



**SUMMARY AND PUBLICATION OF BEST PRACTICES  
IN ROAD SAFETY IN THE MEMBER STATES**

**THEMATIC REPORT:  
INFRASTRUCTURE**

**THE FINAL REPORT OF SUPREME CONSISTS OF 14 PARTS:**

<b>PART A</b>	METHODOLOGY
<b>PART B</b>	LIST OF MEASURES COLLECTED AND ANALYSED
<b>PART C</b>	BEST PRACTICES IN ROAD SAFETY HANDBOOK FOR MEASURES AT THE COUNTRY LEVEL
<b>PART D</b>	BEST PRACTICES IN ROAD SAFETY HANDBOOK FOR MEASURES AT THE EUROPEAN LEVEL
<b>PART E</b>	REVIEW OF IMPLEMENTATION AT THE COUNTRY LEVEL
<b>PART F1</b>	THEMATIC REPORT: EDUCATION AND CAMPAIGNS
<b>PART F2</b>	THEMATIC REPORT: DRIVER EDUCATION, TRAINING & LICENSING
<b>PART F3</b>	THEMATIC REPORT: REHABILITATION AND DIAGNOSTICS
<b>PART F4</b>	THEMATIC REPORT: VEHICLES
<b>PART F5</b>	<b>THEMATIC REPORT: INFRASTRUCTURE</b>
<b>PART F6</b>	THEMATIC REPORT: ENFORCEMENT
<b>PART F7</b>	THEMATIC REPORT: STATISTICS & IN-DEPTH ANALYSIS
<b>PART F8</b>	THEMATIC REPORT: INSTITUTIONAL ORGANISATION OF ROAD SAFETY
<b>PART F9</b>	THEMATIC REPORT: POST ACCIDENT CARE

<b>Tender No:</b>	<b>Contract No:</b>	
TREN/E3/27-2005	SER-TREN/E3-2005-SUPREME-S07.53754	
<b>Project Start:</b>	<b>Project End:</b>	<b>Date of issue of this report:</b>
18th of December 2005	17th of June 2007	17th of June 2007



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	IBSR-BIVV Institut Belge Pour La Sécurité Routière	BE		TNO Business Unit Mobility & Logistics	NL
	CDV Transport Research Centre	CZ		DHV Group	NL
	DTF Danish Transport Research Institute	DK		TØI Institute of Transport Economics	NO
	DVR Deutscher Verkehrssicherheitsrat e.V.	DE		IBDIM Road and Bridge Research Institute	PL
	CERTH/HIT Hellenic Institute of Transport	EL		PRP Prevenção Rodoviária Portuguesa	PT
	FITSA Foundation Technological Institute for Automobile Safety	ES		SPV Slovene Road Safety Council	SI
	INRETS Institut National de Recherche sur les Transports et leur Sécurité	FR		VÚD Transport Research Institute Inc.	SK
	NRA National Roads Authority	IE		bfu Schweizerische Beratungsstelle für Unfallverhütung	CH
	SIPSiVi Italian Society of Road Safety Psychology	IT		VTT Technical Research Centre of Finland	FI
	ETEK Cyprus Scientific and Technical Chamber	CY		VTI Swedish National Road and Transport Research Institute	SE
	Celu satiksmes izpete, SIA (Road Traffic Research Ltd)	LV		TRL Limited	UK
	TRRI Transport and Road Research Institute	LT		CIECA Commission Internationale des Examens de Conduite Automobile	INT
	KTI Institute for Transport Sciences	HU		ETSC European Transport Safety Council	INT
	WHO Europe World Health Organization - Regional Office for Europe				

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# Introduction

# 1 The SUPREME project

The objective of the SUPREME project is to collect, analyse, summarise and publish best practices in road safety in the Member States of the European Union as well as in Switzerland and Norway, with a view to implementation in as many partner states as possible. By making the study results available to a broad target audience across Europe – and thereby encouraging the take-up of successful strategies – the project wants to contribute to reaching the 50% reduction target of road fatalities, which the European Commission set in its White Paper "European transport policy for 2010: time to decide" (2001).

Analysis, synthesis and further selection of collected data were carried out along nine categories of measures and covers all areas of road safety work.

1. Education & Campaigns
2. Driver Education, Training & Licensing
3. Rehabilitation and Re-Licensing
4. Vehicles (incl. ITS)
5. Infrastructure (incl. ITS)
6. Enforcement
7. Statistics & In-depth Analysis
8. Institutional Organisation of Road Safety
9. Post Accident Care

In order to avoid overlapping between these categories, a detailed list of subcategories and – in some cases including even sub-subcategories - has been provided.

Accordingly, nine "Thematic Reports" (of which one is the volume in front of you) shall give a detailed description of best available practices for each of these categories, featuring basic characteristics such as target groups, quantitative and qualitative goals, key issues, duration of implementation and effects, coverage, costs, actors involved, implementation procedures as well as **key success factors** and potential **implementation barriers** in other countries or at the European level.

The crucial task of the project lies within the sound **identification of best practice** from the vast amount of available measures. In order to facilitate this process, a set of tools for collection, classification, selection and ranking of measures has been developed, along with guidelines for the assessment process at country level. As the common basis of all further activities, a list of eight best practice criteria was developed and transferred into a questionnaire. While the major part of this questionnaire consisted of a common set of core elements, some questions also addressed key features for each category.

On this basis, the SUPREME network of "Country Experts" has provided information from various stakeholders in cooperation with the respective Analysis Group members. Although 227 questionnaires have been completed, not all subcategories of road safety measures have been addressed. So this is the first step of data collection.



As an additional step, a list of road safety measures that had not been covered by questionnaires but were considered potential best practices by the SUPREME consortium, was compiled. Additional information was gathered from available scientific literature and earlier European projects. This extended list of potential best practices was the starting point for the second step of selection and analysis within each of the nine Thematic Reports.

#### **Further SUPREME activities**

Based upon these findings, 27 country surveys will be produced. The current status of implementation of best practice measures as well as implementation barriers shall be addressed and necessary steps shall be outlined.

Further, two separate handbooks will be provided, one for the European level (European institutions, international organisations, global industries) and one for the Country level (Ministries, regions, local level: stakeholders, policy makers, practitioners and the interested public).

For more information about the SUPREME project and latest results, please visit the SUPREME website, which is [http://ec.europa.eu/transport/supreme/index\\_en.htm](http://ec.europa.eu/transport/supreme/index_en.htm).

## **2 Objectives of this volume**

Infrastructure can be defined as the basic facilities, services and installations needed for the functioning of a community or society. The term has diverse meanings in different fields, but is perhaps most widely understood to refer to roads, and sewers. These various elements may collectively be termed civil infrastructure, municipal infrastructure, or simply public works, although they may be developed and operated as private-sector or government enterprises. In this report infrastructure is defined as the basic facilities, services and installations needed for the functioning of transport on roads, highways and streets.

*Infra-*, “below, underneath, beneath” and *structura*, “fitting together, adjustments, building” both comes from Latin.

# **Data collection**

A detailed and comprehensive questionnaire was created for the purpose to collect information from the member states of the European Union as well as in Switzerland and Norway about their experience regarding good or best practise in road safety (BPM). In addition to this data collection, the project will examine other work that has already been carried out in the field.

To simplify the questionnaire the thematic was divided into categories. The category infrastructure was divided in the following overview categories: planning, construction and design, equipment and exploitation, maintenance and operations, road safety audits and finally road inspections. Those overview categories were in turn divided into sub-categories as follows:

◆ Planning (Urban and rural):

Land use, Road Safety Impact, Location of major equipment (Schools etc), Network structure and Other.

◆ Construction and design (Urban and rural):

Intersection geometry, Pedestrian /Bicycle Design and speed, Self explaining roads, "Error avoidance" and Others.

◆ Equipment and exploitation (Urban and rural):

Traffic managements schemes, ITS (Variable message signs etc.), Road side (emergency lanes, crash absorbers etc), Pedestrian and bicyclist facilities, Speed reduction (humps, chicanes etc) and Others.

◆ Maintenance and operations (Urban and rural):

Maintenance management and procedures, Winter road maintenance procedures and Others.

◆ Road Safety Audits and Road Inspections:

Audits of road construction, Assessment of major transport projects, Audits of other road safety projects and Others.

# **Survey of submitted infrastruc- ture measures**

Altogether 42 proposals from 16 countries were submitted as potential best practise measures in the category infrastructure, see Table 1. Not surprisingly 15 submissions are in the categories Construction and design and 15 in Equipment and exploitation. 5 cover intersection design using the round about concepts. Multiple answers are also submitted for winter speed zones, rumble strips, road safety audits and 2 plus 1 lane roads. In the tables 2 to 6 the second column refers to the questionnaire number that can be found in Annex 1.

Questionnaire numbering	Category	Number of answers
5.1	Planning	3
5.2	Construction and design	14
5.3	Equipment and exploitation	15
5.4	Maintenance and operations	3
5.5	Road Safety Audits and Road Inspections	7
<b>Total answers</b>	42	

Table 1 Summary on submitted proposals as best practise infrastructure

5.1 Planning (Urban and rural)	3 answers
Land use	-
Road Safety Impact	-
Location of major equipment (Schools etc)	101
Network structure	148, 185
Other	-

Table 2 Sub category, Planning

5.2 Construction and design (Urban and rural)	14 answers
Intersection geometry	93, 99, 199, 236, 368
Pedestrian /Bicycle	140
Design and speed	191, 111, 190
Self explaining roads "Error avoidance"	186, 96
Others	172, 235, 349

Table 3 Sub category, Construction and design

<b>5.3 Equipment and exploitation (Urban and rural)</b>	<b>15 answers</b>
Traffic managements schemes	287, 315
ITS (Variable message signs etc.)	180
Road side (emergency lanes, crash absorbers etc)	197, 271
Pedestrian and bicyclist facilities	261
Speed reduction (humps, chicanes etc)	49, 149, 193, 306, 396
Others	188, 280, 303, 405

Table 4 Sub category, Equipment and exploitation

<b>5.4 Maintenance and operations (Urban and rural)</b>	<b>3 answers</b>
Maintenance management and procedures	390
Winter road maintenance procedures	-
Others	201, 273

Table 5 Sub category, Maintenance and operations

<b>5.5 Road Safety Audits and Road Inspections</b>	<b>7 answers</b>
Audits of road construction	62, 151, 272, 379
Assessment of major transport projects	428
Audits of other road safety projects	-
Others	192, 83

Table 6 Sub category, Road safety audits and road inspections

# **The assessment and selection process**

### 3 Analysis process

The analysis and selection process can be described to be a three step process: assessment of effectiveness, assessment of other criteria according to table 1, and then a final recommendation of measures. In the area of infrastructure measures to increase safety there are a number of reference literatures. As support in the analysis process some literature see list below have been studied mainly to support or suggest or even reject proposed BMP from the questionnaires.

### 4 Assessment of effectiveness

Effectiveness here means the capability to cause a sustained and significant reduction in the number of road accidents and accident victims, in particular fatalities and serious injuries. It includes indications of positive environmental effects, a reasonable safety potential, and positive difference between benefits and costs.

Only measures which were considered to be effective were qualified for a second stage of the assessment procedure. The effectiveness of a specific measure should be confirmed by a scientific based evaluation. If such an evaluation is missing or insufficient results from evaluation of equal or similar measures could give sufficient support for qualification for the next stage. Insufficient evidence of effectiveness thus means that there is no study showing significant positive effect on traffic safety or there are not enough data to show that the measure has an impact. In practise the effectiveness of the proposed measures sometimes had to be based on expert knowledge and/or fact from the literature rather than in the answers.

Category	Measure	Effectiveness and justification
5.1.4 Planning Network structure	148 2 plus 1 road type (IE)	Effective. Evaluation has been done.
Category	Measure	Effectiveness and justification
5.2.1 Intersection geometry	368 Roundabouts (CZ)	Effective. Judgment and results from other documented studies
"	236 Roundabouts (BE)	Effective. Decision based empirical analysis
"	93 Roundabout 3D visual effect (SE)	Effective. Evaluation has been done
"	99 Roundabout (NL)	Effective. Evaluation has been done
"	199 Roundabouts (NO)	Effective. No specific evaluation The effect estimation is based on results from documented studies
5.2.4 Construction and design	186 Milled rumble strips on centre line and shoulder (SE)	Effective. Evaluation has been done.

Category	Measure	Effectiveness and justification
5.3.6 Others	405 Home Zone (UK)	Effective. Decision based on documented effects of traffic calming measures, general effects on accident severity of speed level and on experience from similar implemented schemes. Home Zone is an innovative measure in UK and it takes time to get a sufficient amount of data for analysis.
5.3.5 Speed reduction	396 20 miles per hour zones (UK)	Effective. Decision based on evaluation study and results from documented studies
5.3.5 Speed reduction	149 Traffic calming (IE)	Effective. Decision based on evaluation study and results from documented studies
5.3.5 Speed reduction	306 Generalisation 30 km/h in school surroundings (BE)	Effective. Decision based on the known relation between accident severity and speed level
5.3.5 Speed reduction	193 Lowering speed limits on hazardous road sections (NO)	Effective. Decision based on the known relation between accident severity and speed level
5.3.1 Traffic managements scheme	287 Urban Safety Management (UK)	Effective. Decision based on evaluation study
5.3.1 Traffic managements scheme	315 Local Traffic Management Scheme (MT)	Effective. Decision based on evaluation study
5.3.2 ITS	180 Intelligent system for identification and signal-ling at technically unprotected level crossings (AT)	Ineffective. Lack of evaluation information
5.3.3 Forgiveing road sides	197 Forgiveing road sides (DK)	Ineffective. Lack of evaluation information linked to this specific technique
5.3.4 Pedestrian and bicycle-list facilities	261 Generalization of Limited One-way traffic (GLO) (BE)	Ineffective. Not sufficient data to show the safety potential and possibilities of this measure
5.3.3 Rode side	271 Installation of additional guardrails to enhance motorcyclists' protection (ES)	Ineffective. Not sufficient data to show the safety potential and possibilities of this measure
5.3.6 Others	280 Program for the installation of flashing lights with half barriers (HU)	Ineffective. Not sufficient data to show the safety potential and possibilities of this measure
5.3.6 Others	303 Information on the radio (ORF) about drivers driving against the traffic on motorways (AT)	Ineffective. Not sufficient data to show the safety effect of this measure
5.3.6 Others	188 Improvement of street inflow to Austrian RoLa-Terminals (AT)	Ineffective. Not sufficient data to show the safety effect of this measure

Category	Measure	Effectiveness and justification
5.5.4 Others	384 Safety Analysis of Road Networks (DE)	Effective. Decision based on documented effects of high risk site management and on experience from similar implemented schemes. ESN is an innovative measure in DE and it takes time to get a sufficient amount of data for analysis.
5.5.1 Audits of road construction	272 Road Safety Inspections (ES)	Ineffective. Lack of data showing possible safety effects by using this particular method
5.5.4 Road Safety Audits and Road Inspections	192 Road Safety Audit (DK)	Effective. Decision based on evaluation study
5.5.1 Audits of road construction	62 Survey of road condition and road evaluation – Road-STAR (AT)	Ineffective. Lack of data showing possible safety effects by using this particular method
5.5.1 Audits of road construction	379 Training and further education for road safety auditors (DE)	Effective. Decision based on documented effects of training for road safety auditors and on experience from similar implemented schemes. Safety audit is an innovative measure in DE and it takes time to get a sufficient amount of data for analysis.
5.5.4 Others	83 Technical accident analysis (CH)	Ineffective. Lack of data showing safety benefit by using this particular technique

Table 7 Result of assessment of the effectiveness of proposed measures

## 5 Infrastructure assessment of other criteria

In this step of the analysis other criteria's was formulated as in the

Criterion		Value and value label	
1	Description of the measure	0	Superficial
		1	Fair
		2	Adequate
2	Definition of target group	0	Superficial
		1	Fair
		2	Adequate
3	Size of road safety problem	0	Minor
		1	Moderate
		2	Major
4	Expected effects on safety	0	Not estimated
		1	Not estimated but obvious
		2	Estimated
5	Evaluation of effectiveness	0	Insufficient evidence of effectiveness
		1	Data indicate effect or previous studies
		2	Adequate evaluation
6	Costs and benefits	0	Not estimated, no indication of cost-effectiveness
		1	Not estimated but may be cost-effective
		2	Estimated and costs exceed benefits
7	Public acceptance	0	Not assessed and no indication of high acceptability
		1	Not assessed but may be reasonably acceptable
		2	Assessed and favourable
8	Sustainable effects	0	Not likely
		1	Possible but not certain
		2	Probably sustainable effects
9	Transferable effects	0	Not likely
		1	Possible but not certain
		2	Probably transferable effects

Table 8. A three degree scale 0, 1 and 2 was used to judge how well the measures fulfilled each of the nine criteria. The definition of the scale value varies with criterion and is defined in the

Criterion		Value and value label	
1	Description of the measure	0	Superficial
		1	Fair
		2	Adequate
2	Definition of target group	0	Superficial
		1	Fair
		2	Adequate
3	Size of road safety problem	0	Minor
		1	Moderate
		2	Major
4	Expected effects on safety	0	Not estimated
		1	Not estimated but obvious
		2	Estimated
5	Evaluation of effectiveness	0	Insufficient evidence of effectiveness
		1	Data indicate effect or previous studies
		2	Adequate evaluation
6	Costs and benefits	0	Not estimated, no indication of cost-effectiveness
		1	Not estimated but may be cost-effective
		2	Estimated and costs exceed benefits
7	Public acceptance	0	Not assessed and no indication of high acceptability
		1	Not assessed but may be reasonably acceptable
		2	Assessed and favourable
8	Sustainable effects	0	Not likely
		1	Possible but not certain
		2	Probably sustainable effects
9	Transferable effects	0	Not likely
		1	Possible but not certain
		2	Probably transferable effects

Table 8, column 2. The evaluation was done with instructions to as far as possible judge by information from the answers in the questionnaire. If there was missing information in the answer but this is obvious from expert knowledge or could be found in the literature an evaluation value greater than 0 was possible. The given information in the questionnaires was often very deficient. Therefore the

ratings should be considered as indicative rather than definite facts. Of course consequently this indication also concerns the total score.

Criterion		Value and value label	
1	Description of the measure	0	Superficial
		1	Fair
		2	Adequate
2	Definition of target group	0	Superficial
		1	Fair
		2	Adequate
3	Size of road safety problem	0	Minor
		1	Moderate
		2	Major
4	Expected effects on safety	0	Not estimated
		1	Not estimated but obvious
		2	Estimated
5	Evaluation of effectiveness	0	Insufficient evidence of effectiveness
		1	Data indicate effect or previous studies
		2	Adequate evaluation
6	Costs and benefits	0	Not estimated, no indication of cost-effectiveness
		1	Not estimated but may be cost-effective
		2	Estimated and costs exceed benefits
7	Public acceptance	0	Not assessed and no indication of high acceptability
		1	Not assessed but may be reasonably acceptable
		2	Assessed and favourable
8	Sustainable effects	0	Not likely
		1	Possible but not certain
		2	Probably sustainable effects
9	Transferable effects	0	Not likely
		1	Possible but not certain
		2	Probably transferable effects

Table 8 Other criteria definitions

## 6 Rating of suggested measures

The result of the rating is presented in the Table 9. Among the 13 measures in Table 9 four have been selected. The following criteria have been used. The measure is effective in reducing severe and fatal accident – a high score means the effect is well documented and the effect is at least fairly good. The size of the safety potential is large. The measure is cost-effective. A high score means the effect is well documented and the effect is at least fairly good. The effect of the measure is sustainable, acceptable and transferable – a high score means probably sustainable effects, possibilities for high acceptance and high degree of transferability.

Four measures are selected and suggested as Best Practice Measure because they are shown effective, they are transferable, clearly defined and well focused.

Home Zone (UK)

20 miles per hour zones (UK)

Road Safety Audit (DK)

Roundabout (NL)

These four suggested BPMs have high total scores and the highest total score compared to other equal or very similar measures from other countries. 2 plus 1 roads and milled rumble strips are good candidates, they are cost effective but the transferability at least for 2 plus 1 road can be discussed. The sustainability for rumble strips can be questioned.

Chosen measures	1	2	3	4	5	6	7	8	9	S:a
405 Home Zone (UK)	2	2	1	1	2	1	2	2	2	15
396 20 miles per hour zones (UK)	2	2	1	2	2	1	2	2	2	16
149 Traffic calming (IE)	1	1	2	1	1	2	1	2	2	13
306 Generalisation 30 km/h in school surroundings (BE)	2	2	1	2	1	0	1	1	2	12
193 Lowering speed limits on hazardous road sections (NO)	0	1	1	1	1	1	1	1	2	9
287 Urban Safety Management (UK)	0	1	1	2	2	0	1	2	1	10
315 Local Traffic Management Scheme (MT)	1	0	0	2	1	0	1	1	1	7
192 Road Safety Audit (DK)	1	2	1	2	2	1	2	1	2	14
368 Roundabouts (CZ)	1	1	2	1	1	2	2	2	2	14
236 Roundabouts (BE)	1	2	2	2	1	1	2	2	2	15
93 Roundabout 3D visual effect (SE)	1	2	2	1	2	1	2	1	2	14
99 Roundabout (NL)	2	2	2	2	2	1	2	2	2	17
199 Roundabouts (NO)	1	1	2	1	1	2	2	2	2	14
186 Milled rumble strips (SE)	2	2	2	2	2	2	2	1	1	16
185 2 plus 1 road type (IR)	2	2	2	2	2	2	1	2	1	16

Table 9 Assessment of infrastructure measures

# **Recommendations**

Below is an in depth description of the recommended best practise measures.

## 7 Road safety audit

### Country

Denmark. Road safety audit is in use in most of the western countries. Besides Denmark also Ireland considered safety audit to be a BPM.

### Description

Road Safety Audit is a systematic and independent road safety assessment of new traffic and road projects, including major operating and maintenance projects on existing roads, road safety improvement schemes, physical planning, etc. Project design is typically the result of a weighing of many different aspects; mobility, accessibility, environment, road safety, economy, etc. In a road safety audit only road safety is considered - based on the best and newest available knowledge. The purpose of road safety audit is to prevent accidents by making projects safe before being put into operation. Road safety audits can be performed at various stages in the project. In Denmark 5 stages are defined: Stage 1 Planning, Stage 2 Preliminary Design, Stage 3 Detailed Design, Stage 4 Opening, and Stage 5 Operation. Stage 5 is typically performed about one year after project completion. After that, road safety on existing roads can be runningly monitored by black spot analysis, road safety inspections, etc. It is advantageous to perform road safety audit as early in the project as possible. It is thus more efficient to adjust project drawings than already built roads.

### Target group

Accidents that might occur on new built roads as a result of deficiencies from the guidelines or schemes in the road construction process

### Size of the road problem

Not described in numbers but there are reasons to believe that there is a fairly large safety potential

### Cost and benefits

Not described in number but it is stated that "the effect is comparable to the effects of Black Spot Analysis". In the Irish BPM the benefit – cost ratio is estimated as around 9. In the handbook of road safety (Elvik, R) the conclusion is that safety audit, at least as it is practiced in Denmark, is very cost-effective.

### **Public acceptability**

There is a wide acceptance for Road Safety Audit in the road sector, including the decision making processes

### **Sustainability**

Road Safety Audit is expected to have positive long-term effects on the design of the road network

### **Transferability**

The Road Safety audit technique is already in use in several European countries and often a mandatory procedure in the construction procedure of new roads. Based on empirical evidence, expert opinion and own considerations the statement is that the measure should be easy to implement in other countries

### **Why best practice**

Road Safety Audit is an efficient method to prevent accidents from happening on completion of road and traffic projects. Thus at various stages of the project cycle the project design is assessed using the newest and best knowledge on road safety. This ensures that projects are as safe as possible before opening and operation. The method is cost-effective, widely used, used in various contexts, the application is standardized and operational defined which makes it easy to adapt to conditions in other countries and in new situations.

## 8 Home zone

### Country

United Kingdom. The home zone concept is used in many countries, most often in western countries.

### Description

The Home Zone concept also known as the Dutch word “Woonerf” meaning living street was pioneered in the 1970s in the Netherlands. Since then this concept has been transferred to many other countries and adopted to specific conditions of a country. The basic idea is to let the different road users share the same area. To do this the motor vehicle speed must be low, as a rule below 10 – 15 km/h. Home Zones are often associated with residential areas but are also suitable and used in other traffic environments like in town centres. In the UK the BMP is restricted to residential areas “with streets designed to be places for people, instead of just for motor traffic”. The aim is to improve the quality of life within them – the intended outcome will be that streets become safer for people to walk, cycle or children to play. Particular focus is on vulnerable road users. Home Zones promote the concept of shared road space for all and on equal conditions. Low speeds are maintained by different physical measures and with special road sign. Benches, flower beds, play areas, lamp posts fences and trees increase the aesthetic experience and give the motorist signal to drive in a careful way.

### Target group

All road users are the broad focus of Home Zones in areas where the aim is to promote the concept of shared road space for all – not for instance for motorized vehicles only. The specific focus is on severe accidents involving vulnerable road users and motor vehicles.

### Size of the road problem

Fairly large. In Great Britain 29 % of all roads are minor urban roads and it is on them Home Zone could be implemented.

### Cost and benefits

The cost benefit ration has not been determined in United Kingdom. One reason for that is that Home Zones are an innovative measure and it will take time for sufficient data to accumulate to enable a reliable benefit-cost-ratio to be calculated. In the Handbook of Road Safety Measures (Elvik, R) the benefit-cost ratio is calculated based on an example. There are safety and environmental benefits but there are travel time costs. Whether the difference between benefit and cost will be negative

or positive depends on the amount of traffic and the accessibility to alternative roads with higher speed level

### **Public acceptability**

The experience from the UK is that there is a substantial support for the measure,

### **Sustainability**

The sustainability is expected to be high as a result of the long term effects from the physical traffic calming measures.

### **Transferability**

The concept of shared road space in residential areas for example is already widespread in Europe. The condition for transferability is high.

### **Why best practice**

Home Zones change the way in which streets are used in order to improve quality of life. The outcome is that the streets become places for people who walk or cycle. The dominance by vehicular traffic is overcome and safe and green spaces are created.

## 9 30 km per hour zones

### Country

United Kingdom. The measure is used in many countries among those Ireland and Belgium who has given respectively “Traffic calming” and “Generalization 30 km/h in school surroundings” as BMPs.

### Description

30-zones have been installed in residential areas, in roads passing schools and in shopping streets. The idea is to slow motor vehicle speed to a level below 30 km/h. A 30-zones is indicated by boundary signing and physical traffic calming measures to provide a self-enforcing speed reducing element. The measure is primarily designed to reduce injury accidents to vulnerable road users as pedestrians and cyclists. Vehicle occupant casualties will also be reduced. 30-zones affect accidents by reducing impact speeds and therefore severity of injuries. Five percent reduction of mean speed is expected to diminish risk of fatality by at least 20 %. The addition of traffic calming features is needed to obtain speed reductions to 30 km/h or below.

### Target group

All road users with focus on pedestrians and cyclists in areas where the proportion of pedestrians and cyclists is high

### Size of the road problem

The road safety problem is large. Many of the streets or parts of them are qualified because of the large proportion of pedestrians and cyclists for 30 km/h.

### Cost and benefits

Costs associated with the measure, besides investment and installation cost, are maintenance cost – depends on size of zone and features installed – ecological cost which may increase carbon emission especially if features are inappropriate distance apart encouraging braking and acceleration and through traffic has not been discouraged. Benefits are less accident costs, positive health effect because of more walking and cycling instead of using car. Traffic may be reduced especially through the elimination of through traffic. Flows are reduced typically by 15 – 25 %.

The benefit-cost ration depends on the installation cost of the zone, but typically installation costs will be more than recovered in the first year of operation. Results from calculations made in the Handbook of Road Safety Measures (Elvik, R) show that there are reasons to expect much higher benefit than cost for 30-zones



### **Public acceptability**

30-zones are widely accepted providing that consultation has had a positive outcome and ensuring that features are designed such that they do not unacceptably impede the emergency services or bus operators.

### **Sustainability**

The sustainability is high as long as the engineering features within the 30-zone is self enforcing.

### **Transferability**

The concept of 30-zones is already widespread in Europe. The condition for transferability is high.

### **Why best practice**

30-zones yield a substantial reduction in injury accidents/casualties with a high rate of return on installation costs. In 1996 TRL carried out a national study of 20 30-zones. The result showed that speeds within the zones were reduced by 27 %, injury accident (all categories combined) were reduced by 61 % and serious accidents by 70 %. Other benefits are increases in walking (for example children to school) and improved accessibility for the mobility impaired.

## 10 Roundabouts

### Country

The Netherlands. Roundabouts are in use in many European countries, among them Norway, Belgium, Sweden and the Czech Republic which all have the roundabout as BMP.

### Description

Since 1986 over 2000 roundabouts have been built in the Netherlands, mostly in urban area. The implementation is still under progress.. The number is rapidly increasing in other countries as well. In Sweden the number of roundabouts was 150 in the beginning of 1980s and is 2000 at present. The roundabouts in the Netherlands are characterized by a pure circular design, a narrow carriageway, radially oriented entry roads and right-of-way of the traffic on the roundabout. The roundabout is aimed at lowering the speed and to remove right angle and head on collisions. A driver approaching a roundabout is forced to lower his entry speed. He has to give priority to all traffic on the roundabout.

### Target group

The measure is focused on junctions, mostly junctions on main roads. The effect of the measure is firstly reduction of severe and fatal accidents with focus on accidents that occur between motor vehicles and are of the type head on or right angel accidents

### Size of the road problem

The road safety problem is large. A high proportion of the severe or fatal accidents occur in junctions and many of these junctions are suitable to convert to roundabouts. In the Netherlands the total number of relevant junctions amounts to 45 000.

### Cost and benefits

Benefits are greater than costs when converting from a traditional junction to a roundabout given a sufficient amount of traffic and a not low proportion of traffic on minor roads. Roundabouts have a greater capacity than normal give-way or signalized junctions. There are also requirements for less emission when converting to a roundabout. The experience in Sweden is at least 8000 motor vehicles should enter the roundabout during a 24 hour period and at lest 20 – 30 % of the traffic should enter from the minor roads for the roundabout to be more efficient than an ordinary or signalized intersection. According to the Handbook of Traffic Safety Measure (Elvik, R) injury accidents will decrease by 32 % in a 3 leg junction and 41 % in a 4 leg junction when converting to from an ordinary junction

to a roundabout. Corresponding figures are 11% and 17 % when converting from a signalized junction to a roundabout. The number fatal or severe accidents will decrease much more as one of the positive effects of the roundabout is lower speeds. But as a rule the number of accidents with property damage only will increase – around 50 %. The majority of these accidents are rear end accidents. The benefit-cost ratio when converting a typical 3 or 4 leg junction to a roundabout is around 2 (Elvik, R)

### **Public acceptability**

The public acceptance is high in the Netherlands and in other countries where roundabouts are common.

### **Sustainability**

The mechanism of accident prevention on roundabouts is sustainable to a high degree.

### **Transferability**

The degree of transferability is high. Maybe the introduction phase could cause some resistance from the road users as they are not used to drive in roundabouts. But as the experience and the number of roundabouts increases the degree of acceptability and transferability will also increase.

### **Why best practice**

A roundabout is a sustainable solution for accident problem in many junctions. The measure has a great safety effect and there is a large safety potential. The measure has a traffic calming effect and also positive effects on environment and on accessibility.

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# **Annex**

## 11 Annex1:

### Short description of submitted answers

The following are short description of the measure from the questionnaire. The number in parenthesis is the questionnaire number followed from what country it originates. They are presented in increasing order.

#### **Speed reduction measures (49, Sweden)**

In the city of Gothenburg a system of physical speed reducing measures was taken to slow down the speed level of motor vehicles in areas with unprotected road users. The aim of this was reduce the large number fatalities and severe injuries among the unprotected road users. The most frequent measure was humps including raised crossings and raised junctions. The result of the implementation showed (besides lower speeds and a higher degree of separation between unprotected road users and cars) a remarkable reduction of the number of severe accidents specially accidents with unprotected road users involved. In total more than 2000 physical speed reducing measures were taken on both local and main streets. Most of the actions were taken during 1997 – 2003. During that time the number of severe accidents dropped by two thirds. The major part of this reduction was due to the speed reduction measures and to some extent a result of reduced car traffic in areas with unprotected road users.

#### **Survey of road condition and road evaluation - RoadSTAR (Road Surface Tester of arsenal research) (62, Austria)**

The RoadSTAR is a high speed road surface condition monitoring device. It allows the most important surface properties and road geometry parameters such as skid resistance, texture, unevenness, rut depth, crossfall, gradient, curvature and slope to be measured under normal traffic conditions at measuring speeds between 40 km/h and 120 km/h (standard speed 60 km/h). Measuring runs are additionally recorded digitally on video tapes. All measured values are tagged with differentially corrected GPS coordinates.

#### **Technical accident analysis (83, Switzerland)**

The technical accident analysis is a specific procedure of black spot analysis (site where the number of the accidents and their severity is so high that one can assume that there are infrastructural deficiencies). On one side, the layout, design and geometry of the site is compared to the norms in order to determine the infrastructural deficiencies (“detected deficiencies”). This comparison is done without knowing the accident pattern. On the other side, the deficiencies that may lead to the accidents are evaluated on the basis of the accident pattern (“probable deficiencies”) by another person who doesn’t know the layout, design and geometry of the site. In a further step, the “detected deficiencies” are compared to the “probable deficiencies” in order to point out the “determinant deficiencies” (all deficiencies which are mentioned on both lists). Finally countermeasures are proposed in order to treat the “determinant deficiencies”. If a black spot is then treated, an appropriate “before/after” analysis is undertaken in order to evaluate the efficiency of the treatment of the black spot. The described measure actually has 2 levels of implementation: 1) as a procedure/standard2) as an effective case analysis (technical accident analysis)

### Round about painted to give a 3D visual effect (93, Sweden)

Intersections are locations where the paths of vehicles cross. Intersecting path can be simple crossings of right angles to a large number of paths crossing. This creates points of conflict. One solution is to build a round about. This measure is of a design that aims to use visual effects. The circular island in a round about is painted so that it appears as three dimensional. The effect on safety, accessibility and behaviour has been studied.



Figur Example of a 3D round about design

### Installation of longitudinal rumble strips between the driving lanes and the shoulder (96, Spain)

Installation of longitudinal rumble strips between the driving lanes and the shoulder in order to prevent drivers from suffering road accidents due to distractions and accidental road departure. These rumble strips produce vibrations on the vehicle, warning the driver if he is about to leave the road.

### Roundabout (99, Netherlands)

Intersections are locations where the paths of vehicles cross. Intersecting path can be simple crossings of right angles to a large number of paths crossing. This creates points of conflict. One solution is to build a round about. Since 1986, over 2,000 roundabouts have been built in the Netherlands, most of them in urban areas. The roundabouts are characterized by a pure circular design, a narrow carriageway, radial orientated entry roads, and right-of-way of the traffic on the roundabout.

### The project "Safe Road to School" (101, Latvia)

The aim of the project was to ensure maximum safety for children when they are travelling to and from the school. To ensure safe road to the school for children-pupils it is necessary to make trustworthy surroundings with improving the road infrastructure, to educate the children regarding safe walking and cycling, as well as to establish road traffic patrols to provide a safe place to cross the street for children and other pedestrians on their journey to and from the school. Therefore the project "Safe Road to School" contents three parts:- proposals to improve infrastructure around schools

to increase the safety of children-pupils;- recommendations for teaching the Road traffic rules and guidelines for teaching staff;- the road traffic patrol handbook. The proposals include the statement of the level of traffic safety and existing problems as well as a detailed list of necessary measures to improve the situation at each of 95 schools. Within the framework of this project three speed humps were already located at two schools. This measure should be combined with education of children regarding safe behaviour on streets and establishing road traffic patrols to provide a safe cross the street in difficult places for children walking to and from the school.

#### **Zone 60 (111, Netherlands)**

As a start of the 'Sustainable Safe' programme it was agreed to establish Zone 30 areas on access roads inside urban areas and on access roads in rural areas Zone 60 areas. The idea is to discourage the use of access roads by through traffic and reduce the number and severity of accidents, mainly with vulnerable roads users due to the reduction of speed (from 50 to 30 km/h respectively 80 to 60 km/h). Beside the decrease of the maximum speed, the measure comprises the adjustment of the road design (single lane carriageway so no axis marking, and narrowed by edge strips when road width exceeds 4,5 metre) and intersection design (no right-of-way, and speed reducing measures).

#### **Cyclist vademecum for the Brussels Capital Region (140, Belgium)**

The Cyclist & acute; s Vademecum for the Brussels-Capital Region consists of a series of technical publications to facilitate the implementation of cycle infrastructure in an urban environment. It is intended to the managers of roadway systems (municipal and regional Services) and proposes precise recommendations for infrastructural solutions, illustrated by many diagrams and pictures.

#### **2 plus 1 road type (148, Ireland)**

A 2 plus 1 road consists of two lanes in one direction of travel and one lane in the opposite direction. The two-lane section, which provides a safe overtaking zone, alternates with a one-lane section at intervals of 2km approximately. The traffic streams are separated by a safety barrier system, which prevents overtaking manoeuvres on the one-lane section. Right turning movements will be at controlled designated junctions and a reduction of head on collisions is anticipated.

#### **Traffic Calming (149, Ireland)**

Definitions of traffic calming vary, but they all share the goal of reducing vehicle speeds, improving safety, and enhancing quality of life. Some include all three "Es," traffic education, enforcement, and engineering. Most definitions focus on engineering measures to change driver behaviour. Some focus on engineering measures that compel drivers to slow down, excluding those that use barriers to divert traffic.

This measure deals with speed reduction by altering the appearance of the road on the approach to and within towns and villages.

#### **Road Safety Audit. (151, Ireland)**

Road Safety Audit is the evaluation of road schemes during design and construction to identify potential safety hazards before the scheme is opened to traffic, and to recommend measures to eliminate or mitigate those problems.

a)

### **Paying attention to Powered Two Wheelers (172, Belgium)**

Paying attention to Powered Two Wheelers is a publication aimed at high way/roads managers to inform them about the characteristics and specific needs of Powered Two Wheelers. The publication summarizes all kinds of hazards PTW drivers can encounter and how the road manager should prevent these hazards from occurring, through adequate design or maintenance of road infrastructure.

### **Intelligent system for identification and signalling at technically unprotected level crossings (180, Austria)**

The project ISIS-EK deals with the improvement of the safety at railroad crossings (level crossings) which do not have any technical safety system. By using state of the art technology in detection and LED-signalisation with very low energy consumption, it is possible to operate a system with batteries which are charged by solar energy. Therefore also isolated railroad crossings can be equipped with this innovative signalisation system. It works this way: If a driver comes near to a railroad crossing a variable message sign informs him that there is a railroad crossing without barriers ahead, and the sign gives information about the distance. e.g. 50 metres. Approximately 2 metres in front of the railroad crossing, there are Lane Lights on the road. The traffic sign and the Lane Lights are activated if a train comes or a driver arrives at the crossing (detection system). The system is deactivated when the train passes another sensor; if the car has activated the system, it is deactivated after a short time span.

### **2 plus 1 cable separated road (185, Sweden)**

2+1 road with cable wire separated lanes are converted, app. 13 metres wide roads, with the aim to avoid head on collisions. The concept is meant to be a cheap way to create separated roads. Two lanes in one direction are separated from one lane in the other direction with a cable wire. This is altered every 2-3 km of road length.

### **Milled rumble strips on centre line and shoulder (186, Sweden)**

Milled strips in combination with ordinary painted road markings. Regularly milled or formed holes in the pavement to create vibration and sound when passing over.



### **Improvement of street inflow to Austrian RoLa-Terminals (Pilot project at location Wels) (188, Austria)**

Rolop is an information system for lorry drivers (traffic sign and sms (on mobile phone)). The F&E-Project ROLOP is designed to provide an information system for user of an intermodal Cargo-terminal concerning the actual load of the parking area for trucks at the Terminal. Laser- and Video technology is used to detect access and departure at the terminal parking area. These data are processed in a data base. A service number is provided and the information about the actual park load can be called up by lorry drivers (sms, mobile phone). If it is possible (technical equipment on board of truck), the information can be received automatically. To show the degree of load at the parking area at the terminal graphically, there is a variable message sign at the access road. It is up to the driver to use sms and to decide what to do. The measure gives relevant information.

### **Lower wintertime speed limits (191, Finland)**

In Finland and other northern countries accident risks are higher in winter than in summer. In many cases this depends on poor driving conditions – slippery road conditions and darkness. At the end of October most 100 km/h speed limit signs on single carriageway roads are manually changed to 80 km/h speed limit signs and all 120 km/h speed limit signs on motorways are manually changed to 100 km/h speed limit signs. For the summertime the speed limits are changed back in early March. Finnish Road Administration decides the dates of speed limit change. During the winter period 2004-2005 even 70 km/h limits were tested on few road stretches with normally 80 km/h speed limit. First experiment of lower wintertime speed limits was carried out in Finland 1987-1989.

### **Road Safety Audit (192, Denmark)**

Road Safety Audit is a systematic and independent road safety assessment of new traffic and road projects, including major operating and maintenance projects on existing roads, road safety improvement schemes, physical planning, etc. Project design is typically the result of a weighing of many different aspects; mobility, accessibility, environment, road safety, economy, etc. In a road safety audit only road safety is considered - based on the best and newest available knowledge. The purpose of road safety audit is to prevent accidents by making projects safe before being put into operation. Road safety audits can be performed at various stages in the project. In Denmark 5 stages are defined: Stage 1 Planning, Stage 2 Preliminary Design, Stage 3 Detailed Design, Stage 4 Opening, and Stage 5 Operation. Stage 5 is typically performed about one year after project completion. After that, road safety on existing roads can be runningly monitored by black spot analysis, road safety inspections, etc. It is advantageous to perform road safety audit as early in the project as possible. It is thus more efficient to adjust project drawings than already built roads.

### **Lowering speed limits on hazardous road sections, hereafter referred to as “Lowered speed limits” (193, Norway)**

Speed limits on road sections with high accident frequency and severity are lowered. During the years 2000-2002, a new tool for identifying hazardous road sections was developed in Norway. This tool computes injury severity density. It identifies a road section as hazardous if it has a high expected value of injury severity density. When estimating injury severity density, the number of injured road users for a specific road section is weighted in proportion to the costs to society of the injuries. As an example, a fatal injury counts as 33.2 slight injuries. Thus, more weight is given to

fatal and serious injuries. The expected value of injury severity density is estimated by applying the empirical Bayes method, which involves adjusting the recorded number of injured road users on a particular road section for random fluctuations, thus obtaining estimates of the long-term expected values. Based on the injury severity score, speed limits are reduced to 80 km/h on road sections with 90 km/h and to 70 km/h on sections with 80 km/h speed limit.

#### **Forgiving road sides (197, Denmark)**

Forgiving road sides is a measure aimed at reducing the risk of accidents and severe injuries if road users by accident leave the roadway. In the method the road's surroundings are assessed in regard to the speed limit. The higher the speed, the higher the need for a forgiving road side. In Denmark the guidelines for road design includes the definition of a safety zone. The safety zone is defined as a zone along the roadway that has to be free of dangerous fixed objects and steep up- and downward slopes. The width of the necessary safety zone is dependent on the speed limit. The higher the speed, the wider the zone. The safety zone's purpose is to give road users an area to regain control of their vehicle without risk of hitting dangerous objects or overturning. The forgiving road side must include a firm area nearest to the roadway. Paved and unpaved areas are not be separated by high and sharp edges.

#### **Roundabouts (199, Norway)**

A roundabout is a one-way circulatory carriageway around a central island, which replaces junctions or intersections. Roundabouts aim at improving traffic flow and reducing the number of serious accidents. Entering traffic has to give way to traffic within the roundabout, at all entries into the roundabout there are roundabout signs (round blue sign with a circle of arrows) together with yield signs. Roundabouts replace junctions with 3, 4 or more arms on most types of roads (usually not on motorways).

#### **Black Spot Analysis (201, Denmark)**

Black Spot Analysis is aimed at identifying those junctions or road sections where the number of accidents is significantly higher than expected - given the traffic and type of road or junctions. These locations will thus often appear less dangerous to the road users than they actually are. The black spot analysis includes: 1) Identification of accident-prone locations 2) Accident analysis and recommendations for improvements 3) Preliminary design of improvements 4) Calculation of first-year-return and prioritization 5) Construction 6) Evaluation of safety development after approx. 3 years

#### **Conflict-free traffic signals (235, Belgium)**

Conflict-free traffic lights on intersections, avoiding conflicts between straight on traffic and vehicles that turn left

#### **Roundabouts (236, Belgium)**

A roundabout is a one-way circulatory carriageway around a central island, which replaces junctions or intersections. Roundabouts aim at improving traffic flow and reducing the number of serious accidents. This measure is about creation of roundabouts at new intersections or as a replacement of intersections equipped with traffic lights.

#### **Generalisation of Limited One-way traffic (GLO) (261, Belgium)**

The legal possibility to allow cyclists to drive in the opposite direction in one-way streets already existed in Belgium since 1991. This change in the traffic rules was meant to promote cycling by enabling cyclists to avoid detours, especially in older city centres with many one-way streets, and to avoid dangerous road sections and crossings. Only very few municipalities applied this new measure because they considered it to be unsafe for the cyclists, although practice in some cities proved them wrong. To overcome the fears of the municipalities the Belgian government introduced GLO in 2002: at the latest on the 1st of July 2004 in all one-way streets that answered some conditions regarding width and speed, GLO had to be implemented. Only the streets where the municipalities considered it to be dangerous were excluded from this obligation (the government didn't want to interfere in the general responsibility of the road managers). Although one-way streets without GLO should become the exception, according to the Geneva Convention it was the general situation that had to be equipped with additional traffic signs. Because no sanctions were mentioned, because the municipalities were overloaded with all kinds of tasks and still had doubts about the safety, and because in some cases infrastructural adaptations would be necessary, very many municipalities did not (fully) obey their obligation.

#### **Installation of additional guardrails to enhance motorcyclists' protection (271, Spain)**

Installation of new metallic barriers in the lower part of the conventional metal guardrails in order to avoid severe injuries of motorcyclists when colliding with the posts. The double barrier complies with Internal Regulation 18/2004 of the Spanish Ministry of Public Infrastructure. This measure maintains the original level of safety for other road users.

#### **.Road Safety Inspections (272, Spain)**

The measure consists on road safety inspections in the Spanish national (federal) road network.- A group of experts revises the infrastructure and its relationship with the environment in order to detect potential risks.- The objective is to guarantee that safety characteristics are compatible and adequate to the road category.

#### **Management of High Risk Sites (273, Spain)**

Yearly identification and treatment of High Risk Sites performed by the Directorate General for Roads (Spanish Ministry of Public Infrastructure). A stretch is considered as High Risk Site when its accident risk there is statistically higher than in other stretches of similar characteristics. Road improvements in these sites can lead to significant reduction of the number of accidents.

#### **Program for the installation of flashing lights with half barriers (280, Hungary)**

Experience shows that, despite their resource scarcity both railway and road sectors are making efforts for the enhancement of the safety installations at crossings. Consequently, during the last five years, the program for changing the safety operation mode of the railway crossings has accelerated (from 1998 onwards about 50 crossings with flashing lights have also been equipped with half barriers), simultaneously, it became clear that the installation of optics ensure better visibility, while in the road sector different pavement markings, advance warning signs and local speed limits have been applied. It would be important if interventions were implemented in a harmonised way, focusing the resources on the really most dangerous crossings. (The yearly-prepared danger scale could also be helpful.)This program included the following elements:1. Creation of database containing essential

data (geometry, securing mode, accidents, traffic volume, interventions, operation) on railway crossings;2. Creation of point system, and then the preparation of the order of the railway-crossings, based on this point system;3. Interventions in the most dangerous railway crossings.

#### **Urban Safety Management (287, Great Britain)**

An area-wide multidisciplinary approach to managing safety within urban areas.

#### **Information on the radio (ORF) about drivers driving against the traffic on motorways (303, Austria)**

Broadcasting of a spoken warning concerning a driver driving against the traffic on an intercept of a motorway/highway via traffic broadcast of ORF. The programme on air is interrupted immediately and the spoken warning is sent. The police receives the information about the driver via emergency call and informs the broadcast station.99% of the information is given by the police, therefore this information is checked and reliable, 1% is given by drivers. (The correctness is checked by an editorial journalist).

#### **Generalisation 30 km/hour in school surroundings (306, Belgium)**

On 1 September 2005 a speed limit of 30km/hour was applied in all school surroundings. A 30km/hour speed limit is an important measure for the children's safety and independence in traffic and improves the road safety in general. Research shows us that the speed at which an accident occurs is of crucial importance for the vulnerable road users. 5% of the pedestrians who are hit by a vehicle at the speed of 30km/hour, die. At a speed of 50 km/hour, the number of deaths increases to 45%. This figure rises to 85% if the vehicle drives 65 km/hour. Hence, reducing the maximum speed to 30 km/hour in school surroundings considerably increased the road safety in these areas. The raised road safety can of course only come about if the measure is effectively observed also in practice. Legislation on itself is not enough. The school surroundings must in the first place be delimited as an area 30 by placing road signs and other structural interventions.

#### **Local Traffic Management Scheme (315, Malta)**

Upgrading the road infrastructure to introduce traffic management (including timed pedestrianisation) in a mixed land use area in order to increase road safety and maximise capacity of links and junctions. The case study is an area with a high concentration of night entertainment. The project involved: 1. Closure of roads to traffic (pedestrianisation) between the hours of 1900 and 0600 in the centre where all night activities (bars, restaurants) are located.2. Re-direction of coaches and large vehicles away from the centre.

#### **Rebuilding of intersections with accident risk (349, Hungary)**

Hungarian Government started this programme in 1996 on national road network to connect black spot analysis with the rebuilding of the unsafe intersections. Every year all counties (19) prepared studies on the intersections where more than 2 accidents occurred per year. The essence of rebuilding is the creation of safer intersections providing better connections for the subordinate traffic stream. Government policy encouraged highway authorities to develop intersections, particularly in the context of the intersection types expected to reduce road casualties in a three-year period. The view of roundabouts (special type of intersections) encompassing the safety with speed reductions is also encouraged.

### **Roundabouts (368, Czech Republic)**

A roundabout is a one-way circulatory carriageway around a central island, which replaces junctions or intersections. Roundabouts aim at improving traffic flow and reducing the number of serious accidents. This measure aims at rebuilding 4-arms intersections in urban areas into roundabouts.

### **Training and further education for road safety auditors (379, Germany)**

The measure is a set of special training measures for internal and external auditors (internal, i.e. coming from administrative authorities, external, i.e. coming from private engineering companies). Two different types of training are offered according to the kind of roads in question. There are training measures relating to roads outside built-up areas (motorways and rural roads) and to roads inside urban areas (major urban and residential roads). The training is split up in several stages, such as theoretical and practical phases. If attending the training additionally to the usual working time, it will take approx. four months to obtain the certificate. The certificate is valued for three years and can be renewed by passing an examination. For the renewal of the certificate it is necessary to have carried through two audits and to attend two "Symposia on Road Safety Audit". The two-day "Symposium on Road Safety Audit" is offered once a year. It is meant as a further education for the auditors. The latest technological developments and research are presented on the first day of the Symposium. Another focus, on the second day, is a forum that offers the exchange of views and experiences of the auditors.

### **Safety Analysis of Road Networks (384, Germany)**

This measure is a procedure of how to calculate the safety potential of road networks. The result of the safety analysis indicates possible deficiencies of road design, road alignment or road condition. They complement procedures coming from the sector of road design, land planning and environmental planning. The safety potential analysis of road networks is valid for roads with connecting functions inside and outside urban areas as well as roads with access functions inside urban areas.

### **Carriageway milling (390, Czech Republic)**

Special kind of light milling of carriageway let to an automatic crowding out water from the carriageway by ongoing road traffic.

### **20 miles per hour zones (396, United Kingdom)**

20 miles per hour (30 km/h) zones have been installed in many residential areas, in roads passing schools and in some shopping streets. The 20mph zone is indicated by boundary signing and physical traffic calming measures are used to provide a self-enforcing speed reducing element.

### **Home Zone (405, United Kingdom)**

Home Zones are residential areas with streets designed to be places for people, instead of just for motor traffic. The aim is to change the way that streets are used in order to improve the quality of life within them - the intended outcome will be that the streets become safer for people to walk, cycle or children to play.

### **Road safety impact assessment of road design projects (428, Lithuania)**

A road safety audit is a formal safety performance examination of an existing or future road or intersection by an independent audit team. This measure concerns evaluation of traffic safety of major projects during the design phase.

## 12 Annex 2: Questionnaire Infrastructure

### SUPREME: Best Practice Questionnaire

#### Category “Infrastructure”

⇒ VTI, Leif Sjogren

##### Introduction and instructions

##### Step 1: Selection of the measure

Please select road safety measures from your country that are examples for very good - and possibly best - practice in road safety in Europe. **Best practice** refers to a road safety policy that is successful. A successful road safety measure is one that brings about a sustained **reduction in the number of road accidents and accident victims**, in particular fatalities and serious injuries.

Evaluation of measures and selection of best practice will be based on a list of criteria. Each measure you select will be assessed with an individual questionnaire, i.e. you fill out one questionnaire for each measure.

As different measures require different criteria, the questionnaire you fill out depends on the type of measure. At the end of this chapter you will find an overview of **categories** of safety measures, with examples of measures included in each of the categories. To open a questionnaire, please select the category for the measure you want to assess, and click on the link provided in the overview. There are two types of criteria: General description criteria (to be assessed for all measures, except for those in the categories “Statistics and In-depth analysis” and “Institutional Organization of Road Safety”), and specific description criteria (specific for measures in each category).

The questionnaire is organised as follows:

**Part 1:** The first part of each questionnaire contains questions on **background** information about the selected measure.

**Part 2: General description criteria** are assessed in the second part of the questionnaire. This part is identical for all measures in all categories. In some cases, not all criteria are applicable. In these cases, the criteria are marked “not relevant”, or may be marked as such by the respondent. General description criteria are:

- **Focus of the measure:** A clearly defined **road safety problem** that the measure is intended to solve.
- **Size of the road safety problem:** Quantitative assessment of the number of accidents, fatalities and severe injuries that the measure is expected to influence.

- **Expected effects on safety:** Quantitative assessment of the likely impact of the measure on accidents or accident-contributing risk factors.
- **Evaluation of effects:** Actual impact of the measure on accidents or accident-contributing risk factors.
- **Costs and benefits:** Assessment and comparison to alternative measures.
- **Acceptance:** Public, policy maker, and user / driver acceptance.
- **Sustainable effects:** Commitment to the continued use of the measure, long-term effects.
- **Transferability:** Applicability on a wider scale, within and across countries.

**Part 3: Specific description criteria** are assessed in part 3 of the questionnaire. This part is specific for each category, you will find more detailed information in the questionnaires.

**Resume:** Summary of why the measure is proposed as Best Practice.

#### Categories

- ⇒ Here, the **table with categories, subcategories, examples, exclusion examples and criteria** will be provided. Each category is linked to the respective questionnaire.





- **Level and density of implementation:** At what level and in which density is the measure implemented (e.g. number of units on national / regional / local / ... level)?

....

- How long does it **take to implement** the measure (e.g. may be implemented immediately, in 5 years, long term)?

....

- When can (90% of the) effects be expected (e.g. immediately, in 5 years, long term)?

....

In which other European countries is the measure currently in use or available?

- Please give information, if available.

....

Who is responsible for the measure?

- Responsibility refers to implementation, enforcement, incentives to use the measure, and activities related to the measure.

*E.g.: Legal form of implementing body/bodies, international organisation, authority, industry, NGOs, others.*

....

What is the legal background for implementation of the measure?

- Legal background includes laws, directives, norms, certificates, incentives, voluntary measures.

....

## Part 2: General description criteria

In this part of the questionnaire, the safety measure will be assessed by 8 general description criteria. This part is identical for all categories.

If a criterion is not applicable to your measure, please answer "not relevant", and give a short explanation why the criterion is not applicable.

### Focus of the measure

The focus of a safety measure is the **road safety problem** the measure is intended to solve. It may be a specific type of accident, a type or group of road users, or a type of accident location. Some measures may be more general.

### What is the focus of the measure?

Please specify the focus of the measure in terms of **at least one** of the following aspects.

If the focus is a **combination** of factors (e.g. group of road users with specific type of accident), you can describe the focus under both aspects, or under the aspect that seems most important. (*If you are uncertain, it may be helpful to look at question "2. Size of the road safety problem"*).

- **Accident types**, specified by type of collision, condition under which the accident occurs, or type of vehicle involved in the accident:

*E.g.: Single accidents, side collisions, animal collisions, head-on-collisions, night time-accidents, accidents on wet roads, accidents involving heavy trucks, accidents in working zones.*

....

- **Road users**, specified by personal or demographic characteristics (e.g. age, sex, length of licence ownership, car- or truck driver) or by certain types of behaviour (e.g. speeding, driving under influence, traffic violations):

*E.g.: Children, inexperienced drivers, old people, drunk drivers, drivers not using seat belts, speeding drivers.*

....

- **Accident locations**: Specified by road category, type of intersection, driving conditions, or other characteristics of accident locations.

*E.g.: highways, acceleration lanes, rural roads, urban areas, roundabouts, pedestrian crossings, roads or location with specific characteristics, slippery roads.*

....

- **Vehicles**: Specified by adaptations to vehicles, prevention of unsafe participation in traffic, other modes/vehicle category, etc.

*E.g. adaptations to (the use of) heavy vehicles, passenger cars, mopeds, bicycles.*

....

- **Unspecified / all accidents**: If a specific focus cannot be defined, please give a short explanation.

#### How does the measure affect accidents?

- Please describe the **mechanism** by which the measure has an impact on the specified focus. If available, please refer to relevant **theoretical background** or empirical **studies**.

*E.g.: Avoidance of skidding due to improvement of vehicle dynamics, reduction of exposure, improvement of skills, change of attitudes, decrease of impact (air bag).*

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

#### Size of the road safety problem

In a first step we would like to know how large the focus of the measure is. In a second step we would like you to describe the risk of accidents, fatalities, and severe injuries within the focus of the measure.

#### How large is the focus of the measure?

Please give your assessment according to the specified focus of the measure. If a quantitative assessment is not possible, please give an estimation and explain the rationale.

- **Accidents:** If a type of accident is the focus of the measure, what is the **proportion** of the specified type of accident, relative to all accidents?

*E.g.: "X% of all accidents are head-on-collisions."*

*E.g.: "X% of accidents occur on slippery roads."*

- **Source/s (Accidents):** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

- **Road users:** If a type or group of road users is the focus of the measure, what is the **proportion** of the specified type of road users, relative to all road users. If possible, also include **exposure** data in your answer.

*E.g.: "X% of all driving license holders are over Y years old."*

*E.g.: "X% of all vehicle kilometres travelled (VKT) are driven by professional drivers of trucks over 20t."*

*E.g. "X% of road users do not use seat belts, exceed speed limits, are fined more than twice a year...."*

- **Source/s** (Road users): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Locations:** If a type or group of accident location is the focus of the measure, what is the **proportion** of this type of location relative to the whole road net (in terms of km or vehicle kilometres travelled), or relative to other variants of this type of location.

*E.g.: "X% of all roads in this country are rural roads."*

*E.g.: "X% of all VKT are travelled on rural roads."*

*E.g.: "X% of all motorway crossings are designed as cloverleaves."*

....

- **Source/s** (Locations): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Vehicles:** If the measure focuses on a specific group of vehicles (or how these vehicles are used), what is the proportion of the specified type of vehicle, relative to all vehicles. If possible, also include exposure data in your answer.

*E.g.: "in X% of all accidents, a heavy vehicle is involved."*

*E.g. "the share of moped kilometres is X% of all kilometres travelled, while the share of moped accidents with fatalities/injuries is Y%"*

*E.g. "X% of heavy vehicles is not equipped with blind spot mirror."*

....

- **Source/s** (Vehicles): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Unspecified focus / all accidents as focus of the measure:**

....

- **Source/s** (Unspecified focus): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

What is the accident risk within the focus of the measure?

The definition of accident risk varies, depending on the specified **focus**:

- **Accidents:** If a specific type of accidents is the focus of the measure, please give information about

- 13 the probability of the accident being **fatal**
- 14 the probability of the accident having **serious injuries** as a consequence.
- 15 If possible, relate these risks to **other** types of accidents.

*E.g.: "X% of all side-collisions are fatal, Y% of all side-collisions result in serious injuries. The risk of being fatal is Z times higher for side-collisions than it is for frontal collisions."*

*E.g.: "Night-time accidents have X times higher risk of being fatal than daytime accidents."*

....

- **Source/s** (Accidents): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Road users:** If a group of road users is the focus of the measure, please give information about
  - the probability of an **accident** within this group of road users,
  - the probability of a **fatal** accident within this group of road users,
  - the probability of a **severe injury** accident within this group of road users.
  - If possible, relate these risks to **other** groups of road users.

*E.g.: "The risk of being involved in a fatal accident for inexperienced drivers is X."*

*E.g.: "Young and inexperienced drivers have X times higher risk of being involved in an accident than experienced drivers, who are aged over 20 and have minimum 2 years unrestricted driving licence."*

*E.g.: "Professional drivers have X times higher risk of being involved in an accident due to sleepiness than non-professional drivers."*

*E.g.: "Drivers not using hands free mobile phones have X times higher risk of being involved in an accident than drivers using hands free mobile phone."*

....

- **Source/s** (Road users): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Locations:** If a specific type accident location is the focus of the measure, please give information about
  - the probability of an **accident** at this type of accident location,
  - the probability of a **fatal** accident at this type of accident location,
  - the probability of a **severe injury** accident at this type of accident location.
  - If possible, relate these risks to **other** types of accident location.

*E.g.: “On ramps of grade-separated junctions without an acceleration lane, the accident risk is X accidents per million vehicle km travelled. The risk of a fatal accident is Y, and the risk of a severe injury accident is Z accidents per million vehicle km travelled.”*

*E.g.: “X% of all fatal accidents happen on rural roads in areas with low population density.”*

....

- **Source/s** (Locations): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Vehicles:** If a group of vehicles is the focus of the measure, please give information about
  - the probability of an **accident** for this group of vehicles,
  - the probability of a **fatal** accident for this group of vehicles,
  - the probability of a **severe injury** accident for this group of vehicles.
  - If possible, relate these risks to **other** groups of vehicles.

*E.g.: “The risk of being involved in a fatal accident for trucks is X.”*

*E.g.: “The risk of being involved in accidents is X times higher for moped riders than for cyclists.”*

....

- **Source/s** (Vehicles): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Unspecified focus / all accidents as focus of the measure:**

....

- **Source/s** (Unspecified focus): Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

**Expected effects**

Were the effects of the measure estimated before it was implemented?

- Yes or No? If yes, how and by whom where the effects estimated?

....

- **If yes**, what were the expected effects?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.
- If effects were estimated, was this assessment **taken into account in decisions** concerning the measure?

.....

#### Evaluation of effects

Evaluation of effects refers to the effects on numbers, types or proportions of **accidents, fatalities or severe injuries**, on **risk factors** that are known to contribute to accidents, and on **side effects** of the measure.

How does the measure affect accidents in terms of reduced numbers of accidents, fatalities or severe injuries?

- Please give information about the effects of the measure, preferably from **empirical studies**. If a quantitative assessment is not possible, please give an estimation and explain the rationale or the source of the estimation.

.....

- Please give **background information** about the evaluation of effects of the measure on accidents, fatalities, and severe injuries. The summary should include
  - a description of how the effect has been **calculated** (e.g. accident counts, indirect measure),
  - information about the **type of study** (e.g. accident analysis, accident statistics, observational studies, survey)
  - information about the **design of the study** (e.g. control group, duration of before and after periods),
  - If the measure is a **part of a larger measure**, if road safety effects were evaluated separately.
  - Please also make a short comment on the **quality** of the study, especially about possible confounding factors.

*E.g.: "Study X estimated a reduction of the total number of accidents in urban areas by Y%"*

*E.g.: "Based on the evaluation, X% of all accident fatalities are expected to be avoided by the measure. Y% of all fatal accidents will not be avoided but have less serious consequences (severe or light injuries), due to (...)"*

.....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

.....

How does the measure affect accidents in terms of reduced accident-contributing risk-factors?

- Please give information about effects of the measure on accident-contributing factors (e.g. changes in behaviour or attitudes, traffic offences, exposure, traffic conditions), preferably from **empirical studies**. The summary should include information about



- the type of **contributing factor**, and why, how, and to what degree it contributes to accidents,
- the **design** of the study (e.g. control group) and how the effect has been calculated, and a comment on the **quality** of the study, especially about possible confounding factors.

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

Are any positive or negative side effects of the measure expected or witnessed?

- Side-effects can be expected or unintended. Unintended side effects include positive and negative effects on accidents or behaviour which are not specifically within the focus of the measure. Side effects also include those not directly related to traffic safety (i.e. health, environment). Please describe the side-effects and whether they were expected or not.

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

Costs and benefits

Please give a summary of the costs and benefits of the measure in your country.

The analysis may be based on empirical results or on estimations. If a quantitative assessment is not possible, please give an estimation and explain the rationale or the source of the estimation.

Please describe precisely, what types of costs / benefits you are referring to, how they are related to the measure, and how they have been computed.

What cost are associated with the measure?

- Costs in **financial** terms: e.g. investments, maintenance costs, enforcement costs, reward systems, administration costs, long-term costs (ecological or social costs). Please specify **type** and **amount** of financial costs associated with the measure.

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- **Who** bears the financial costs of the measure (e.g. user group, state government)?

....

- What **other types of costs** are there, for example ecological or social consequences, mobility, etc.?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

What benefits are associated with the measure?

- Benefits in **financial** terms, e.g. cost savings. Benefits include financial effects of reduced accident costs. Please specify **type** and **amount** of financial benefits, and specify the exact figures used in the analysis (e.g. the economic value attached to a saved live).

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

- What **other types of benefits** are there, for example environmental or social effects, and traffic performance?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

What is the benefit-cost-ratio for the measure in your country?

- What **benefit-cost ratio** is associated with the measure? Please specify if the computed ratio is a benefit-cost-ratio or a cost- benefit-ratio.

....

- How has the benefit-cost ratio been **calculated:** Based on which types of costs, types of benefits, relevant actors, timeframe etc. has it been computed?

....

- At which **stage of the implementation** of the measure has the benefit-cost analysis been conducted (before, during or after implementation)?

....

- How do you judge the **quality** of the benefit-cost analysis (e.g. if the effect is likely to be over- or underestimated, consideration of confounding factors)?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

Has the benefit-cost-ratio of this measure been compared to the benefit-cost-ratio for other measures aiming at reducing accidents within the same focus?

- If so, please give the benefit-cost-ratio for these measures.

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

### Acceptance

Acceptance of the measure includes **public acceptance, acceptance by road users, policy makers, and other stakeholders (e.g. automotive industry)**. It is related to attitudes and behavioural consequences of the measure, especially to willingness to apply the measure, or to comply. Other relevant issues can be political, legal, financial, technical and administrative aspects.

To what degree is there acceptance for the measure?

- If possible refer to empirical quantitative or qualitative **studies**. Information about public acceptance may be based on surveys, media, consumer and / or behaviour studies, decision-making processes (e.g. in parliament). Please include information about the type and design of the study. In the absence of such a study, what is the perceived level of acceptance of the measure?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

Has acceptance been taken into account in the planning and implementation process?

- At which stages of implementation (before, during or after) has acceptance been measured?  
Has there been public participation in the planning / implementation process?

....

### Sustainability

Sustainability includes **long-term effects** and **changes of effects** over time. Effects are considered to be sustainable when the effect is permanent and does not decrease over time.

To what degree are the effects of the measure expected to be sustainable?

- The assessment can be quantitative or stated in qualitative terms. It can be based on
  - a **study** of earlier similar measures: if so, please provide a short description and source,



- a scientific **analysis**: if so, please provide a short description of the scientific basis, or
- an assessment of **contributing factors** (factors necessary to achieve and maintain the effectiveness) to its effectiveness (e.g. commitment to make use of the measure, requirement of police enforcement, skill improvement, risk compensation, exposure effects, public support, quality assurance, continuous monitoring).

....

- **Source/s**: Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

**Transferability**

Transferability includes prospects for using the measure successfully in other **countries** or **regions**, or on a **larger scale**.

**To what degree is the measure transferable?**

- If available, refer to studies of the measure in other countries, explicit comparison with other countries, and publications about the measure in other countries.

....

- **Source/s**: Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

**Which factors contribute to the transferability of the measure?**

- Contributing factors include **conditions for the effectiveness** of the measure in other countries or regions, or on a larger scale, and **specific requirements** necessary which may be difficult to fulfil elsewhere.

*E.g.: "The measure can only be expected to be effective if it is combined with enforcement"*

*E.g.: "The effects of the measure within the focus are expected to be larger if measure Y is also implemented"*

....

- **Source/s**: Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

**Which factors limit the transferability of the measure?**

- Limiting factors include potential **obstacles** for the effectiveness of the measure in other countries or regions, or on a larger scale.

....



- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

....

To what degree can the measure be effective for types of accidents, groups of road users, or accident locations, other than those specified as the focus of the measure?

....

- **Source/s:** Please make clear whether the information is based on: empirical evidence (published / unpublished), expert opinion, own considerations etc. In case of published studies, please give full reference.

Resume

Why should the measure be included in the list of best-practice road safety measures in Europe?

- Please give a short statement about what qualifies the measure as “Best Practice” in Europe.

....