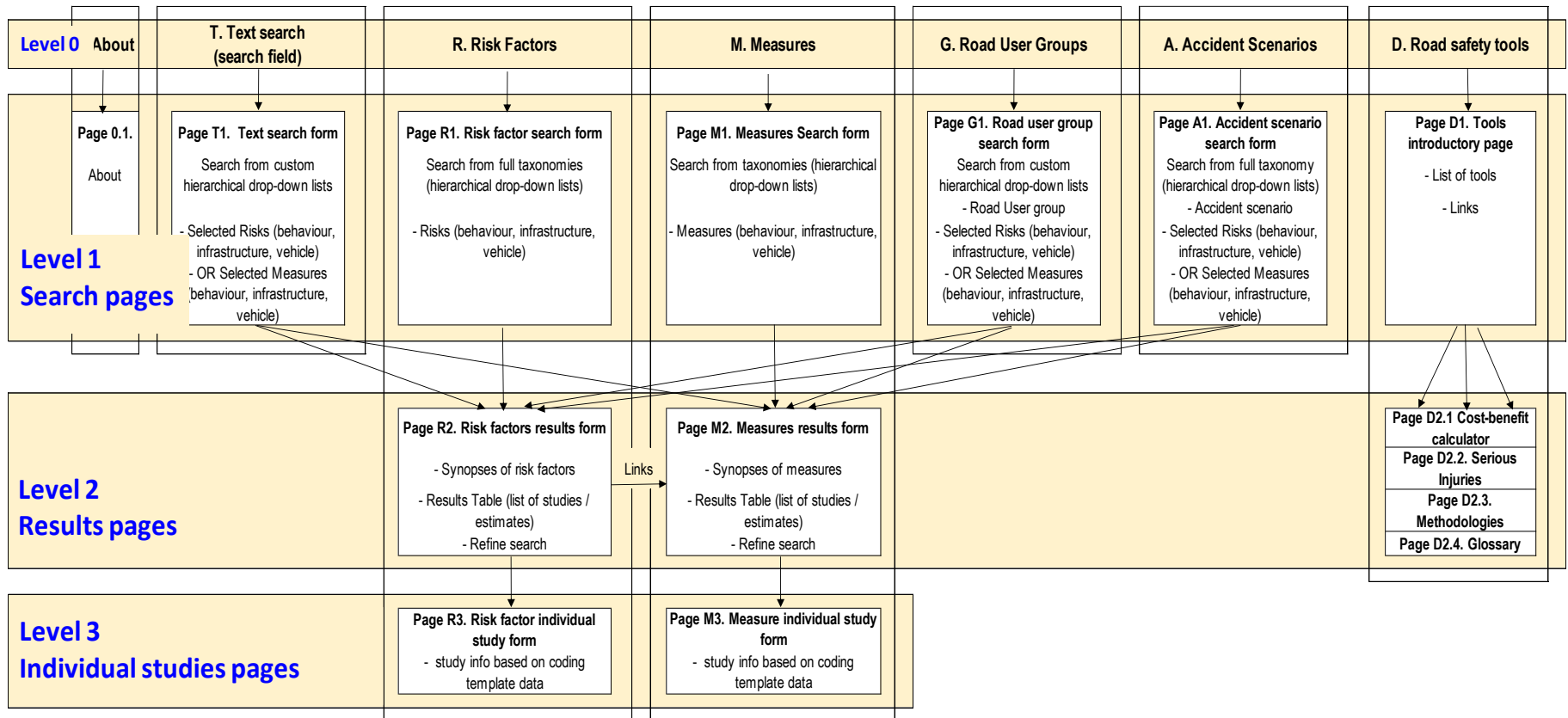


Relational Data Base

- 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 tabs for 'About', 'Search', and 'Tools'. Below the navigation menu, there is a main content area with a paragraph of text and a table of search options.

The SafetyCube DSS is the European Road Safety Decision Support System, which has been produced within the European research project SafetyCube, funded within the Horizons 2020 Programme of the European Commission, aiming to support evidence-based policy making.

The SafetyCube Decision Support System provides detailed interactive information on a large list of road accident risk factors and related road safety countermeasures.

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

- Categories (3)
road user, infrastructure, vehicle
- Topics (57)
e.g. roadside deficiencies, distraction inside vehicle, inappropriate speed
- Specific risk factors (175)
e.g. no clear-zone, mobile phone, too fast / too slow

The screenshot shows the SafetyCube DSS website interface. At the top, there is a navigation bar with tabs for 'About', 'Search', and 'Tools'. Below this, a large banner image shows a tunnel with a car's headlights illuminating the road. The text 'SafetyCube DSS - European Road Safety Decision Support System' is overlaid on the image.

Below the banner, there is a row of five colored boxes representing different search categories: 'Text Search' (orange), 'Risk Factors' (green), 'Road Safety Measures' (grey), 'Road User Groups' (blue), and 'Accident Scenarios' (yellow). The 'Risk Factors' box is highlighted.

Underneath the 'Risk Factors' box, there is a detailed table with three columns: 'Behaviour', 'Infrastructure', and 'Vehicle'. The table lists various risk factors and their associated details.

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 run-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 run-off road)	
Insufficient knowledge	Lanes / ramps deficiencies	

Measures Search Parameters



Three categories of taxonomy fields

- Categories
road user, infrastructure, vehicle
- Topics
e.g. formal tools to address road network deficiencies, speed regulation
- Specific measures
e.g. road safety audits, lower speed limits

The screenshot shows the SafetyCube DSS website. The browser address bar displays 'http://www.safetycube-dss.eu/structure'. The page features a navigation menu with 'About', 'Search', and 'Tools' tabs. Below the menu is a descriptive paragraph about the DSS system. A horizontal bar contains five categories: 'Text Search', 'Risk Factors', 'Road Safety Measures', 'Road User Groups', and 'Accident Scenarios'. The 'Road Safety Measures' category is highlighted, leading to a table with the following structure:

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 main content area displays search results for 'Work Zone duration' and 'Work Zone length'. Each result includes a summary paragraph and a 'Related Road Safety Measures' button. Below the summaries is a table with columns: Risk Factor, Source, Outcome variable, Effect estimator, Effect size, and Country.

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

Individual study results



Title, author, source, abstract

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

Study design info

- Country
- Research Method, Design, Sample N
- Control group, Risk Group
- Modifying Conditions

Study results:

- Table listing the effects reported in the study
- Table columns concern main study / effect characteristics (outcome variable, effect type, size and confidence intervals, statistical significance)

SafetyCube DSS

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

[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)

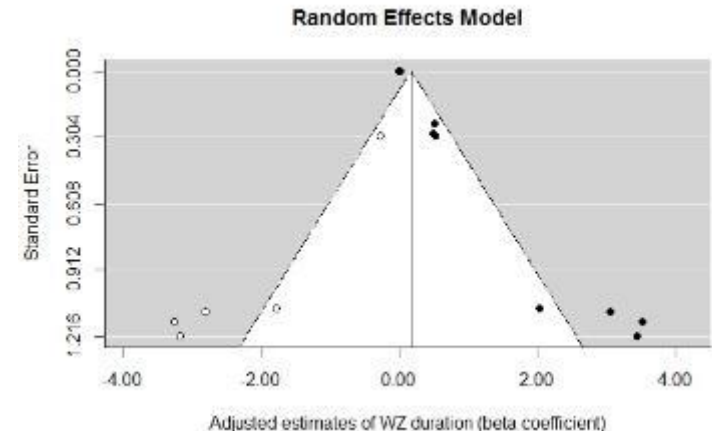
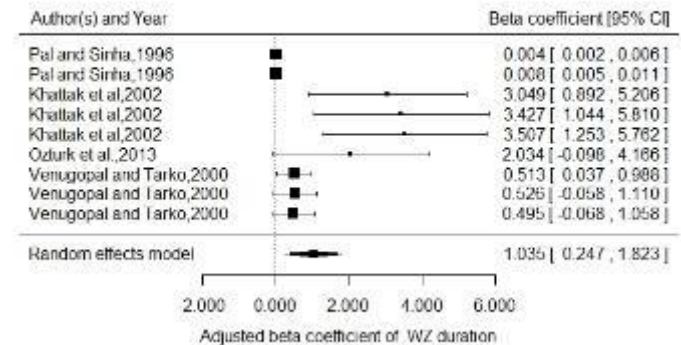
- Effect of risk factor / measure and ranking (colour code)
- Risk / safety effect mechanisms
- Risk / safety effects size, transferability of effects

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
- 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

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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

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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

roundabouts

Risk Factors			Measures		
Behaviour	Infrastructure	Vehicle	Behaviour	Infrastructure	Vehicle
<i>not applicable</i>	At-grade junctions deficiencies	<i>not applicable</i>	<i>not applicable</i>	At grade junction treatments (conversion to roundabout)	<i>not applicable</i>
	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*
- **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 Enhancement and Update**
 - *Starting on April 2018 (end of SafetyCube project)*



Example questions addressed

- how important is my road safety problem?
- who else is having similar problems?
- 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



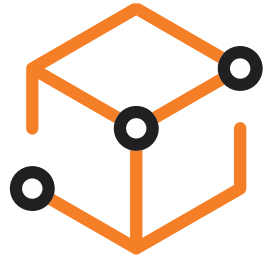
SafetyCube DSS

Delivering a long waited powerful tool



- The SafetyCube DSS is a powerful Road Safety Decision Support Tool:
 - long waited,
 - full of scientific evidence,
 - user friendly, web-based and interactive
- 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 and worldwide, constantly improved and enhanced





SafetyCube



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