Cost-Effectiveness Evaluation of Selected Road Safety Measures

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Introduction and Scope

- **Evidence based road safety policies:** more desirable and crucial for targeted road safety improvements
- **Comprehensive analysis and ranking** of risk factors and road safety measures required – aim of the SafetyCube project
- **Economic Efficiency Assessment (EEA)** of road safety measures is necessary for quantification and prioritization of road safety measures
- Assessment and ranking leading to the **European Road Safety Decision Support System (DSS)**

Methods for prioritizing measures (1/3)

Cost-Effectiveness Analysis (CEA)
Number of crashes prevented by the measure/ unit cost of implementing the measure

- **Benefits**
  - less information is necessary
  - not necessary to have an estimation of the monetary value of a crash

- **Limitations**
  - economic evaluation regarding only one outcome of the measure
  - not possible to account for different crash severity levels or different policy fields (environment, mobility)

Methods for prioritizing measures (2/3)

Cost-Utility Analysis (CUA)
Measures impact expressed by
Quality Adjusted Life Years (QALY)

Fatalities assessed by Years of Life Lost (YLL)

Injuries assessed by Years Lived with Disability (YLD)

CUA calculates the cost per QALY

- **Benefits**
  – possibility to account for different crash severity levels

- **Limitations**
  – not possible to account for different policy fields (environment, mobility)

Methods for prioritizing measures (3/3)

Cost-Benefit Analysis (CBA)

Monetary values are assigned to each type of benefit that results from the measure. Sum of benefits is then compared to the costs of the measure. Ranking based on:

1. Net Present Value (NPV) = Benefits – Costs
2. Benefit-Cost Ratio (BCR) = Benefits / Costs

(If BCR > 1, measure is cost-effective)

- **Benefits**
  - possibility to account for different crash severity levels and different policy fields (environment, mobility)
  - determines right balance between safety and other objectives
- **Limitations**
  - requires more input than CEA, CUA

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.
6. Carrying out **cost-benefit analyses** for the most effective measures

- **Systems approach:** links between infrastructure, user and vehicle risks
- Rigorous assessment of the **quality of the data / study methods**

SafetyCube Taxonomies

Three-level taxonomies

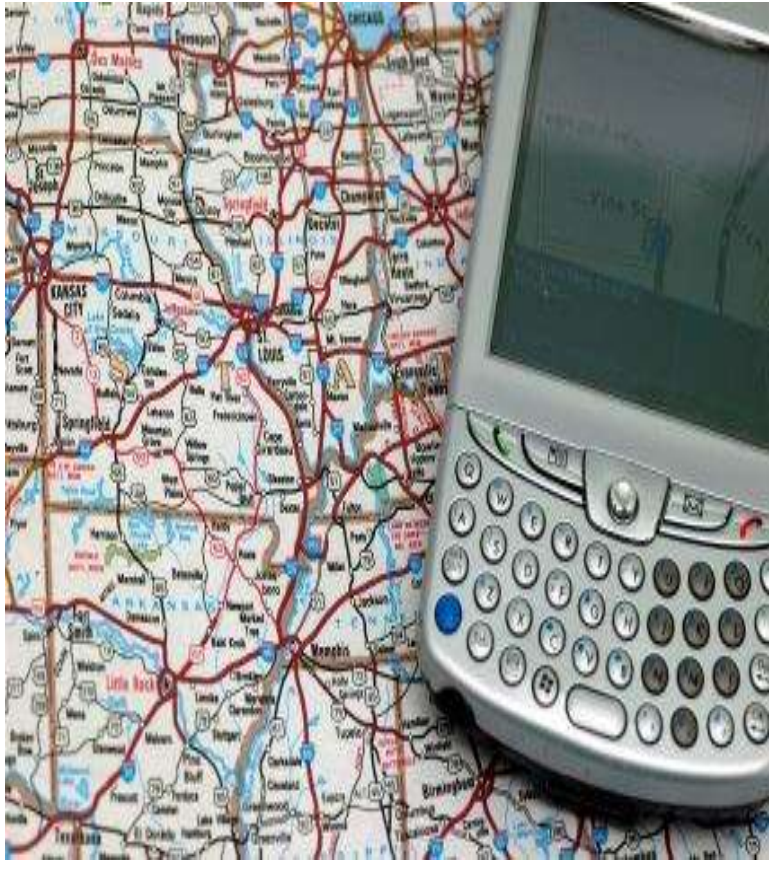
Separately for risks and measures

- **4 Categories**
  road user, infrastructure, vehicle, post impact care
- **38 risks, 50 measures (88 in total)**
  e.g. distraction, roadside, crashworthiness
- **120 specific risks, 193 specific measures (313 in total)**
  e.g. mobile phone use, no clear-zone, low pedestrian rating (NCAP)

Examined measures

Measures where relevant studies/ financial figures were available

- **Road infrastructure (5 measures)**
  - Road safety audits *(light/heavy measure case)*
  - Traffic signal installation *(county roads/highways)*
  - Installation of safety barriers
  - High risk sites treatment
  - Installation of chevron signs
- **Behavior (2 measures)**
  - DUI checkpoints/breath testing
  - General police speeding enforcement



2 measures warranted two separate approaches

Cost-Benefit Analyses inputs

For the selected measures:

- **Crash cost data**
  Distinguishing between injury severity categories
- **Measure effectiveness and implementation costs**
  Obtained from high quality studies and reports

$$Benefits = \sum_s Target\ Crashes_s * Effectiveness_s * Crash\ costs_s$$

- **Formation of a common baseline**
  Reference currency: €, Reference year: 2015

$$present\ value = \frac{actual\ value}{(1 + discount\ rate)^{year}}$$

- **Different scenario predictions to mitigate uncertainty**

Cost-Benefit Analyses outputs

Formation of 7 possible prediction scenarios with respective BCR calculation:

1. Best estimate
2. Low measure effectiveness (lower limit of 95% CI)
3. High measure effectiveness (upper limit of 95% CI)
4. Low measure cost (-50%)
5. High measure cost (+100%)
6. Worst case (combining 2 and 5)
7. Best case (combining 3 and 4)

Cost-Benefit Analyses results

	Measure	Benefit-to-cost ratio (BCR)						
		Best estimate	Low measure effect	High measure effect	Low measure cost: -50%	High measure cost: +100%	Worst case scenario = high cost + low effect	Best case scenario = low cost + high effect
Road infrastructure	Road safety audits – light measure case	**21.7**	16.4	27.0	43.5	10.9	8.2	54.0
	Installation of safety barriers	**19.5**	10.6	25.4	39.1	9.8	5.3	21.2
	High risk sites treatment	**16.1**	13.2	18.4	32.2	8.1	6.6	36.8
	Traffic signal installation – highways	**3.7**	1.8	5.2	7.4	1.9	0.9	10.5
	Road safety audits – heavy measure case	**2.9**	2.2	3.6	5.7	1.4	1.1	7.1
	Installation of chevron signs	**2.7**	1.4	5.5	5.5	1.4	0.7	10.9
	Traffic signal installation – county roads	**1.1**	0.5	1.5	2.2	0.5	0.3	3.1
Behavior	Law and enforcement – DUI checkpoints, breath testing	**7.3**	5.7	9.4	14.6	3.7	2.9	18.8
	Law and enforcement – General police enforcement of speeding	**1.0**	0.7	1.3	2.0	0.5	0.4	2.6

Discussion of results

- Road safety measures addressing a **critical point in a focused manner** (road safety audits, installation of safety barriers and high risk sites treatment) have highest BCRs
- Overall, **most measures** appear to be cost-effective (BCR >1)
- 5 measures appear to be cost-effective **consistently** – in all 7 scenarios
- CBA is a tool to **enable comparisons**, however singular cases must be treated **with caution**, taking particularities into account

SafetyCube DSS Calculator (1/2)

- 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.**

Main Functions

- 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

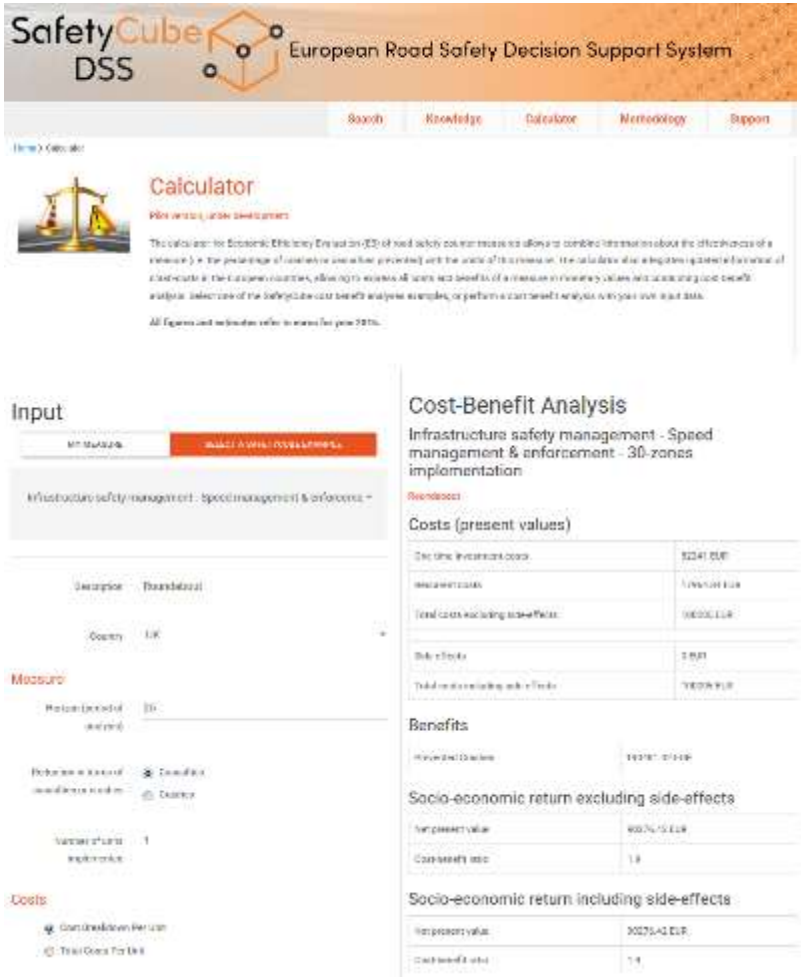
SafetyCube DSS Calculator (2/2)

Economic Efficiency Evaluation Tool (E3)

- Fully integrated in the DSS
- Enables users to create their custom CBA "My Measure" function with free input on:
  - Country, years of analyses
  - Basis: Crashes or Casualties
  - Costs (implementation and annual)
  - Measure effectiveness (per severity category)
  - Penetration rate and side effects

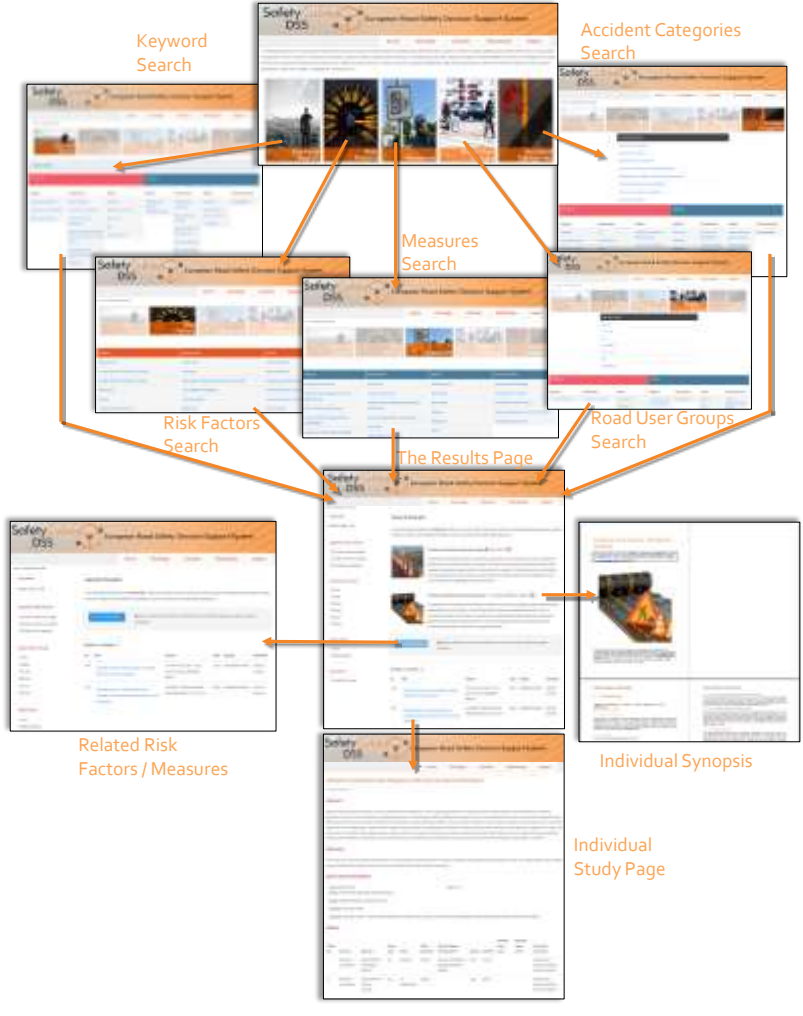
Contains all SafetyCube example CBAs on:

- Behaviour (12 examples)
- Infrastructure (19 examples)
- Vehicle systems (4 examples)
- Post-impact care (1 example)



SafetyCube DSS Overview

- **Search:** (5 entry points)
- **Results pages:** (Introduction, Colour codes, Synopses, Coded studies)
- **Individual Studies:** pages (Disaggregate level, detailed effects listed, some studies not in synopses)
- **Calculator:** Economic Efficiency Evaluation
- **Links between Risk Factors:** Information about which risks can be remedied by which types of measures
- **Methodology:** System documentation
- **Support:** Contact, help, feedback
- **Available** online since April 2017: https://www.roadsafety-dss.eu/



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