

SafetyCube - the European Road Safety Decision Support System

www.roadsafety-dss.eu



Professor [George Yannis](#), National Technical University of Athens



26th Meeting of the International Traffic Safety Data and Analysis Group (IRTAD), Paris, 4-6 April, 2018

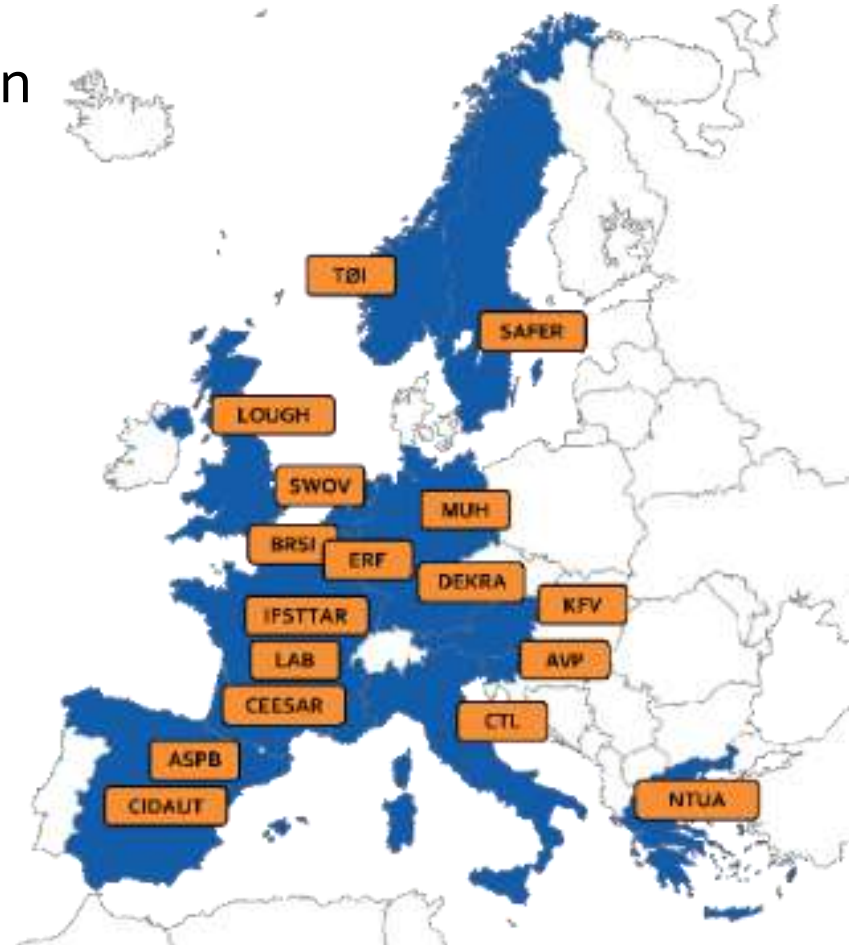


The SafetyCube project



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 DSS Objectives



The SafetyCube DSS objective is to provide the European and Global road safety community a **user friendly, web-based, interactive Decision Support Tool** to properly substantiate their 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 and problems
- road safety measures
- best estimate of effectiveness
- cost-benefit evaluation
- all related analytic background

Special focus on linking road safety problems with related measures.



Current Road Safety DSS Worldwide



- Crash Modification Factors Clearinghouse (www.cmfclearinghouse.org) by NHTSA (USA) - **6.251 CMF** on infrastructure only - ongoing
- 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 (<http://toolkit.irap.org/>) by iRAP - **58 treatments** (42 on infrastructure)
- Safety Performance Factors Clearinghouse (<http://spftool.com/>) by Tatum Group LLC, - **few SPF** - subscribers only

SafetyCube DSS Users



- **Public authorities** - local, regional, national, European and international
- **Industry** - Infrastructure, Vehicle, Insurance, Technology
- **Research Institutes, Experts**
- **Non Governmental Organisations**
- **Mass Media**
- **Everyone**



The SafetyCube DSS is intended to have **a life well beyond the end of the SafetyCube research project**. It is developed in a form that can readily be incorporated within the existing European Road Safety Observatory of the European Commission DG-MOVE.

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)



Selection and Coding of Studies



Study search in key databases

(Scopus, TRID, Elsevier, Taylor & Francis, Springer etc.)

Study selection and prioritization criteria

- Studies with quantitative results
- Meta-analyses, or other high quality studies (peer-reviewed)
- Recent studies
- European studies

Study selection and prioritization criteria

- Study design and methodology
- Results and their confidence intervals
- Study limitations



SafetyCube DSS Design Principles



- A **Modern** web-based tool
- Highly **Ergonomic** interface
- **Simple** structure
- Powerful **Search** Engines
- Fully **Documented** information
- Easily **Updated**



SafetyCube DSS Search Engine



- **Fully linked search**
 - search a road safety problem alone or through the measures
 - search a measure alone or through the road safety problems
 - search for risks and measures related to specific road user groups or crash types (accident categories)
- **Fully detailed search**
 - search by any parameter in each data table in the database
- **Fully flexible search**
 - adjust and customize search according to results
- **Fully documented search**
 - access background information at any stage (supporting documentation, links, etc.)



SafetyCube DSS Menu

- **Search**
Risk Factors & Measures
- **Knowledge**
211 Synopses, Serious Injuries, Accident Scenarios
- **Calculator**
Economic Efficiency Evaluation
- **Methodology**
System documentation
- **Support**
Contact, help, feedback



The Search Structure

- — ○
- **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)
- **Links** between Risk Factors
Information about which risks
can be remedied by which types
of measures



SafetyCube DSS Entry Points

- **Keyword search**
(all database keywords)
- **Risk factor search**
(taxonomy)
- **Measures search**
(taxonomy)
- **Road User Groups**
(database keywords related to each group)
- **Accident Categories**
(inquiries about specific scenarios)

The screenshot displays the SafetyCube DSS website. The header includes the logo and the text 'European Road Safety Decision Support System'. Below the header is a navigation bar with links: Search, Knowledge, Calculator, Methodology, and Support. The main content area features a 'Keyword Search' section with five categories: Keyword Search, Risk Factors, Measures, Road User Groups, and Accident Categories. A sidebar on the left lists various pedestrian-related terms: PEDESTRIANS, CHILD PEDESTRIANS, PEDESTRIAN CROSSING, PEDESTRIAN CROSSING, PEDESTRIAN SIGNAL, PEDESTRIAN CRASHES, PEDESTRIAN AIRBAGS, and PEDESTRIAN DETECTION. The main content area shows a detailed view of the 'PEDESTRIANS' category, which is divided into 'Risk Factors' and 'Measures'. The 'Risk Factors' section is further divided into 'Behavior', 'Infrastructure', and 'Vehicle' categories. The 'Measures' section is divided into 'Behavior', 'Infrastructure', and 'Vehicle' categories. The 'Risk Factors' section includes a table with the following data:

| Behavior | Infrastructure | Vehicle |
|-----------------------------|---|-----------------------|
| Functional impairment | Adverse weather | Motorist |
| Distraction and inattention | Poor junction visibility | Validity / Competency |
| Traffic rule violations | All-grade junction deficiencies | PW / ATV |
| | Median / barrier deficiencies (risk of crash with oncoming traffic) | LDV |
| | Unaligned/vertical alignment deficiencies | Passenger Cars |
| | Traffic flow | |

The 'Measures' section includes a table with the following data:

| Behavior | Infrastructure | Vehicle | Post Impact Care |
|---|--------------------------------|---------------------------------|------------------|
| Education and voluntary behavior programs | Traffic signals treatments | Positioner | Not Applicable |
| | Road markings and junctions | Vulnerable Road User Protection | |
| | Speed management & enforcement | | |
| | Speed management | | |
| | Rail road crossings | | |
| | Traffic signs treatments | | |

SafetyCube DSS Results Pages



Search results

- Synopses, and their short summaries & colour codes
- Table listing the available studies

Refine search

- Specific Risk factor / Measure
- Other **search filters**:
 - Road user groups: All, car occupants, drivers, passengers, PTW riders, pedestrians, cyclists, HGVs.
 - Road types: All, motorways, rural roads, urban roads
 - Country: EU, EU countries, US and Canada, Australia, Asia.

Links to related measures

- Select a specific risk factor / measure
- Get the list of related measures



SafetyCube Synopses



211 Syntheses on risk factors / measures

Summary (2 pages)

- Effect of risk factor / measure and ranking (colour code)
- Risk / safety effect mechanisms
- Risk / safety effects size, transferability of effects

Scientific overview (4-5 pages)

- Comparative analysis of available studies
- Analysis results:
Meta-analysis/Vote-count analysis/Qualitative analysis

Supporting document (3-10 pages)

- Literature search strategy and study selection criteria
- Detailed analyses

Presence of workzones - Workzone duration

Presence of the Workzone in the German Traffic Rules, § 1, Paragraphs 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126, 127, 128, 129, 130, 131, 132, 133, 134, 135, 136, 137, 138, 139, 140, 141, 142, 143, 144, 145, 146, 147, 148, 149, 150, 151, 152, 153, 154, 155, 156, 157, 158, 159, 160, 161, 162, 163, 164, 165, 166, 167, 168, 169, 170, 171, 172, 173, 174, 175, 176, 177, 178, 179, 180, 181, 182, 183, 184, 185, 186, 187, 188, 189, 190, 191, 192, 193, 194, 195, 196, 197, 198, 199, 200, 201, 202, 203, 204, 205, 206, 207, 208, 209, 210, 211, 212, 213, 214, 215, 216, 217, 218, 219, 220, 221, 222, 223, 224, 225, 226, 227, 228, 229, 230, 231, 232, 233, 234, 235, 236, 237, 238, 239, 240, 241, 242, 243, 244, 245, 246, 247, 248, 249, 250, 251, 252, 253, 254, 255, 256, 257, 258, 259, 260, 261, 262, 263, 264, 265, 266, 267, 268, 269, 270, 271, 272, 273, 274, 275, 276, 277, 278, 279, 280, 281, 282, 283, 284, 285, 286, 287, 288, 289, 290, 291, 292, 293, 294, 295, 296, 297, 298, 299, 300, 301, 302, 303, 304, 305, 306, 307, 308, 309, 310, 311, 312, 313, 314, 315, 316, 317, 318, 319, 320, 321, 322, 323, 324, 325, 326, 327, 328, 329, 330, 331, 332, 333, 334, 335, 336, 337, 338, 339, 340, 341, 342, 343, 344, 345, 346, 347, 348, 349, 350, 351, 352, 353, 354, 355, 356, 357, 358, 359, 360, 361, 362, 363, 364, 365, 366, 367, 368, 369, 370, 371, 372, 373, 374, 375, 376, 377, 378, 379, 380, 381, 382, 383, 384, 385, 386, 387, 388, 389, 390, 391, 392, 393, 394, 395, 396, 397, 398, 399, 400, 401, 402, 403, 404, 405, 406, 407, 408, 409, 410, 411, 412, 413, 414, 415, 416, 417, 418, 419, 420, 421, 422, 423, 424, 425, 426, 427, 428, 429, 430, 431, 432, 433, 434, 435, 436, 437, 438, 439, 440, 441, 442, 443, 444, 445, 446, 447, 448, 449, 450, 451, 452, 453, 454, 455, 456, 457, 458, 459, 460, 461, 462, 463, 464, 465, 466, 467, 468, 469, 470, 471, 472, 473, 474, 475, 476, 477, 478, 479, 480, 481, 482, 483, 484, 485, 486, 487, 488, 489, 490, 491, 492, 493, 494, 495, 496, 497, 498, 499, 500, 501, 502, 503, 504, 505, 506, 507, 508, 509, 510, 511, 512, 513, 514, 515, 516, 517, 518, 519, 520, 521, 522, 523, 524, 525, 526, 527, 528, 529, 530, 531, 532, 533, 534, 535, 536, 537, 538, 539, 540, 541, 542, 543, 544, 545, 546, 547, 548, 549, 550, 551, 552, 553, 554, 555, 556, 557, 558, 559, 560, 561, 562, 563, 564, 565, 566, 567, 568, 569, 570, 571, 572, 573, 574, 575, 576, 577, 578, 579, 580, 581, 582, 583, 584, 585, 586, 587, 588, 589, 590, 591, 592, 593, 594, 595, 596, 597, 598, 599, 600, 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 614, 615, 616, 617, 618, 619, 620, 621, 622, 623, 624, 625, 626, 627, 628, 629, 630, 631, 632, 633, 634, 635, 636, 637, 638, 639, 640, 641, 642, 643, 644, 645, 646, 647, 648, 649, 650, 651, 652, 653, 654, 655, 656, 657, 658, 659, 660, 661, 662, 663, 664, 665, 666, 667, 668, 669, 670, 671, 672, 673, 674, 675, 676, 677, 678, 679, 680, 681, 682, 683, 684, 685, 686, 687, 688, 689, 690, 691, 692, 693, 694, 695, 696, 697, 698, 699, 700, 701, 702, 703, 704, 705, 706, 707, 708, 709, 710, 711, 712, 713, 714, 715, 716, 717, 718, 719, 720, 721, 722, 723, 724, 725, 726, 727, 728, 729, 730, 731, 732, 733, 734, 735, 736, 737, 738, 739, 740, 741, 742, 743, 744, 745, 746, 747, 748, 749, 750, 751, 752, 753, 754, 755, 756, 757, 758, 759, 760, 761, 762, 763, 764, 765, 766, 767, 768, 769, 770, 771, 772, 773, 774, 775, 776, 777, 778, 779, 780, 781, 782, 783, 784, 785, 786, 787, 788, 789, 790, 791, 792, 793, 794, 795, 796, 797, 798, 799, 800, 801, 802, 803, 804, 805, 806, 807, 808, 809, 810, 811, 812, 813, 814, 815, 816, 817, 818, 819, 820, 821, 822, 8

SafetyCube Related Risks / Measures

- Linking based on a **dedicated model** categorizing risks
- Risk Factors (118) are **linked** to one or more Road Safety Measure(s) (167)*
- A total of **762 links** between risk factors and measures

* A few risk factors or measures (e.g. post-impact care) were not "linkable".




SafetyCube DSS

European Road Safety Decision Support System

[Search](#)
[Knowledge](#)
[Calculator](#)
[Methodology](#)
[Support](#)

Related Studies for "poor visibility - darkness"

The following measures are related to the risk factor you selected, select a measure from the table below to use the available safety.cube results.

| Measure | Measure description | Vehicle | Post Occupancy |
|--|---|---|----------------|
| Designing or redesign protective clothing and visibility | Installation of road lighting Improvement of existing lighting | Lightweighting (structural, engine, electronic systems, ...) High inertia Variable inertia (active + remedial electronic systems control (ACC)) | Not applicable |

| Countries | SafetyCube Synopses |
|----------------|---|
| CANADA | Installation of lighting & improvements to existing lighting: GREEN (EFFICIENT) - L |
| NETHERLANDS | The vast majority of results show that the installation of road lighting and improvements to existing road lighting have favourable effects on the number of occurring crashes. |
| UNITED KINGDOM | |
| UNITED STATES | |

| ID | Title | Source | Year | Design | Countries |
|-----|---|---|------|-------------------|---------------|
| 254 | Relationship Between Roadway Illuminance Level and Nighttime Road Intersection Safety | (TRANSPORTATION RESEARCH BOARD JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, VOL. 2495, PP. 3-15) | 2015 | CONCEPT SECTIONAL | UNITED STATES |
| 255 | Road Lighting Effects on Bicycle and Pedestrian Accident Frequency Case study in Montreal, Quebec, Canada | (TRANSPORTATION RESEARCH RECORDS JOURNAL OF THE TRANSPORTATION RESEARCH BOARD, NO. 2555, PP. 89-94) | 2016 | CONCEPT SECTIONAL | CANADA |

SafetyCube DSS Individual Study Pages

Title, author, source, abstract

- Link to URL for full-text download (depending on Institute permissions)

Study design info:

- Country
- Research Method, Design, Sample
- Exposure/Control group
- Risk/Outcome Group
- Modifying Conditions
- Potential limitations

Study results:

- Table listing the detailed effects reported in the study

SafetyCube

DSS

European Road Safety Decision Support System

Home

Knowledge

Database

Reference

Support

Modeling work zone crash frequency by quantifying measurement errors in work zone length

Varg, L. / Varg, A., Uutinen, J. / Bibliography

Abstract

Work zone safety is an essential part of road safety management. It is a complex task, as it involves many different factors, such as traffic volume, road geometry, and weather conditions. The purpose of this study is to develop a model that can predict the number of crashes that occur in work zones, taking into account the measurement errors in work zone length. The model is based on a log-linear regression model, and it is evaluated using data from a large number of work zones. The results show that the model is able to predict the number of crashes with a high degree of accuracy, and that the measurement errors in work zone length have a significant impact on the results.

Full Text Download

Summary

This study investigates the effect of work zone length on crash frequency. The study is based on a log-linear regression model, and it is evaluated using data from a large number of work zones. The results show that the model is able to predict the number of crashes with a high degree of accuracy, and that the measurement errors in work zone length have a significant impact on the results.

Basic Study Information

Topic: ROAD SAFETY

Author: VARG, L. / VARG, A., UUTINEN, J. / Bibliography

Editor: VARG, L. / VARG, A., UUTINEN, J. / Bibliography

Country: FINLAND

Keywords: FULL-SCALE MEASUREMENT, CRASH FREQUENCY, ROAD SAFETY, ROAD DESIGN, ANALYSIS, WORK ZONE

Effects

| Effect No. | Outcome | Exposure | Group Type | Group | Effect Estimator | Effect Definition | Sample | Estimate | Estimate Lower Limit | Estimate Upper Limit | Confidence Interval |
|------------|----------|----------|------------|----------|------------------|-------------------|--------|----------|----------------------|----------------------|---------------------|
| 1 | WZLENGTH | WZLENGTH | RELATIVE | RELATIVE | 0.47 | 0.75 | 0.95 | 0.47 | 0.75 | 0.95 | CONFIDENCE INTERVAL |
| 2 | WZLENGTH | WZLENGTH | RELATIVE | RELATIVE | 0.47 | 0.75 | 0.95 | 0.47 | 0.75 | 0.95 | CONFIDENCE INTERVAL |

SafetyCube DSS Calculator

- 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

The screenshot displays the 'SafetyCube DSS' web application. The top navigation bar includes links for 'Home', 'Knowledge', 'Calculator', 'Methodology', and 'Support'. The main heading is 'Calculator', with a sub-heading 'First example of the design process'. A brief description follows, explaining the tool's purpose in calculating the effectiveness of road safety measures. Below this, the 'Input' section shows a dropdown menu for 'Infrastructure safety management - Speed management & enforcement - 3D-zones implementation'. The 'Costs (present values)' table lists various costs: 'Infrastructure investment costs' (10,000,000), 'Road construction costs' (1,700,000,000), 'Total costs excluding side-effects' (1,710,000,000), 'Current costs' (0), and 'Total net including side-effects' (1,710,000,000). The 'Benefits' section shows 'Prevented Crashes' (1,700,000,000). The 'Socio-economic return excluding side-effects' table shows 'Net present value' (107,791,219.79) and 'Discount rate' (1.8). The 'Socio-economic return including side-effects' table shows 'Net present value' (107,791,219.79) and 'Discount rate' (1.8).

| Costs (present values) | |
|------------------------------------|---------------|
| Infrastructure investment costs | 10,000,000 |
| Road construction costs | 1,700,000,000 |
| Total costs excluding side-effects | 1,710,000,000 |
| Current costs | 0 |
| Total net including side-effects | 1,710,000,000 |

| Benefits | |
|-------------------|---------------|
| Prevented Crashes | 1,700,000,000 |

| Socio-economic return excluding side-effects | |
|--|----------------|
| Net present value | 107,791,219.79 |
| Discount rate | 1.8 |

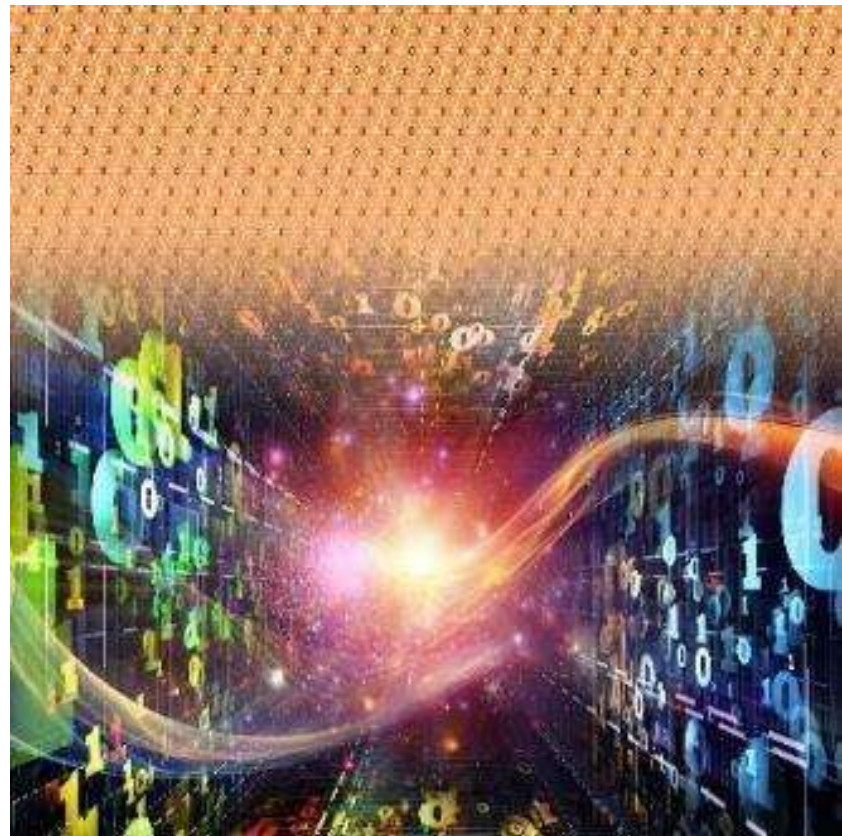
| Socio-economic return including side-effects | |
|--|----------------|
| Net present value | 107,791,219.79 |
| Discount rate | 1.8 |

SafetyCube DSS Knowledge Wealth



SafetyCube DSS contains:

- more than 1,250 **studies**,
- with more than 7,500 **estimates** of risks/measure effects on:
 - behaviour,
 - infrastructure,
 - vehicle, and
 - post impact care
- **211 Synopses**
- **36 cost-benefit analyses** (adjustable)



Example questions addressed

- how important is my road safety problem?
- who else is having similar problems?
- what solutions are usually proposed for my problem?
- how efficient are the solutions proposed?
- which is the most efficient solution?
- and if I have a combination of problems...

...then use SafetyCube DSS to have the answers



SafetyCube Next Steps



- SafetyCube DSS **Opening** (October 2017)
- The **future operation** of the SafetyCube DSS concerns:
 1. the uninterrupted operation of the current SafetyCube DSS
 2. updates of the risk factors, measures and cost-benefit analyses (recent studies but also older ones)
 3. addition of studies in more languages
 4. translation of the contents in other languages
 5. possibility to receive, check and incorporate studies submitted by external experts and organizations and the respective quality control
 6. incorporation of additional data and knowledge sections



Delivering a long waited powerful tool

- SafetyCube DSS is the first integrated road safety support system **developed in Europe**
- SafetyCube DSS **offers for the first time** scientific evidence on:
 - risks and not only measures
 - risks and measures not only on infrastructure
 - a very large number of estimates of risks and measures effects
 - links between risks factors and measures
- SafetyCube DSS aims to be a **reference system** for road safety in Europe, constantly improved and enhanced



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Professor [George Yannis](#), National Technical University of Athens



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