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International Conference

SMART CITIES & MOBILITY AS A SERVICE

EFFECTIVENESS OF INTELLIGENT SPEED ADAPTATION, COLLISION WARNING AND ALCOLOCK SYSTEMS ON DRIVING BEHAVIOUR AND SAFETY

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The SafetyCube project

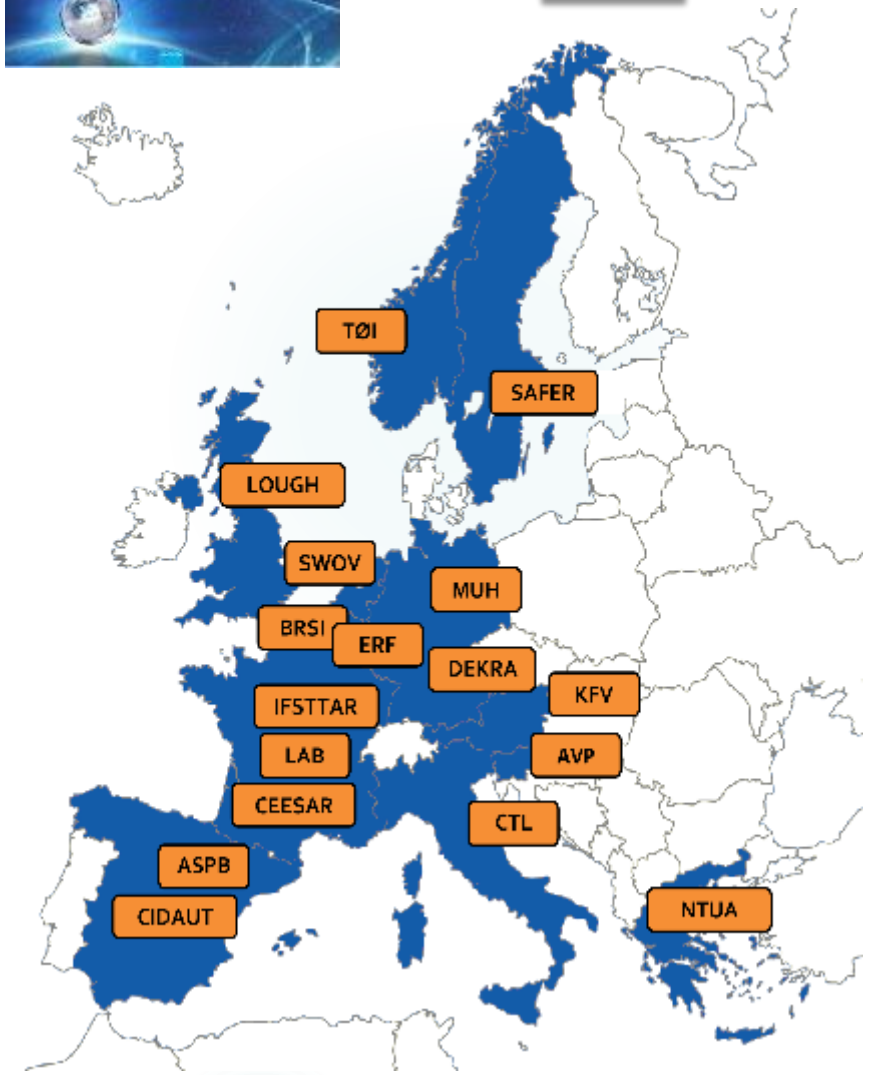
SafetyCube - Safety CaUsation, Benefits and Efficiency
www.safetycube-project.eu

- May 2015 - April 2018

Objective: to provide the European and Global road safety community a user friendly, web-based, interactive **Decision Support System (DSS)** to properly substantiate their road safety decisions for measures, programmes, policies and strategies to be implemented at local, regional, national, and European level.

The main contents of the SafetyCube DSS concern:

- road accident **risk factors**
- road safety **measures**
- best estimate of effects on **casualty reduction**
- **cost-benefit** evaluation
- all related **analytic background**



Risk Factors and Measures

SafetyCube

Problem:

- **Evidence-based** road safety policies are becoming more widespread
- **Linking** of risks and measures is imperative:
  - Specific effects are required,
  - Current knowledge is dispersed amongst several countries and repositories,
  - Effects are not comparable and reported in dissimilar manners

Solution:

- SafetyCube meets this need by generating **new knowledge** about risk factors and measures to be integrated in the Road Safety Decision Support System (DSS)
- This knowledge is attained by gathering, assessing and meta-analyzing **research**

SafetyCube Methodology

- **Methodologies** and guidelines developed in SafetyCube.

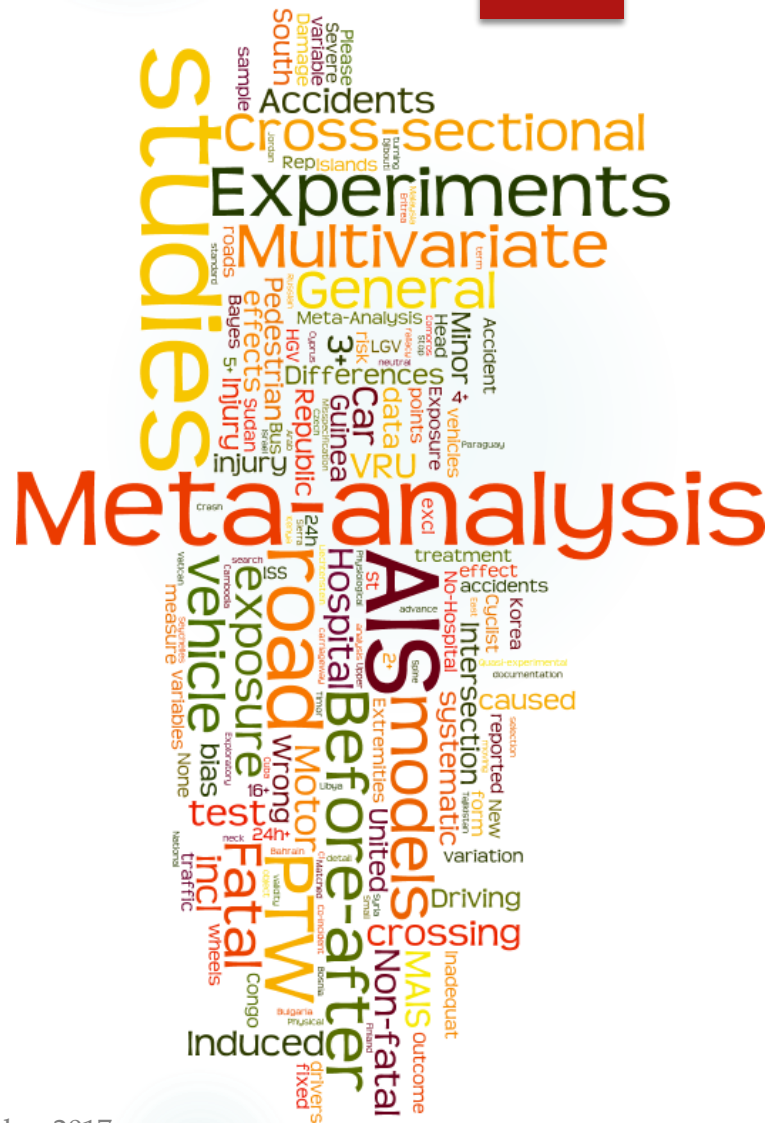
1. Creating **taxonomies** of risk factors and measures
2. Exhaustive **literature review** and rigorous study selection criteria
3. Use of a **template for coding** studies, to be introduced in the DSS back-end database
4. Studies analyzed for carrying out **meta-analyses** to estimate the effects of risk factors / measures.
5. Compiling **Synopses** summarizing results of risk factors/measures, including a "colour code" denoting their impacts.

- Systematic and case-by-case approach:
  links between infrastructure, user and vehicle risks
- **Hot topics** & additional risk factors and measures
- Assessment of the **quality** of the data / study methods

Challenges and Criteria

- **Several challenges** when examining road safety studies:
  - **Considerable variations** at study design levels (e.g. cross-sectional vs. case-control studies etc.)
  - Inclusion of **all relevant parameters** (e.g. different road users, scenarios), topic complexity (e.g. land use regulations)
  - **Relevant outputs** to road safety, quantifiable impacts (e.g. impact on crashes, driver behavioral variables)

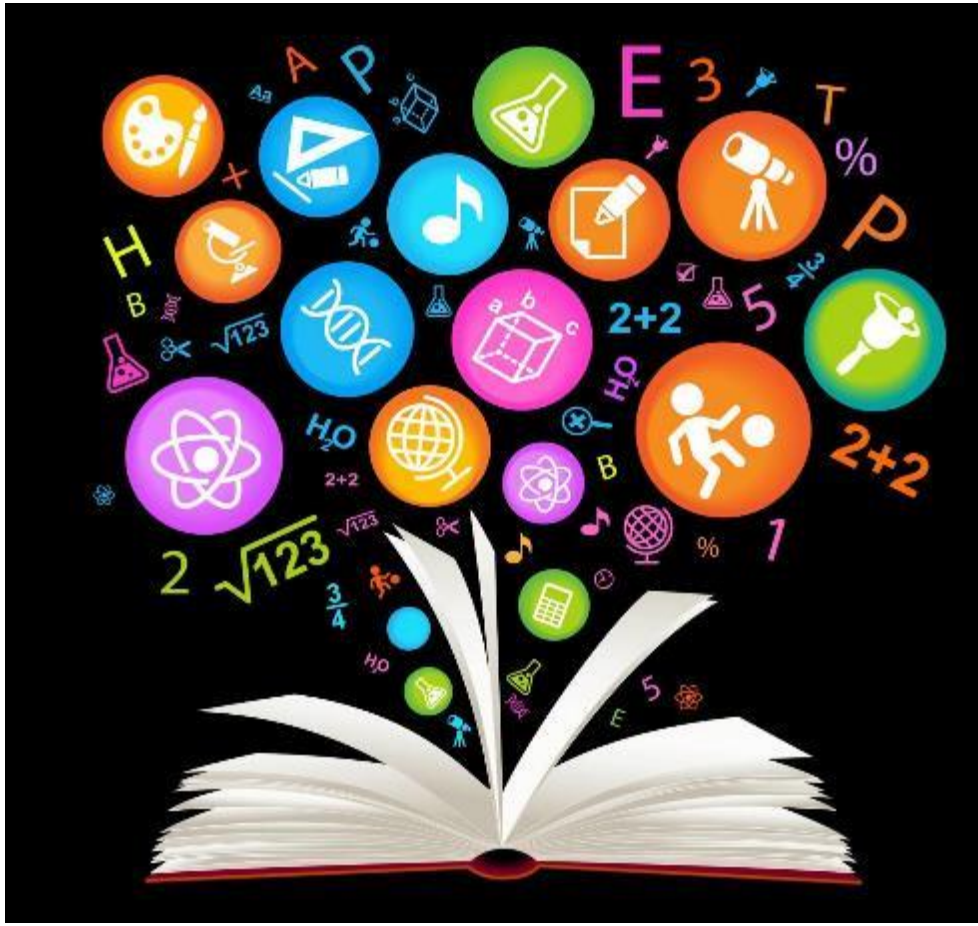
- Rigorous criteria for study inclusion:
  - Study **year**: 1990 or newer
  - Document **type**: Journal (unless more studies are required)
  - Existing **meta-analyses** prioritized at all times
  - Good overall **quality**, verification and transferability of results



Synopses: Concise Knowledge

Every topic adequately studied is summarized in a **Synopsis:**

- **Pertinent studies** are grouped and assessed
- A relevant analysis is conducted (**Meta-analysis** conducted when possible, vote-count or review-type analysis alternatively)
- Synopses include assigning a colour code: **Ranking** of risks and measures
- Synopses contain **condensed knowledge** and can be used by all road safety stakeholders for reference and planning
- They are considered **living documents** – **updateable** as research progresses
- **Quality control** at all stages ensures verified and accurate outcomes



Measures in the Taxonomy

The following measures are present in the vehicle related taxonomy section

Topic	Subtopic	Measures / Safety Systems
Active safety - ADAS	Longitudinal control	Collision Warning
	Longitudinal control	Intelligent Speed adaptation (& Speed Limiter + Speed regulator)
	Driver assistance	Alcohol Interlock (ALC - alcolock)

Examined Studies

	Author(s); Year; Country;	Method for measure investigation	Outcome indicator
Collision warning systems	Bueno et al.;2014;France	Absolute Difference	Break reaction time; Time to collision; Maximum deceleration time; Mean deceleration; Driving speed; Task load index of mental effort; Task load index of effort; Task load index of discouragement; Task load index of irritation; Task load index of stress; Task load index of annoyance
	Chang et al.;2009;Taiwan	Absolute difference	Mean speed; Reaction time; Mean of lateral position deviation; Accident rate; Standard deviation of speed
	Jamson et al.; 2008; UK	Absolute difference	Minimum time headway
	Ruscio et al.; 2015; Switzerland	Absolute difference	Reaction Time; Force on the brake
	Wege et al.; 2013; various	Absolute difference; Percentage change	Distance to lead vehicle; Minimum time headway; Minimum time to collision; Warning length; Immediately looking forward; Duration of glances; Number of glance transitions toward to the down AOI
Intelligent speed adaptation	Adell, E., & Varhelyi, A.;2008; Sweden	Absolute Difference	Irritation score; Stress score; Safety score; Speeding tickets risk score; Speed change score; Driving effort score;
	Adell et al.;2008; Hungary and Spain	Absolute Difference	Mean speed; Perceived safety performance
	Brookhuis, & de Waard; 1999; Netherlands	Absolute Difference	Proportion of time driving above the limit; Proportion of time driving above the limit+10%
	Hjälmdahl et al.; 2002; Sweden	Absolute Difference	Mean speed; Expected decrease in the number of injury accidents; Expected decrease in the number of fatal accidents
	Várhelyi et al.; 2004; Sweden	Absolute Difference	Various mean speeds; Accident rate; Maximum approach speed at intersection; Turning speed at intersection
	Várhelyi and Makinen; 2001; Netherlands, Spain and Sweden	Absolute Difference	Mean travel speed; Mean time gaps; Giving way to pedestrians; Giving way to cyclists; Giving way to cars; Mental demand score; Physical demand score; Time pressure score; Performance score; Effort score; Frustration level score; Mean turning speeds at intersection
Alcolock	Bjerre & Kostela; 2008; Sweden	Absolute Proportion	Number of failures when first attempting to start the engine
	Bjerre; 2005; Sweden	Absolute Proportion	Number of failures when first attempting to start the engine; Number of injury crashes reported by the police. The evaluation has been made in an interlock and medical monitoring program after a DWI offence.

Study Analyses Examples

- **Study review** concluded that:
  - There is an adequate **number** of studies, however;
  - Those studies have not used the same **model** for analysis but **radically different** ones.
  - There are **different indicators**, and even when they coincide they are not measured in the same way.
  - The **sampling frames** were quite different.

- **A vote-count analysis** was used for effect quantification for collision warning systems and Intelligent speed adaptation

- For alcolock only a **qualitative** investigation was possible

Outcome definition	Tested in number of studies	Result (number of effects)			Result (number of effects) Without statistical evaluation		
		↑	-	↓	↑*	-	↓*
Mean speed	4	2	11	26	3	21	17
Perceived safety performance	1	-	4	-	-	-	-
Proportion of time driving above the limit	1	-	-	-	4	4	1
Expected decrease in the number of fatal accidents	1	-	-	12	-	-	-
Accident rate	1	-	-	1	-	-	-
Mean time gaps	1	-	5	-	-	-	-
Giving way to pedestrians	1	-	-	-	-	1	2
Mental demand score	1	-	-	-	3	-	1
Physical demand score	1	-	-	-		-	4
Time pressure score	1	-	-	-	1	-	3
Performance score	1	-	-	-		-	4
Effort score	1	-	-	-	4	-	-
Frustration level score	1	-	-	-	4	-	-

Collision Warning Results

- **Indicative results** include:
  - Synopsis colour code: **Grey**
  - Collision warning systems show **unclear results** in practice
  - **No statistically significant** results on travel speeds, reaction time, force on break etc.
  - The majority of studies use simulation and originate from developed countries

Intelligent Speed Adaptation Results

- **Indicative results** include:
  - Synopsis colour code: **Light Green**
  - Intelligent Speed Adaptation systems can **reduce** crash frequency, mean speed and speeding driver numbers
  - **No statistical modelling** for results
  - Again, the majority of studies originate from developed countries

Alcohol Interlock Results

- **Indicative results** include:
  - Synopsis colour code: **Light Green**
  - Alcolock systems have **positive impacts** (e.g. engine stops when blood alcohol levels are increased)
  - Studies examined **commercial vehicles**
  - **More research** is needed on its effectiveness
  - Very few studies (from Sweden); **limited result transferability**

Conclusions

- Intelligent Speed adaptation appears the most **effective measure**, followed by alcolock based on examined studies
- There is room for the exploration of more **safety-critical variables** (crashes, injuries)
- Often detailed road safety **data is lacking** for more targeted research
- Overall **no in-depth** statistical modelling or verification, usually descriptive statistics are used
- Therefore, **knowledge gaps** were identified

Future Challenges

- Addressing current **knowledge gaps** on the effectiveness of vehicle-related road safety measures
- Gathering detailed vehicle measure road safety **data** and performing **in-depth analyses** is required
- The SafetyCube DSS provides a vehicle for concise **standardization and documentation** of research results
- Continuous **research** and respective **updating** of the SafetyCube DSS will lead to a road safety encyclopaedia

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