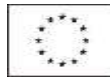


SafetyCube

Linking road safety risk factors and measures

Eleonora Papadimitriou, NTUA

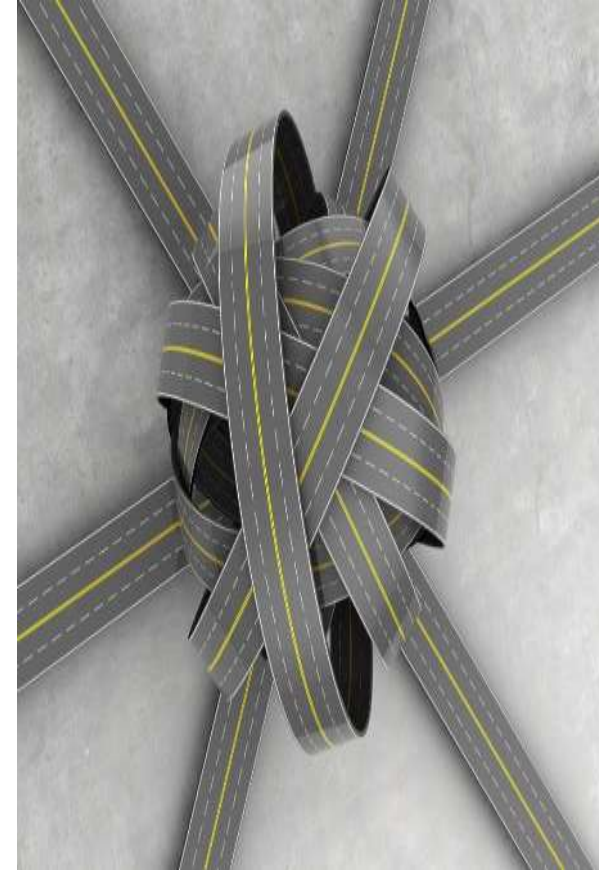


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 633485

25-Mar-18

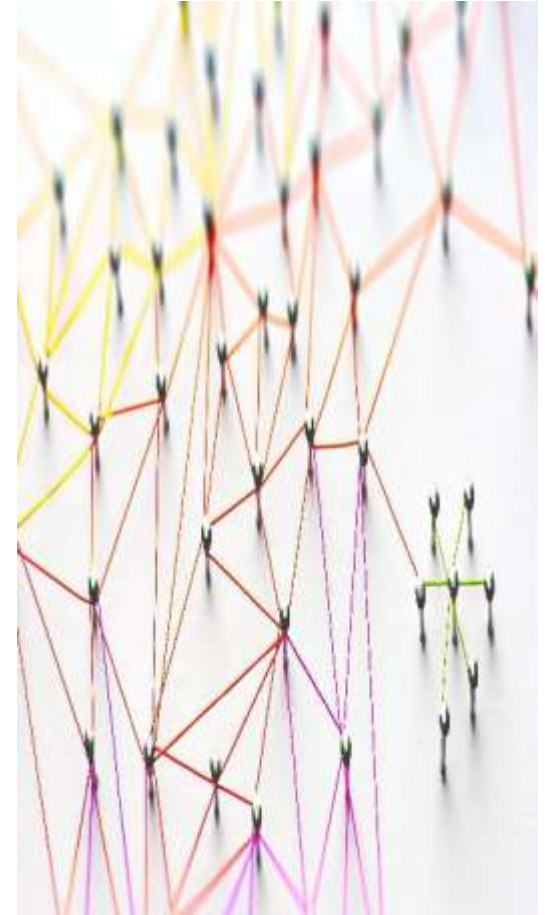
Background

- — ○
- SafetyCube brings together many dimensions of road safety, which are inherently inter-related:
 - *risk factors, outcomes and measures;*
 - *crash risk, occurrence and severity;*
 - *pre-crash, crash configurations and consequences, and post-crash care;*
 - *road user, infrastructure and vehicle characteristics.*
- The SafetyCube DSS aims to provide for the first time a range of solutions for many specific road safety problems, within a systems approach.



Objective

- — ○
- To link road safety risks and measures on the basis of a theoretical background, and integrate the links in the SafetyCube DSS.
- For the development of the links:
 - *Took into account existing theoretical frameworks that link road safety risk factors with outcomes and related measures.*
 - *Combined these frameworks, exploiting elements of each, to yield a dedicated model for linking SafetyCube risks and measures*
 - *Implemented the model in a structured and user-friendly way in the DSS*



Review of existing frameworks

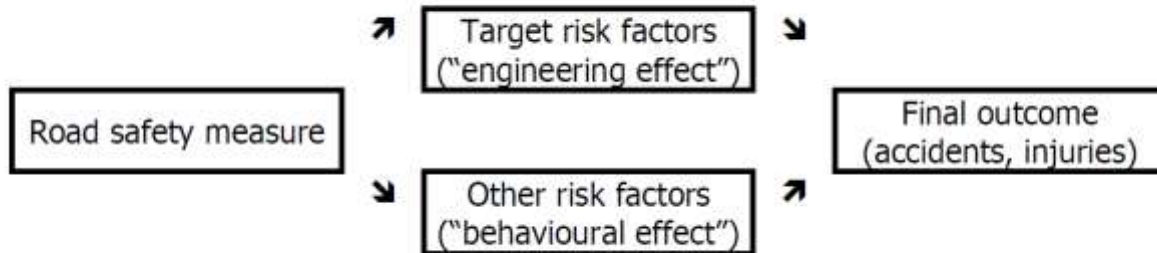
- **Multilevel approach**
 - *road users are nested into vehicles/roads; vehicles/roads are nested into accidents...*
- **Haddon Matrix**
 - *cross-classification of different crash components (road, user, vehicle) with the crash event configuration (pre-crash, crash, post-crash).*
- **Safe Systems Approach**
 - *a socio-technical system, with road users, vehicles and road as the components that interact with each other in order to "produce" transport of people and goods*

All with useful concepts, but none fully fits SafetyCube objectives



Main background

- Building on the theoretical framework to link risks and measures of *Elvik (2004)*
- A measure affects road safety by two causal chains:
 - *engineering effect*
 - *human behavioural feedback to engineering changes*



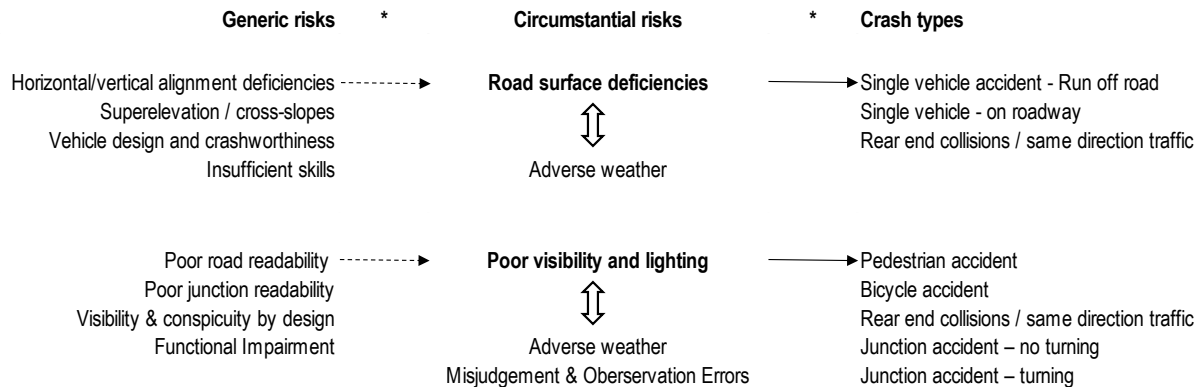
Decomposition of risks

- Risks may be generic or circumstantial, or associated with different crash outcomes
 - **Generic (pre-crash):** factors 'pre-existing' the crash due to system design and its objective safety potential, i.e. the 'baseline risk' (e.g. road design, driver experience, vehicle passive safety)
 - **Circumstantial (crash-specific):** factors that may be present circumstantially creating specific high risk conditions (e.g. congestion, frost and snow, alcohol impairment, vehicle failure), over the 'baseline' risk level created 'by design'
 - **Risks affecting the crash outcomes** (e.g. age, non-use of restraint systems)



Chains of risk factors and outcomes

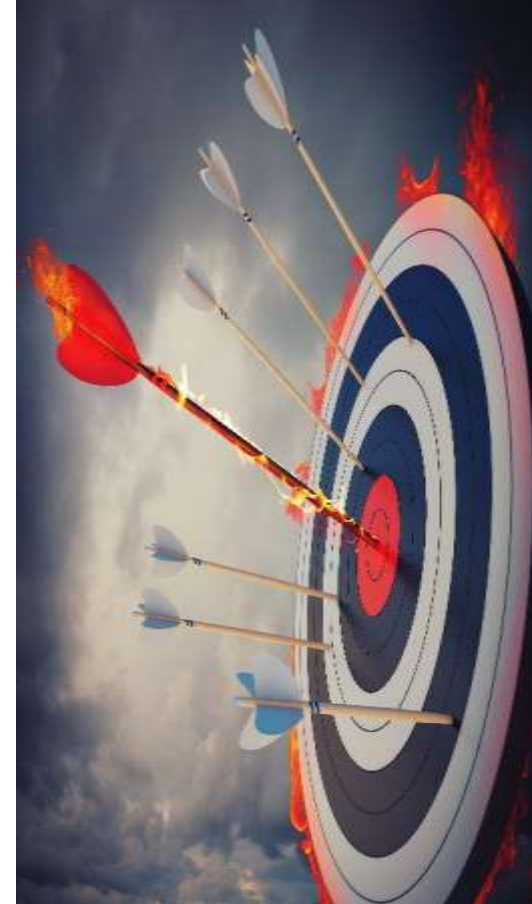
- Each crash type is caused by a (combination of) circumstantial risk(s), which are due to or strengthened by pre-existing generic risks.
- The combination of risk factors then may result to specific crash types and related crash consequences.



Mechanisms of measures effects



- Accordingly, based on Elvik's approach (2004) measures may affect risk factors through **three mechanisms**:
 - one related to **addressing the 'generic' factors** (i.e. which are beyond the user control)
 - one related to **addressing 'circumstantial' factors** (i.e. crash-specific conditions)
 - a third one to **directly affect safety outcomes**:
 - *Crash type*
 - *Injury severity*



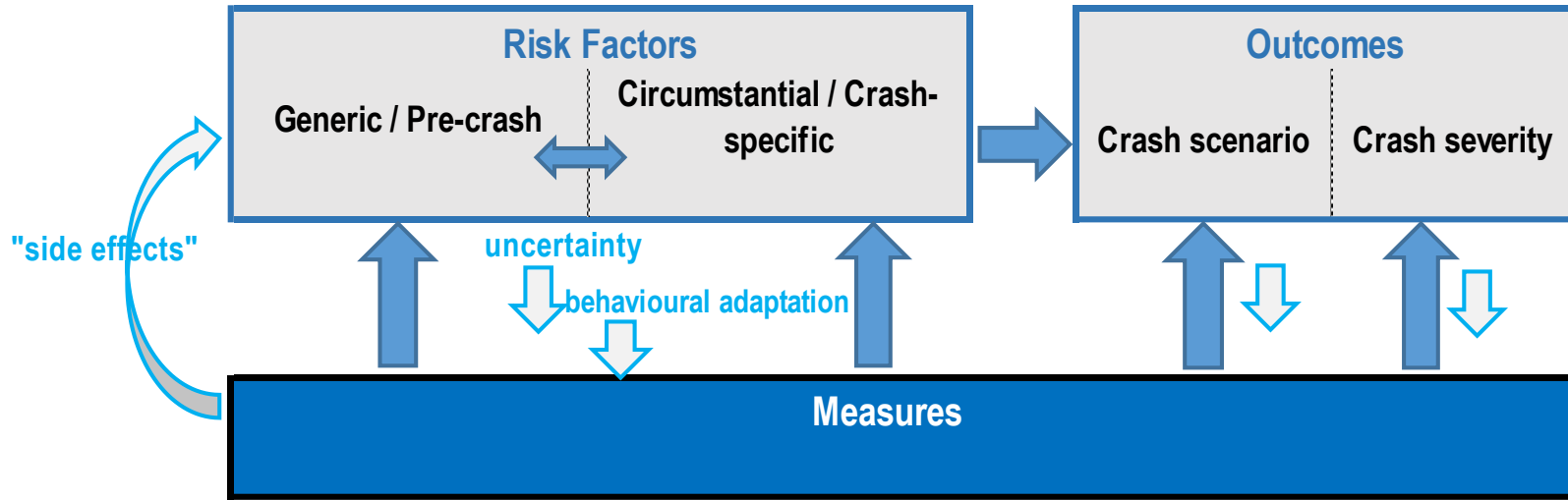
Measures effectiveness



- The expected effectiveness of measures may be compromised:
 - Due to **behavioural adaptation** of road users
 - Measures may have other **"side-effects"** (accident migration, induction of new risks etc.)
 - The effectiveness of measures will vary in different settings (**uncertainty**)
- The proposed model reflects the **theoretical potential** of measures to address risks
- The **existing evidence** in the literature give the final answer as regards the (current) strength of each link between a risk and a measure.



Proposed SafetyCube model



Actual linking of risks and measures



- At the lowest SafetyCube taxonomy level

Vehicle Risk factor	Related measures	WP	Notes
Compatibility, Age & Underrun	Regulation UN R32 (Behaviour of the structure in rear-end collision)	6	
	Underrun protection (Front / Side + Lateral Side Guards / Rear)	6	
	Vehicle inspection	6	
	Regulation ECE R13 (braking systems)	6	
Low Star rating (EuroNCap)	EuroNcap (Full width & ODB)	6	
	EuroNCap (MBD & Pole)	6	
	Pedestrian protection (Active bonnet, pedestrian airbag, EuroNCap, ...)	6	
	Child Restraint System (usage, fitting, misuse, ISOFIX, EuroNCap, ...)	6	
Risk for unbelted occupants	Seat belt (effectiveness) SBR and Load limiter included	6	
	anti-submarining (airbags, seat bossage, knee airbzg, seatbel pretensionner,...)	6	
	Seat belt	4	Law and enforcement
	Seat belt	4	Awareness raising and campaigns
Risk of injury in case of fire	extraction from passenger car	7	
	extraction from LGV	7	
	extraction from truck	7	
	extraction from bus	7	
Risk of injury in Rollover	AirBag protection (Roof, curtains, ...)	6	
	RollOver protection system	6	
	shoulder implementation (shoulder type)	5	
	increase shoulder width	5	
	change shoulder type	5	
	safety barriers installation	5	
	change type of safety barriers	5	
	create clear-zone / remove obstacles	5	
	increase width of clear-zone	5	

DSS links to related measures

- Measures for “Fatigue - not enough sleep”

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
Fitness to drive, medical referrals	Installation of median	Electronic Stability Control (ESC)	Not Applicable
Cameos on fatigue	Increase median width	Lane Departure Warning (LDW), Lane Keeping Assist (LKA) & Lane Centering System	
	change median type	Drowsiness and Distraction Recognition	
	Implementation of rumble strips at centerline		
	shoulder implementation (shoulder type)		
	Increase shoulder width		
	change shoulder type		
	safety barriers installation		
	change type of safety barriers		
	create clear-zone / remove obstacles		
	Increase width of clear-zone		
	implementation of edgeline rumble strips		

Countries

GREECE

SafetyCube Synopses



Effectiveness of Road Safety Campaigns: ● LIGHT GREEN (PROBABLY EFFECTIVE) - [D](#)

There is some indication that campaigns are beneficial for road safety on various levels. Meta-analyses show an association with accident reduction, increased safe behaviours and risk awareness. However, for other outcome variables such as drink-driving or safety relevant attitudes, no such effect was found. Furthermore, meta-analysed studies vary strongly, mainly regarding the design of the evaluated campaigns.

ID	Title	Source	Year	Design	Countries
49	Do Road Safety Communication Campaigns Work? How to Assess the Impact of a National Fatigue Campaign on Driving Behavior	TRANSPORTATION RESEARCH RECORD, JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, NO. 2364, TRANSPORTATION RESEARCH BOARD OF THE NATIONAL ACADEMIES, WASHINGTON, D.C., 2013, PP. 62-70.	2013	BEFORE-AFTER	GREECE

DSS links to related risks

- Risks addressed by “Emergency Braking Assistance Systems”

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

Behavior	Infrastructure	Vehicle
Headway distance	secondary crashes	Risk to be injured in rear impact
Insufficient skills and operating errors		
Observation errors		
Elderly (65+)		

Road User Group

- ALL
- CAR
- LGV

Road Type

- ALL
- RURAL ROAD
- SUBURBAN ROAD
- URBAN ROAD

Countries

- FINLAND
- UNITED KINGDOM
- UNITED STATES

SafetyCube Synopses



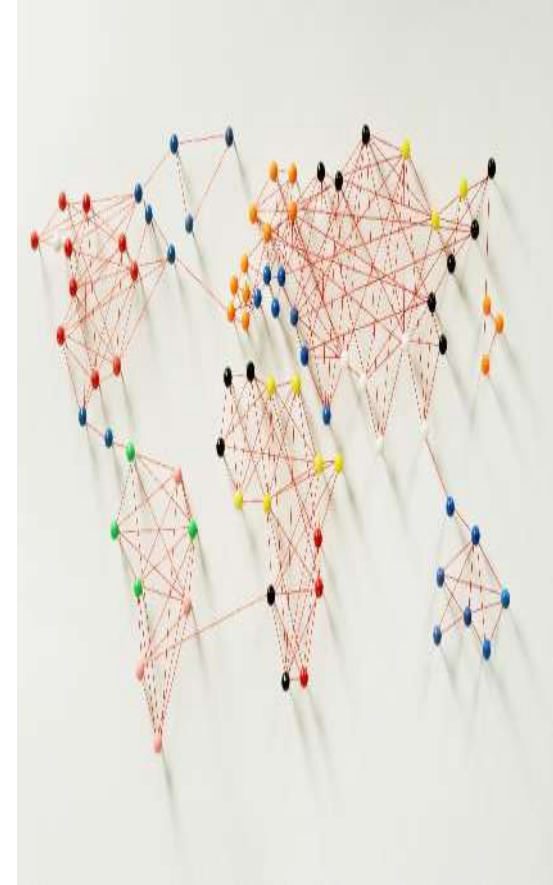
Risk taking - Close Following Behaviour ● YELLOW (PROBABLY RISKY) - [?]

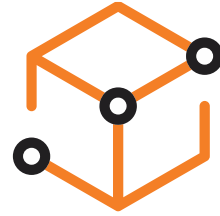
Although following too closely is seen as one of the main reasons for rear end crashes, studies that evaluate the risk of this behaviour in connection to accidents are rare. However, if headway distances are so short that it is no longer possible to stop in time in the case of an emergency stop, it can be presumed as risky. Quite a proportion of drivers engage in such a behaviour. Results of one study indicate a higher crash risk for short headways.

ID	Title	Source	Year	Design	Countries
765	Driver crash risk factors and prevalence evaluation using naturalistic driving data	PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA PNAS, PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES	2016	CASE-CONTROL	UNITED STATES
772	Close-following drivers on two-lane highways	ACCID. ANAL. AND PREV., VOL 29, NO. 6, PP. 723-729	1997	QUASI-EXPERIMENTAL	FINLAND
840	Car following decisions under three visibility	ACCIDENT ANALYSIS AND PREVENTION, 39(1), 106-116	2007	EXPERIMENTAL	UNITED STATES

Conclusions

- — ○
 - A **theoretical framework** for linking risk factors and measures
 - *based on a crash chain model*
 - *applied through existing expert knowledge*
 - Links are **integrated in the DSS** to explore and identify a range of solutions with potential of addressing road safety problems
 - The DSS contents (individual studies, synopses and meta-analyses) “validate” or “conditionalize” the links, assist to **understand the conditions of measures effectiveness** and flag the sources of uncertainty.

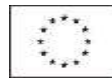




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