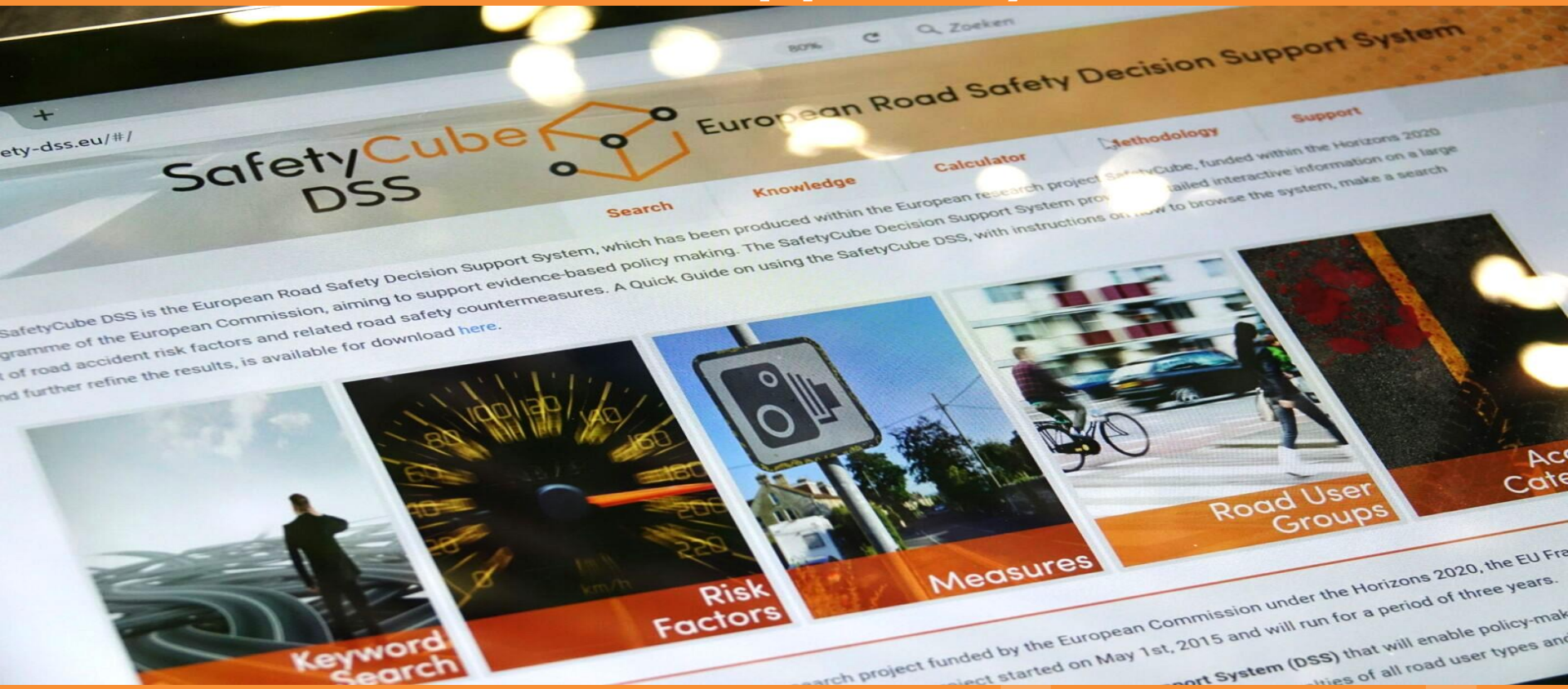
SafetyCube - the European Road Safety Decision Support System



Prof. George Yannis
National Technical University of Athens

CARE Experts Group Meeting
Brussels, October 6, 2017

The SafetyCube project

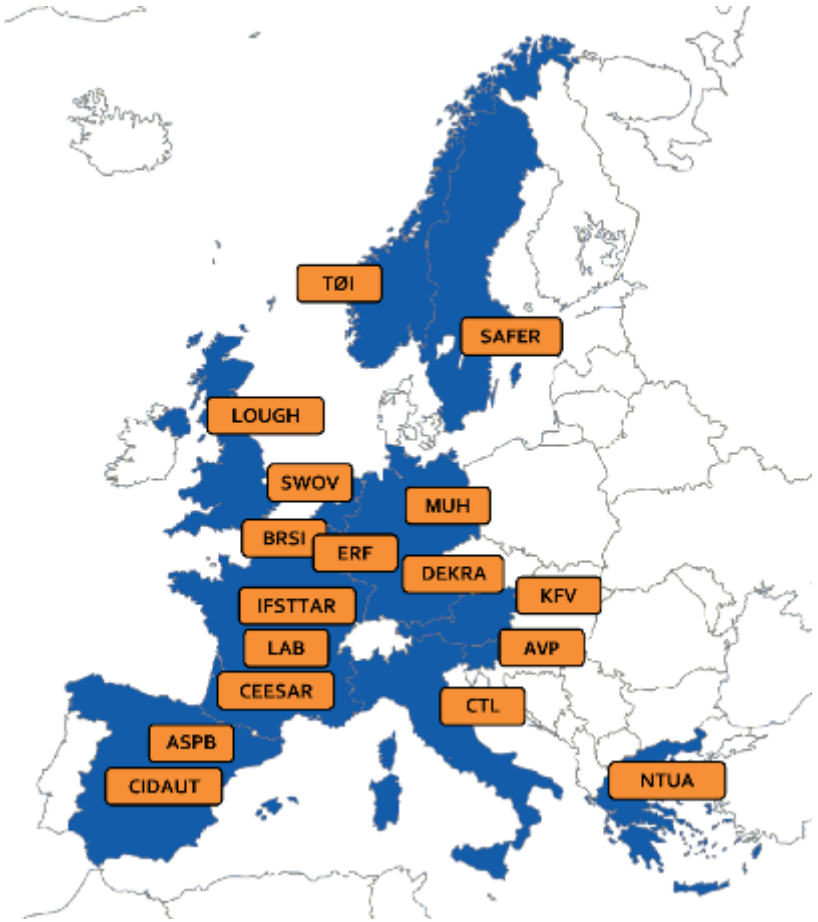
Funded by the European Commission under the **Horizon 2020** research framework programme

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)
  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, 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
- Emphassis 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

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

Synopsis 11: Presence of workzones-
Workzone length

1 Summary

Theofilatos A., Papadimitriou E., Ziakopoulos A., Yannis G., Diamandouros K., Durso C.
September 2016

COLOUR CODE: RED

The presence of long workzones is intuitively considered as a risk factor, since more crashes are likely to occur in extensive work zone areas (increased crash risk). This result was reported by all coded studies, which have show a consistant negative effect on the number of crashes (increased crash risk) and was also confirmed by the meta-analysis carried out. One study also indicates that increased lengths of work zones increase the probability of crash occurrence.

KEYWORDS

Work zones; length; crashes

1.1 ABSTRACT

It can be assumed that long work zones may increase risk of crashes, because work zones are unfamiliar road environments for most road users, due to special arrangements (lane closures, traffic disruptions, changes in road delineation and signage, presence of barriers, obstacles, workers etc.). In general, work zone length was found to significantly increase the number of crashes. The vast majority of international literature investigates crash frequency, indicating that longer work zone lengths in road networks are associated with an increased number of crashes at a 95% confidence level. This result is confirmed by the meta-analysis that was carried out, which revealed a significant overall estimate of work zone length. Moreover, only one study that investigates crash risk (probability of crash occurrence vs non-crash occurrence) was found, suggesting that work zone length significantly increases crash risk.

1.2 BACKGROUND

1.2.1 Definitions of workzone length

This risk factor has a straightforward definition in international literature. It is defined as "work zone length" and examined as numerical variable measured in miles or kilometers. However, a number of studies measure it as the natural logarithm of length, for modelling purposes.

1.2.2 How does work zone length affect road safety?

It is expected that long work zones may increase risk of crashes, because work zones are unfamiliar road environments for most road users, due to special arrangements (lane closures, traffic disruptions, changes in road delineation and signage, presence of barriers, obstacles, workers etc.). Therefore, driver exposure to such risky elements increases.Consequently, it is likely that they pose a greater threat to the safety of road users than regular road segments. Therefore, presence of such arrangements for long road segments can deteriorate road safety levels.

1.2.3 Which safety outcomes are effected by work zone length?

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

SafetyCube | Synopsis on work zone length(WP3 1

SafetyCube | Synopsis on work zone length(WP3 2

measured as crash risk (probability of crash occurrence versus probability of non-crash occurrence[1]). It is noted that no studies concerning crash or injury severity were identified through the literature search.

1.2.4 How is the effect of work zone length studied?

In general, when the impact of work zone length is examined, crash data from police records are usually utilized. Regarding the methods of analysis, the effect of workzone length is usually examined by applying multivariable 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 rare-events logistic regression models.

1.3 OVERVIEW OF RESULTS

The initial 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 same direction of the effect is observed when crash risk is examined (probability of crash occurrence vs non crash occurrence[1]), where there is also a negative effect of work zone length on safety.

on the frequency of crashes is constrained to be the same for all observations (all work zone segments). Consequently, the resulting parameter estimates may be biased.

Overall, this risk factor could be considered to be adequately studied. However, there are no studies focusing on the effect of work zone length on crash or injury severity. Moreover, they all concern states of the US and there is no specific focus on different road users. In conclusion, data concerning more countries and different road users are needed.

SafetyCube Links between Risks & Measures

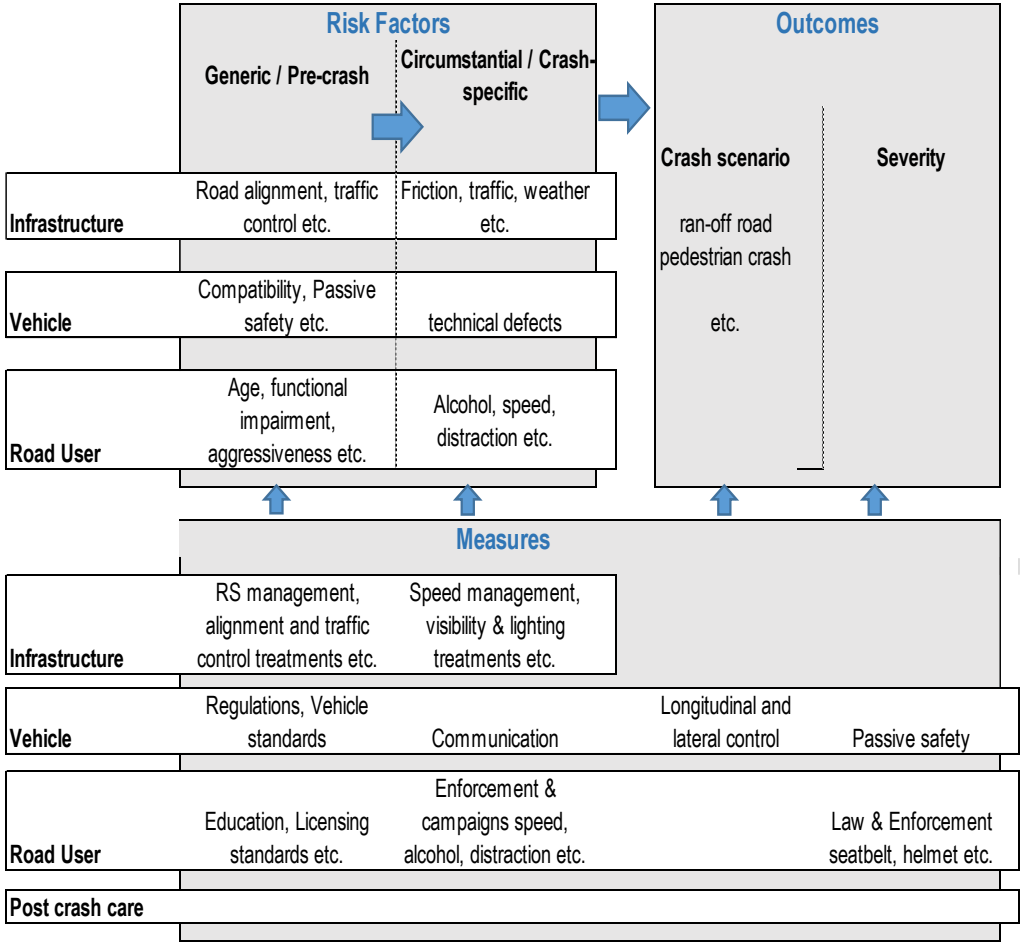
Based on a dedicated methodology

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

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

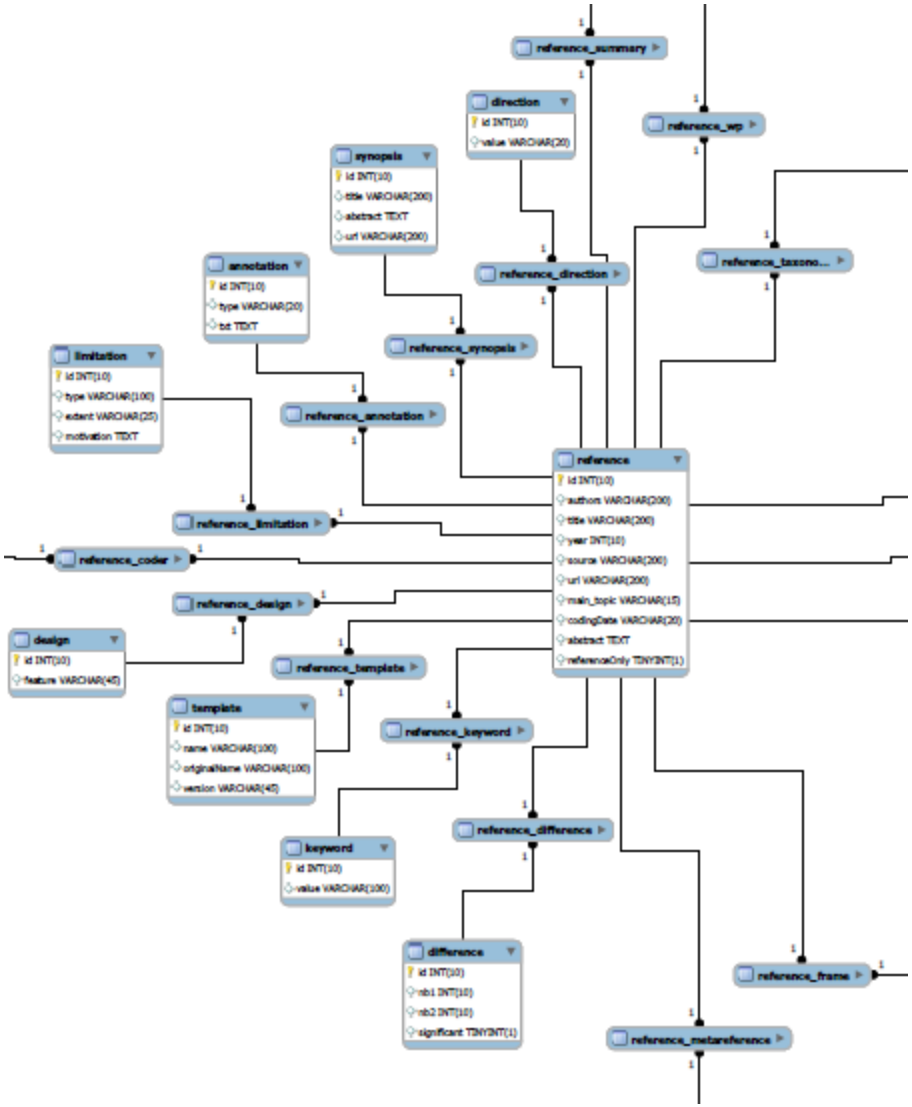
- Measures may address:
  - *Generic risks: (e.g. road safety audit)*
  - *Circumstantial risks (e.g. enforcement)*

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

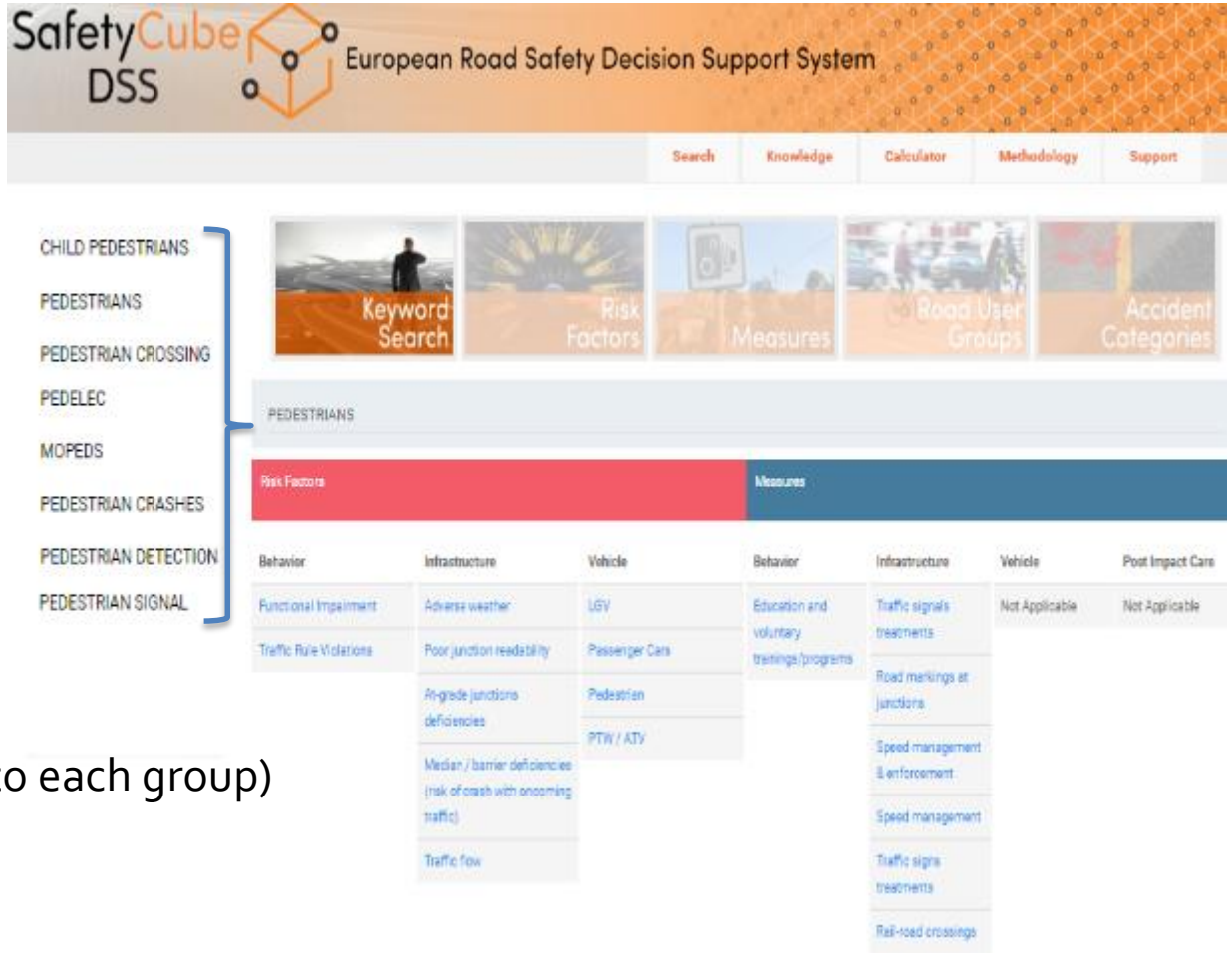
SafetyCube DSS Menu

- **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)



SafetyCube DSS Results Pages

Search results

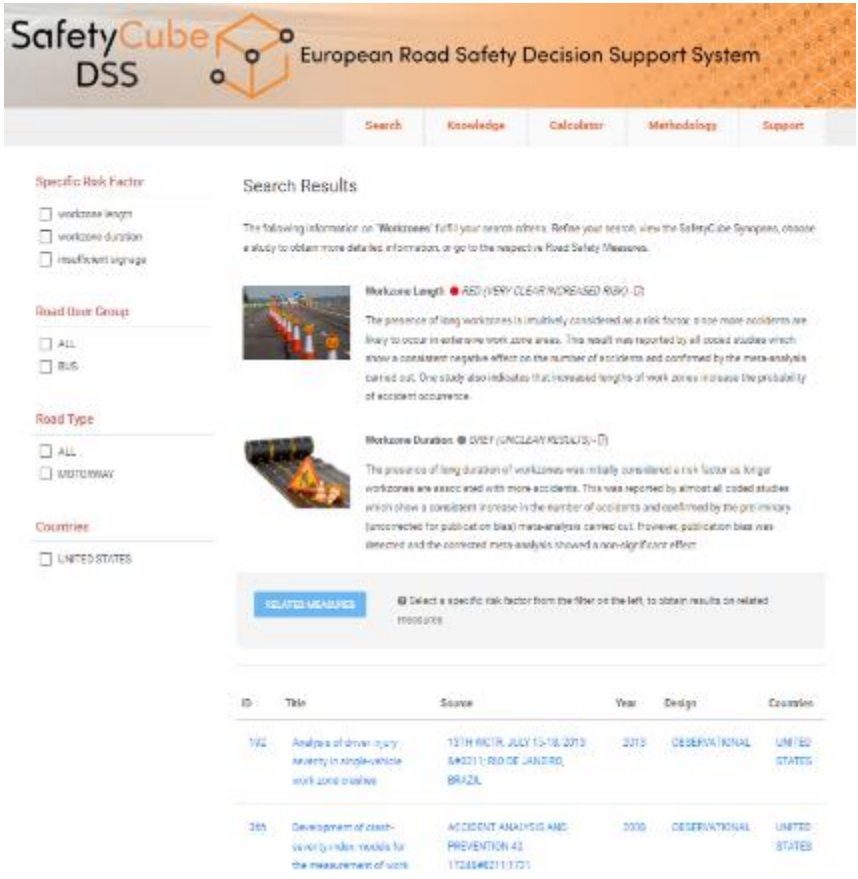
- Synopses, and their short summaries & colour codes
- Table listing the available studies

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



SafetyCube DSS Individual Study Pages

Title, author, source, abstract

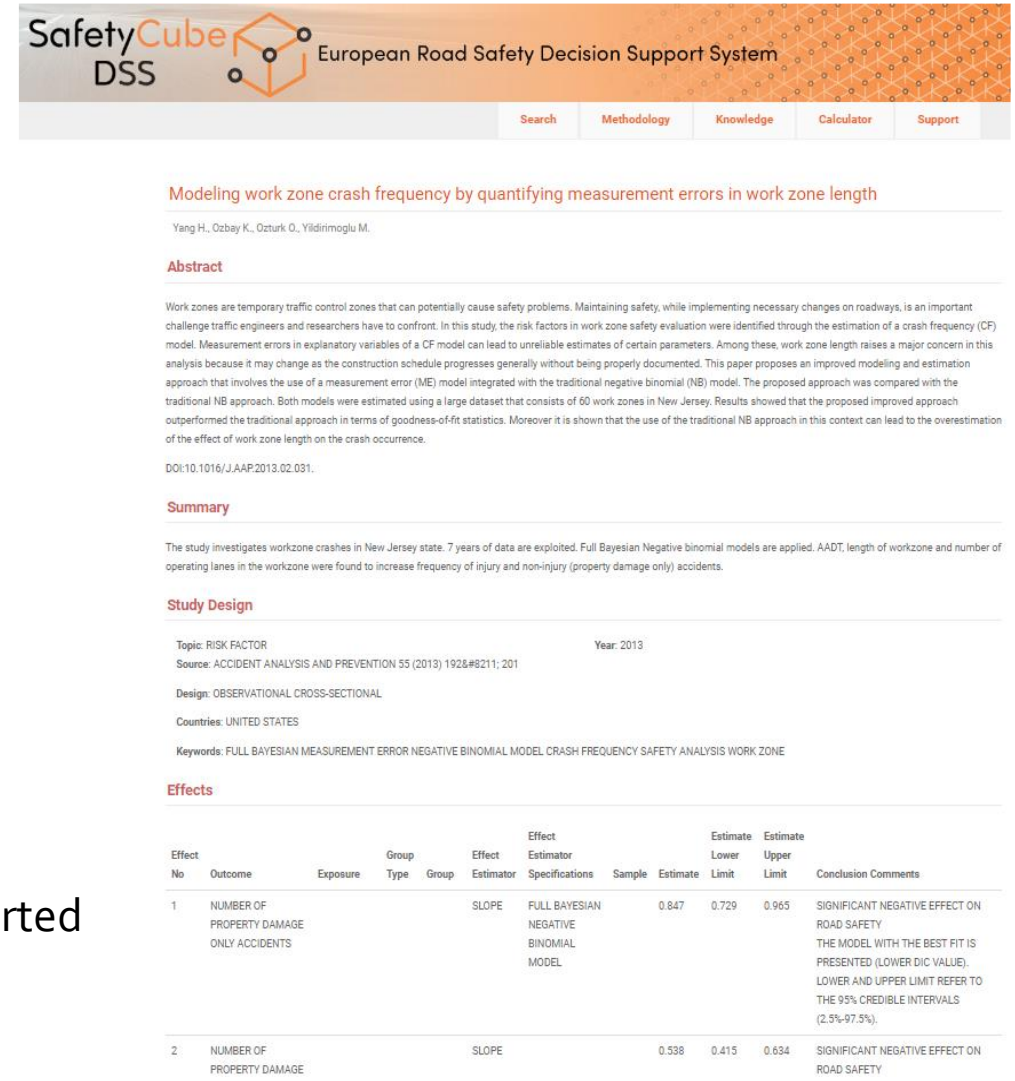
- Link to URL for full-text download (depending on Institute permissions))

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



SafetyCube DSS European Road Safety Decision Support System

Search | Methodology | Knowledge | Calculator | Support

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

Yang H., Ozbay K., Ozturk O., Yildirimoglu M.

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 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 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 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.2013.02.031.

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
Year: 2013
Source: ACCIDENT ANALYSIS AND PREVENTION 55 (2013) 192– 201

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	Group	Effect Estimator	Effect Estimator Specifications	Sample	Estimate	Estimate Lower Limit	Estimate Upper Limit	Conclusion 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 (2.5%-97.5%).
2	NUMBER OF PROPERTY DAMAGE				SLOPE			0.538	0.415	0.634	SIGNIFICANT NEGATIVE EFFECT ON ROAD SAFETY

SafetyCube Related Risks / Measures

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

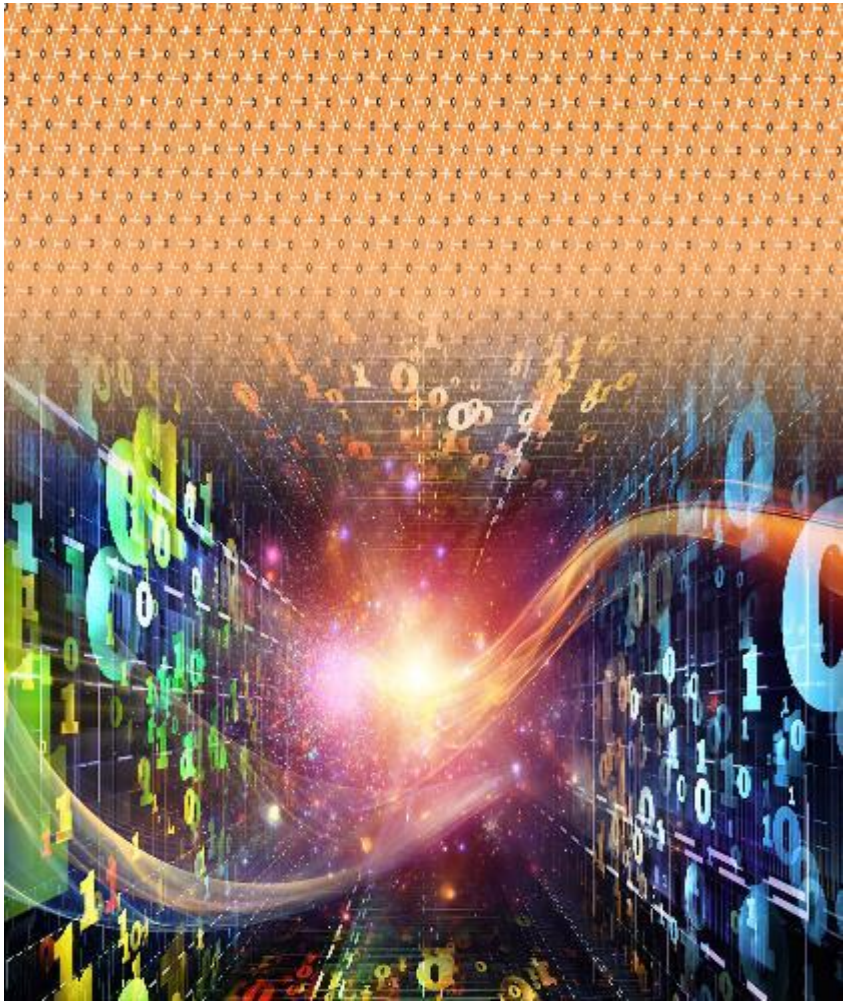
SafetyCube DSS will eventually include by April 2018:

- 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…*

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

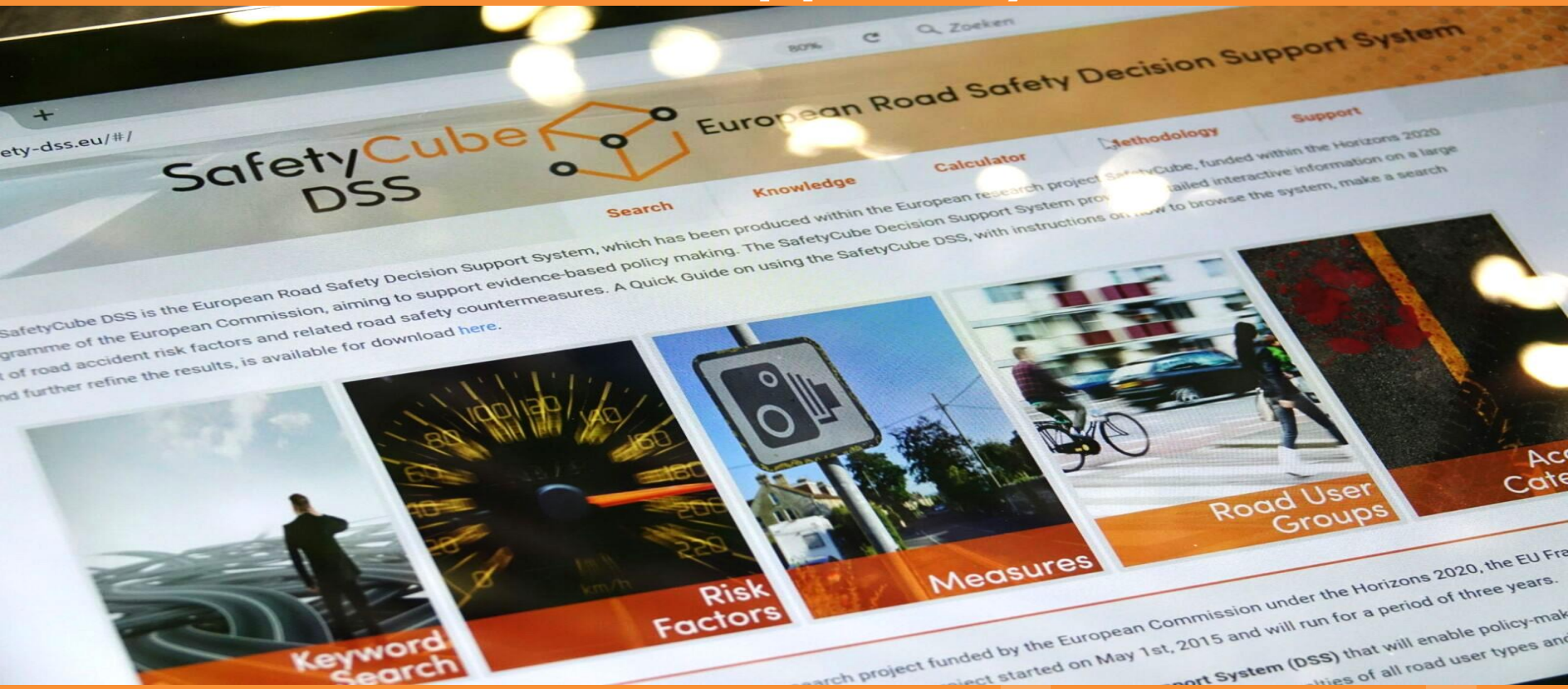
Delivering a long waited powerful tool

- 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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