

Summary:

# Subjective and Objective Safety

## The Effect of Road Safety Measures on Subjective Safety among Vulnerable Road Users

**A literature study of 54 safety measures that may affect vulnerable road users reveals that the effect on subjective safety has been studied directly for only 14 measures and indirectly for another 14 measures. Supplementary theoretical considerations show that 70-80 % of the measures probably have a positive effect on subjective safety. 78 out of 125 submeasures are assessed to have a positive effect on both objective and subjective safety, while 25 have opposite effects on objective and subjective safety. Further investigation is relevant for at least 50 of the submeasures. One fourth of these measures are ranked as the measures most relevant for further studies.**

### Objective and subjective safety

Objective safety can be described as the actual number or risk of road accidents or injuries, while subjective safety is the feeling or perception of safety, i.e. how people subjectively experience accident risk in traffic.

The objective of this project have been to collect all available knowledge and studies regarding the effects of various road safety measures on subjective safety, and to assess relationships and discrepancies between the effects on objective and subjective safety for selected road safety measures.

### 54 road safety measures selected for the study

Among 111 road safety measures described in “The Handbook of Road Safety Measures” 54 measures have been selected for this study. These measures have been divided into 125 varying submeasures. The measures are selected because they are assumed to affect objective safety, subjective safety and/or mobility among cyclists and/or pedestrians.

A comprehensive literature study regarding each of the selected measures was conducted. Over 200 studies or references have been included in this study.

However, for many of the measures no evaluation studies have been found. Thus, supplementary theoretical and qualitative considerations about the effect on subjective safety have been performed for each measure.

## Positive effect on subjective safety

Table S.1 summarizes the number of measures and submeasures with various effects on subjective safety among vulnerable road users.

*Table S.1. Number of measures and submeasures with varying effect on subjective safety among vulnerable road users. Brackets indicate the number of submeasures.*

Category	Number of Measures	Effect		
		Positive	Negative	No, unknown, ambiguous
<b>Design and road furniture</b>	17 (45)	9 (30)	3 (10)	5 (5)
<b>Road maintenance</b>	5 (5)	5 (5)	0 (0)	0 (0)
<b>Traffic control</b>	17 (39)	12 (35)	3 (3)	2 (1)
<b>Vehicle design and protective devices</b>	8 (25)	6 (23)	0 (0)	2 (2)
<b>Training, education and enforcement</b>	7 (11)	7 (11)	0 (0)	0 (0)
<b>Total</b>	54 (125)	39 (104)	6 (13)	9 (8)

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Based on the results from the studies found in literature and the qualitative considerations, it is assessed that 39 measures or 104 submeasures to a larger or smaller extent have positive effects on subjective safety of cyclists, pedestrians or both of them. This corresponds to 70-83 % of the measures. The 39 measures with probably positive effect on subjective safety are listed in table S.2.

*Table S.2. Measures with positive effect on subjective safety.*

<b>Design and road furniture</b>	<b>Traffic control</b>	<b>Vehicle design and protective devices</b>
– Tracks for walking and cycling	– Traffic calming	– Reflective materials and protective clothing
– Motorways	– Environmental streets	– Cycle helmets
– Bypasses	– Pedestrian streets	– Regulating automobile engine capacity and top speed
– Arterial roads	– Urban play streets	– Safety equipment on trucks
– Channelisation of junctions	– Access control	– Bicycle safety equipment
– Staggered junctions	– Traffic signal control at intersections	– Safety standards for trailers and caravans
– Guardrails, crash cushions	– Signal-controlled pedestrian crossings	<b>Training, education and enforcement</b>
– Horizontal curve treatments	– Speed limits	– Safety standards for transporting school children
– Road lighting	– Speed-reducing devices	– Education before school
<b>Road maintenance</b>	– Traffic control for vulnerable road users	– Education in schools
– Ordinary resurfacing	– Parking regulation	– Stationary speed enforcement
– Improving evenness	– One-way streets	– Patrolling
– Improving friction		– Automatic speed enforcement
– Winter maintenance of roads		– Red light cameras
– Winter maintenance of foot and cycle tracks		

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Only six measures or 13 submeasures are assessed to have negative effects on subjective safety. This corresponds to 9-10 %. The remaining nine measures have none, unknown or ambiguous effect. Measures with negative, none, unknown or ambiguous effect are listed in table S.3.

*Table S.3. Measures with no, unknown, ambiguous or negative effect on subjective safety among vulnerable road users.*

No, unknown, ambiguous effect	Negative effect
– Roundabouts	– Redesigning junctions
– Black spot treatment	– Interchanges
– Cross section improvements	– Improving road alignment and sight conditions
– Roadside safety treatment	– Yield signs at intersections
– Rehabilitation, reconstruction and resurfacing	– Stop signs at intersections
– Priority control	– Bus lanes and bus stop design
– Road markings	
– Regulating vehicle mass	
– Under-run guard rails on trucks	

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## Positive effect on both objective and subjective safety

The 125 submeasures are classified regarding effect on objective and subjective safety. The classification is summaries in table S.4.

Fortunately most of the measures are classified as “good” measures having positive effect on both objective and subjective safety. In total, 78 (62 %) of the 125 submeasures are included in this category.

*Table S.4. Total number of submeasures in each of the nine defined groups with varying effect on objective and subjective safety.*

Objective	Subjective			Total
	Positive	Negative	No, unknown, ambiguous	
<b>Positive</b>	78	9	6	93
<b>Negative</b>	16	2	1	19
<b>No, unknown, ambiguous</b>	10	2	1	13
<b>Total</b>	104	13	8	125

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The remaining 47 (38 %) of the measures are “problem” measures. These measures should be used with caution and an assessment of the effect should be made considering the specific case.

20 measures are measures with unknown or unclear effect on objective or subjective safety.

25 measures are measures with opposite effect on objective and subjective safety. Among these 16 measures have positive effect on subjective safety and negative effect on objective safety, while nine measures have positive effect on objective safety and negative effect on subjective safety. Table S.5 lists these 25 measures.

Two measures have negative effect on both objective and subjective safety. These measures should not be used if the aim is improving objective and subjective safety.

*Table S.5. Measures with opposite effect on objective and subjective safety.*

<b>Positive effect on subjective safety and negative effect on objective safety</b>	<b>Positive effect on objective safety and negative effect on subjective safety</b>
– Tracks for cycling	– Roundabouts, mixed traffic
– T-junctions, full channelisation	– Redesigning, gradient on road
– T-junctions, minor road channelisation	– Redesigning, sight condition
– Curve treatments, road widening	– Interchanges (instead of crossroad)
– Curve treatments, transition curves	– Passing lanes (one side)
– Ordinary resurfacing of roads	– Road alignment, general improvement
– Improving the evenness of the surface	– Sight conditions, removing obstacles
– Winter maintenance of tracks, more	– Yield signs at intersections
– Speed-reducing, raised intersections	– Stop signs at intersections
– Wide edge line	
– Shoulder rumble line	
– Delineator posts with reflectors	
– Ordinary pedestrian crossing	
– Pedestrian crossings, mixed phases, intersection	
– One-way streets	
– Cycle equipment, spokes reflectors	

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## Significant lack of knowledge

This project reveals lack of knowledge among several road safety measures regarding their effect on subjective safety among vulnerable road users. Among the 54 measures, the effect has been studied directly for only 14 measures (26 %) and indirectly for another 14 measures. Table S.6 summarises the number of measures studied for five categories of safety measures.

*Table S.6. Number of measures where the effect on subjective safety among vulnerable road users directly or indirectly has been studied.*

<b>Category</b>	<b>Measures</b>	<b>Directly</b>	<b>Indirectly</b>	<b>No studies</b>
<b>1. Design and road furniture</b>	17	3	1	13
<b>2. Road maintenance</b>	5	2	3	0
<b>3. Traffic control</b>	17	7	4	6
<b>4. Vehicle design and protective devices</b>	8	2	3	3
<b>5. Training, education and enforcement</b>	7	0	3	4
<b>Total</b>	54	14	14	26

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There is not only a lack of knowledge on the effect on subjective safety, but also on the effect on objective safety. The problem is that the effect on objective safety for cyclists and/or pedestrians has been evaluated for fewer than 20 % of the sub-measures. For the remaining 80 % the general effect for all road users are used.

Thus, it is assumed that the effect among vulnerable road users has the same sign as the effect for all road users. This may not always be the case.

## Difficult to estimate the effect

This project reveals 10 varying problems with estimating the effect of road safety measures on subjective safety among vulnerable road users:

1. *Few studies*: The effect on subjective safety among vulnerable road users has only been studied directly for less than one fourth of the measures included.
2. *Amount of studies*: For each measure studied it is only possible to find one or maybe a few studies dealing with the question.
3. *Quality of studies*: The quality of the studies has not been examined, but some of the studies are based on very few respondents.
4. *Over-interpretation*: The effect on subjective safety among vulnerable road users has been studied indirectly for about another fourth of the measures included. The result of these studies may have been over-interpreted.
5. *Qualitative considerations not verified*: Assumptions about various correlations have not been verified satisfactorily.
6. *Difficult to sum up qualitative considerations*: It is difficult to assess the effect when factors having an impact on subjective safety have opposite directions. This is the case for several of the measures.
7. *Ambiguous or unknown results*: Ambiguous or unknown results about the effect on subjective safety for several measures.
8. *Magnitude of effect*: The magnitude of the effect on subjective safety is often unknown.
9. *Number*: Number of vulnerable road users in the area is not taken account for in the assessment of effect.
10. *Division of vulnerable road users*: Vulnerable road users are not divided systematically between cyclists and pedestrians. This may only be possible in the qualitative considerations.

## More research needed

Due to the quality and the quantity of the evaluation studies performed further evaluation is both recommended for measures already studied and for measures not studied before.

50 measures are identified for further investigation. However, it is very ambitious to recommend further studies for 50 varying measures. Thus, 13 (one fourth) of the measures have been selected as measures where further studies are most relevant.

The measures selected are those with ambiguous, unknown, significant and/or opposite effect on objective and/or subjective safety among vulnerable road users, those where professionals and/or the public “disagree” about the effects and those dominating the current debate among professionals and in the media.

The 13 measures divided into four groups are:

1. *Infrastructure for vulnerable road users:* Track for cycling, winter maintenance of tracks and pedestrian crossings
2. *Cross sections improvements:* lane width and shoulder width
3. *Equipment for bicycle and bicyclist:* Helmet, brake blocks, spokes reflectors, and retro-reflective materials
4. *Regulations of heavy vehicles:* Weight, ban on trailers, speed, and rails.

Beside evaluation studies of specific measures some more general studies that quantify the assumed correlation between influencing factors and subjective safety used in the theoretical considerations are also needed.