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 -
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

1. Analysis of current road safety DSS worldwide
2. Analysis of User Needs (stakeholder workshops, on-line surveys)
3. Development of common methodology and contents collection (WPs 3-7)
4. Design of the DSS
5. Development of the DSS

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, 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 scenarios)

- **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.)
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

Level 0
- About
  - Text search (search field)
    - Risk Factors
    - Measures
    - Road User Groups
    - Accident Scenarios
    - Road safety tools

Level 1
- Search pages
  - Page T1. Text search form
    - Search from custom hierarchical drop-down lists
    - Selected Risks (behaviour, infrastructure, vehicle)
    - OR Selected Measures (behaviour, infrastructure, vehicle)
  - Page R1. Risk factor search form
    - Search from full taxonomies (hierarchical drop-down lists)
    - Risks (behaviour, infrastructure, vehicle)
  - Page M1. Measures search form
    - Search from taxonomies (hierarchical drop-down lists)
    - Measures (behaviour, infrastructure, vehicle)
  - Page G1. Road user group search form
    - Search from custom hierarchical drop-down lists
    - Road User group
    - Selected Risks (behaviour, infrastructure, vehicle)
    - OR Selected Measures (behaviour, infrastructure, vehicle)
  - Page A1. Accident scenario search form
    - Search from full taxonomy (hierarchical drop-down lists)
    - Accident scenario
    - Selected Risks (behaviour, infrastructure, vehicle)
    - OR Selected Measures (behaviour, infrastructure, vehicle)
  - Page D1. Tools introductory page
    - List of tools
    - Links

Level 2
- Results pages
  - Page R2. Risk factors results form
    - Synopses of risk factors
    - Results Table (list of studies / estimates)
    - Refine search
  - Page M2. Measures results form
    - Synopses of measures
    - Results Table (list of studies / estimates)
    - Refine search

Level 3
- Individual studies pages
  - Page R3. Risk factor individual study form
    - Study info based on coding template data
  - Page M3. Measure individual study form
    - Study info based on coding template data

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 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.

<table>
<thead>
<tr>
<th>Text Search</th>
<th>Risk Factors</th>
<th>Road Safety Measures</th>
<th>Road User Groups</th>
<th>Accident Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search for your topic within the entire SafetyCube database of studies on road safety Risk Factors and Measures.</td>
<td>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.</td>
<td>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.</td>
<td>Search for Risk Factors and Measures related to different Road User Groups.</td>
<td>Search for Risk Factors and Measures related to different Accident Scenarios.</td>
</tr>
</tbody>
</table>
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 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.
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

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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
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)

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 (AADT) 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.


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 and 1993
Risk group: Work zone
Control group:
Modifying conditions: AADT

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

<table>
<thead>
<tr>
<th>Risk factor</th>
<th>Unit</th>
<th>Outcome variable</th>
<th>Effect type</th>
<th>Effect size</th>
<th>Main outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ln of workzone duration</td>
<td>Days</td>
<td>Injury and non-injury crashes</td>
<td>Slope</td>
<td>1.1149</td>
<td>Significant negative effect on road safety</td>
</tr>
<tr>
<td>Ln of workzone duration</td>
<td>Days</td>
<td>Non-injury crashes</td>
<td>Slope</td>
<td>1.2317</td>
<td>Significant negative effect on road safety</td>
</tr>
<tr>
<td>Ln of workzone duration</td>
<td>Days</td>
<td>Injury crashes</td>
<td>Slope</td>
<td>1.2549</td>
<td>Significant negative effect on road safety</td>
</tr>
<tr>
<td>Ln of workzone length</td>
<td>Km</td>
<td>Injury and non-injury crashes</td>
<td>Slope</td>
<td>0.6718</td>
<td>Significant negative effect on road safety</td>
</tr>
<tr>
<td>Ln of workzone length</td>
<td>Km</td>
<td>Non-injury crashes</td>
<td>Slope</td>
<td>0.6112</td>
<td>Significant negative effect on road safety</td>
</tr>
<tr>
<td>Ln of workzone length</td>
<td>Km</td>
<td>Injury crashes</td>
<td>Slope</td>
<td>0.7842</td>
<td>Significant negative effect on road safety</td>
</tr>
</tbody>
</table>
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 designs 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
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

About            Search            Tools

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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

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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
SafetyCube Tools pages

Links to SafetyCube tools

• Cost Benefit Calculator
• Serious Injuries
• SafetyCube Methodology
• SafetyCube Glossary
• …
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
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