

# SafetyCube - the European Road Safety Decision Support System



Prof. George Yannis  
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Decision Support System Launch Event  
Brussels, October 5, 2017



# 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 DSS Users



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

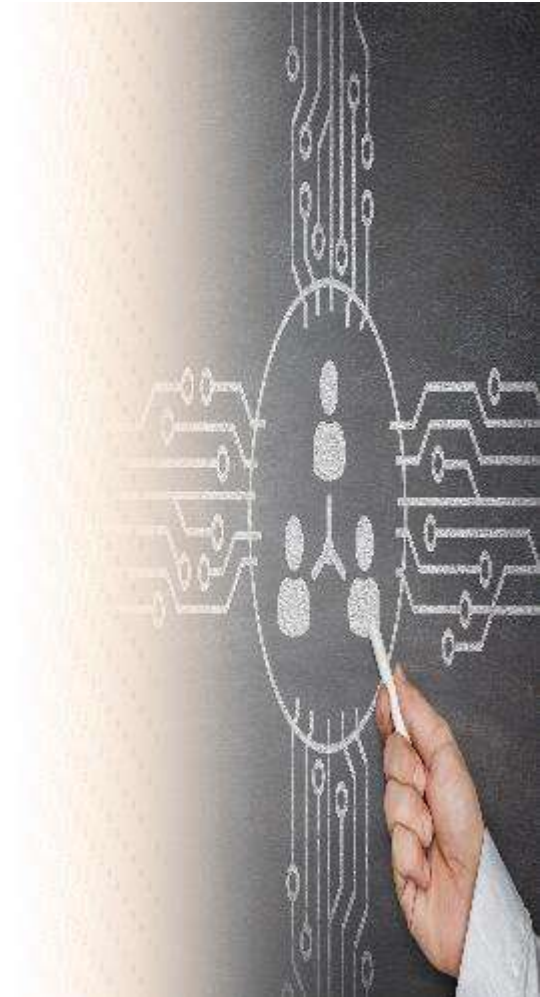
The SafetyCube DSS is intended to have **a life well beyond the end of the SafetyCube** research project. It is developed in a form that can readily be incorporated within the existing European Road Safety Observatory of the European Commission DG-MOVE.





# 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)

Behavior	Infrastructure	Vehicle	Post Impact Care
Law and enforcement	Traffic flow	Frontal impact	Ambulances/helicopters
Education and voluntary training or programmes	Traffic composition	Side impact	Extraction from vehicle
Driver training and licensing	Formal tools to address road network deficiencies	Rear impact	Pre-hospital medical care
Fitness to drive assessment and rehabilitation	Speed management & enforcement	Rollover	Triage and allocation to trauma facilities
Awareness raising and campaigns	Road type	Pedestrian	First aid training drivers
	Road surface treatments	Child	
	Visibility / Lighting treatments	PTW	
	Workzones	Cyclist	
	Horizontal & vertical alignment treatments	HGV	
		Longitudinal	

# 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





## Summary (2 pages)

- ## Scientific overview (4-5 pages)

- ### Supporting document (3-10 pages)

- Literature search strategy and study selection criteria
- Detailed analyses



Trasferrare a: Aggallanino 6, Zalpogno 6, Ivrea 2, Saplendano 6, Riva 2.  
 2 settembre 1948

2019.11.10 星期一

The presence of ferry workstations is tentatively considered as a risk factor, since more crashes are likely to occur in urbanized work areas areas (increased crash risk). This result was supported by all coded studies, which have shown a consistent negative effect on the number of crashes (increased crash risk) and was also confirmed by the meta-analysis carried out. This study also indicates that increased lengths of work areas increase the probability of crash occurrence.

● 2019年10月1日起，新到图书一律按9折销售。

Sept: 22-44; length: 100-110

100%

It can be assumed that long work hours may increase risk of injuries, because work hours are an important risk assessment for most road users, due to special arrangements (e.g. overtime, shifts, double shifts), changed road conditions (e.g. darkness, presence of barriers, reduced visibility) and, in general, work hours length can be found to significantly increase the number of accidents. The last majority of measurement-based investigations (work frequency, including also longer work hours) and risk networks (not associated with an increased number of crashes at a 95% confidence level) did not confirm the hypothesis that the more driving was performed, the more significant overall amount of work hours length increases risk. Only two studies that investigated crash risk probability of each occupation in each month measured are found, suggesting that work hours length significantly increases crash risk.

1000

### 3.1.4 Sufficiency of sample size

The test paper has a straightforward difference in international versions. It is printed as 'cent cent length' and examined as 'centimetre centimetre' in miles or 'centimetre', however, a number of studies measure it as 'centimetre' together with length, for modelling purposes.

0.4.4. *How does work and family affect each other?*

It is expected that long-term care may increase risk of stroke, because work stress is an inferior work environment for most men, due to its special arrangements (time pressure, shifts, disruptions, changes in meal distribution and spacing, presence of patients, visitors, customers etc.). Therefore, a clear approach to such risks is almost impossible. Consequently, it is likely that they pose a general threat to the safety of road users than regular road segments. Therefore, presence of such arrangements for long-term segments can determine road safety levels.

2.4.4 Which safety concerns are affected by work area height?

in international literature, the effect of work zone length on road safety has been measured mainly on the basis of crash frequency (number of crashes occurred). Less frequently, it was found to be

It is noted that no studies concerning crash injury severity were identified through the literature search.

2.2.2. *What is the effect of work stress health-related*

In general, when the impact of work zone length is examined, crash data from police reports are usually utilized. Applying the methods of analysis, the effect of workzone length is usually examined by applying multinomial (or linear statistical) models. When crash frequency is examined, the relationship between work zone length and number of crashes is investigated by applying negative binomial models. Probability of crash occurrence was investigated by applying two events (logit) regression models.

[illegible]

The prior examination of relevant studies suggests that the effect of work zone length on road safety is generally consistent, showing that when work zones have increased length the number of crashes is increased. The joint direction of the effect is obtained when crash risk is examined separately of crash severity or non-crash severity<sup>2</sup>, while there is also a negative effect of work zone length on safety.

on the frequency of vocalizations is presumed to be the same for all observations (all were same segments). Consequently, the resulting parameter estimates may be biased.

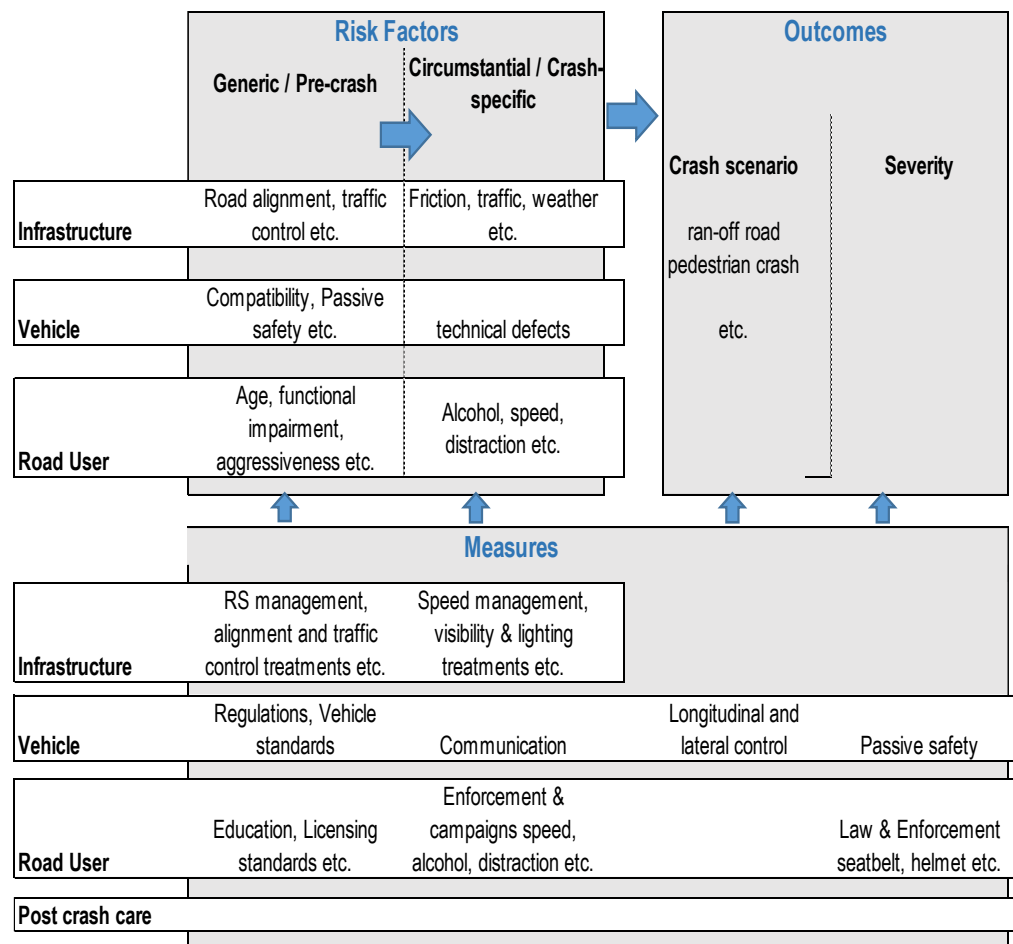
Overall, the role of Twitter could be considered to be adequately studied. However, there are no studies focusing on the effects of work and length on media or spilling over effects. Moreover, this all concern studies of the US and there is no specific focus on different media users. In conclusion, data concerning more countries and different media users are needed.

# SafetyCube Links between Risks & Measures

Based on a dedicated methodology

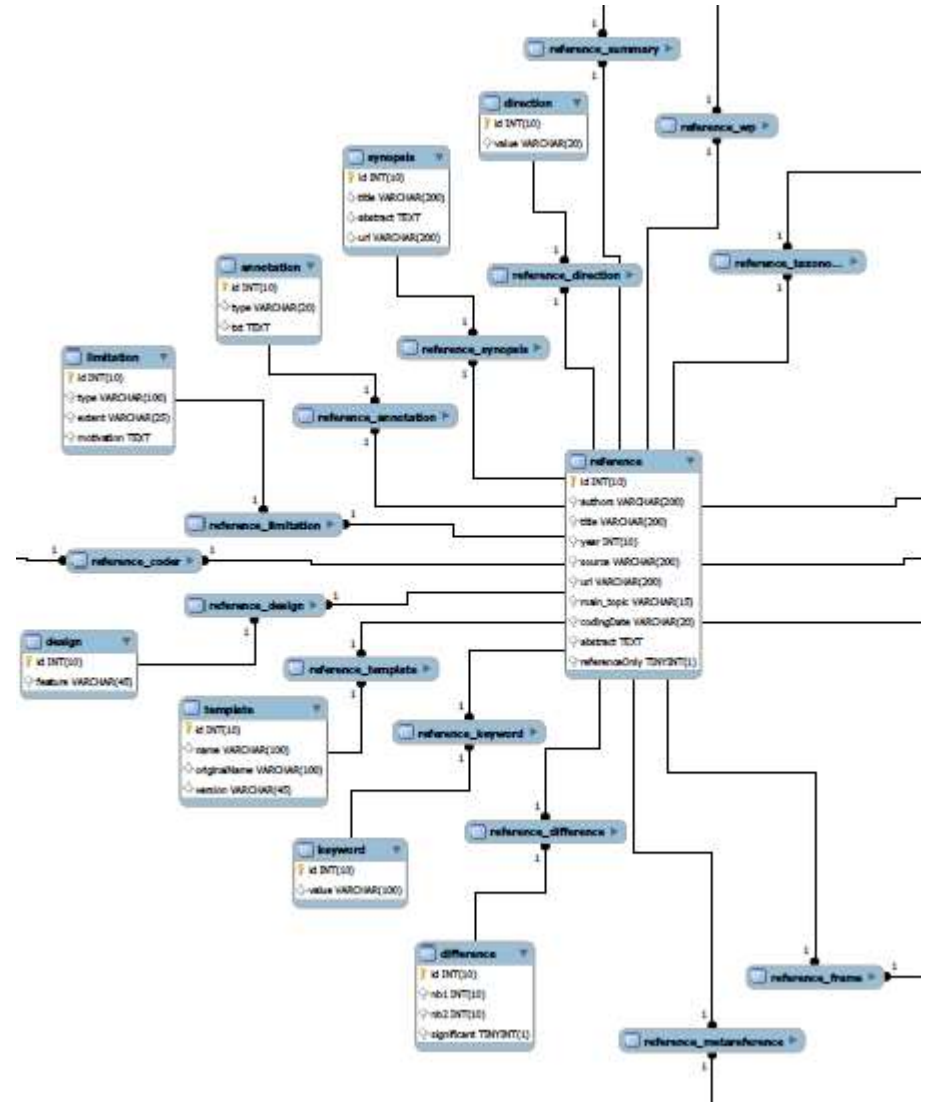
- Sequence of crash events
- Pre-crash events → crash → consequences/outcomes
- Risk factors can be:
  - Generic (e.g. alignment deficiency)
  - Circumstantial (e.g. alcohol)
- Measures may address:
  - Generic risks: (e.g. road safety audit)
  - Circumstantial risks (e.g. enforcement)

Validated through studies and synopses results (ongoing)



# SafetyCube DSS back-end database

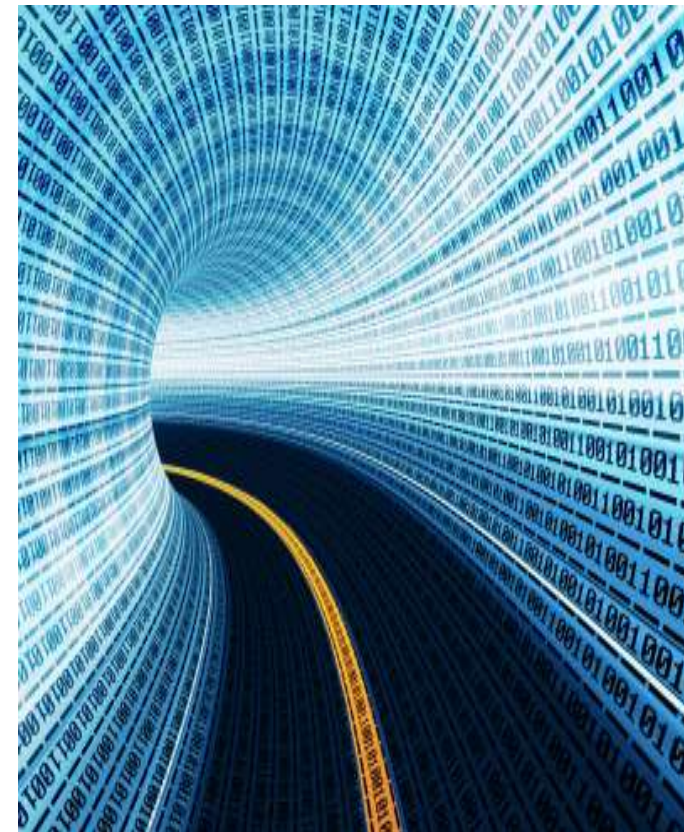
- Coded studies, Synopses and Links undergo a thorough checking and debugging process
- All inputs are eventually stored in a **relational database**, which serves as the back-end of the DSS
- Front-end DSS results are retrieved through the DSS search Engine (queries on the back-end database).



# 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)

The screenshot displays the SafetyCube DSS interface. The header includes the logo and the text 'European Road Safety Decision Support System'. A navigation bar contains links for Search, Knowledge, Calculator, Methodology, and Support. The main content area shows a list of categories on the left, with 'PEDESTRIANS' selected. To the right, there are five large tiles for Keyword Search, Risk Factors, Measures, Road User Groups, and Accident Categories. Below these, a table lists risk factors and measures for pedestrians.

Risk Factors			Measures			
Behavior	Infrastructure	Vehicle	Behavior	Infrastructure	Vehicle	Post Impact Care
Functional Impairment	Adverse weather	LDV	Education and voluntary trainings/programs	Traffic signs treatments	Not Applicable	Not Applicable
Traffic Rule Violations	Poor junction readability	Passenger Cars		Road markings at junctions		
	At-grade junction deficiencies	Pedestrian		Speed management & enforcement		
	Median / barrier deficiencies (risk of crash with oncoming traffic)	PTV / ATV		Speed management		
	Traffic flow			Traffic signs treatments		
				Rail-road crossings		

# SafetyCube DSS Results Pages

## Search results

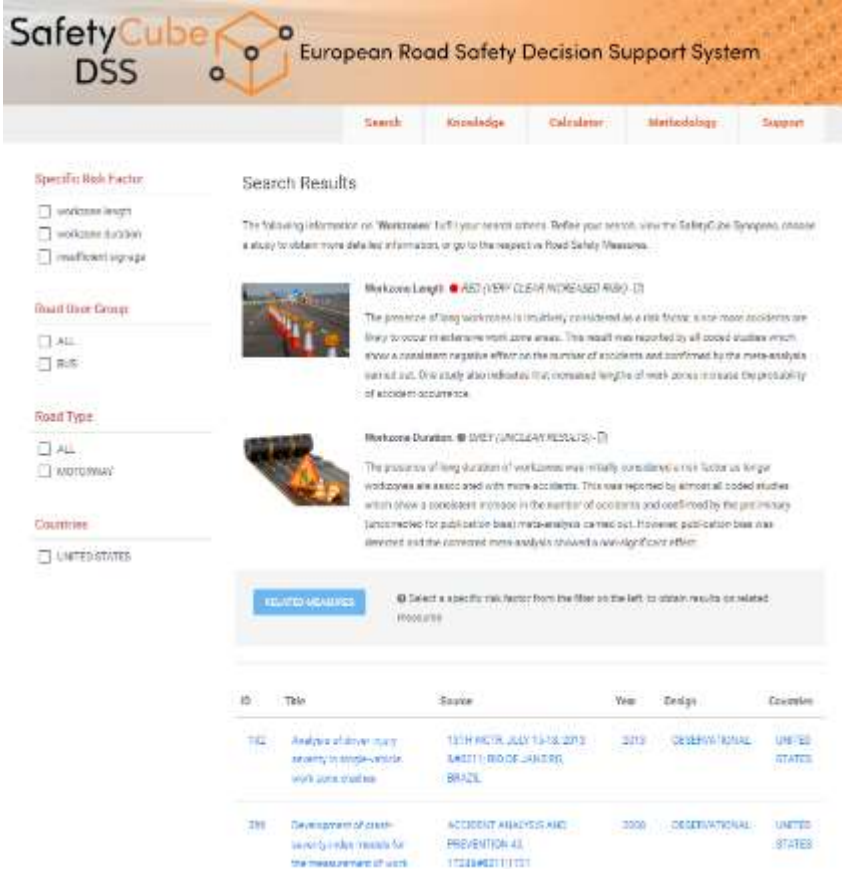
- Synopses, and their short summaries & colour codes
- Table listing the available studies

## 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



The screenshot displays the SafetyCube DSS interface. The header includes the logo and the text 'European Road Safety Decision Support System'. Navigation tabs for 'Search', 'Knowledge', 'Calculator', 'Methodology', and 'Support' are visible. The left sidebar contains filters for 'Specific Risk Factor' (Workzone length, Workzone duration, Insufficient signage), 'Road User Groups' (All, Bus), 'Road Type' (All, Motorway), and 'Country' (United States). The main content area shows 'Search Results' for 'Workzone Length' with a red dot indicating a selected filter. It includes a synopsis of the filter's impact on accident rates, a 'RELATED MEASURES' button, and a table of related studies.

ID	Title	Source	Year	Design	Country
162	Analysis of driver injury severity by single-vehicle work zone crashes	11TH FICHT, JULY 13-18, 2013 SAFETY 11: ROAD SAFETY BRAZIL	2013	OBSERVATIONAL	UNITED STATES
288	Development of crash severity index results for the measurement of work	ACCIDENT ANALYSIS AND PREVENTION 43 17238462111121	2008	OBSERVATIONAL	UNITED STATES

# 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



### Modeling work zone crash frequency by quantifying measurement errors in work zone length

Heng H., Orbay R., Ozkan G., Vlastakis M.

#### Abstract

Work zones are temporary traffic control zones that can potentially cause safety problems. Maintaining safety while implementing necessary changes on highways is an important challenge traffic engineers and researchers have to confront. In this study, the risk factors in work zone safety evaluation were identified through the estimation of a crash frequency (CF) model. Measurement errors in explanatory variables of a CF model can lead to unreliable estimates of certain parameters. Among these, work zone length raises a major concern in this analysis because it may change as the construction schedule progresses generally without being properly documented. This paper proposed 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 estimated 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 the overestimation of the effect of work zone length on the crash occurrence.

DOI:10.1016/j.aap.2013.02.021

#### Summary

The study investigates workzone crashes in New Jersey state. 7 years of data are exploited. Full Bayesian negative binomial models are applied. AADT, 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

Topic: RISK FACTOR  
Source: ACCIDENT ANALYSIS AND PREVENTION 58 (2013) 182&#x2013;191  
Design: OBSERVATIONAL CROSS-SECTIONAL  
Countries: UNITED STATES  
Keywords: FULL BAYESIAN MEASUREMENT ERROR NEGATIVE BINOMIAL MODEL CRASH-FREQUENCY SAFETY ANALYSIS WORK ZONE

#### Effects

Effect No.	Outcome	Exposure	Group Type	Effect Group	Effect Estimator	Estimator Specifications	Sample	Estimate	Estimate Lower Limit	Estimate Upper Limit	Credible Comments
1	NUMBER OF PROPERTY DAMAGE ONLY ACCIDENTS				SLOPE	FULL BAYESIAN NEGATIVE BINOMIAL MODEL		0.847	0.729	0.965	SIGNIFICANT NEGATIVE EFFECT ON ROAD SAFETY THE MODEL WITH THE BEST FIT IS PRESENTED (LOWER DIC VALUE). LOWER AND UPPER LIMIT REFER TO THE 95% CREDIBLE INTERVALS (0.3%&#x2013;0.2%).
2	NUMBER OF PROPERTY DAMAGE				SLOPE			0.838	0.413	0.858	SIGNIFICANT NEGATIVE EFFECT ON ROAD SAFETY



# 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.

Behavior	Infrastructure	Vehicle	Post Impact Care
Helmet, protective clothing and visibility	Installation of road lighting	Enhanced Headlights (automated, adaptive, advanced system, ...)	Not Applicable
	Improvement of existing lighting	Night Vision	
		Vehicle backup camera - Reversing Detection or Camera systems (REV)	

### Countries

- ☐ CANADA
- ☐ NETHERLANDS
- ☐ UNITED KINGDOM
- ☐ UNITED STATES

ID	Title	Source	Year	Design	Countries
327	Relationship Between Roadway Illuminance Level and Nighttime Rural Intersection Safety	TRANSPORTATION RESEARCH RECORD: JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, NO. 2485, PP. 88-92;11;15	2015	CROSS-SECTIONAL	UNITED STATES
328	Road Lighting Effects on Bicycle and Pedestrian Accident Frequency Case	TRANSPORTATION RESEARCH RECORD: JOURNAL OF THE	2016	CROSS-SECTIONAL	CANADA

# SafetyCube DSS Calculator



## Economic Efficiency Evaluation Tool (E<sub>3</sub>)

- 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 ...

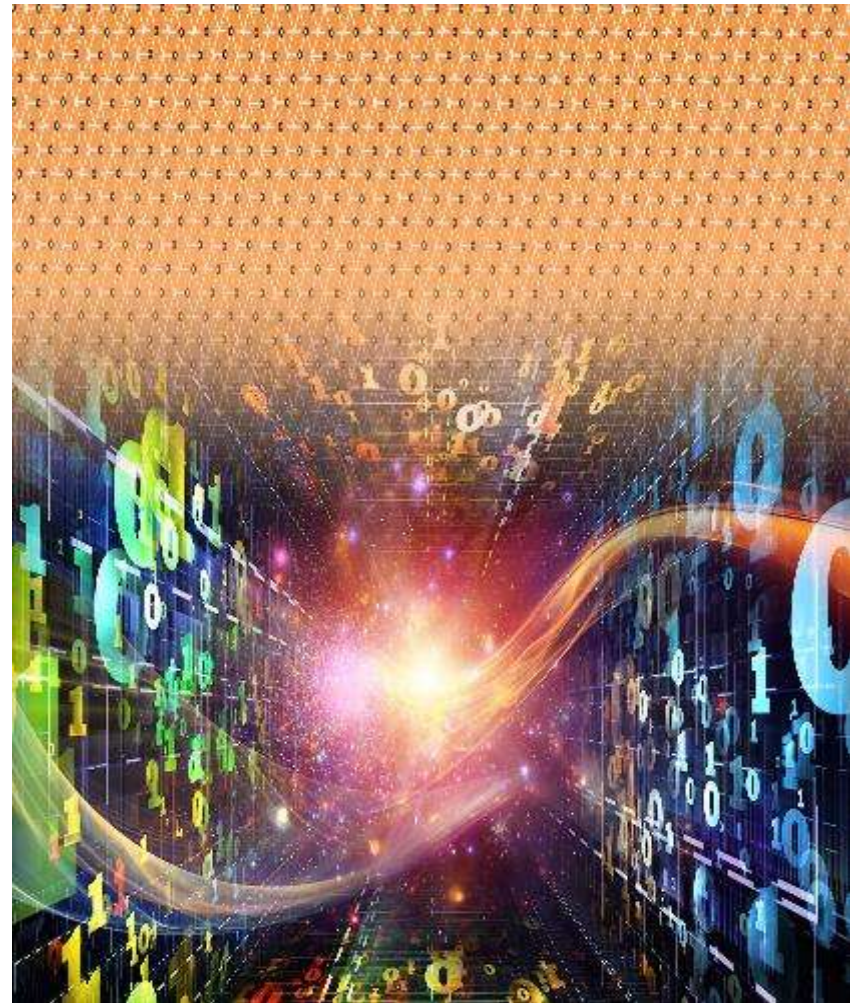


# SafetyCube DSS Knowledge Wealth



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...*





- ... 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



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