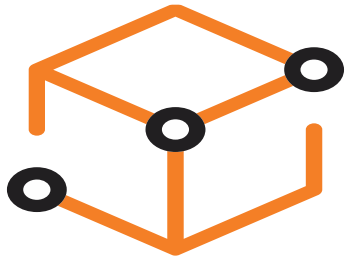

SafetyCube

Economic evaluation of road safety measures

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Content

- Economic evaluation
- Why (not) cost-benefit analysis?
- Approach in the H2020 SafetyCube project
- Discussion and conclusions

Economic evaluation

- Reasons to set up economic evaluations of road safety investments (Hauer, 2011):
  - *Justify public money spending*
  - *Establish priority between projects*

Methods for economic evaluation

Effectiveness

What will be the reduction in the number of accidents / injuries / fatalities?

Cost-effectiveness

How many deaths/injuries will be avoided per unit cost of the measure?

Cost-utility

What will be the cost per QALY when implementing the measure?

Cost-benefit

Do the benefits exceed the costs of implementing the measure?

Cost-Benefit Analysis (CBA)

- Measure costs and benefits are expressed in monetary terms and subsequently compared
- Future costs and benefits are expressed in Net Present Values by applying discount rates

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

- In a CBA analysis, it is possible to account for – positive and negative – side effects, e.g environmental or mobility impacts

- Two indicators can be used for prioritisation
  - *Benefit-Cost ratio (benefits/costs)*
  - *Net present value (benefits – costs)*

Why might a CBA be not a good idea?

- Ethically justifiable to assign a monetary value to a human life?
- Applying discount rates means that the value of a saved life in the future is lower than the value of a saved life today.
- Benefit valuation strongly depends on the 'Value of a Statistical Life' (VoSL). However:
  - *Inherent problems with VoSL calculations (Hauer, 2011)*
  - *Much variation in estimates, thus high uncertainty in eventual results.*
- Values for input parameters (= measure costs, effects on crashes, safety benefits) not easily transferable between countries or jurisdictions.

Why could a CBA be a good idea?

- Supports rational decision-making
- Allows to compare effects of a very different
  - *Safety*
  - *Time*
  - *Comfort*

The EU H2020 SafetyCube project

Road Safety
Decision **S**upport **S**ystem

Risks

Measures

Policy-makers & stakeholders

- ❑ strategies
- ❑ measures
- ❑ cost-effective approaches

Reduce casualties
- All road users
- All severities

Economic Efficiency Evaluation (E³) tool

Input

- Measure description, unit of implementation, time horizon
- Measure costs (initial + recurrent)
- Effectiveness of the measure, penetration rate, number of affected crashes
- Crash costs

Calculations

- Costs and benefits per year

Output

- Number of Prevented casualties , Benefit-to-cost ratio, Net Present value of costs and prevented crashes/injuries, break-even costs

Extra analyses

- Sensitivity analyses
- Side impacts

STANDARD VALUES PER COST COMPONENT AND TYPE OF CASUALTY/CRASH

	Medical costs	Production loss	Human costs	Property damage	Administrative costs	Other costs	Total (unit) costs
Fatalities	€ 5,430	€ 655,376	€ 1,587,001	€ 11,555	€ 6,346	€ 3,638	€ 2,269,346
Serious injuries	€ 16,719	€ 43,627	€ 230,385	€ 7,622	€ 4,364	€ 413	€ 303,130
Slight injuries	€ 1,439	€ 2,669	€ 15,597	€ 5,317	€ 1,876	€ 519	€ 27,418
Fatal crashes	€ 11,757	€ 727,616	€ 1,809,467	€ 17,542	€ 8,891	€ 3,817	€ 2,579,089
Serious injury crashes	€ 19,158	€ 50,285	€ 263,945	€ 11,143	€ 5,557	€ 709	€ 350,796
Slight injury crashes	€ 1,957	€ 3,629	€ 21,212	€ 7,231	€ 2,677	€ 634	€ 37,340
PDO crashes	€ 0	€ 0	€ 0	€ 2,795	€ 764	€ 400	€ 3,960

Some preliminary results (infrastructure)

Measure	Unit of analysis	Benefit-to-cost ratio (best estimate)	Net Present Value (in EUR EU-2015 PPP)	Total costs per unit of analysis (in EUR EU-2015 PPP)	Break-even measure cost (in EUR EU-2015 PPP)
*Road safety audits - Light measure addition	1 km	3.4	€ 193 505	€ 79 189	€ 272 694
*Road safety audits - Heavy measure addition	1 km	0.5	-€ 326 597	€ 599 291	€ 272 694
High risk sites treatment	1 location (intersection)	16.1	€ 869 803	€ 57 561	€ 927 363
Dynamic speed limits	1 km	1.1	€ 31 548	€ 490 192	€ 521 739
Section control	1 km	19.5	€ 2 834 895	€ 152 913	€ 2 987 808
Implementation of 30-zones	1 area	1.6	€ 66 038	€ 110 226	€ 176 265[1]
Installation of lighting & Improvement of existing lighting	1 km	0.7	€ -24 888	€ 85962	€ 61073
Implementation of rumble strips at centreline	1 km	9.1	€ 7950	€ 987	€ 8938
Installation of chevron signs	1 location (curve)	4.9	€ 34 746	€ 8 814	€ 2 904
Channelisation	1 location (intersection)	8.4	€ 1 452 858	€ 196 061	€ 1 648 919
Installation of traffic calming schemes	1 area	0.4	-€ 392 061	€ 612 633	€ 220 572
Safety barriers installation	1 km	19.5	€ 1 339 933	€ 72 314	€ 1 412 247
Convert junction to roundabout	1 location (intersection)	9.2	€ 3 749 171	€ 455 122	€ 4 204 293
Traffic signal installation	1 location (intersection)	1.1	€ 305 575	€ 3 439 981	€ 107 016
*Traffic signal installation - highways	1 location (intersection)	3.7	€ 559 388	€ 206 874	€ 766 263

Some preliminary results (behaviour)

Measure	Unit of analysis	Total costs per unit of analysis (in EUR EU-2015 PPP)	B/C ratio Best estimate	NPV (in EUR EU-2015 PPP)	Break-even measure cost
Law and enforcement – General police enforcement, speeding	One area of enforcement with a total length of 88 km.	€ 5,856,879	1.0	€ 122,489	€ 5,979,369
Law and enforcement – DUI checkpoints, selective and random breath testing	DUI testing for 100,000 drivers for a year	€ 3,284,143	7.3	€ 20,732,246	€ 24,007,389
Law and enforcement – seatbelt wearing	one country, increase of seatbelt enforcement by factor 2	€ 66,551,400	2.5	NOK 94,765,585	NOK 159,693,780
Fitness to drive assessment and rehabilitation – Alcohol interlock	participation of a serious offender in an alcohol interlock programm	€3,068	10.9	€ 131,281,642	€ 32,130
Awareness raising and campaigns – Seatbelt	1 national seatbelt campiagn	€ 468,832	42.2	€ 19,300,582	€ 19,769,414
Education – Hazard perception training	1 harzad perception training	-	-	€ 120,155	€ 120,155
Formal pre-license training, Graduated driver licensing	1 training intervention	€ 132,620	344.7	€ 45,583,464	€ 45,716,085
Education and voluntary trainings – Child pedestrian training	1 child pedestrian training	€ 574,689	1.6	€ 325,293	€ 899,982
Awareness raising and campaigns – Child restraint	1 nationwide booster seat programme 4-8-years old	€ 463,980	2.9	€ 903,512	€ 1,367,492
Awareness raising and campaigns – Drink-driving	1 drink-driving advertising campaign	€ 862,157	2.1	€ 932,113	€ 1,794,270
Law and enforcement – Red light cameras	1 red light camera on an intersection, 253 implemented units	€109,400	3.7	€ 71,491,929	€ 388,358
Fitness to drive assessment and rehabilitation – Mandatory eyesight test	1 visual mandatory eyesight test and treatment if necessary and possible	€ 47	0.5	-2,782,968	€ 24

Sensitivity analysis

Measure	**Benefit-to-cost ratio (best estimate)**	**Benefit-to-cost ratio** (worst case scenario = high cost + low effect)	**Benefit-to-cost ratio** (ideal case scenario = low cost + high effect)
Law and enforcement – General police enforcement, speeding	1.0	0.4	2.6
Law and enforcement – DUI checkpoints, selective and random breath testing	7.3	2.9	18.8
Law and enforcement – seatbelt wearing	2.5	0.9	6.2
Fitness to drive assessment and rehabilitation – Alcohol interlock	10.9	2.9	27.5
Awareness raising and campaigns – Seatbelt	42.2	17.4	101.9

Synopses

CBA Dynamic Speed Limits

Stijn Daniels, VIAS, September 2017

ABSTRACT

An existing evaluation study on effects of dynamic speed limits on motorways in Flanders, Belgium (De Pauw et al., 2017) was recoded. The resulting best estimate of the benefit-to-cost ratio is 0.9 which means that the costs tend to exceed the benefits slightly.

INPUT INFORMATION

The only available before-and-after study (De Pauw et al., 2017) reports a significant reduction of 18% of injury crashes due to the presence of a dynamic speed limits (DSL) system on motorways in Flanders, Belgium. The same study also contained cost information. The estimated implementation cost in this paper is 316 000 EUR (2010 prices) per kilometre. The estimated annual maintenance and operational cost is 9876 EUR (2010 prices) per kilometre. These costs apply to Belgium and are updated to 2015 values by applying the inflation conversion value of 1.07. The applied time horizon for the measure is 25 years. All costs and effects are expressed per kilometre of motorways that are equipped with dynamic speed limits. The study evaluated 59.5 km of motorways that are equipped with the system. The affected number of casualties was retrieved from De Pauw et al. (2017). The contains an on the total number of injured people and a separate estimate on the effect on the number of serious injuries. For the CBA the effect on PDO crashes was assumed to be the same as the effect on the number of slight injury crashes. No side effects were taken into account.

RESULTS

Table 1 provides the input values and the result estimated benefit-to-cost ratio for DSL. It shows a B/C ratio of 0.9. This means that the costs tend to exceed the benefits.

Table 1 Input values and B/C ratio for the 'best estimate' scenario

Scenario	Input values	B/C ratio
Best estimate	Fatal injury crashes: -6% Serious injury crashes: -6% Slight injury crashes: -18% PDO only crashes: -18% Impl. cost: 388120 €/km Annual cost: 10567 €/km Affected nr of crashes per year: Fatalities: 0.0446 (2.66 crashes/59.4 km, see De Pauw et al., 2017) Ser. Inj. 0.4021 Slight inj.: 1.6078 PDO: (suggested value by the calculator): 9.797	0.9

SENSITIVITY ANALYSIS

We used the upper and lower limits of the 95% confidence intervals of the estimates in De Pauw et al.(2017) to run a sensitivity analysis. The values represent a (much) lower than expected and a (much) higher than expected effect respectively. Subsequently the effect is calculated for cases in which the measure costs are lower of or higher than estimated. Table 2 presents the results.

Table 2 Sensitivity analyses

	Input values	B/C ratio
Low effect	Fatal injury crashes: +29% Serious injury crashes: +29% Slight injury crashes: -4% PDO only crashes: -4%	-2.0
High effect	Fatal injury crashes:-32% Serious injury crashes: -32% Slight injury crashes: -30% PDO only crashes: -30%	3.1
Low measure cost (-50%)	Impl. cost: 194060 €/km Annual cost: 5284 €/km	1.7
High measure cost (+100%)	Impl. cost: 776240 €/km Annual cost: 21134 €/km	0.4

We define a 'worst case scenario' as a combination of a much worse than expected effect (i.e. the lower limit of the 95% CI) and a higher than expected measure cost (i.e. the estimated cost +100%). Also a 'best case scenario' is defined which is a combination of a much better than expected effect (upper limit of the 95% CI) and a lower than expected measure cost (estimated cost -50%). The results of the CBA for these scenarios are reflected in Table 3.

Table 3 CBA for worst case and best case scenarios

Scenario	Input values	B/C ratio
Worst case	Fatal injury crashes: +29% Serious inj. crashes: +29% Slight injury crashes: -4% PDO only crashes: -4% Impl. cost: 776240 €/km Annual cost: 21134 €/km	-1.0
Best case	Fatal injury crashes:-32% Serious inj. crashes: -32% Slight injury crashes: -30% PDO only crashes: -30% Impl. cost: 194060 €/km Annual cost: 5284 €/km	6.1

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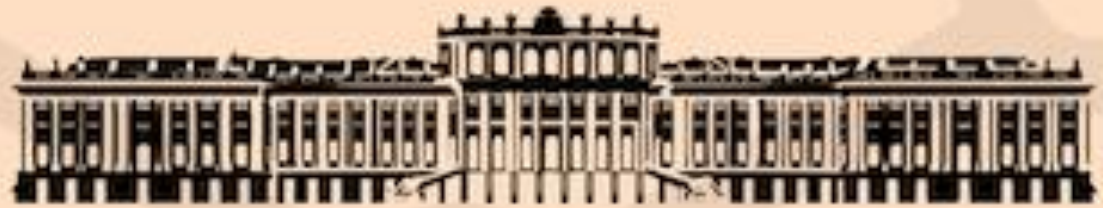
SafetyCube: an attempt to address some typical CBA issues

- Common method for estimating crash costs
- All costs and benefits in EU 2015 Purchasing Power Parity
- Showing uncertainty by carrying out sensitivity analyses
  - *Lower-than-expected and higher-than-expected effects (95% CI limits)*
  - *Measure costs -50% and +100%*
  - *'worst case' and 'ideal case' scenarios*
- Synopsis documents for every measure with description of assumptions

Conclusions

- CBA yield interesting information
- CBA can contribute to a rational approach
- However CBA results highly dependent on input values.
- CBA should be used as a decision support tool, not as a decision tool.

SafetyCube



FINAL CONFERENCE

MARCH 22 & 23 2018

VIENNA

www.safetycube-project.eu

Economic evaluation of road safety measures in the EU SafetyCube project

Questions?