SafetyCube

Obstructive sleep apnoea and crash risk: Case study results within the development of the European road safety Decision Support System

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OSA and crash risk

- OSA (untreated) widely recognised as a crash risk in fatigue/sleep field.
- Road safety policy making fatigue can be overlooked.
  - *Lack of understanding compared to other risks e.g. speeding, drink driving.*
- Increasing prominence of evidence based policy making
  - *Requires access and understanding of scientific literature*

SafetyCube project

Safety Causation, Benefits and Efficiency (SafetyCube)
www.safetycube-project.eu

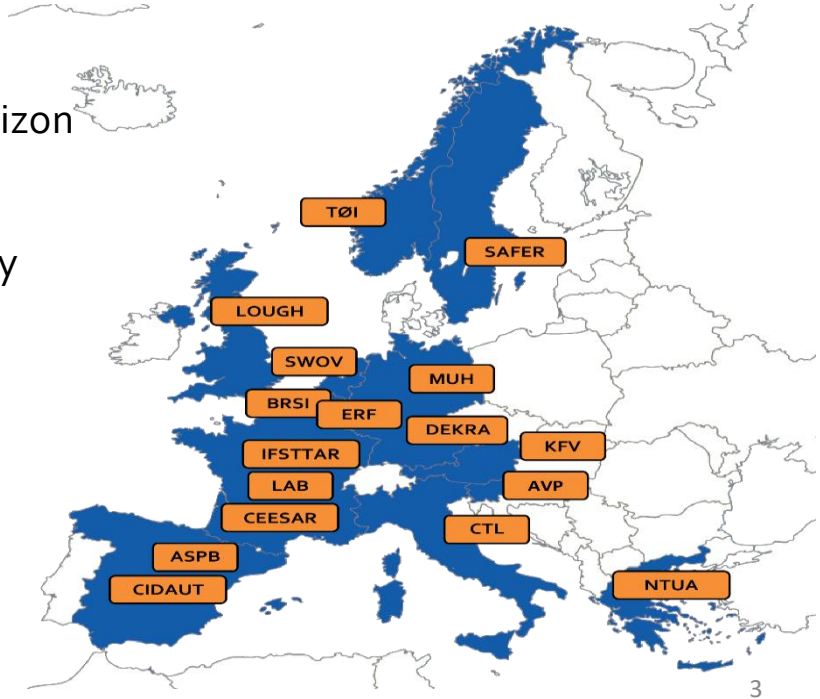
Funded by the European Commission under the Horizon 2020 research framework programme

Coordinator: Pete Thomas, Loughborough University

Start: May 2015

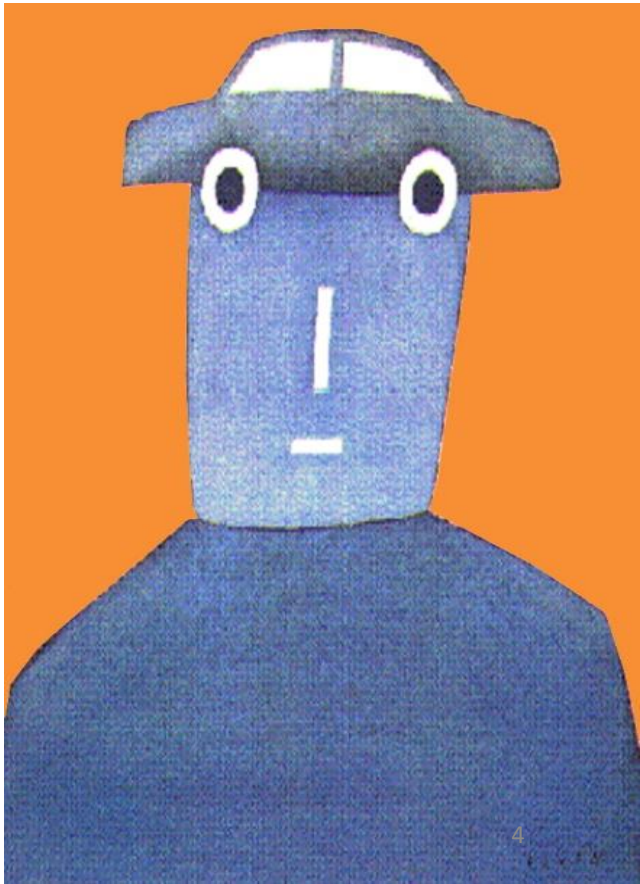
Finish: April 2018

17 partners from 12 EU countries



SafetyCube concept and vision

- There is rapid growth in knowledge about road safety risks and measures.
- It is an increasing challenge to effectively access this body of knowledge.
- The Road Safety DSS will provide easy access to a greater amount of knowledge than any existing policy support system.



Road Safety DSS Objectives

The SafetyCube DSS objective is to provide ***a user friendly, web-based, interactive Decision Support System t****o properly substantiate 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
- road safety counter measures
- cost-benefit evaluation
- all related analytic background
- linking road safety problems with related countermeasures.

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

What is a risk factor?

- Any factor that contributes to the occurrence or the consequence of road accidents.
- Direct influence on the risk of an accident

OR

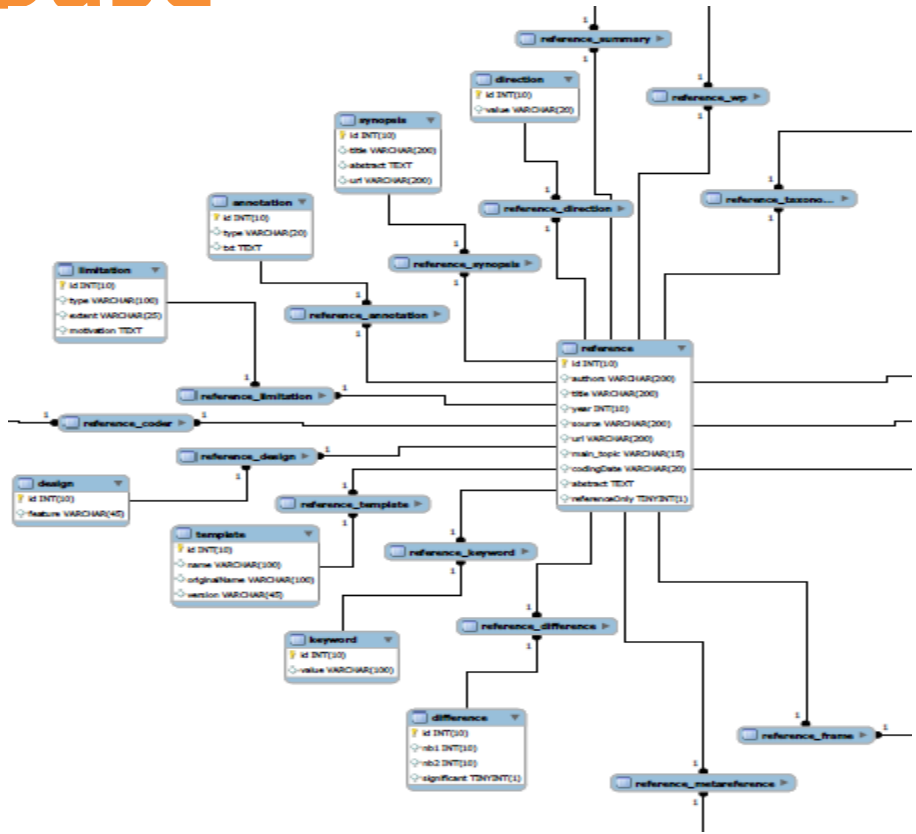
- Indirect influence by a Safety Performance Indicator.

Co-ordinated methodology

- The Safe System: Road User behaviour, Infrastructure, Vehicles, Injury prevention.
  - *Common methodological approach*
- Taxonomy of risks and measures
  - *Comprehensive*
  - *Inter-linked*
- Coding studies for a back end database
- Drafting synopses summarising findings

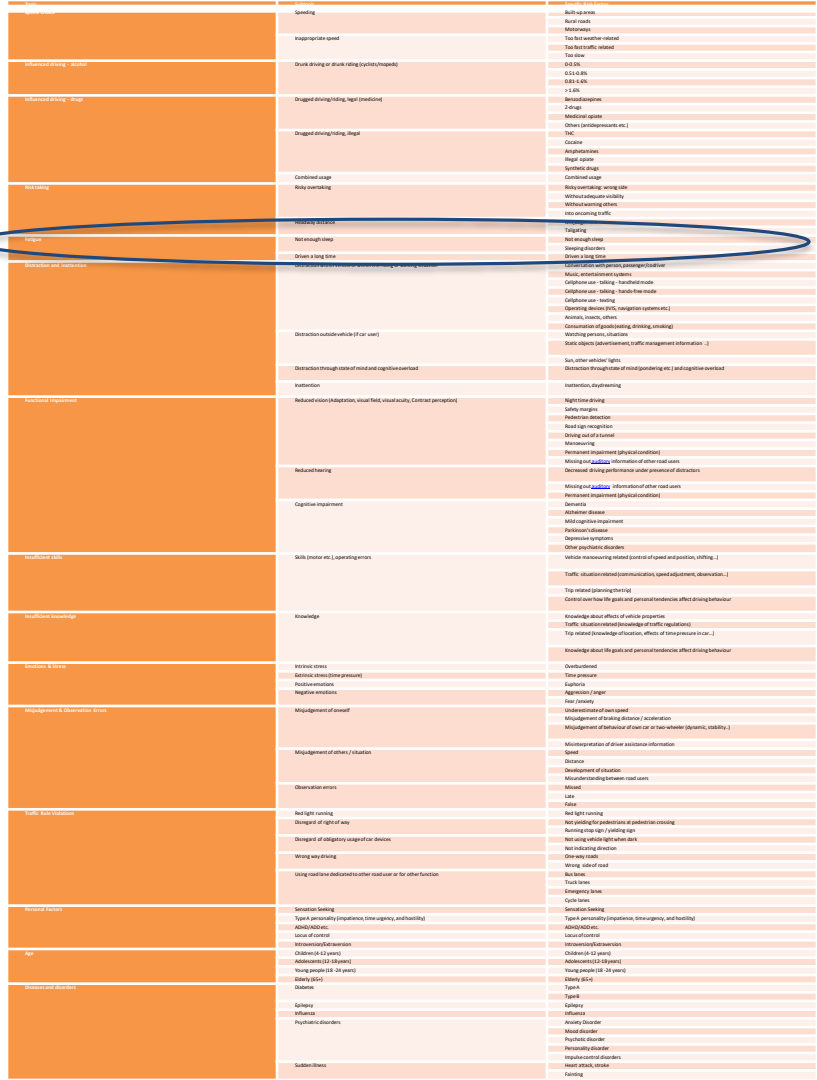
Relational Data Base

- Flexible coding template to treat all studies with the same method.
- The templates of **coded studies** undergo a thorough checking and debugging process
- The templates are eventually stored in a **relational database,** which serves as the back-end of the DSS
- Front-end DSS results are retrieved through **queries** on the back-end database (DSS search engine).



Road user behaviour risks taxonomy

- 25 considered risk factors
- Fatigue is one



Case study– Obstructive Sleep Apnoea

- Taxonomy location

– road user behaviour – risks

Topic	Subtopic	Specific Risk Factor
Fatigue	Not enough sleep	Not enough sleep
		Sleep disorders - OSA
	Driven a long time	Driven a long time

Method

- Literature search
- Prioritising studies for coding
- Coding
- Meta-analysis (if possible)
- Synopsis writing following standard guidelines

Obstructive Sleep Apnoea - outcome

COLOUR CODE: RED

- Studies consistently show that untreated Obstructive Sleep Apnoea is associated with increased risk for road traffic accidents.

Literature search

Database: Scopus **Date:** 3 May 2016

search no.	search terms / operators / combined queries	hits
#1	"fatigue*" OR "sleep*" OR "tired*" OR "drowsy" OR "drowsiness" OR "alert*" OR "monoton*" OR "time on task" OR "mental* fatigue*" OR "mental* tired*"	393,733
#2	"Sleep disorde*" OR "Narcolepsy" OR "Apneoa" OR "'Apnea" OR "Sleep disordered breathing" OR "OSA"	72,103
#3	"road safety" OR "traffic safety" OR "driv*" OR "road" OR "transport" OR "traffic" OR "Pedestrian" OR "Rider"	1,586,152
#4	"collision*" OR "crash*" OR "accident*" OR "incident*" OR "Road casualt*" OR "Road fatalit*" OR "injur*"	1,164,341
#5	"risk*" OR "severit*" OR "frequenc*"	3,472,721
#6	#1 OR #2	405,751
#7	#6 AND #3 AND #4 AND #5	1,682

- English
- Title –ABS-Key
- 1 Jan 2006 – 3 May 2016
- Europe, Israel, North America, Australia, New Zealand and Japan

= 997 hits

Screening

1. First pass title and abstract relevance screening, de-duplication, = 159 remaining studies
2. Removal of those without codable data (quantifiable effect size of influence on crashes: review/commentary/no quantitative data/no control group removed), identification of meta-analysis, separation by topic = 20 OSA studies
3. Full text obtained for 18 OSA studies

Prioritisation

1. Meta-analysis;
2. Studies examining crash risk for truck drivers published after the meta analysis literature search date;
3. Studies examining crash risk for general driving population published after the meta analysis literature search date;
4. Simulator studies.

Final coded studies

- Basoglu, O. K., & Tasbakan, M. S. (2014). Elevated risk of sleepiness-related motor vehicle accidents in patients with obstructive sleep apnea syndrome: a case-control study. *Traffic Injury Prevention*, *15*(5), 470–6.
- Catarino, R., Spratley, J., Catarino, I., Lunet, N., & Pais-Clemente, M. (2014). Sleepiness and sleepdisordered breathing in truck drivers : risk analysis of road accidents. *Sleep & Breathing = Schlaf & Atmung*, *18*(1), 59–68.
- Garbarino, S., Pitidis, A., Giustini, M., Taggi, F., & Sanna, A. (2015). Motor vehicle accidents and obstructive sleep apnea syndrome: A methodology to calculate the related burden of injuries. *Chronic Respiratory Disease*, *12*(4), 320–8.
- May, J. F., Porter, B. E., & Ware, J. C. (2016). The deterioration of driving performance over time in drivers with untreated sleep apnea. *Accident; Analysis and Prevention*, *89*, 95–102
- Meuleners, L., Fraser, M. L., Govorko, M. H., & Stevenson, M. R. (2015). Obstructive sleep apnea, health-related factors, and long distance heavy vehicle crashes in Western Australia: a case control study. *Journal of Clinical Sleep Medicine : JCSM : Official Publication of the American Academy of Sleep Medicine*, *11*(4), 413–8.
- Tregear, S., Reston, J., Schoelles, K., & Phillips, B. (2009). Obstructive sleep apnea and risk of motor vehicle crash: Systematic review and meta-analysis. *Journal of Clinical Sleep Medicine*.

Individual study results in DSS

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

SafetyCube DSS — European Road Safety Decision Support System

Search Methodology

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=pc

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 ar
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

Synopsis

- Summary (2 pages, lay language)
  - *Abstract*
  - *Background – How is it defined? How is it measured? Etc*
  - *Overview of results*
- Scientific overview
  - *Detailed review of considered studies methodologies*
  - *Review of study effects on road safety*
- Supporting Document
  - *Literature search process*
  - *Additional details about reviewed studies*

Road user behaviour risk overview

Risky	Probably risky	Unclear
• Influenced driving – alcohol • Influenced Driving – drugs (legal & illegal) • Speeding and inappropriate speed • Traffic rule violations – red light running • Distraction – cell phone use (hand held) • Distraction – cell phone use (hands free) • Distraction – cell phone use (texting) • Fatigue – sleep disorders – sleep apnea	• Risk taking – overtaking • Risk taking – close following behaviour • Insufficient knowledge and skills • Functional impairment – cognitive impairment • Functional impairment – vision loss • Diseases and disorders – diabetes • Personal factors – sensation seeking • Personal factors – ADHD • Emotions – anger, aggression • Fatigue – Not enough sleep/driving while tired • Distraction – conversation with passengers • Distraction – outside of vehicle • Distraction – cognitive overload and inattention	• Functional impairment – hearing loss (few studies) • Observation errors (few studies) • Distraction – music – entertainment systems (many studies, mixed results) • Distraction – operating devices (many studies, mixed results)

Strengths

- Comprehensive summaries of existing knowledge **accessible** to policy makers and practitioners.
  - *Road user behaviour, infrastructure, vehicles*
- Standardised approach to coding scientific literature.
- Ranking of risks factors.
- Effectiveness ranking of countermeasures.
- Detailed explanations of individual analysed study.
- Established system which can be expanded in the future.

Limitations

- Need for codable data to apply a common methodology.
- Many studies of risk factors focus on conditions of behaviour (situations under which a behaviour is shown, or which groups are more likely to experience this risk) these cannot be directly related to crashes.
- Broad topic range necessitated restriction of individual scope – OSA is the only sleep disorder considered in the DSS.

Road Safety DSS Development
Next steps

- DSS web interface **Development phase**
  - *between November 2016 and May 2017*
  - *So far including all risk factors (~3.500 effects from 600 studies) and several measures*
  - *Measures analysis on going (completed by June)*
- DSS **testing phase**
  - *Will be ready in August 2016*
- DSS **opening**
  - *September 2017*
- Continuous **Enhancement and Update**
  - *Starting on September 2017 and will be updated to April 2018 (end of SafetyCube project) onwards*

Conclusion

- Custodians of road safety budgets need a broad understanding of **all** crash risks to appropriately allocate funds.
- There is a need to increase understanding of OSA by policy makers
  - *Demonstrated by inter-country inconsistency on OSA related road safety policy*
- The approach taken in discipline specific research is not always the most relevant for policy makers – real world crash focused
- DSS provides a go-between tool to give policy makers an overview of a problem

Thank you
Questions?

SafetyCube

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Opening: September 2017

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