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# Safety effects of infrastructure road safety measures

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# Risk Factors and Measures

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 dissimilarly

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) www.safetycube-project.eu
- This knowledge is attained by gathering, assessing and meta-analyzing research

# SafetyCube Methodology

1. Creating taxonomies of road safety measures
2. Exhaustive literature review and rigorous study selection criteria
3. Use of a standardized template for coding studies
4. Carrying out meta-analyses to estimate the effects of measures.
5. Drafting Synopses summarizing results of measures, including a “colour code” denoting their impacts.

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

# SafetyCube Infrastructure Taxonomy

The Taxonomy endeavors to:

- Capture all elements of road safety studied worldwide:
  - 11 infrastructure elements including
  - 24 general measures including
  - 94 specific measures
- Examine parameters on a road safety measure basis
- Link scientifically researched appropriate measure(s) in a case-by-case approach with risk factors

| Infrastructure element | General measure | Specific measure |
|---|---|---|
| Infrastructure safety management | Formal tools to address road network deficiencies *hot topic* | Road safety audits implementation |
| | | Road safety inspections implementation |
| | | High risk sites identification |
| | | Land use regulations improvement |
| | Speed management & enforcement | Reduction of speed limit |
| | | Dynamic (weather-variant) speed limits *hot topic* |
| | | Individual Dynamic Speed Warning *hot topic* |
| | | Speed cameras[4] |
| | | Section control |
| | | Speed humps |
| | | Woonerfs implementation |
| | | Narrowings |
| | | School zones |
| | | 30-zones implementation |
| | | Traffic calming schemes |

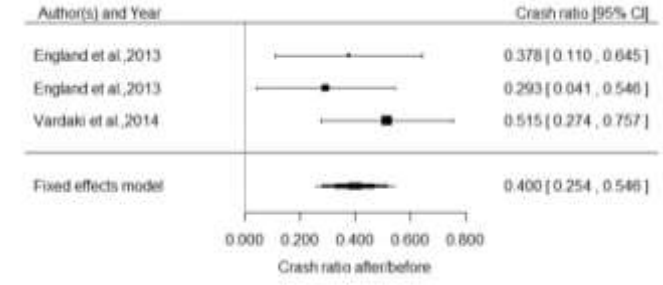
# Challenges and Criteria

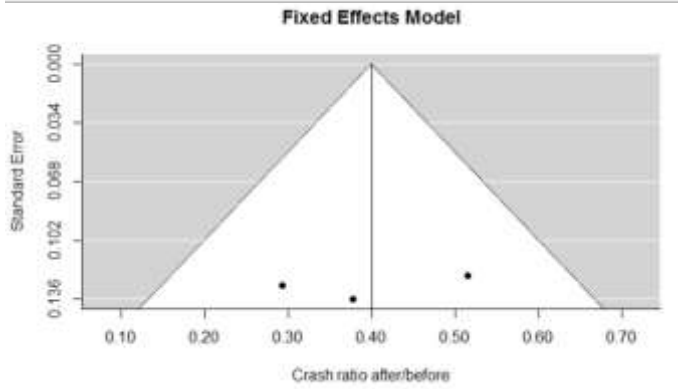
- Several challenges when examining road safety studies:
  - Considerable variations at study design levels (e.g. cross-sectional vs. case-control studies etc.)
  - Inclusion of all relevant parameters (e.g. different road users, scenarios), topic complexity (e.g. land use regulations)
  - Relevant outputs 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 when possible, vote-count or review-type analysis alternatively)
- Synopses assign a colour code: Ranking of measures
- Quality control at all stages ensures verified and accurate outcomes



# Main Results (1/3)

For Road Safety infrastructure measures:

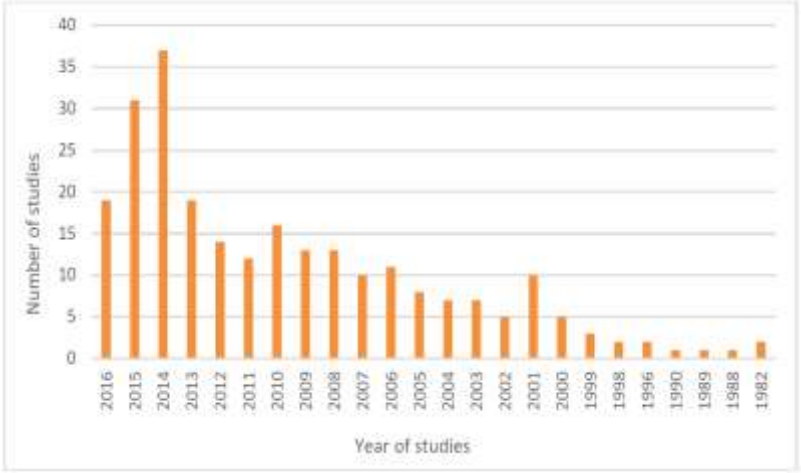
- 48 synopses have been compiled
- Most include existing meta-analyses, 2 include new meta-analyses
- 16 measures -> **Green** (consistent evidence of a positive effect on road safety)
- 19 measures -> **Light Green** (probably effective - likely positive effect on road safety)
- 14 measures -> **Grey** (unclear – no clear conclusions)
- Contributions by 9 SafetyCube partners

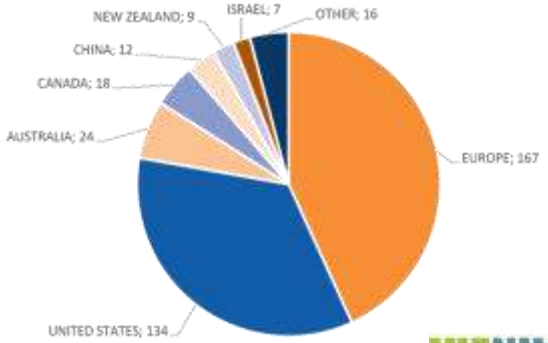
| Green (clearly reducing risk) | Light green (probably reducing risk) | Grey (Unclear) |
|---|---|---|
| ✓ HGV traffic restrictions | ✓ Road safety audits & inspections | ? Implementation of woonerfs |
| ✓ Speed limit reduction measures to increase road safety | ✓ High risk sites treatment | ? Installation of median |
| ✓ Dynamic speed display signs | ✓ Implementation of narrowings | ? Increase number of lanes |
| ✓ Installation of section control & speed cameras | ✓ School zones | ? Increase lane width |
| ✓ Installation of speed humps | ✓ Installation of traffic calming schemes | ? Change shoulder type |
| ✓ Implementation of 30-zones | ✓ Road surface treatments | ? Installation of cycle lane and cycle path |
| ✓ Installation of lighting & Improvement of existing lighting | ✓ Increase median width | ? V2I schemes |
| ✓ Workzones: Signage installation and improvement | ✓ Change median type | ? Convert junction to roundabout (cyclists) |
| ✓ Implementation of rumble strips at centreline | ✓ Shoulder implementation (shoulder type) | ? Improve skewness or junction angle |
| ✓ Installation of chevron signs | ✓ Increase shoulder width | ? Convert 4-leg junction to staggered junctions |
| ✓ Traffic sign installation; Traffic sign maintenance | ✓ Safety barriers installation; Change type of safety barriers | ? STOP / YIELD signs installation / replacement |
| ✓ Convert at-grade junction to interchange | ✓ Create clear-zone / remove obstacles & Increase width of clear-zone | ? Road markings implementation |
| ✓ Sight distance treatments | ✓ Implementation of edgeline rumble strips | ? Implementation of marked crosswalk |
| ✓ Automatic barriers installation at rail-road crossings | ✓ Variable message signs | ? Traffic signal reconfiguration |
| ✓ Dynamic speed limits | ✓ Convert junction to roundabout | |
| ✓ Creation of by-pass roads | ✓ Channelisation | |
| | ✓ Installation of rail-road crossing traffic sign | |
| | ✓ Traffic signal installation | |
| | ✓ 2+1 roads | |

# Main Results (2/3)

For Road Safety infrastructure measures:

- Overall 250 studies were coded
- 160 studies had ‘before-after’ designs (>50%)
- Studies included over 1800 road safety effects
- Examined outcomes (times examined):
  - Accident rate/risk (96)
  - Vehicle speed (58)
  - Behaviour of drivers/pedestrians (52)
  - Injury or Casualty rate/risk (38)
  - Conflicts (5)
  - CMF (4)
  - Other (3)



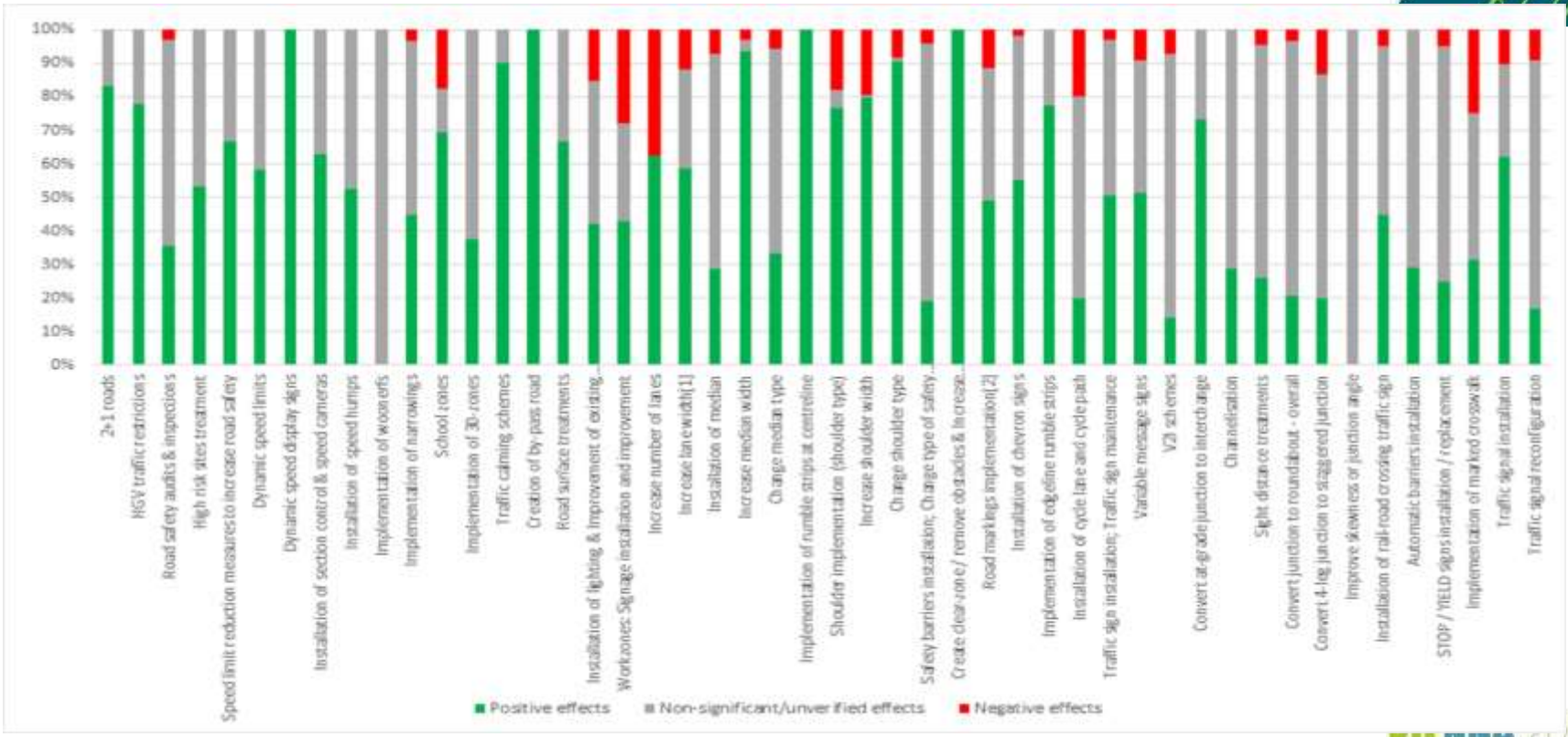
# Main Results (3/3)

To determine color code, affected road safety outcomes were examined:

- Crash risk: number of crashes per unit of exposure
- Crash frequency
- Crash severity of the injuries sustained by crash casualties
- Measures examined by road type applicability (with overlap):
  - Motorways (25 measures)
  - Rural Roads (39 measures)
  - Urban roads (38 measures)

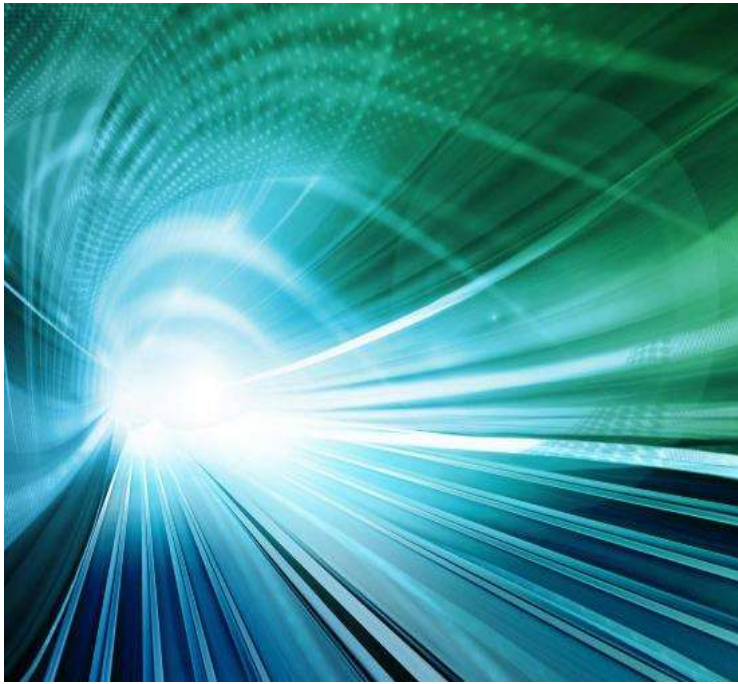
| Infrastructure Element | Specific Measure | Colour code | Crash risk* | Crash frequency | Crash severity** | Hot topic (Yes/No) | Road types studied | | | Additional Remarks |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Motorways | Rural Roads | Urban Roads | |
| Alignment-junctions | Channelisation | Light green | ↓ | ↓ | - | N | | ✓ | ✓ | Differences between the effectiveness of left-turn lanes and of right-turn lanes or between T-arms and crossroads are different to quantify |
| | Sight distance treatments | Green | ↓ | ↓ | - | Y | | ✓ | ✓ | |
| | Convert junction to roundabout - overall*** | Light green | - | ↓ | ↓ | N | | ✓ | ✓ | In the case of multi-lane roundabouts, there can even be increases to damage only accident frequency. Roundabouts are also more effective on roads with a higher speed limit. |
| | Convert junction to roundabout - cyclists*** | Grey | - | ↑ | - | N | | ✓ | ✓ | |
| | Convert 4-leg junction to staggered junction | Grey | - | - | - | N | | ✓ | ✓ | Converting 4-leg junctions to staggered T-junctions when the amount of side road traffic is low, appears to significantly increase injury as well as property damage only crash occurrence |
| | Improve skewness or junction angle | Grey | - | - | - | Y | | ✓ | ✓ | |
| | Installation of rail-road crossing traffic sign | Light green | ↓ | ↓ | - | N | | ✓ | ✓ | Stop signs were negatively effective at crossings with higher train speeds (e.g. train speed higher than 30 mph) or track classifications (classes mainly referring to the maximum speed limit). Other types of specific warning signs (e.g. hazard warning signs or highly reflective warning signs) seem to significantly reduce crash occurrence as well. |
| Traffic control - | Automatic barriers installation | Green | ↓ | ↓ | - | N | | ✓ | ✓ | |

# Vote Count Analyses Results



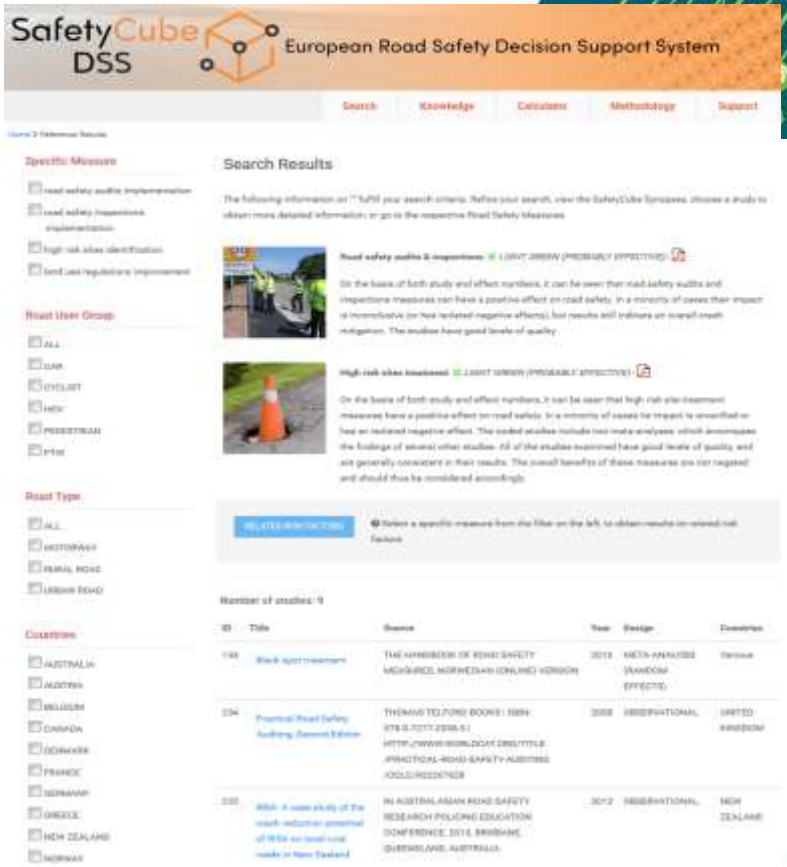
# Conclusions

- Implementation of a standardized methodology
- Exhaustive scope for all road safety aspects from many databases
- Meta-analyses utilization:
  concise and comprehensive knowledge
- High-Quality, recent
  studies have been exploited
- Prioritizing European Studies for transferability
- Ranking of road safety infrastructure measure effectiveness



# Integration to the DSS

- Addressing current knowledge gaps on the effectiveness of infrastructure road safety measures
- The SafetyCube DSS provides a means for concise standardization-documentation of research results
- Continuous research and respective updating of SafetyCube DSS will lead to a road safety encyclopaedia
- Available at: [https://www.roadsafety-dss.eu](https://www.roadsafety-dss.eu)



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