SafetyCube - the European Road Safety Decision Support System

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The 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 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
- all related analytic background

Special focus on linking road safety problems with related measures.
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 Methodology

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

- **Systems approach**: links between infrastructure, user and vehicle risks
- 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 Taxonomies

Three-level taxonomies
Separately for risks and measures

• **4 Categories**
  road user, infrastructure, vehicle, post impact care

• **88 Topics**
  e.g. distraction, roadside, crashworthiness

• **175 Specific topics**
  e.g. mobile phone use, no clear-zone, low pedestrian rating (NCAP)
Selection and Coding of Studies

Study search in key databases
(Scopus, TRID, Elsevier, Taylor & Francis, Springer etc.)

Study selection and prioritization criteria
• Studies with quantitative results
• Meta-analyses, or other high quality studies (peer-reviewed journals)
• Recent studies
• European studies

Coding of studies in a dedicated template
• Study design and methodology
• Results and their confidence intervals
• Study limitations
SafetyCube Synopses

139 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
SafetyCube Links between Risks & Measures

Based on a dedicated methodology

- **Sequence of crash events**
  - Pre-crash events → crash → consequences/outcomes

- **Risk factors can be:**
  - *Generic* (e.g. alignment deficiency)
  - *Circumstantial* (e.g. alcohol)

- **Measures may address:**
  - *Generic risks*: (e.g. road safety audit)
  - *Circumstantial risks*: (e.g. enforcement)

Validated through studies and synopses results (ongoing)

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Measures</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Infrastructure</strong></td>
<td>Road alignment, traffic control etc.</td>
<td>Friction, traffic, weather etc.</td>
</tr>
<tr>
<td><strong>Vehicle</strong></td>
<td>Compatibility, Passive safety etc.</td>
<td>technical defects</td>
</tr>
<tr>
<td><strong>Road User</strong></td>
<td>Age, functional impairment, aggressiveness etc.</td>
<td>Alcohol, speed, distraction etc.</td>
</tr>
</tbody>
</table>

- **Measures**
  - **Infrastructure**: RS management, alignment and traffic control treatments etc.
  - **Speed management**, visibility & lighting treatments etc.

- **Vehicle**: Regulations, Vehicle standards, Communication, Longitudinal and lateral control, Passive safety

- **Road User**: Education, Licensing standards etc., Enforcement & campaigns speed, alcohol, distraction etc.

- **Post crash care**

<table>
<thead>
<tr>
<th>Crash scenario</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ran-off road pedestrian crash etc.</td>
<td></td>
</tr>
</tbody>
</table>
Coded studies, Synopses and Links undergo a thorough checking and debugging process.

All inputs are eventually stored in a **relational database**, which serves as the back-end of the DSS.

Front-end DSS results are retrieved through the DSS search Engine (queries on the back-end database).
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 categories)

• Fully detailed search
  – search by any parameter in each data table in the database

• Fully flexible search
  – adjust and customize search according to results

• Fully documented search
  – access background information at any stage (supporting documentation, links, etc.)
SafetyCube DSS Design Principles

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

Five entry points

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

Two Interlinked Pillars
  - Risk Factors
  - Road Safety Measures
SafetyCube DSS Menu

- **Search**
  Risk Factors & Measures

- **Knowledge**
  135 synopses

- **Calculator**
  Econ. Efficiency Evaluation
  (under development)

- **Methodology**
  System documentation

- **Support**
  Contact, help, feedback
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)
SafetyCube DSS Results Pages

Search results
• Synopses, and their short summaries & colour codes
• Table listing the available studies

Refine search
• Specific Risk factor / Measure
• Other search filters:
  - Road user groups: All, car occupants, drivers, passengers, PTW riders, pedestrians, cyclists, HGV.
  - Road types: All, motorways, rural roads, urban roads
  - Country: EU, EU countries (all names), US and Canada, Australia, Asia.

Links to related measures
• Select a specific risk factor / measure
• Get the list of related measures
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

Abstract

Work zones are temporary traffic control zones that can potentially cause safety problems. Maintaining safety, while implementing necessary changes on roadways, is an important challenge for traffic engineers and researchers alike. In this study, the risk factors in work zone safety evaluation were identified through the estimation of a crash frequency (CF) model. The model was used in an exploratory analysis of a CF model, and it was utilized to estimate crash parameters. Among these, work zone length values remain a major concern in this analysis because they may change the construction schedule's progression generally without being properly documented. This paper proposes an improved modeling and estimation approach that involves the use of a measurement error (ME) model integrated with the traditional negative binomial (NB) model. The proposed approach was compared with the traditional NB approach. Both models were evaluated using a large dataset that consists of 60 work zones in New Jersey. Results showed that the proposed improved approach outperformed the traditional approach in terms of goodness-of-fit statistics. Moreover, it is shown that the use of the traditional NB approach in this context can lead to an overestimation of the effect of work zone length on the crash occurrence.

DOI: 10.1016/j.jsr.2019.02.381.

Summary

This study investigates work zone crashes in New Jersey state. 7 years of data are exploited. Full Bayesian negative binomial models are applied. AODT, length of workzone and number of operating lanes in the workzone were found to increase frequency of injury and non-injury (property damage only) accidents.

Study Design

<table>
<thead>
<tr>
<th>Topic</th>
<th>Risk Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design:</td>
<td>Observational, Cross-sectional</td>
</tr>
<tr>
<td>Country:</td>
<td>United States</td>
</tr>
</tbody>
</table>

Keywords: Full Bayesian Measurement Error Negative Binomial Model Crash Frequency Safety Analysis Work Zone

Effects

<table>
<thead>
<tr>
<th>Effect No.</th>
<th>Outcome</th>
<th>Exposure</th>
<th>Group Type</th>
<th>Group</th>
<th>Effect Estimator Specification</th>
<th>Sample Estimate</th>
<th>Estimate Lower Limit</th>
<th>Estimate Upper Limit</th>
<th>Conclusion Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Number of Property Damage Only Accidents</td>
<td>Slope</td>
<td>Full Bayesian Negative Binomial Model</td>
<td>0.847</td>
<td>0.709</td>
<td>0.965</td>
<td>Significant negative effect on road safety. The model with the best fit is presented (lower DIC values), lower and upper limit refers to the 95% credible intervals (0.74%–0.97%).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Number of Property Damage</td>
<td>Slope</td>
<td>Full Bayesian Negative Binomial Model</td>
<td>0.528</td>
<td>0.415</td>
<td>0.634</td>
<td>Significant negative effect on road safety.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

No significant effects were found for other risk factors.
SafetyCube Related Risks / Measures

Related Studies for "poor visibility - darkness"

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

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Infrastructure</th>
<th>Vehicle</th>
<th>Post Impact Care</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helmet, protective clothing &amp; visibility</td>
<td>installation of road lighting</td>
<td>Enhanced headlights (automated, adaptive, advanced systems, etc.)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Improvement of existing lighting</td>
<td>Night Vision</td>
<td>Vehicle backup camera - Reversing Detection or Camera systems (DIC)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ID</th>
<th>Title</th>
<th>Source</th>
<th>Year</th>
<th>Design</th>
<th>Countries</th>
</tr>
</thead>
<tbody>
<tr>
<td>327</td>
<td>Relationship Between Roadway Illuminance, Level and Nighttime Rural Intersection Safety</td>
<td>TRANSPORTATION RESEARCH RECORD: JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, NO. 2485, PP. 86-92/11, 15</td>
<td>2015</td>
<td>CROSS-SECTIONAL</td>
<td>UNITED STATES</td>
</tr>
<tr>
<td>328</td>
<td>Road Lighting Effects on Bicycle and Pedestrian Accident Frequency Case</td>
<td>TRANSPORTATION RESEARCH RECORD: JOURNAL OF THE</td>
<td>2016</td>
<td>CROSS-SECTIONAL</td>
<td>CANADA</td>
</tr>
</tbody>
</table>
SafetyCube DSS Calculator

Economic Efficiency Evaluation Tool (E3)

- 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**.

- 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

- Under development and coming soon ...
SafetyCube DSS Knowledge Wealth

SafetyCube DSS will eventually include by April 2018:

- more than **1,200 studies**,

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

- more than **150 Synopses**

- more than **50 cost-benefit analyses** (adjustable)
Development and Operation Phases

- SafetyCube DSS Pilot Operation
  - Started early 2017
  - User feedback exploited

- SafetyCube DSS Opening
  - October 2017

- Continuous Enhancement and Update
  - Until April 2018 (end of SafetyCube project)
  - And beyond...
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. It is developed in a form that can readily be incorporated within the existing European Road Safety Observatory of the European Commission DG-MOVE.
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
Delivering a long waited 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 - the European Road Safety Decision Support System

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