Interreg
EUROPEAN UNION
Danube Transnational Programme
RADAR

Project co-funded by European Union funds (ERDF, IPA, ENI)

Your Road Safety is on our RADAR.

Thematic Area 3 report

THEMATIC AREA 3 SPEED MANAGEMENT

RADAR – Risk Assessment on Danube Area Roads

https://www.interreg-danube.eu/radar

Internal Report Hierarchy Level			
Activity Number	4.2	Activity Title	RSEG review and assessment reports
Work Package Number	4	Work Package Title	Strategy and Action Plan
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Status (F: final, D: draft, RD: revised draft):	F		
Version Number	1.0		
File Name	RADAR_project_RSEG_Smart_Speed_Management_Infrastructure		
Issue Date	08.06.2020.		
Project start date and duration	June 1, 2018 – 36 months		

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1. Introduction

Between 2001 and 2010, the number of road deaths in the EU decreased by 43%, and between 2010 and 2018 by another 21%. However, 25,100 people still lost their lives on EU roads in 2018 and about 135,000 were seriously injured [European Commission (4 April 2019), Publication of preliminary road safety statistics 2018]. This is an unacceptable and unnecessary human and social price to pay for mobility. In monetary terms alone, the yearly cost of road crashes in the EU has been estimated in a new study to be around EUR 280 billion, equivalent to about 2% of GDP [European Commission (2019), Handbook on the External Costs of Transport].

In June 2019, the European Commission adopted the EU Road Safety Policy Framework 2021-2030, [European Commission (2018), Communication "Europe on the Move - Sustainable Mobility for Europe: safe, connected, and clean", COM(2018) 293 final) outlining specific policy measures planned for 2021-2030 and developing on the EU Strategic Action Plan on Road Safety published in May 2018. [Annex I to the Communication (https://eur-lex.europa.eu/resource.html?uri=cellar:0e8b694e-59b5-11e8-ab41-01aa75ed71a1.0003.02/DOC_2&format=PDF]. By endorsing the Valletta Declaration on road safety [Council of the European Union (2017), Council conclusions on "Road safety endorsing the Valletta Declaration (Valletta, 28 – 29 March 2017)] of March 2017 in Council conclusions, EU transport ministers also, for the first time, set a target for reducing serious injuries, namely to halve the number of serious injuries in the EU by 2030 from a 2020 baseline.

To move towards these goals, a new approach is set out in the "Europe on the Move" Communication.

Vision Zero

First of all, the idea of "Vision Zero" needs to take hold more than it has so far, both among policy makers and in society at large. Road crashes are "silent killers", in that they often go virtually unnoticed in the public sphere, even though, taken together, they kill as many people – around 500 – as fit into a jumbo jet every week, in Europe alone. We do not accept deaths in the air, and we should no longer accept them on the road – the premise that no loss of life is acceptable needs to inform all decision making on road safety.

Safe System

Secondly, we need to implement the "Safe System" at EU level. The core elements are ensuring safe vehicles, safe infrastructure, safe road use (speed, sober driving, wearing safety belts and helmets) and better post-crash care, all long established and important factors in the Safe System approach.

New trends

Thirdly, we have to be ready to confront new trends, such as the growing phenomenon of distraction by mobile devices. Some technological advances, especially connectivity and automation, will create new road safety opportunities in the future by reducing the role of human errors. However, the best machines are not yet nearly as good as their human counterparts, and at least in the transition phase new risks are emerging, for example related to the presence of vehicles with a wide range of different automated/connected capacity in mixed traffic with "traditional" vehicles and vulnerable road users such as motorbike riders, cyclists and pedestrians.

2. Why speed limits?

Not only is speeding on roadways illegal, but it's considered to the No. 1 cause behind car accidents. Speeding is when a person goes over the posted legal limit on roads, side roads, byways, highways or on just about any other type of driving road (absolute speeding). Beyond speeding just being illegal, driving while speeding in bad conditions is what leads to many of car accidents that happen. During the winter for example when roads are icy, wet or snowy - driving faster – but within the speed limit - can cause your vehicle to go out of control or slide into someone else (relative speeding).

Even lower speeds can kill

One of the biggest reasons why our federal and local state governments determine the proper speeds in each zone isn't just about speeding. It's about giving the driver ample time to stop. If a driver is on a road and the driver is going at 30 km/h when a person suddenly walks out into the street, the lower speed should give the driver enough time to stop. On the other hand, if the speed limit is 30 and the driver is going at 40, this will not give them enough time to step on the brake and stop before hitting someone. Hitting a pedestrian can cause serious injury - or even death.

Avoidance of speeding can prevent problems

Not only is going over the speed limit a possible detriment to the person who gets hit – but also to the driver. If the driver hits someone and they get injured they could be looking at not only a fine but also possible jail time.

Legal speed limits vs. advisory speed limits

You must drive at or below the legal limit if you want to avoid getting a speeding ticket. If you see a **legal speed limit** sign on the road, you must reduce your speed to that limit before you pass the sign. Similarly, if the speed limit increases, you can't increase your speed until after you pass the sign.

Advisory speed limit signs serve as a cautionary notice that road conditions (for example: curving roads or near bridges) could make it dangerous to travel faster than that speed. Since the advisory limit is a suggestion, you typically can't get a ticket just for going over it.

2.1. The three types of speeding

Aside from the signs themselves, there are three different types of speeding.

An **absolute speed limit** means that the speed limit on the posted sign or in the Highway Code, is the fastest speed you can lawfully travel in any situation. The police don't have to consider the circumstances to issue a ticket for an absolute speed limit violation.

Presumed speed limit laws make the legal speed limit slightly less concrete. In some states of USA that use presumed speed limits, motorists can exceed the posted speed limit if they don't put themselves or anyone else at risk. For instance, light traffic and ideal weather might allow you to speed without violating speed limit laws. However, presumed speed limits are highly subjective. An officer can still issue you a ticket, which means you must either pay the fine or defend your actions in court.

Some states use **basic speed limit** laws, which state that all drivers have to keep their speed in line with road conditions. Several different types of hazardous road conditions can impact driver safety and contribute to accidents, such as: rain, fog, ice, snow, work zones, poorly maintained roads. Basic speed limits usually come into play after an accident. The officers who respond to the scene might issue tickets if they find that one or more drivers travelled too fast for road conditions and could have avoided the accident by reducing speed.

2.2. Change of speed limits

Change in speed limits is often subject to intense social and political debates. In many countries, raising the speed limit on the motorway network is a recurrent political argument.

In the past 20 years, nearly all countries have either increased or decreased their speed limits without any clear direction (Example: Figure 1.). These changes are often pushed by political decisions. When the speed limit is reduced, the environmental and safety benefits of reduced speed are often put forward.

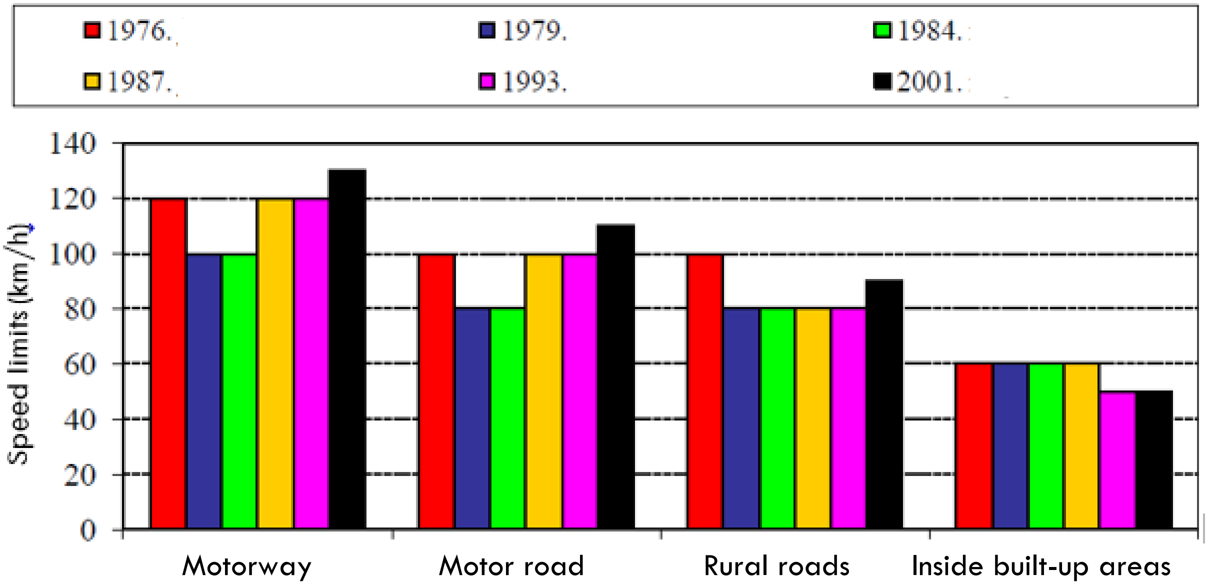


Figure 1 Speed limits in Hungary

In urban areas, all European countries have progressively moved towards a maximum speed limit of 50 km/h or less, with often lower speed limits (20, 25, 30 or 40 km/h) in residential areas or around schools. There is a higher default speed limit during night-time in Poland (60 km/h). When there are discussions whether to change the speed limits in urban areas, they are mostly about lowering the speed in residential areas. Some countries are considering adopting a 30 km/h default speed limit, with higher limits on main arterial roads. In the Netherlands, following a full review of road classification, 70% of road in urban areas are limited to 30 km/h. Poland is considering lowering the speed limit from 60 to 50 km/h at night-time (the limit is already 50 km/h during daytime).

On the road network outside built-up areas, and excluding motorways, speed limits typically vary between 80 and 100 km/h (Austria, Germany and Romania). Most countries have lower speed limits for trucks, buses, and vehicles towing a trailer. There are regular discussions on increasing or decreasing the speed limit by 10 km/h on this network.

The motorway network can be subject to frequent changes and political debates. The speed limit is 140 km/h in Poland and in Bulgaria. In Germany there is a recommended maximum speed of 130 km/h. There is usually a lower speed limit for urban motorways and lower limits for trucks and vehicles towing a trailer.

2.3. State of the art by partner countries: standard speed limits of countries

Standard speed limits (km/h) for passenger cars (category B, unless otherwise stated by traffic signs):

	Built-up areas	Rural roads	Motor roads	Motorways
Austria	50	100	100	130
Montenegro	50	80	100	130
Greece	50	90	110	130
Romania	50	90	100	130
Slovenia	50	90	110	130
Bosnia and Herzegovina	50	80	100	130
Bulgaria	50	90	120	140
Croatia	50	90	110	130
Hungary	50	90	110	130

There are differences between speed limits of cars and coaches, and of HGVs over 3,5t (day and night). There are no current plans to change any of the limits, but in Austria there were two 140 km/h trial sections on motorways, and expert discussion to lower the rural default limit. Of course, only the posted speed limit can be enforced. It means that only the absolute speeding can be controlled.

3. Thematic Area 3 (TA3) topics and focus

TA 3 - Thematic area 3 (RSEG on ITS and other speed management strategies) will focus on producing a roadmap for implementation of specific techniques (such as average speed cameras) and institutional requirements and barriers may be.

Speed has a direct influence on crash occurrence and severity. With higher driving speeds, the number of crashes and the crash severity increase disproportionally. With lower speeds the number of crashes and the crash severity decrease.

Before detailing the speed management tools, it is important to know the methods of analyzing speed data.

3.1. Speed analysis

The arithmetic mean of the measured speed values, i.e. the average speed, is the most commonly used value in statistical analysis. Of course, not all vehicles travel at the same speed, and speed values are scattered around average speeds. The standard deviation (s) is the statistical measure of these differences. Different standard deviations may be associated with the same average speed (Fig. 2). The smaller the standard deviation, the more homogeneous the speed distribution, the smaller the speed differences between the vehicles - less overtaking, less chance of a roll-over accident. It follows that the analysis of speed distributions should not be limited to comparing average speeds, but several characteristics need to be analyzed.

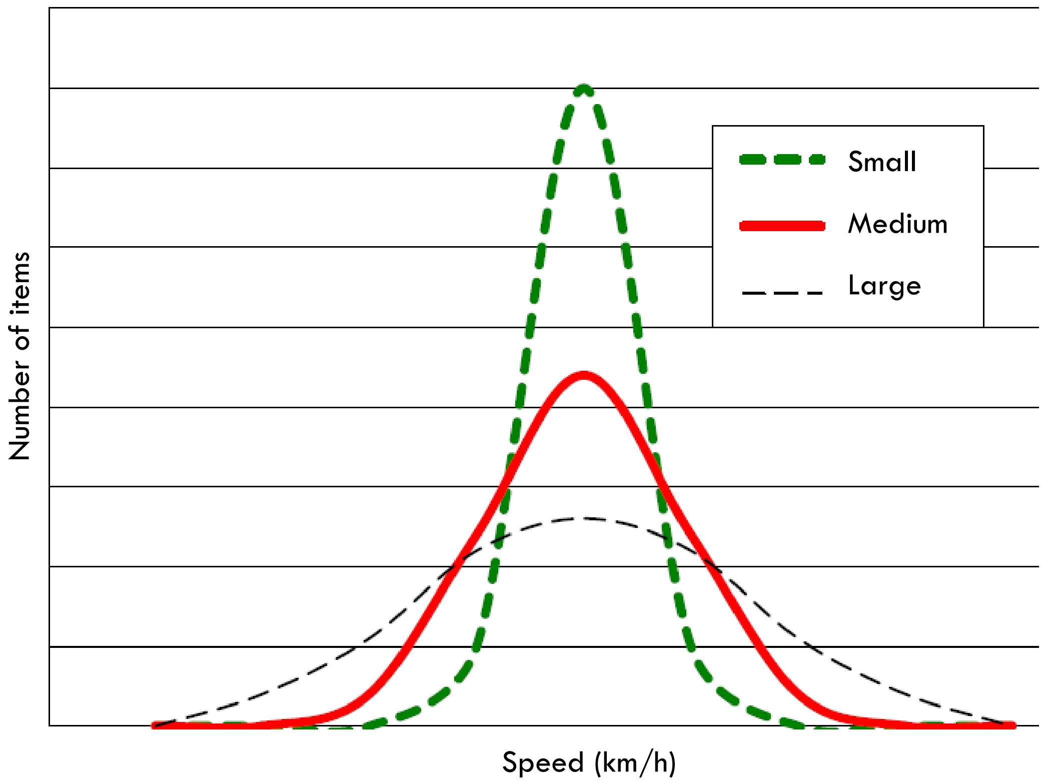


Figure 2 Same mean velocity for different standard deviations (Density function)

The distribution of speeds is the standard normal distribution. It is clearly defined by its two characteristics: mean and standard deviation.

The evaluation of speed measurements is greatly facilitated by the preparation of a summary speed distribution diagram (distribution function - Figure 3). The "before-after" tests compare the highlighted speed characteristics shown in the figure.

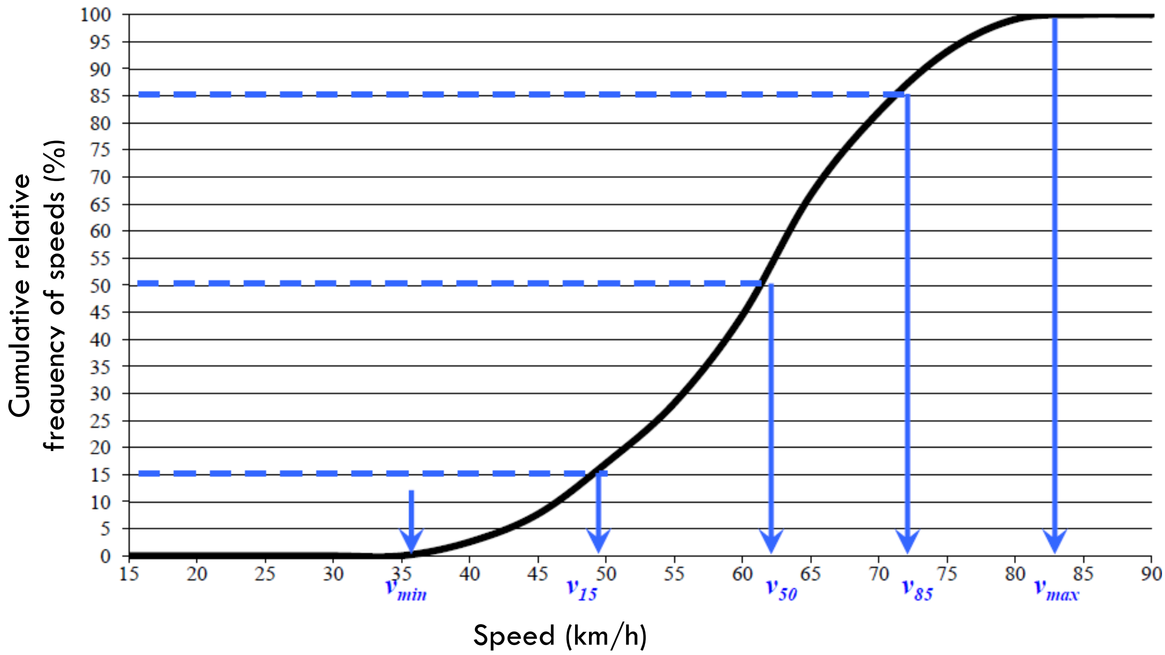


Figure 3 Characteristic values of the cumulative relative frequency curve (Cumulative Distribution function)

The average speed at which vehicles travel, V_{50}, is the speed at which half of the vehicles traveled faster and half slower. V_{15} (V_{85}) refers to the speed at which 15% (85%) of the vehicles have reached or remained below. 8

The V_{85} speed value is used to determine the value of the speed limit, especially where extreme speeds lead to conflict situations. If the speed limit indicated on the road sign is equal to V85, the majority of the drivers accept the limit and can be enforced without police control.

3.2. Speed-accident relationship

One of the basic questions in the field of road safety is the effect that changing the speed of traffic will have on the number and outcome of accidents/injuries. There is no doubt, in principle, that as speed increases, the number of accidents increases, their outcomes worsen, and conversely, as speed drops, fewer and less serious accidents occur in the area. The practical question is how much change will be. One of the best known correlations was made by Göran Nilsson at the Swedish VTI Research Institute, called the "Power Model". According to the model, the change in speed (v_1/v_0) results in a change in the number of accidents (y) and the number of people injured in the accident [*Nilsson, G.: Traffic safety dimensions and Power model to describe the effect of speed on safety, doctoril thesis, Lund, 2004*]:

Number of fatal accidents:

$$y_1 = \left(\frac{v_1}{v_0}\right)^4 y_0$$

Number of fatal and serious accidents: $y_1 = \left(\frac{v_1}{v_0}\right)^3 y_0$

Number of personal injury accidents: $y_1 = \left(\frac{v_1}{v_0}\right)^2 y_0$

If the average speed changes from 80 km/h to 75 km/h, the after/before speed is 75/80, i.e. 0.94. Raising this quotient to power 4 gives $(0.94)^4 = 0.77$, which means it drops from a unit value to 0.77, resulting in a 23% reduction in fatal accidents.

Figure 4 illustrates the relationship between accident rates in the Nilsson model.

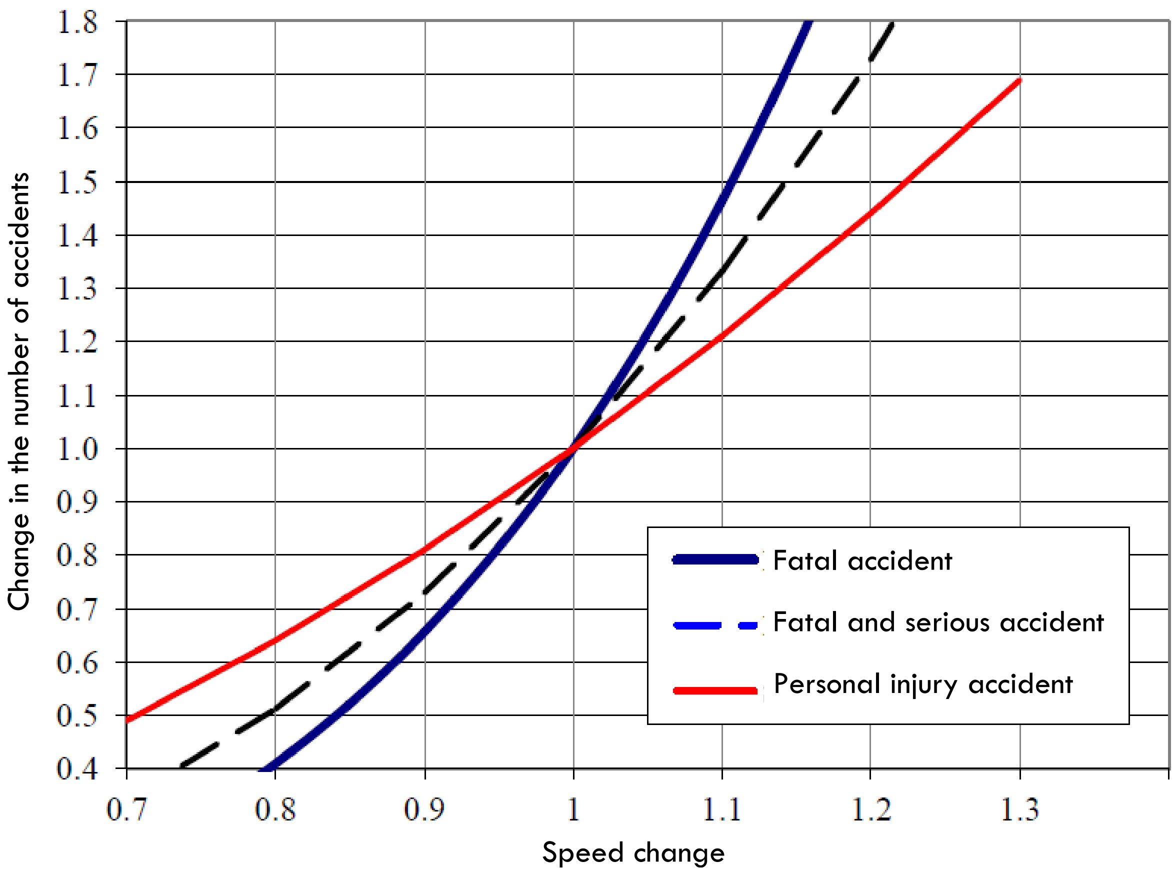


Figure 4 Impact of speed change on accidents

In the coordinate system shown in Figure 3, the average axis shows the change in average speed and the vertical axis shows the change in accident rate. "1" represents the baseline or reference point. The three different curves apply to fatal, fatal + severe and all personal injury accidents. Fatal accidents seem to be the most sensitive to changes in average speed in both directions.

According to the Nilsson model it results in a 5% reduction in speed and a 20% reduction in fatalities. The same is true for a 5% increase in average speed, which will result in 20% more deaths. There is a smaller change in the total number of personal injury accidents - for this to be reduced by 20%, the average speed must be reduced by 10%. In the other direction, the 10% increase in the average speed is accompanied by a 20% increase in the total number of personal injuries.

A study by Hauer and Bonneson [Hauer, E. and Bonneson, J.,: An empirical examination of the relationship between speed and road accidents based on data by Elvik, Christiansen and Amundsen, Highway Safety Manual Task Force, 2006] and an analysis by Cameron and Elvik [Cameron, M. and Elvik, R.: Nilsson's Power Model connecting speed and road trauma: Does it apply to urban roads? Australasian Road Safety Research Policing and Education Conference, Australia, 2008] dealt with the revision of Nilsson's model and the specification of relationships / exponents. Both studies found that the effect of a relative speed change (e.g., 10%) depends on the value of the initial speed. Changes at lower speeds (less than 60 km/h) have been found to have less impact on road safety than changes at higher speeds (more than 60 km/h). Based on all of this, the authors saw two ways to resolve the situation: either to reject Nilsson's model or to make a model with "starting" speed.

Elvik [Elvik, R.: The Power model of the relationship between speed and road safety, TOI report 1034/2009, 2009] has separated the model into motorways/rural roads and urban/local roads. He developed the exponents of the Power Model for these two different models. Exponents were smaller than in Nilsson's original model:

	Motorways/rural roads	Urban/local roads	All roads
Fatal accidents	4.1	2.6	3.5
Fatal and serious accidents	2.6	1.5	2.0
Personal injury accidents	1.6	1.2	1.5

The finding that effects of speed changes tend to be larger on rural roads and motorways than on roads in built-up areas roads suggests that the initial speed is a relevant factor. This was confirmed in a re-analysis of the data [A re-parameterisation of the Power Model of the relationship between the speed of traffic and the number of accidents and accident victims. Accident Analysis and Prevention, 50, 854-860. Elvik, 2013] that showed that the effect of a given relative change in speed on the number and severity of crashes is larger when initial speed is higher. In other words, a reduction of average speed of 10% will have a larger effect when it concerns a reduction from 100 to 90 km/h than when it concerns a reduction from 50 to 45 km/h. In absolute sense, a reduction in average speed of, for example, 10 km/h would result in comparable reduction of the number of crashes independent of the initial speed. This suggests that the relationship between speed and crashes can be better described by an exponential function than by a Power model.

Elvik points out that this does not mean that its results should underestimate the impact of vehicle speed on road safety: speed has always been and continues to be the most important risk factor. In practical life, the 5-10% reduction in the average speed can only be achieved – only with very strict measures and interventions.

The importance of speed distribution should also be emphasized. The above-mentioned models take into account the change and value of average speed, but we do not yet know what the importance of speed distribution is. From the point of view of road safety, since the homogeneous speed distribution is ideal, the same average speed can come from different speed values that are close to each other and from extremes too.

3.3. State of the art by partner countries: central speed database in countries

Centralized speed database in countries:

		Remarks
Austria	No	Only at proprietary repositories, (e.g. at ASFINAG or at regional authorities' level) which are maintained internally and kept non-public.
Montenegro	No	Police administration is responsible for keeping the database.
Greece	No	Traffic Police collects data.
Romania	No	In present there is a speed database on highways only.
Slovenia	No	Source of speed data are automatic traffic counters, VMS, police and municipal inspectorate measurements with mobile measuring equipment. The data is accessible on request.
Bosnia and Herzegovina	No	Speed data can be individually "read" from stationary radars and traffic counters through members of the Ministry of the Internal Affairs and road controllers, who are responsible for keeping these data.
Bulgaria	No	The Ministry of Interior and Ministry of regional development (Road and transport Facilities Institute) have access to the data, In rural areas – in some cities Traffic Control Centres, managed through the Municipality.
Croatia	No	Motorway companies and Croatian roads Ltd collect speed data on the roads in their authority.
Hungary	No	Motorway companies, National Toll Payment Services Plc. and Hungarian roads Ltd collect speed data on the roads in their authority.

The KFV has – for decades – collected speed data using (side) radars and lasers on all road types across Austria. Data was used only internally so far, but might go public in the course of Commission's recent KPI initiative. There is no generic analysis that can be reported from the side of Austrian authorities. KFV does simply calculation of mean, median and 85 percentile speeds for different road types, speed limits and vehicle types.

4. Managing traffic speeds

Traffic speeds involve a complex set of interactions between engineering, legal and driver performance factors. Similarly, there is no reliable guidance on how to attain specific operating speed characteristics (e.g., mean, 85 percentile, speed deviation) and speed relationships (e.g., between 85 percentile and design speeds) during the geometric design process. Until this type of information is implemented, safety can be improved through strategies that result in better geometric designs and infrastructure conditions, more credible and effective speed control and targeted enforcement.

Speed management is a strategy for controlling speed through a comprehensive, interdisciplinary and coordinated approach that encompasses behavioural, enforcement and engineering elements.

4.1. Improving the design process

Once constructed, transportation infrastructure is enduring. Roads and streets are public investments that establish spatial arrangements for community development and economic activity. Alterations may be costly and disruptive. Since the consequences of geometric design are significant and long-lasting, decisions should be deliberate. Geometric design is one potential influence on traffic speeds.

Improving design consistency is another area of speed-related improvement. Desirably, specific features and locations along a travel route should not require unexpected speed reductions. Isolated speed-restrictive features are likely to violate a driver's expectation that has developed from conditions encountered previously. Relative to driver expectancy, geometric features should transition from a higher to lower design speed gradually. As an example, long tangents (with an infinite inferred design speed) between tight curves should be avoided.

4.2. Appropriate speed limits

The management of speed through appropriate speed limits is an essential element of highway safety. Appropriate speed limits are a prerequisite for effective and sustainable speed management. Speed limits should reflect the maximum reasonable speed for normal conditions. Speed limits should be accepted as reasonable by most drivers. Not all drivers will conform to reasonable speed limits. In essence, speed limits separate high-risk and reasonable behaviour. If lower speed limits are desired, then engineering and other measures should be implemented that reduce speeds to a level that would support a lower limit.

4.3. Other measures

Speed limits are not the only tools that agencies can draw on to manage operating speeds. In fact, as discussed previously speed limits usually have a limited effect on operating speeds. Roadway geometry and the frequency of enforcement also play a role in driver judgments and choices regarding speed. A number of proven and promising speed management practices and technologies are available. The suitability of each as an element in an agency's speed management and safety program should be evaluated based on the community, legal and transportation contexts.

Advisory Speed Posting

Speed limits should not be lowered to reflect an isolated restrictive element. This practice tends to reduce the credibility of speed limits. When a speed lower than the speed limit is appropriate for a particular location, the use of an advisory speed plaque and associated traffic control devices should be considered. Figure 5 shows an example of a horizontal alignment change (e.g., curve, roundabout, work zone) combined with advisory speed plaque.

Figure 5. Horizontal curve warning sign with speed advisory plaque.

Improving Friction on Roadway Surfaces

Friction is needed to drive, brake and corner a vehicle. Forces are transmitted between the vehicle and road through friction at the tire-road interface. The characteristics of driving manoeuvres (e.g., turning radius and speed) influence the frictional demand. The available friction is a characteristic of roadway material and vehicle tire properties. It is possible but undesirable for the demand friction to exceed available friction.

Speed display signs

Speed display signs measure the speed of approaching vehicles, typically with radar, and display the measured speed. LED (light emitting diodes) is a common display technology. The signs may be mounted on trailers to increase portability or on fixed support systems. An example dynamic speed display sign is shown below in Figure 6. Many of the signs also display the applicable speed limit (it is possible only in Hungary), creating a direct comparison for drivers. Speed display signs were originally used in connection with temporary conditions, such as works zones. More recently, agencies have deployed and begun to evaluate the effectiveness of these signs in reducing speeds at permanent, speed-sensitive locations.

Figure 6. Example of dynamic speed display sign

Traffic calming

Traffic calming is a term used to describe a set of techniques, consisting mostly of physical features, to affect vehicle operations on one or more streets to improve the street environment for other users (i.e., those not using motorized vehicles). Speed reduction is one of several traffic calming objectives. The specific traffic calming measures selected for application at a particular location should correspond with the unique conditions of the location and the objectives, since not every speed calming technique is appropriate for every roadway. Also, including such measures can result in drivers slowing at the speed calming feature, and speeding between them.

Some of the measures that have been employed to reduce vehicle speeds include:

- speed humps,
- speed tables,
- raised intersections,
- roundabouts,
- chicanes,
- lateral shifts,
- realigned intersections,
- traffic lane narrowing.

Figure 7. Example of chicane (Road No. 10. Hungary)

Variable speed limits

Variable speed limits are speed limits that change based on road, traffic, or weather conditions (reduced visibility, slippery road). At a particular time and place, the applicable speed limit reflects some of the same factors a prudent driver also considers. Improving the consistency between a responsible driver's speed selection and the speed limit may help to restore speed limit credibility and improve safety.

Figure 8. Example of variable speed limit (M1-M7 motorway, Hungary)

Improve Sight Distance

The available sight distance along horizontal curves and at intersections can be improved by controlling vegetation. Vegetation can decrease the sight distance available to traffic control devices as well as decrease sight distance inside horizontal curves. Another mitigation measure for inadequate sight distance on an intersection leg is to install warning flashers on the approach leg.

Enforcing speed limits

Traffic laws, including speed limits, are enforced by police agencies at the state, county and municipal levels. It is extremely rare and generally considered counterproductive to cite drivers operating slightly over the speed limit. Since exceeding the speed limit is so common, it is not practical to issue a ticket to each and every offending driver. Flagrant violators (i.e., drivers operating at very high speeds) pose the greatest risk and are generally the focus of enforcement. Police exercise discretion in deciding at what speed and circumstances a citation will be issued. Police have no specific knowledge of designated and inferred design speeds. Individual vehicle speeds are assessed on the basis of the speed limit, prevailing operating speeds, and environmental conditions.

Figure 9. Fixed speed camera (Road No. 31, Hungary)

Decisions on when and where to enforce speed limits directly affect driver speed selection. Visible and active enforcement reduces operating speeds but the effect diminishes as the distance and time from the site of enforcement increases. The cost and availability of assigning police officers to this function limits the frequency, coverage, and effectiveness of speed enforcement. There are fixed (Fig. 9) and mobile speed cameras and as well as section-control (Fig. 10).

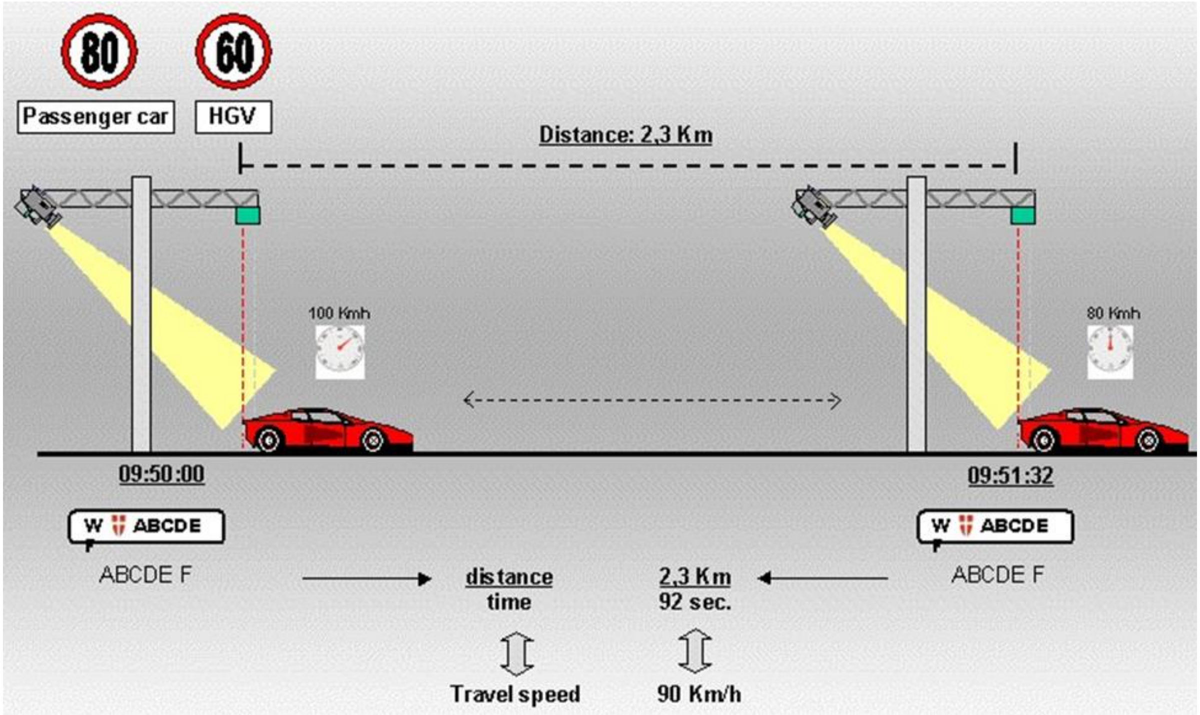


Figure 10. The system of section control

If the travel speed resulting from the ratio of the distance to the time is higher than the maximum speed permitted for that vehicle, the vehicle is considered a speeding one.

4.4. State of the art by partner countries: safe speeds and road design process in countries

Appropriate speeds taken into account in the road design and operation process:

	Design & maintenance philosophy	Road furniture elements are used to curb speeds	Fixed speed cameras	Section Control
Austria	state-of-the-art in terms of safety	gates at village borders, chicanes, humps, raised plateaus and crossings, junction buildouts, narrowings	It can be fairly assumed that the number is in excess of 1,000 sites (less cameras than sites & boxes available)	6 fixed units/5 additional mobile units used temporarily in major work zones
Montenegro	safe speeds are taken into account	speed humps, speed tables, raised intersections, roundabouts, chicanes, lateral shifts, realigned	No cameras (The Police Administration is currently implementing a project to set up speed cameras at 72	No

		intersections, traffic lane narrowing	locations along state roads)	
Greece	Fixed speed cameras installed mostly on motorways.		Speed controls mostly performed using manually operated mobile equipment (app. 210.000 violations/year)	Not implemented.
Romania	Safe speed is taken into account.		Road police manages the speed camera system	there is not a legal background
Slovenia	Safe speeds are taken into account	speed humps, road narrowing, changes in texture, signalization, rumble strips, chicanes…	about 70 fixed speed camera boxes (about 15 measurement devices)	There is no working section control system.
Bosnia and Herzegovina	Safe speeds are taken into account	speed tables, roundabouts, speed humps, optical white lines, sound or vibrating tapes, artificial protrusions, shorter road narrowing, painting of the marked sections.	100 fixed speed cameras on roads.	There aren't working section control system and we don't have any legal background about it.
Bulgaria	The Design Speed is used for the design of the basic geometric elements and for determining the permissible technical parameters of roads or road sections	speed humps, raised intersections, roundabouts, chicanes, speed tables	173 automated technical devices and systems	there is no legal background, only 2 existing test sections
Croatia	there is a By-law on basic conditions to which public roads outside built-up areas and their elements	deviations, speed humps, rumble strips	there are >90 fixed speed cameras on roads	there is no legal background for section control

	must satisfy from the traffic safety status			
Hungary	state-of-the-art in terms of safety	speed humps, speed tables, raised intersections, roundabouts, chicanes, lateral shifts, realigned intersections, traffic lane narrowing	134 fixed locations, and 160 mobile cameras	there is no legal background

5. Case studies

This chapter describes case studies of recent experiences regarding either a change of speed limit or a wide scale implementation of automatic speed enforcement. For each case study, it summarises the evaluations that have been conducted on the impact of these measures on speed and crash occurrence.

5.1. Hungary: decrease/increase of the speed limits (1993, 2001)

The **decrease of the speed limit from 60 km/h to 50 km/h inside built up areas** (on 1 March 1993) proved to be an effective road safety measure in Hungary. The measure was implemented on all roads inside built-up areas, covering 32% of the whole state road network. The decrease in speed limits in built up areas was motivated by the need to follow the European trend in terms of speed limit legislation and also by a strong recommendation by the World Bank to improve road safety inside built-up areas. **The average speed** was 57 km/h in 1992, before the measure was implemented and 52.5 km/h immediately after the introduction of the new limit in April 1993. In March 1994, the average speed was recorded as 51.5 km/h. The greatest effect was achieved in the short run, which – along with other factors – was due to an intensive publicity campaign and police enforcement accompanying the introduction. The effect of the measure has been analysed by Holló [Experience in Hungary with changes in speed limits, in: Speed management, ECMT, Paris, 2006, box 5.3., pp. 101-102.]. Overall, a 37.7% **decrease in the number of road fatalities** was observed in roads inside built up areas. During the same period, the number of fatalities decreased by 23.4% on the "control group" roads (secondary roads outside built up areas). Taking into account the confounding factors, it is calculated that the decrease of the speed limit from 60 km/h to 50 km/h inside built up areas reduced the number of crash deaths in the "after" period by 18.2%.

On 1 May 2001, the **speed limits outside built-up areas were increased** from 120 km/h to 130 km/h on motorways, from 100 km/h to 110 km/h on motor roads (semi-motorways) and from 80 km/h to 90 km/h on rural roads. The changes concerned all roads outside built-up areas, covering 68% of the whole state road network. Between the period before (i.e. before 1 May 2001) and after the Highway Code's amendment (2004) the **average free speed of motor vehicles increased** by 2.1 km/h on rural roads and by 0.7 km/h inside built up areas [Mocsári, T., Effects of cars' speed on road safety, PhD thesis, Széchenyi István University, Győr, 2012.; ITF, Speed and Crash Risk, Research Report. Contribution by Prof. Dr. Holló, Mocsári]. The negative impact on road safety was experienced immediately after the measure was introduced (2002). The **number of fatalities increased** by 13% practically to the level of the year 1995.

For both of the Hungarian case studies, the biggest changes in the number of fatalities could be experienced at the time of the speed limit changes, see Figure 11.

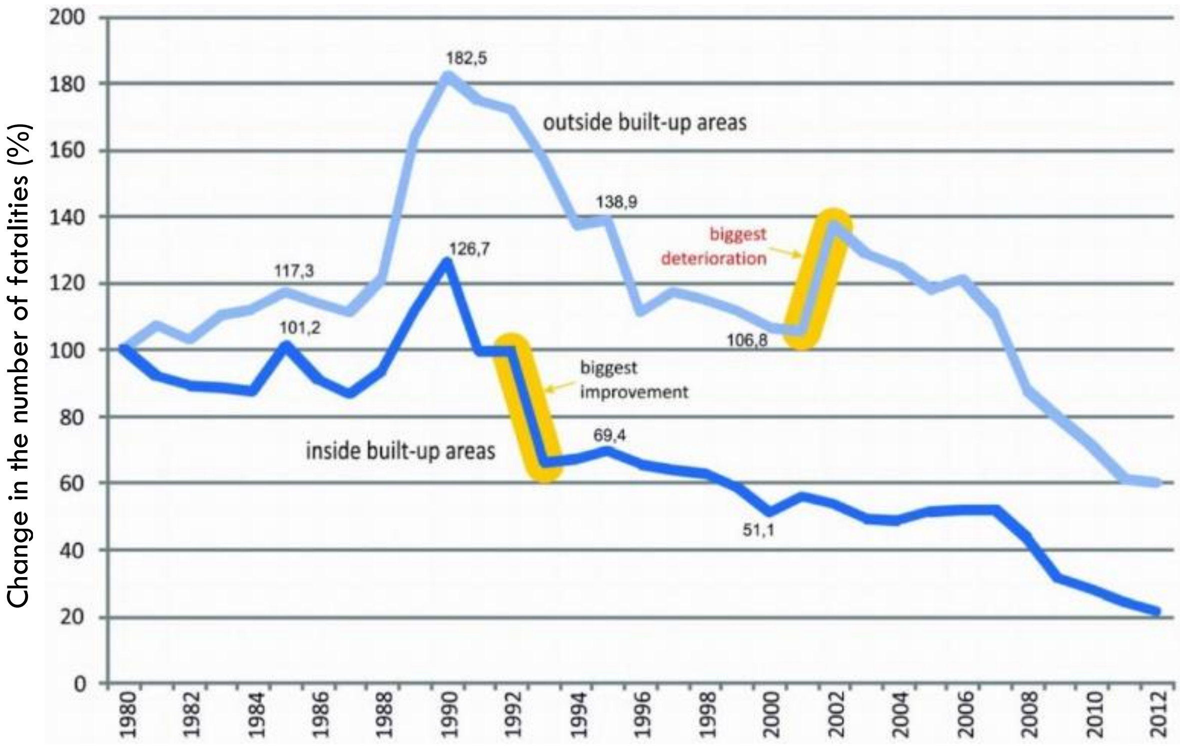


Figure 11. Time series of the number of people killed in road traffic crashes inside and outside built-up areas (Source: Prof. Dr. Holló)

5.2. Sweden: Increase and decrease of speed limits (2008, 2009)

The entire speed limit system of Sweden was reformed in 2008. A new set of limits, i.e., 80, 100, and 120 km/h, was introduced on rural roads to complement the previous limits of 70, 90, and 110 km/h. As a consequence, the speed limit was reduced on many rural roads from 90 km/h to 80 km/h and increased on some motorways with high standards from 110 km/h to 120 km/h.

The motivation was to adapt speed limits to the safety classification of each road, but also a balance between environment and mobility needs.

On rural roads where the **speed limit was reduced from 90 – 80 km/h, the mean speed decreased by 3.1 km/h,** the number of **fatalities decreased by 41%** and the number of seriously injured did not change **significantly. On motorways where the limit was increased, the mean** speed increased by 3.4 km/h, number **of seriously injured increased by 15 seriously injured per year** and no significant change was seen in the number of fatalities [Vadeby, A., Björketun, U. (2015), New speed limits in Sweden – long term traffic safety effects. Report 860 - 2015. VTI. Linköping. In Swedish, English summary].

5.3. France: Introduction of automated speed cameras (2003)

On 14 July 2002, President Chirac decided to make road safety one of the three major national priorities during his five years' mandate. The decision to adopt speed cameras was taken on 18 December 2002 by the Interministerial Committee for Road Safety. Fixed and mobile speed cameras were implemented progressively, with a first stage between November 2003 and March 2004 for the first hundred fixed units, followed by stagnation until the end of summer

2004. All fixed cameras were advertised by a sign about 1 km upstream. From autumn 2004, the implementation accelerated. Then, the extension of the network of fixed speed cameras continued to reach 1 661 in 2009 supplemented by 932 mobile speed cameras. The first cameras were installed by central decision at points in the network with most traffic. Then, the locations were decided at the local level taking into account the characteristics of the infrastructure and levels of crash risk.

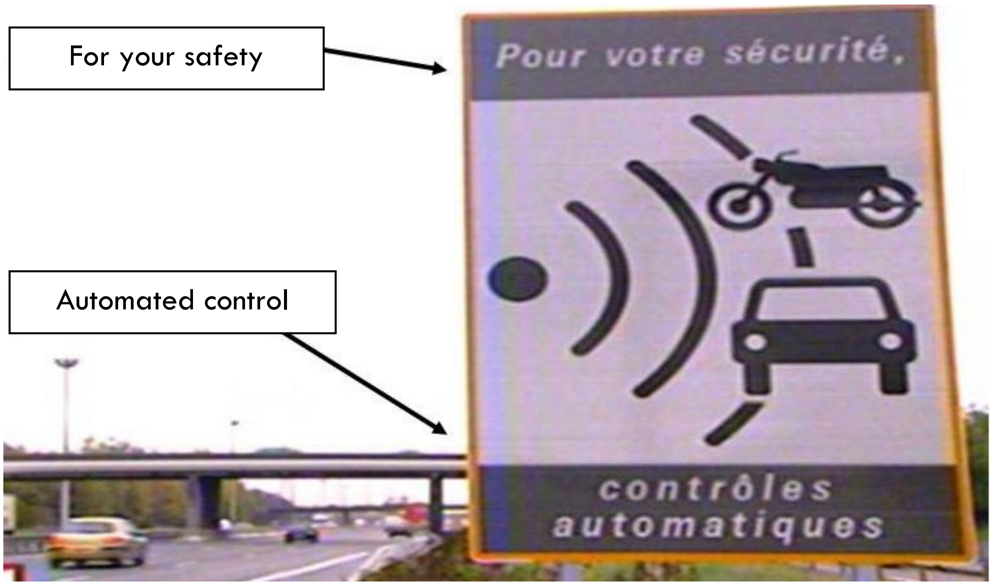


Figure 12. Signboards at speed checkpoints in France

Between 2002 and 2005 the **mean speeds fell by** 8.9 km/h on secondary roads and by 7.7 km/h on two or three lanes highways (two-way roads). **Fatalities decreased** by 25-35% in rural areas, 38% on urban motorways and 14% on urban roads. [Blais, E, and Carnis, L (2015), 'Improving the safety effect of speed camera programs through innovations: Evidence from the French experience'. Journal of Safety Research, Vol. 55.]

Figure 13. Fixed and mobile cameras in France

5.4. Austria: Introduction of section control (2012)

The first section control (Fig. 14) on Austrian motorways was installed in 2003 in the Kaisermühlen Tunnel near Vienna. Since then, several sections of the Austrian motorway network have been equipped with section control (both fixed and mobile units).

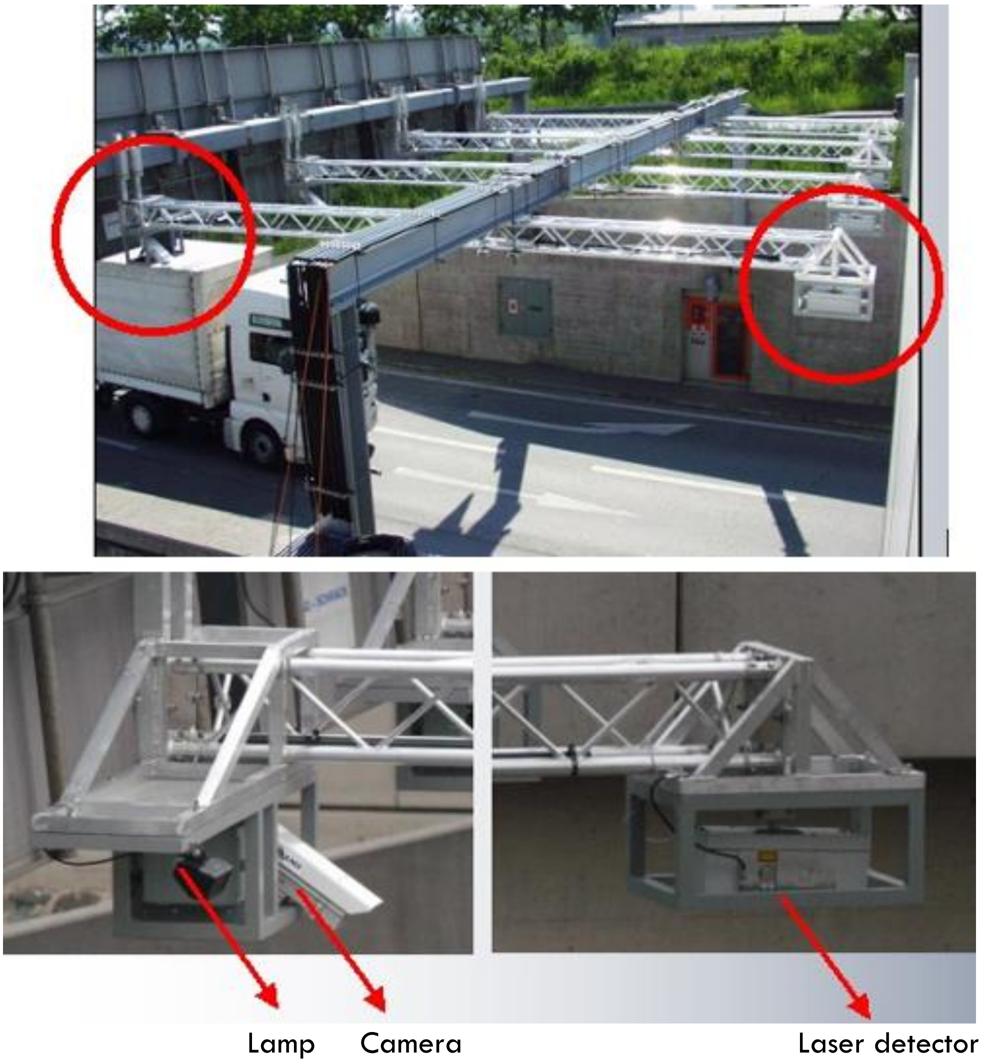


Figure 14. Positioning of cameras and detectors

The cameras and laser detectors are mounted on the portal panels on each traffic lane. In order to take high quality pictures even in the dark, a single lamp was attached to each camera.

In June 2012, section control was installed on the LB37 in Lower Austria on a road section of 4.5 km. The LB37 is an interurban road with a 2+1 cross section without median barrier. The speed limit is 100 km/h. The section control enforcement was implemented to improve road safety. The stretch of road had been identified as a high-risk section.

The **average speeds were reduced** at all five measurement points, by between 3.3 km/h and 10.9 km/h., corresponding to speed reductions of between 3.1% and 10.7%. The counts of injury crashes per year decreased from 5 per year to 1.55/year, corresponding to a 69% reduction. The **number of fatalities was reduced** to zero, from a level of 0.6 per year. The number of people injured decreased by 37% and **the number of people seriously injured decreased** by 61% [KFV Sicherheit-Service GmbH. (2016), Section Control. Wirksamkeit und Einsatzempfehlungen. Wien].

5.5. Hungary: rebuilding of a junction with traffic lights into a roundabout (1997)

The aim of this experiment was to analyse and compare the traffic stream in two different traffic control systems (a crossing with full mask traffic light system and a compact roundabout). The rebuilding was made in the night between the 10-11th of September in 1997.

The speed of the exiting vehicles were recorded at the line of the pedestrian crossings of each legs of the junction. During the evaluation period only with the free speeds were measured, so the vehicles following the slower ones were left out from the sample. The average reduction of the speed was 10 km/h in all speed ranges. From the drivers going to the direction of Budapest, in the roundabout 82% and in the traffic light system only 45% kept the prescribed speed limit - 40 km/h - indicated with traffic signs. It is clear that owing to the roundabout the speeding drivers have to slow down on the pedestrian crossings.

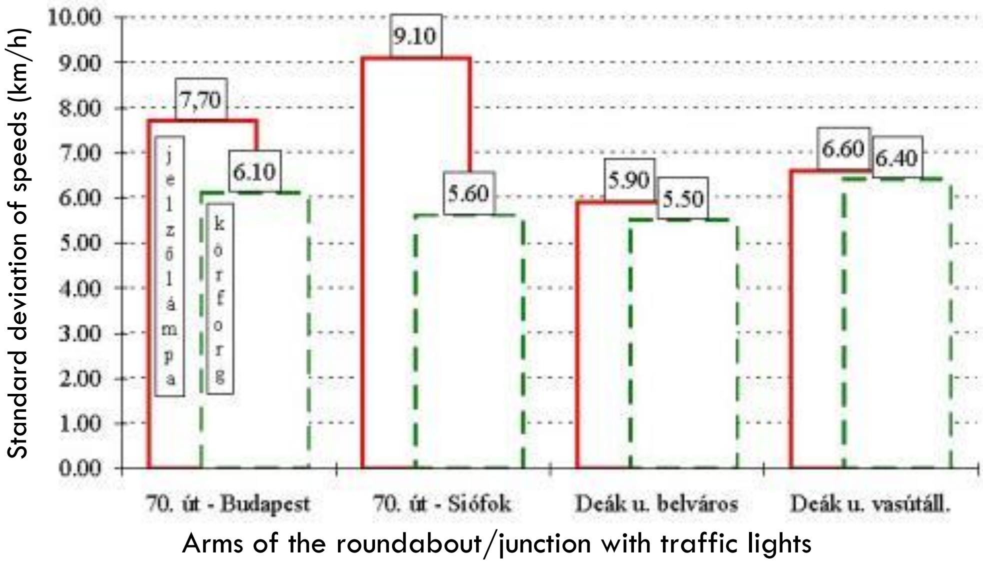


Figure 15. Standard deviation of speeds at arms

The standard deviation of the recorded free speed values (Fig. 15) shows that the roundabout significantly helps the formation of a more homogeneous speed distribution. The more inhomogeneous the speed distribution, the higher the risk of accident, not just because of the vehicle - vehicle conflicts, but also because of endangering the pedestrians. [Hóz, E., Mocsári, T. and Molnár, A. (1997) "5.5. Experimental rebuilding of a crossing with traffic light system into a roundabout in Székesfehérvár", Periodica Polytechnica Transportation Engineering, 26(1-2), pp. 71-88.]

5.6. Hungary: variable message sign for speed limit warning (2007)

In the town Leányfalu, on the crossing section of the main road a variable message sign (VMS) was placed. By installing the sign, which indicated the speed of the vehicles passing by, the main goal was to make the drivers lower their speed. The difference between the signboard off and on and the signboard is shown in Figure 16.

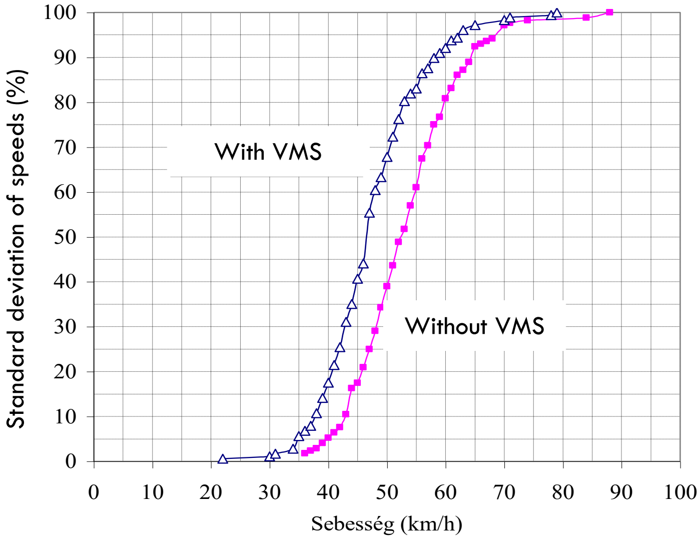


Figure 16. Cumulative relative frequency curve and the VMS

The 5.5 km/h decrease in average speed in the “on mode“ differs from the “off mode” by a 95% significance level, thus demonstrating the beneficial effect of the equipment. This effect is reinforced by the fact that the standard deviation of speeds is also reduced during operation.

5.7. State of the art by partner countries: case studies in countries

There are significant differences among the countries involved in the project in terms of the case studies available. The following part is a summary of the materials received from each country.

Section Controls in Austria

- Six fixed units and five additional mobile units used temporarily in major work zones
- On crashes: especially: reduction of severe accidents (killed & seriously injured)
- On speeds: Reduction of mean speed and v85, Reduction of speed variance (i.e. homogenization of driving speeds, and less excessive speeding (both in numbers and extent)

Increased speed limit on motorways in Greece (2007, 120 to 130 km/h)

- Diploma Thesis by NTUA E. Georgiadou examined the effect on road accidents.
- Data of road accidents (period 2005 2010) on motorway sections:
- Method: “before” and “after” statistical analysis of accidents with control group with x 2 and odds ratio controls
- Athens Thiva : statistically significant increase in the number of deaths only for the first year later not statistically significant
- Athens Tripoli: reduction in accidents and victims, due to improvements in infrastructure.

- Egnatia Motorway: no statistically significant change.

Case study in Slovenia

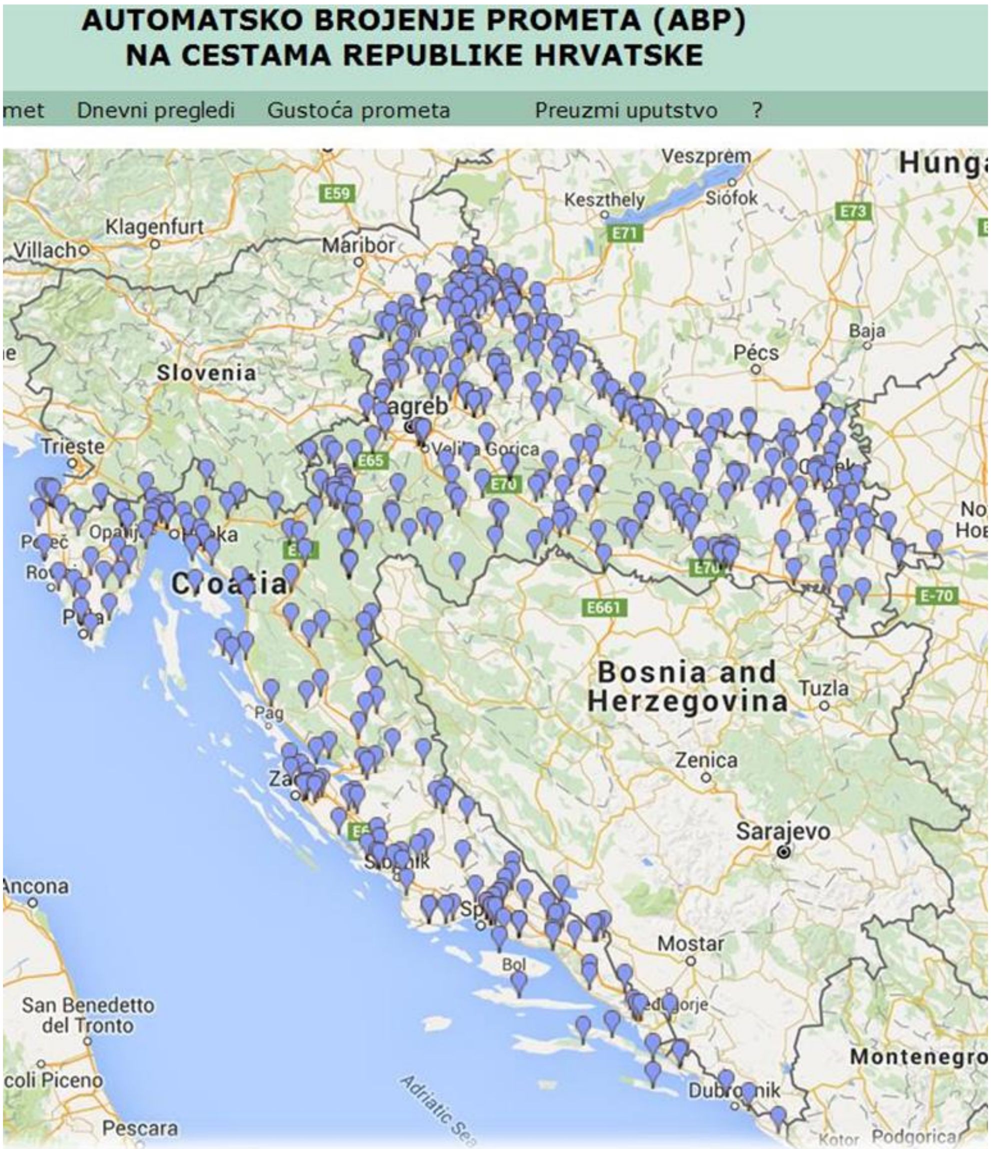
There was a pilot study of section control done a few years ago. The average speed fell from 102 km/h to 92,58 km/h as well as the number of accidents from 12 to 5 in the approximately nine-month testing period in comparison to the same period in last three years before that.

Case studies in the Federation of Bosnia and Herzegovina

- Map of magistral roads of the Federation of Bosnia and Herzegovina - state of speeds (design speed and limitations, operating speed)
- "Respecting the Speed Limit on Highways in Republika Srpska" Published in Proceedings - III International Conference "Traffic Safety in the Local Community", Banja Luka, 2014

Speed analysis on motorways and state roads in Croatia

- 3 spots on 3 different motorways, 226 spots on state roads
- Inductive loops, 2 traffic lines in both directions: 226 spots (452 traffic lanes) and only free flow speeds were analysed. The next map contains these 226 spots in Croatia:


AUTOMATSKO BROJENJE PROMETA (ABP)
NA CESTAMA REPUBLIKE HRVATSKE
met
Dnevni pregledi
Gustoća prometa
Preuzmi uputstvo
?
Veszprém
Hunga
Keszthely
Siófok
Klagenfurt
Villach
Maribor
Slovenia
Pécs
Baja
Trieste
Croatia
Bosnia and
Herzegovina
Tuzla
Zenica
Sarajevo
Ancona
Mostar
Bol
San Benedetto
del Tronto
Montenegro
Dubrovnik
Pescara
Podgorica
Kotor
Adriatic Sea

6. Safe system

According to the Safe System approach, death and serious injury in road collisions are not an inevitable price to be paid for mobility.

The aim is to offer a road system that can accommodate the unavoidable human error without leading to death or serious injury.

While collisions will continue to occur, death and serious injury are largely preventable. The Safe System approach aims for a more forgiving road system. It accepts that people will make mistakes, and argues for a layered combination of measures to prevent people from dying from these mistakes by taking the physics of human vulnerability into account. Better vehicle construction, improved road infrastructure, lower speeds for example all have the capacity to reduce the impact of crashes. Taken together, they should form layers of protection that ensure that if one element fails, another one will compensate to prevent the worst outcome. This approach involves multi-sectoral and multi-disciplinary action and management by objectives, including timed targets and performance tracking.

In its staff working document, the European Commission states that "to measure progress, the most basic - and important- indicators are of course the results on deaths and serious injuries" [COMMISSION STAFF WORKING DOCUMENT EU Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero"] but "the Safe System approach relies on gaining a much clearer understanding of the different issues that influence overall safety performance." The European Commission is therefore asking Member States to voluntarily collect a set of data to produce comparable KPI, bearing in mind the differences in national rules.

Reporting the necessary data to the Commission is voluntary for Member States (Figure 17.). So the success of this exercise will rely on Member States' wholehearted participation, in line with the level of ambition expressed by EU Transport Ministers in the Valletta Declaration. Indeed, a number of Member States already use some or even all of these indicators for their national policies. In any case to ease implementation, different options are offered for certain indicators. Where existing national approaches differ widely, we want to preserve the best national practices, and so it is left as much as possible to Member States to decide on precise methodology, bearing in mind however that the aim is to collect comparable data. In addition, the Commission is providing financial support to Member States to facilitate work on methodology and measurements.

The initial list of KPIs is only a starting point. This will be a living exercise - work will continue on further development of some of the indicators and on adding additional indicators over time.

List of KPIs and basic methodology:

1) Speed: Percentage of vehicles travelling within the speed limit;
2) Safety belt: Percentage of vehicle occupants using the safety belt or child restraint system correctly;
3) Protective equipment: Percentage of riders of powered two wheelers and bicycles wearing a protective helmet;
4) Alcohol: Percentage of drivers driving within the legal limit for blood alcohol content (BAC);
5) Distraction: Percentage of drivers NOT using a handheld mobile device;

6) Vehicle safety: Percentage of new passenger cars with a EuroNCAP safety rating equal or above a predefined threshold;
7) Infrastructure: Percentage of distance driven over roads with a safety rating above an agreed threshold;
8) Post-crash care: Time elapsed in minutes and seconds between the emergency call following a collision resulting in personal injury and the arrival at the scene of the collision of the emergency services.

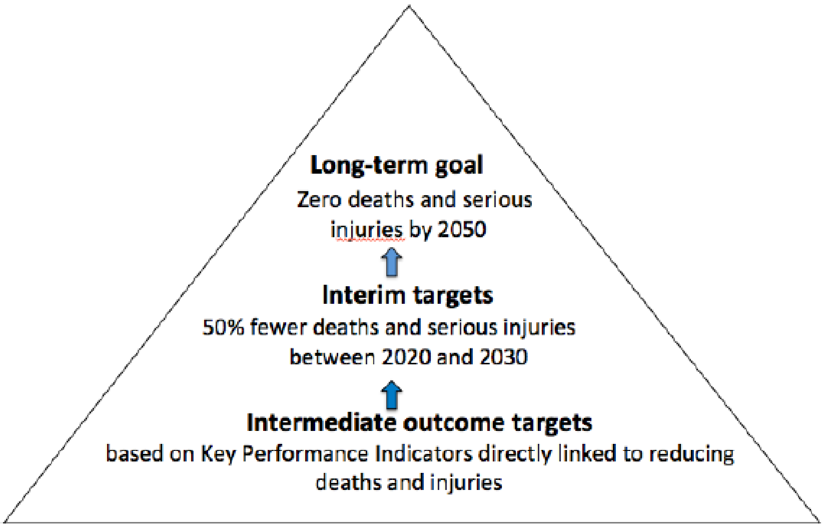


Figure 17: Safe System results hierarchy at EU level

6.1. Appropriate Speed - KPI

Actions to tackle speed is mentioned under the sections before on vehicle with ISA, infrastructure and enforcement. Speed should remain a top priority issue in tackling road deaths and serious injuries within the EU strategy.

The European Commission could develop an EC Recommendation on speed covering infrastructure, vehicle and enforcement. For infrastructure this could follow-up on the work of the new EC led expert group which is due to develop a framework for road classification and encourage Member States to apply safe speed limits in line with the Safe System approach.

These are the EU's minimum methodological requirements for speed KPI:

- Road type coverage: The indicator should cover motorways, rural non-motorway roads and urban roads. The results should be presented separately for the three different road types.
- Vehicle type: The indicator should include at least passenger vehicles (cars). Buses and goods vehicles (light [less than 3.5t] and heavy [more than 3.5t]) and powered two-wheelers are optional in a first phase (results should be presented separately for each vehicle type if possible).
- Location: Member States to decide on the locations of the measurements, but measurements should not take place near safety cameras whether fixed or mobile. The choice of locations should be based on random sampling if this is possible, and in any case done with the objective of ensuring a representative sample.

- Time of day: All Member States should elaborate the indicator for day hours in free flow traffic; the night indicator should be optional due to its higher cost. The results should be shown separately for day and night.
- Day of the week: Measurements to be carried out on Tuesdays, Wednesdays or Thursdays. Weekend measurements also possible but optional, and again should be shown separately if carried out.
- Month: Measurements to be carried out preferably in late spring and/or early autumn.
- Weather: Measurements should not be taken in bad weather conditions (e.g. heavy rain, snow, ice, strong winds or fog). Member States will define the exclusion criteria and report them together with the data.
- Tolerance: No tolerance (beyond the error margin of the measuring device), i.e. the values recorded should be those measured by the instrument.

6.2. State of the art by partner countries: speed KPI

There are great differences between the countries involved in the project in terms of the case studies available. The following is a summary of the materials received from each country.

Austria

- Currently there are no legal precautions for the collection of any of the KPIs of the Commission's exercise, and there is no national speed data collection taking place for the moment.
- The KFV, however, has – for decades – collected speed data using (side) radars and lasers on all road types across the country for internal monitoring and research purposes. Discussion is currently underway to use a subset of KFV data for reporting purposes towards Brussels.
- The EU requirements will most likely be met ("Percentage of vehicles travelling within the speed limit, 3 road types, at least for cars, free flowing traffic, separately day and night, …")

Montenegro

- There is a legal background for collecting KPIs in Montenegro.
- The Ministry of the Interior – Police Administration is responsible for collecting KPIs.
- Montenegro has a plan to collect and analyse KPIs in 2020.
- Yes, speed data will be collected and analysed according to EU needs.

Greece

- Greece is not issuing KPIs for speed
- Hellenic Ministry of Infrastructure and Transport has the intention to develop and use KPIs in compliance with the European definition

Romania

- There are no legal precautions for the collection of any of the KPIs of the Commission's exercise, and there is no national speed data collection taking place for the moment.

Slovenia

- The KPIs mentioned are in Slovenia collected by Slovenian Traffic Safety Agency. The Institute of Criminology at the Faculty of Law made a major research on this topic for the Slovenian Traffic Safety Agency. Available on request.
- Speed data in Slovenia already is collected and analysed according to EU needs.

Bosnia and Herzegovina

There aren't any legal background for collecting KPIs or national speed data collection for the moment. For now, there aren't any plans or chances that speed data will be collected and analysed according to EU needs.

Bulgaria

No information.

Croatia

National program for road traffic safety is the main act which determines KPIs regarding road traffic safety

- adherence of allowed speeds on roads in optimal traffic conditions in 90% of drivers, while other must not exceed established limits by more than 15%;

– the dispersion degree of all vehicle speeds in a traffic flow of no more than 10%;

Ministry of Interior is responsible for collecting the above mentioned KPIs. Croatian roads Ltd plan to collect KPI on risk mapping (2020-2025) – a plan to decrease portion of roads rated with 1 or 2 stars compared in 2020 and 2025. Ministry of Interior is considering to run a program of collecting speed data for CARE KPI.

Hungary

The Hungarian KPI speed data is collected and analysed for the last 5 years.

7. Vehicle safety and automation

A wholesale shift to autonomous and electric vehicles would not just reshape the entire transportation industry, but also our daily lives.

7.1. New vehicle technologies

Numerous versions of electric vehicles have appeared in the transport industry without the legacy regulation being classified in the vehicle, motorcycle, bicycle, or pedestrian categories. These Shall-Gos (electric motorcycle, electric scooter, electric skateboard, electric bicycle, electric unicycle, electric moped, hoverboard, etc.) have very different parameters, compared to traditional vehicles.

More and more often the question is where the Shall-Go can go: on the sidewalk, on the bike path, or on the road? The next question is at what speed? What protective gear should the driver of Shall-Go wear?

The big question for future speed regulation is how European countries will integrate these tools into their own regulatory systems. At present, in the absence of national regulations, individual municipalities have introduced special rules, possibly a total ban on Shall-Go.

Figure 18. Electric unicycle

7.2. Benefits (and disadvantage) of automatic vehicles

An autonomous car is known as a driverless or self-driving car, it was designed to travel in the absence of a human operator.

Driverless cars could work with higher speed limits

As human populations move toward the use of driverless cars, it may become possible to raise the speed limit that vehicles can drive on extended trips. The computers would calculate the operations of the automobile to ensure the occupants remain safe. That means passengers could take care of other needs while the vehicle does the work of transportation without compromising the safety of the people who are on the roadways. The hard question is: what will happen during the transitional period: how do the vehicles with different speed limits go together?

Driverless vehicles can travel in platoons at the same speed

Because a driverless car would likely communicate with the other vehicles around it and the roadway, it would know where to maximize speed and movement. Other automobiles would react when a vehicle needed to exist a highway, for example, preventing the need to force oneself into lanes, cut-off drivers, or miss an exit. Vehicles could travel in bumper-to-bumper platoons while automatically merging to accommodate oncoming traffic. Non-automated vehicles will not travel in this group, dangerous overtaking may occur.

The driver does not know the exact level of automation of the vehicle

Driverless vehicles can have multiple levels of automation. There are some that can follow the previous vehicle at the same speed, or one that can travel in its own lane. Advanced vehicles can overtake or reach a specific traffic destination. Unfortunately, in many cases, the driver is not well-informed, for example they do not know what their vehicle is capable of: it can lead to an accident if they are given control in a driving situation that the vehicle is unable to solve.

More info for today's (and yesterday's) drivers

The automated vehicle receives instant, regular information not only from its sensors in its immediate vicinity, but also from remote parts of the road network. A great challenge for the near future is for drivers of today's vehicles to have access to this information. An accident may occur if a networked automated vehicle slows down due to an expected accident or traffic situation that the surrounding drivers are unaware of and do not understand and cannot follow the manoeuvre of the automated vehicle.

7.3. Vehicle safety and automation in countries

Austria

In Austria, the so-called Decree on Automatic Driving was set in place in 2016, regulating three use cases for test purposes and under the auspices of trained test drivers: a) autonomous buses, b) motorway pilot with automatic lane change, c) self-driving army vehicles. In 2019, a recast was issued, now also including "normal drivers", using a) park assist, motorway assist with automatic lane keeping. Several documents are available that promote safety in the course of design, implementation and maintenance of automation technology:

- https://www.bmvit.gv.at/dam/jcr:c6bff4ce-45e0-48ae-b415-1afa08849874/automatisiert2019_ua.pdf
- https://fersi.org/wp-content/uploads/2019/02/180202-Safety-through-automation-final.pdf
- https://www.kfv.at/wp-content/uploads/2018/11/KFV_Code-of-Conduct_EN.pdf

Montenegro

There is no regulation for automatic vehicles in Montenegro.

Greece

Micro mobility on city streets has brought in important safety implications mainly for the vulnerable road users. New ITS technologies are expected to assist in more effective speed management. Until 2022 new safety technologies will become mandatory in European vehicles. In Greece, there is no legislator framework for autonomous vehicles yet.

Romania

There is no legislative regulation and there are no autonomous vehicles on the Romanian market yet. In this moment these type of vehicles are not travel in our country. There is still no trust in cars that drive alone because people consider them more dangerous than those driven by people. Even though the technology is advancing at a rapid pace and we must adapt, the authorities don't have enought trust about the degree of safety that such cars can offer.

Slovenia

The future of road vehicle automation brings many challenges that we are trying to predict now and overcome in the future. Especially in the early stages of automation there will be a huge need for introduction of the new technology to all road users, followed by finding a way for vehicles of different level of automation to coexist between themselves and with regular vehicles. Not to mention the ethical dilemmas that arise upon autonomous vehicles reactions in critical situations that are far from any conclusions. Lastly there will be a need for a standardised design between manufacturers for some elements in order to be able to share the same road and have safe interactions with other road users in day-to-day situations. Same goes for infrastructure, where needed.

- There is currently no regulation for autonomous vehicles in Slovenia.
- Autonomous vehicles can drive in Slovenia, if there is a driver driving them. Which makes them non-autonomous.

Bosnia and Herzegovina

There is no regulation for automatic vehicles in Bosnia and Herzegovina.

Because there are no any regulations, case studies or any tests done in our country, automatic vehicles can not travel in Bosnia and Herzegovina.

Bulgaria

There is no regulation for automatic vehicles in Bulgaria.

Croatia

Croatian roads Ltd plan to carry out a pilot project on automatic vehicles in order to evaluate actual impact of traffic signs and road equipment on automatic vehicles. There is no regulation for automatic vehicles in Croatia. There is no ban on automatic vehicles in Croatia, but in case of an accident driver is responsible for all actions regarding vehicle and driving.

Hungary

Regarding to vehicle safety and automation, Hungary has a test track (it is under construction) for autonomous vehicles at the city of Zalaegerszeg.

The Hungarian Government has implemented an update in the rules regarding the testing of autonomous vehicles in NFM regulation in 2017. The legislative reform introduced a new legal category named „autonomous vehicle for development purposes". A vehicle qualifies as an autonomous vehicle for developmental purposes if the vehicle serves the development of autonomous operation, and includes a test-driver who can manually intervene in the operation of the vehicle if necessary. The relevant decree also lays down a regulatory framework to categorize vehicles based on their level of autonomy on a scale between 0 and 5. The categorization follows the guideline of the SAE (Society of Automotive Engineers).

The new legislation introduces a registration requirement for vehicle manufacturers to conduct their testing operations, and the rules include several guarantees to ensure the safety of the testing operation, e.g. the testing of the vehicles' autonomous functions can only be performed on the pre-approved routes. Operational liability for the autonomous vehicle lies with the developer of the autonomous vehicle.

8. Speed management: review of literature

This chapter covers projects that deal with speed management or traffic calming measures.

Speed management: A road safety manual for decision-makers and practitioners [http://whqlibdoc.who.int/publications/2008/9782940395040_eng.pdf?ua=1]

The speed management practice manual jointly prepared by GRSP, WHO, the FIA Foundation and the World Bank, on speed management. Speed has been identified as a key risk factor in road traffic injuries, influencing both the risk of a road traffic crash as well as the severity of the injuries that result from crashes. This speed management manual proposes simple, effective and low-cost solutions to excessive and inappropriate speed that can be implemented on a national or local level. It targets governments, non-governmental organizations and road safety practitioners, particularly those in low- and middle-income countries. The manual is based on a modular structure that provides evidence, examples, case studies and practical steps on how to manage vehicle speed.

The manual essentially provides guidance on the following:

- The background evidence on why speed is a risk factor and why it is important to start a speed management programme;
- The steps needed to undertake a problem assessment in a country;
- How to plan and implement a programme, including setting up a working group, developing a plan, examples of laws and enforcement, how to develop public education and publicity campaigns; and finally
- How to evaluate the programme.
- The key principles and practical steps that this manual presents can easily be adapted and made relevant to different contexts around the world. The partners on this manual hope that this document will be used by policy-makers, decision-makers and other professionals to support the implementation of speed management programmes in different countries.

Speed Management Action Plan Template Problem Identification, Solutions, Implementation, Evaluation
[https://www.ite.org/pub/?id=00BF2C0A-F301-4D82-3008-827016F01F03]

Speed Management: A Manual for Local Rural Road Owners
[https://safety.fhwa.dot.gov/local_rural/training/fhwasa010413spmgmt/speedmanagementguide.pdf]

Speed Management Toolkit
[https://safety.fhwa.dot.gov/speedmgt/ref_mats/docs/speedmanagementtoolkit_final.pdf]

The Speed Management for Safety resource hub is an interactive website on speed management for all transportation professionals seeking to safely manage speeds. The Institute of Transportation Engineers developed this resource hub with funding from the Road to Zero Coalition, to provide transportation professionals with tools when considering the intricate factors in advancing effective speed management and road design. Creating a comprehensive speed management program can be an element of a successful Vision Zero plan toward eliminating roadway-related fatalities in the United States by 2050.

Transportation professionals understand the critical connection of vehicular speed to fatalities and serious injuries, but the factors in designing a road for safe speeds, mobility, and context is complex. With the use of roads evolving, speed management must take into consideration policy, road design, and enforcement to provide a safe environment for vehicles, freight, public transit, pedestrians, bicycles, and other modes.

This Speed Management for Safety resource hub provides a comprehensive overview of factors and resources available to transportation professionals when evaluating, designing, implementing, and enforcing safe speeds. The resource hub is not meant to be a stand-alone resource on all aspects of speed management, but instead is intended to expose all transportation professionals to speed management concepts and available resources.

FDOT Design Manual – Speed Management
[https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/roadway/fdm/2019/2019fdm202speedmgmt.pdf?sfvrsn=129ec9ff_4]

This manual describes strategies that may be used to achieve desired operating speeds across all context classifications. The strategies described in this chapter are national best practices for low speed facilities and are allowable on arterials and collectors when consistent with the context classification of the roadway.

The FDM recognizes a range of design speeds for each context classification. For very low speed conditions (35 mph or less) the context classification design speed range indicates the upper end of desirable operating speeds. For instance, the design speed range for C4 is 30-45 mph, but in conditions where on-street parking is present, a 35 mph or lower design speed should be used. Additionally, when the current design speed of a roadway exceeds the allowable range for the context classification or exceeds the target speed for conditions within the roadway, the strategies described in this chapter can be used to achieve a lower operating speed.

ASAP - Appropriate Speed Saves All People
[https://www.cedr.eu/strategic-plan-tasks/research/cedr-call-2012/call-2012-safety/asap-project-results/]

It is important that European road users are presented with consistent traffic control techniques, regardless of where they travel within Europe. Speed management of traffic through work zones is important for the safety of both the road user and road worker. A work zone will entail deviations from normal travel in a discrete road section and appropriate speed is needed to ensure that the driver can navigate the vehicle through the work zone routing, particularly if there are abrupt lateral deviations from road design norms. Without proper control of the vehicle, the driver may cause the vehicle to enter the restricted areas of the work zone. Infringement into these areas can cause injury to the car passengers or the road worker. Thus selection and control of traffic speeds in work zones are crucial components for road safety. A resource for best practice guidelines and financial implications of work zone speed control is not available in Europe. A common information source should be made available if European road users and road workers are to have the best level of safety, regardless of the country or region. The ASAP project - Appropriate Speed saves All People - was designed to address the issues of speed management in work zones.

The project runs from February 2013 to January 2015 with funding from the CEDR TRANSNATIONAL ROAD RESEARCH PROGRAMME Call 2012 - Safety: Safety of road workers and interaction with road users.

The main objective of the ASAP project is to gather knowledge on effective speed management measures through road works zones through literature review, information gathering from national expertise and practitioners, on-going research in Europe and abroad, and stakeholder consultations. The accumulated information will be documented to provide practical and readily understandable recommendations as to how to effectively manage speed through road works zones, in terms of

1. Engineering, design, and conspicuity of road works,
2. enforcement and
3. driver education/information,

with the aim of reducing risks to road workers without significantly increasing risks to road users.

Speed and crash risk
[https://www.itf-oecd.org/sites/default/files/docs/speed-crash-risk.pdf]

Inappropriate speed is responsible for 20 to 30% of all fatal road crashes. After reviewing the current knowledge on the relationship between speed and crash risk, this report analyses eleven cases from ten countries that have recently changed speed limits or introduced a large-scale automatic speed control. The analysis of International Transport Forum confirms the very strong relationship between speed and crash risk and that higher speed is associated with increased occurrence and severity of road crashes. (The International Transport Forum is an intergovernmental organisation with 59 member countries.)

Best practice for cost-effective road safety infrastructure investments
[https://www.cedr.eu/download/Publications/2008/e_Road_Safety_Investments_Report.pdf]

The EU target of reducing fatalities by 50% within a decade will only be achieved through the introduction of the most effective road safety measures, therefore, their economic appraisal is considered a very important tool in the hands of decision makers. The O7 Task Group of CEDR collected best practices to ensure cost - effectiveness on road safety investments has been initiated, as part of a broader Strategic Plan. This Report will also supplement the previous CEDR report titled "Most Effective Short-, Medium- and Long-Term Measures to Improve Safety on European Roads" (CEDR, 2006), by quantifying and subsequently classifying several infrastructure related road safety measures.

In this Synthesis, a complete list of 55 examined road safety investments is presented in an exhaustive literature review. These are classified according to the type of infrastructure they can be implemented (general, motorways, rural roads, junctions, urban areas). Out of these 55 investments, more than half can be applied on simple road sections, even more of them on bend sections and others can be applied on junctions. Additionally, more than half of the investments can be applied in more than one infrastructure element. This overall assessment allowed for the selection of the following five investments:

- roadside treatments (clear zones, safety barriers),
- speed limits,
- junctions layout (roundabout, realignment, staggering, channelization),
- traffic control at junctions (traffic signs, traffic signals),
- traffic calming schemes.

Speeding (SafetyNet)
[https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/specialist/knowledge/pdf/speeding.pdf
http://www.dacota-project.eu/Links/erso/safetynet/content/safetynet.html]

SafetyNet is an Integrated Project funded by DG-TREN of the European Commission. The objective of the project is to build the framework of a European Road Safety Observatory, which will be the primary focus for road safety data and knowledge, as specified in the Road Safety Action Plan 2003. The Observatory will support all aspects of road and vehicle safety policy development at European and national levels. It will make new proposals for common European approaches in several areas including exposure data and Safety Performance Indicators. It will extend the CARE database to incorporate the new EU Member States and will develop new fatal and in-depth accident causation databases. It will also develop new statistical methods that can be used to analyse combined macroscopic and other data. 22 institutes from 17 countries cooperate in the SafetyNet project. This project lasts for four and a half years and was completed in 2008.

9. Recommendations

Across the Danube region procedures for improving infrastructure safety are variable and often not very satisfactory. Economically effective and proven measures are often not implemented due to limited budgets. A standardised and systematic approach is highly recommended in the cause of improving road safety statistics to nearer or better than the EU average.

With the goal of reasonable money spending/investing in road safety and most effectively reducing fatal and serious injuries on roads, a proven fast implementing and relatively low cost-high benefit-cost rate countermeasure are available. There are many experiences from world's leading and top-performing countries, which may be used as a good-practice examples, adapted in implemented in the Danube region to contribute to safer road transport.

The suggestions received from each country are as follows:

Austria

There has been much discussion – and insight – at expert level for years that the current 100 k/h default speed limit on rural roads is detrimental to safety. It was suggested therefore by experts that a more flexible regulation could save many lives, e.g. a default limit of 80 kph that could be increased to 100 kph if a number of criteria were met. The idea has, however, not yet sparked much enthusiasm at political level.

New ideas and recommendations:

- Speed-activated warning signs (e.g. "Slow down" in the approach of bends);
- Variable speed limit signs on high-level roads (traffic and/or weather-dependent;
- Time-dependent speed limits, e.g. in the vicinity of schools during opening hours;
- Transversal rumble strips in the approach of junctions or sharp bends;
- Efficiency of administration of fines from automatic speed enforcement;
- Lack of resources among authorities tasked with the issuing of fines;
- Different degrees auf automation (centralised & nearly full automation in France. Inefficient manual ado in other countries …).

Montenegro

It is necessary to collect and analyse KPIs and, based on the results, define an action plan for implementing the necessary measures; Installation of speed cameras, analysis of vehicle speeds and implementation of appropriate measures (technical measures, definition of slow traffic zones, zone 30 ... preventive and repressive measures of the Police Administration)

Greece

Speed limits setting: revision of guidelines & systematic implementation.

Speed limits consistency: homogenous speed limits for similar road types must be defined, eliminating local speed limit reductions.

Speed enforcement: implementation of section control, minimization of the obstacles in violation, processing procedures.

Speed data collection: systematic collection of speed data development of anonymized speed data base, more detailed information by the Police, regarding speed violations.

Romania

As the vehicles number grow each year to increase the road infrastructure safety we need to built many more bypass roads for urban areas and highways.

For the existent network of national roads and highways we have a program to install more and more metallic guardrails and new jersey safety parapet on four lines roads.

We can say that a new approach to traffic safety has been started since 2000, when based on loans granted by the World Bank, the first pilot projects to eliminate dangerous points were implemented. Based on the conclusions and experience gained, together with the World Bank, new projects and new initiatives have resulted, which change the mentality and approach of road safety.

Since then, the development of the national program of priority actions for the safety of traffic in Romania has been made aware. The focus on results has gradually improved, culminating in the adoption of the National Road Safety Strategy for the period 2016 - 2020 at national government level, with medium and long term strategies regarding the road infrastructure, which aims to reduce the number of accidents by 50%.

CNAIR systematizes its internal policies and modernizes the procedures for planning investment projects and maintenance works that reflect safety recommendations, results from road safety checks, road safety audits, road safety impact assessment and road classifications, depending on the risk. for the production of an accident with victims.

Traffic technology helps solve problems that hinder this process. Beyond the design and construction of transport infrastructures, traffic engineering focuses on the functional aspects of the geometry of roads that make it circulate, including traffic signs, traffic signals, intersection management and road surface markings.

Slovenia

In order to increase the level of road infrastructure safety the first step is to direct more funds into maintenance of existing roads.

Regarding safe speed: Section control on highways and frequent speed control on other roads. Also change of legislation that would held the owner of the vehicle responsible for speeding regardless of the driver at the moment of offence.

An European study on the number of (fixed) speed cameras per km or km travelled or population or some other unit in order to compare the effect of the density on road safety (and speeds).

Bosnia and Herzegovina

First that needs to be done in Bosnia and Herzegovina is to create national speed database according to EU needs. We need to have better legal background and regulations. Also, many more case studies, tests and so on.

Croatia

A more unified approach on the same types of roads in Croatia regarding the application of traffic calming devices might result with better adoption of traffic rulers, and drivers awareness of the need for conscientious driving and compliance with traffic rules

Need for more systematical approach:

- evaluation of existing roads and drivers behavior (speeding);
- recommendations for improvement;
- replacement and/or implementation of better road equipment, or prove to be safer road design in the process of road construction.

Hungary

Task for the near future: data (speed, accident, road section typical data) analysis, more money for new roads and road maintenance, implementation of EU Directive.

RADAR project Thematic Area 3 (TA3): Intelligent Transportation System, speed management and traffic calming approaches

RECOMMENDATIONS SHEET

Recommendations for state governments/ministries/agencies:

- *To define – at least on long run - a national minimal standard for the safety of existing and new roads based on one of the internationally recognized methodologies. To elaborate guidelines for Intelligent Transportation System, speed management and traffic calming approaches;*
- *to ensure certain portion of road infrastructure investments is allocated to road safety intervention;*
- *to ensure embedding of the Safe System approach into the mainstream of road design/investment and maintenance legislation and practice;*
- *to ensure trainings of road safety auditors;*
- *to transfer Safe system approach to local governments and local road authorities;*
- *to take into serious consideration also 2nd level roads, like regional roads;*

- *make knowledge transfer with demonstrations of good practices and approaches for road authorities and to regional/local governments.*

Recommendations for local governments:

- *to start systematic road safety data collection and analysis to plan interventions/investments on most critical locations.*
- *New ideas and recommendations:*
    - *Speed-activated warning signs (e.g. “Slow down” in the approach of bends and other dangerous locations);*
    - *Variable speed limit signs on high-level roads (traffic and/or weather-dependent);*
    - *Time-dependent speed limits, e.g. in the vicinity of schools during opening hours;*
    - *Transversal rumble strips in the approach of junctions or sharp bends;*
    - *Efficiency of administration of fines from automatic speed enforcement;*
    - *Lack of resources among authorities tasked with the issuing of fines;*
    - *Different degrees of automation (centralized & nearly full automation in France. Inefficient manual processing in other countries …).*

Recommendations for road authorities:

- *Speed limits setting: elaboration and continuous revision of guidelines & systematic implementation;*
- *Speed limits consistency: differentiated speed limits depending on the function, alignment, volume and structure of traffic must be defined, in accordance with the reasonable local speed limits;*
- *Speed enforcement: implementation of section control, minimization of the obstacles in violation, processing procedures;*
- *Speed data collection and analysis: systematic collection of speed data development of anonymized speed database. Further development of the methodology of analysis (for example speed development by road types, etc.)*

Your Road Safety is on our RADAR.