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# O.T.2.1

# Danube Infrastructure Road Safety Improvement Strategy

**RADAR – Risk Assessment on Danube Area Roads**

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

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# Abbreviation list

| Version | Name and Company |
|---|---|
| AADT | Annual average daily traffic |
| DIRSIAP | Danube Infrastructure Road Safety Improvement Action Plans |
| DIRSIS | Danube Infrastructure Road Safety Improvement Strategy |
| EC | European Commission |
| ETSC | European Transport Safety Council |
| EU | European Union |
| iRAP | International Road Assessment Programm |
| ITS | Intelligent Transport Systems |
| MAIS | Maximum Abbreviated Injury Scale |
| NGO | Non-governmental Organization |
| PIARC | World Road Association |
| RADAR | Risk Assessment on Danube Area Roads |
| RISM | Road Infrastructure Safety Management Directive 2019/1396/EC |
| RSA | Road Safety Audit |
| RSI | Road Safety Inspection |
| RSIA | Road Safety Impact Assessment |
| RSEG | Road Safety Expert Group |
| SENSoR | South East Neighbourhood Safe Routes |
| SRIP | Safer Roads Investment Plan |
| TA | Thematic Area |
| UN | United Nations |
| VRU | Vulnerable road user |

# 1. Introduction – aim of the document

The RADAR (Risk Assessment on Danube Area Roads) project addresses the under-performing road safety performance in the Danube Region. The main objective is the improvement of the road infrastructure safety in the region, by raising capacity and enhancing transnational cooperation in the sector, for all road users, including vulnerable road users (VRUs), on the Danube major, secondary and tertiary road network. Specifically, RADAR aims to overcome lack of institutional capacity and in specific the capacity of technical personnel and engineers responsible for road safety in the Danube area. The wide geographical coverage of RADAR is designed to raise the standard of infrastructure safety across the network of the Danube region where those least advanced in road safety will learn from the best. RADAR provides a Strategy and Action Plan for road infrastructure investment and demonstrates what the benefits will be over the next 20 years.

This document, the Danube Infrastructure Road Safety Improvement Strategy (DIRSIS) as a main deliverable of the RADAR project provides a vision, objectives, and goals for road safety in the Danube Region on 6 Thematic Areas (TA) that RADAR is focusing on. Drafted together by RADAR partners as a result of the work done within the Road Safety Expert Group (RSEG), it includes the inputs from all participating countries, the knowledge acquired in the training and study visits and benefits from the results of the Pilot Actions.

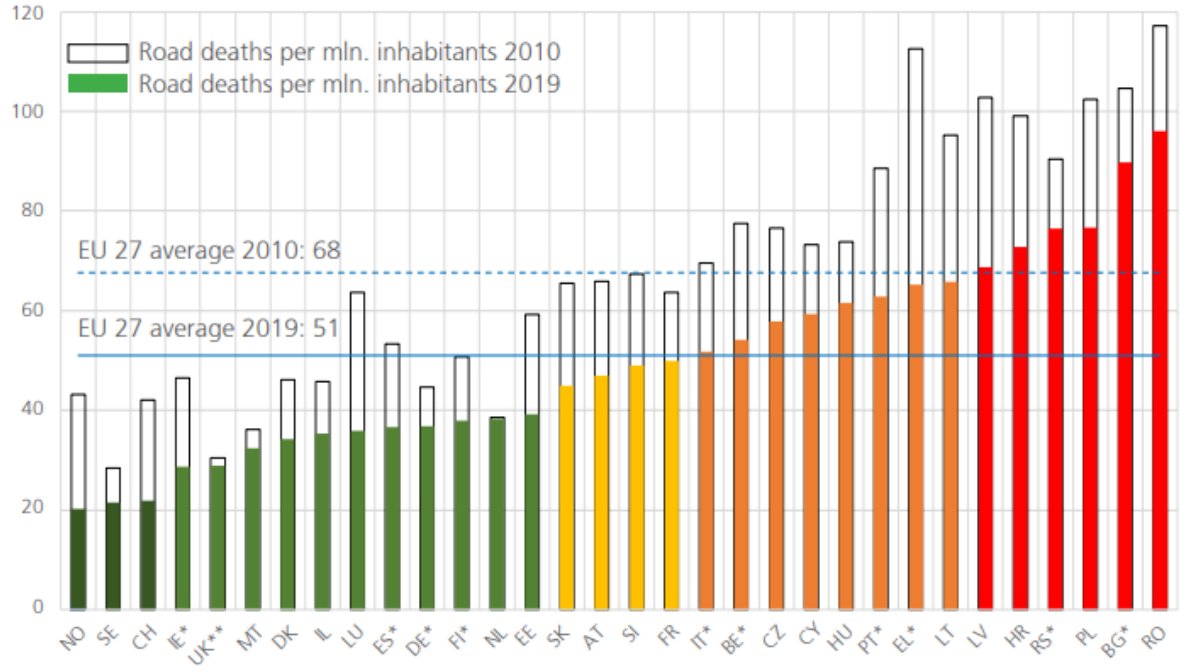
This Strategy aims for Policy Integration and better-coordinated intervention on road safety infrastructural solutions at a transnational level. Implementation of the Strategy, if complemented with higher knowledge and the common use of best practice methodologies and tools in the different countries will result in reduced deaths and serious injuries for vehicle occupants, motorcyclists, cyclists and pedestrians. It has been estimated that adoption of the approach set out by this Strategy has the potential to reduce severe casualties by around 25-40% on the roads where it is applied.

# 2. Assessment of the road safety situation

As a basis for the strategic objectives and recommendations for improvement, the current, general road safety data of the European Union (EU) and the Danube Region have been summarized and analysed, highlighting the need of further road safety related actions.

## 2.1. General road safety data of the EU

The road safety situation of the EU Member Countries is analysed by the European Transport Safety Council (ETSC) each year. Our first Figure shows the result of the evaluation related to the year 2019 (note that the road accident data of year 2020 is significantly distorted by the COVID-19 pandemic and therefore not recommended for drawing conclusions).




*National provisional estimates used for 2019, as final figures for 2019 were not yet available at the time of going to print.
**UK data for 2019 were the provisional total for Great Britain for the year ending June 2019 combined with the total for Northern Ireland for the calendar year 2019

*Figure 1 Mortality rate (killed/million inhabitants) in the European countries (present EU Member States, the United Kingdom, Norway, Switzerland, Israel, Serbia) (ETSC, 2020)*

ETSC uses the mortality rate in form (killed/ million inhabitants) which has to be taken into account during the comparison between EU Member States and countries in the Danube area. In the Figure not only the EU 27 averages for 2010 and 2019, but the mortality rates for 2010 and 2019 can be seen as well. With comparison of the two values (2010 and 2019) the development can be assessed too. Between 2010 and 2019 the average mortality rate in the 27 EU member states decreased from 68 to 51 killed/million inhabitants. In case of some European countries the development was not too high (MT, NL, HU, etc.), but in case of some other countries there was a great development (NO, CH, EL, etc.)

The ETSC defines the following categories for characterizing the mortality rate of the European countries.

*1. Table Categories for characterizing the mortality rate of European countries (ETSC, 2020)*

| Mortality rate (killed/million inhabitants): | Colour: |
|---|---|
| <22 | Dark green |
| 23-39 | Green |
| 40-50 | Yellow |
| 51-67 | Orange |
| >68 | Red |

The three leading countries are: Norway, Sweden and Switzerland. In Norway the mortality rate is 20 killed/million inhabitants. In 2019 the highest rate of mortality was in Romania and Bulgaria with 96 and 90 killed per million inhabitants respective.

The values of the countries in the Danube Region are unfavourable in comparison. Even the best performing countries, Austria and Slovenia (with 47 and 48.7 killed/million inhabitants) fall into the yellow category. The Czech Republic and Hungary with mortality rates 57.8 and 61.6 are in the orange group of countries. Croatia and Bulgaria with mortality rates of 73.2 and 90 are positioned in the last, red group of countries. Moldova – with its mortality rate (103.3 killed/million inhabitants) would be the last one in the comparison. This value is more than two times higher than the EU 27 average for 2019.

In chapter 2.2., the road safety situation of the partner countries of RADAR project is analysed in more details, but also this short evaluation clearly shows the necessity of the elaboration of an effective road safety strategy for the countries in the Danube Region.

In the most successful countries the „safe system" approach is used, which means that not only the infrastructure, but the vehicle fleet and the road users are very important factors in the accident prevention, they need comprehensive and coordinated measures. So the synergic effect can be strengthened.



## 2.2. General road safety data of the Danube Region

The number of road fatalities in the project partner countries has been summarized in Table 2, according to the 30-day definition. Considering the significant distortion effects of the COVID-19 pandemic on the travel behaviour and the road accident data of 2020, the 5-year period of 2015-2019 has been investigated.

*2. Table Number of road fatalities in the countries of project partners (30-day definition)*

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **AT** | 479 | 432 | 414 | 409 | 416 |
| **BA** | 341 | 321 | 298 | 277 | 261 |
| **BG** | 708 | 708 | 682 | 611 | 628 |
| **HR** | 348 | 307 | 331 | 317 | 297 |
| **CZ** | 735 | 611 | 577 | 656 | 618 |
| **HU** | 644 | 607 | 625 | 633 | 602 |
| **MD** | 300 | 311 | 302 | 274 | 277 |
| **SI** | 120 | 130 | 104 | 91 | 102 |

Figure 2 gives an overview about the change in the number of road fatalities in the partner countries of the project between 2015 and 2019.

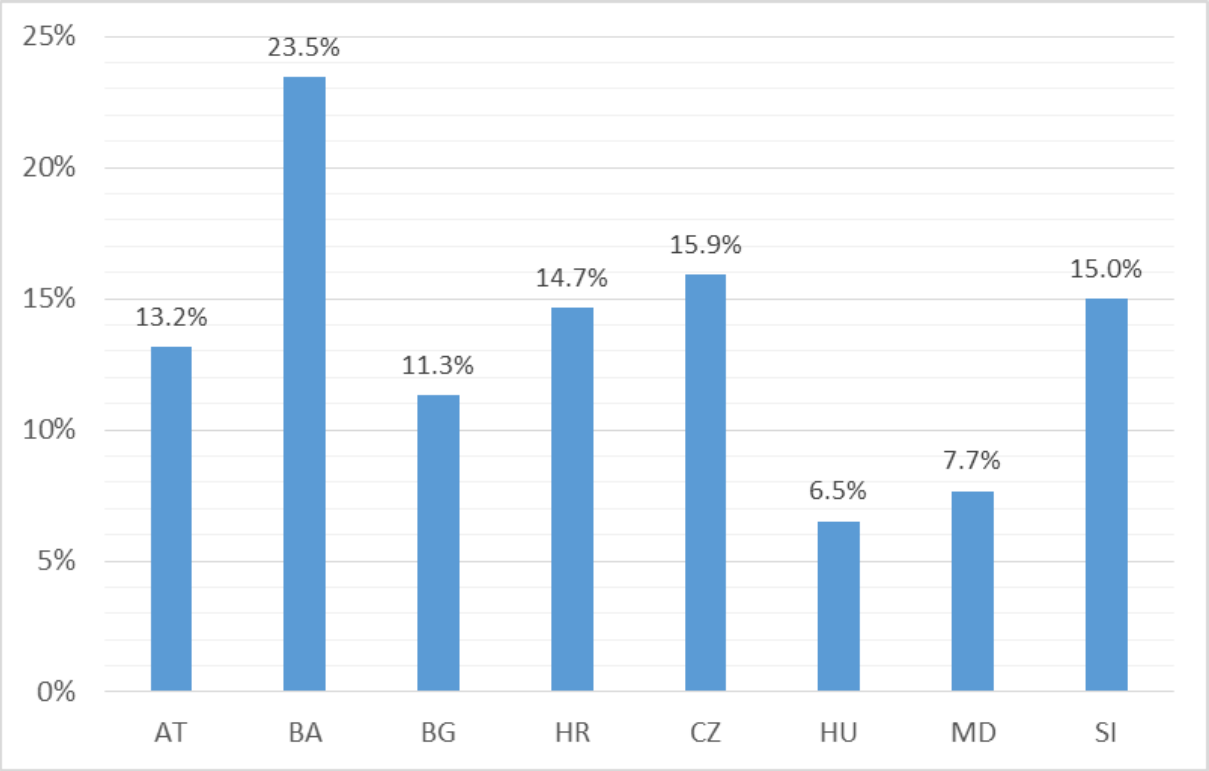



*Figure 2 Reduction in the number of road fatalities in the partner countries (2015-2019)*



The biggest (23.5 %) reduction could be experienced in Bosnia and Herzegovina, then in the Czech Republic (15.9 %) and Slovenia (15 %). The following countries are Croatia (14.7 %), Austria (13.2 %), Bulgaria (11.3 %), Moldova (7.7 %) and Hungary (6.5 %).

Although the numbers of serious and slight injuries have been collected from the project partners too, these data cannot be used for any comparison because the national definitions are entirely different. Only in case of fatalities can be spoken about a uniform, 30-day definition. Although there is already such an EU definition (MAIS3+) for the seriously injured persons as well, this is only used in some countries, mostly which are in leading position in the field of road safety. Out of the 8 partner countries only 3 have – at least estimated – MAIS3+ data (Folla, Yannis and Pérez, 2019). Under such circumstances only the number of fatalities can be used for any international comparison.

Unfortunately, the number of vehicle kilometres is not collected in most countries, or only available for certain road categories. The other two internationally accepted indicator of exposure are the number of inhabitants and the vehicle fleet. So, for international comparison, the so-called mortality rate (killed/100,000 or one million inhabitants), and the fatality rate (killed/10,000 motor vehicles) are available.

Mortality rate is the most commonly used indicator regarding the international literature. However, this indicator could be used without distortion only in case if all countries could have the same level of motorization (motor vehicles/1000 population). Since this is far not the case

in the reality, there is always some distortion if only this indicator is used. It is a well-known fact that the level of motorization has influence on the level of road safety.

*3. Table Level of motorization (motor vehicle/1000 inhabitants) in the partner countries*

| | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|
| **AT** | 762,5 | 764,8 | 771,9 | 781,6 | 789,8 |
| **BA** | n.a | n.a | n.a | n.a | n.a |
| **BG** | 548,8 | 548,9 | 528,7 | 488,7 | 494,1 |
| **HR** | 460,5 | 480,5 | 500,8 | 527,0 | 548,8 |
| **CZ** | 691,8 | 714,8 | 740,6 | 754,7 | 768,4 |
| **HU** | 394,3 | 409,2 | 429,9 | 451,8 | 473,3 |
| **MD** | 275,3 | 319,1 | 341,7 | 364,0 | 376,7 |
| **SI** | 720,7 | 740,8 | 773,6 | 792,4 | 805,3 |

The mortality rates of the partner countries are indicated in Figure 3 (for years 2015-2019, Bosnia and Herzegovina was excluded from this analysis due to the lack of population data).

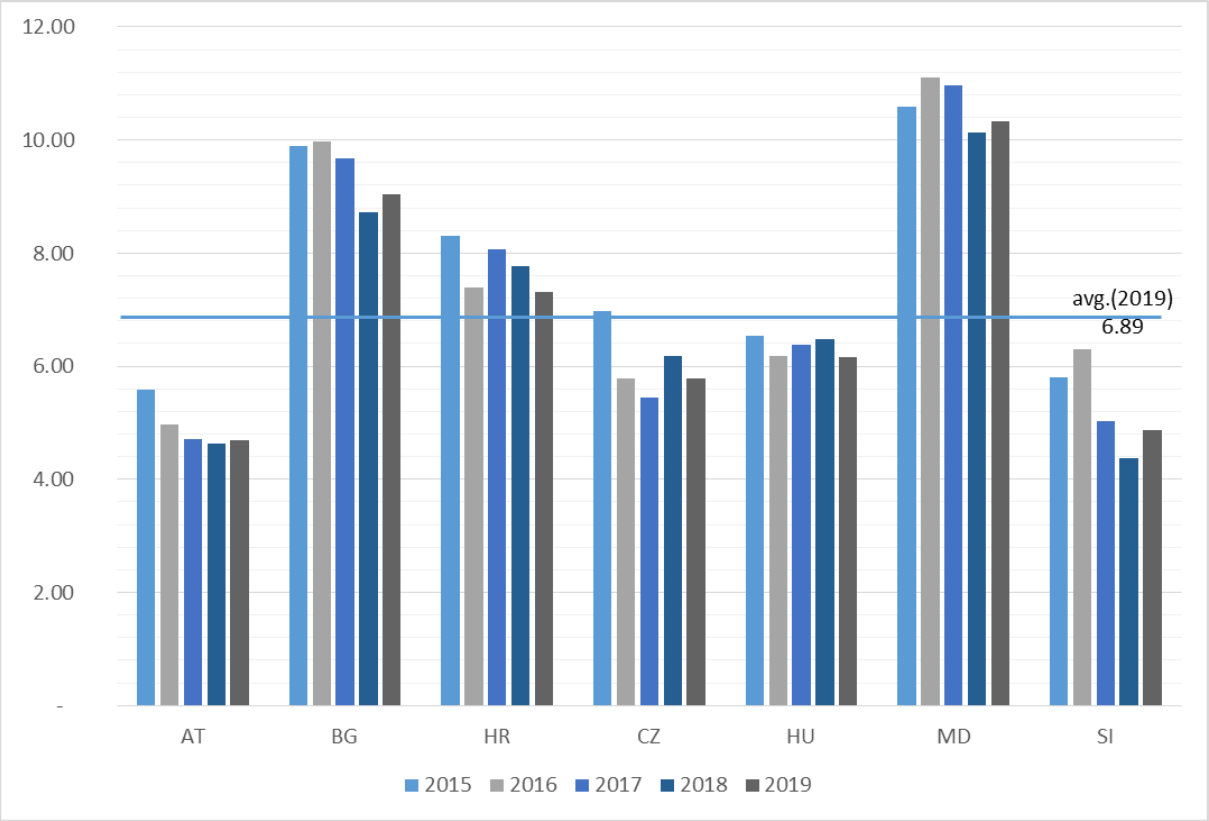



*Figure 3 Development of the mortality rates (killed/100,000 inhabitants) in the partner countries between 2015 and 2019*

The horizontal line marks the average mortality rate of the investigated countries (6.89 killed/100,000 inhabitants) in 2019.

It can be seen, that Moldova has the highest mortality rate (above 10 killed/100,000 population). The country characterized by the second higher mortality rate is Bulgaria, and the

third highest value can be seen in case of Croatia. These countries are above the 2019 average of the investigated partner countries. The other four countries (Austria, Slovenia, Czech Republic and Hungary) are below the 2019 average. The road safety ranking of the partner countries based on the mortality rate is:

1.Austria, 2. Slovenia, 3. Czech Republic, 4. Hungary, 5. Croatia, 6. Bulgaria, 7. Moldova.

The other possibility for ranking is the fatality rate (killed/10,000 motor vehicles). The development of these values can be seen in Figure 4.

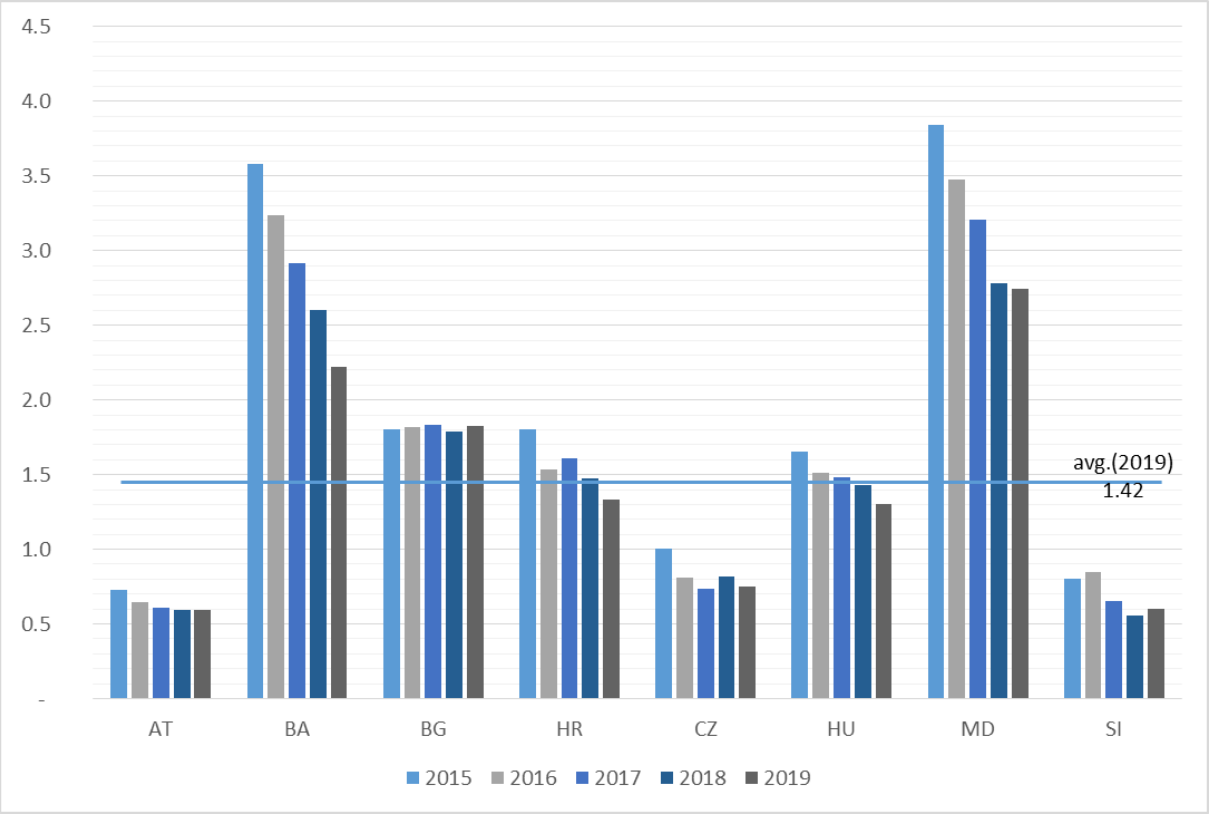



*Figure 4 Development of the fatality rates (killed/10,000 motor vehicles) in the partner countries between 2015 and 2019*

This ranking is already a bit different from those of Figure 3. The highest fatality rate can be experienced in Moldova too, but the decreasing trend can be seen clearly (in 2015 the fatality rate was almost 4 killed/10,000 motor vehicles, in 2019 its value was 2.74). The second highest fatality rate can be observed here in Bosnia and Herzegovina, but the improving trend is clear in this case too. The rate decreased from 3.6 (2015) to about 2.2 killed/10,000 motor vehicles. Besides these two countries, Bulgaria is also above the 2019 average.

The ranking of countries based on the fatality rate is the following:

1.Austria, 2. Slovenia, 3. Czech Republic, 4. Hungary, 5. Croatia, 6. Bulgaria, 7. Bosnia and Herzegovina, 8. Moldova.

The two different ranking methods point in the same direction, increasing the reliability of the results of the analysis. The Trinca model provides the possibility to combine the indicators of the

mortality and the fatality rates (Trinca, 1988). In Figure 5, the road safety situation of Danube countries can be observed based on the referred model (Bosnia and Herzegovina is excluded due to the lack of population data).

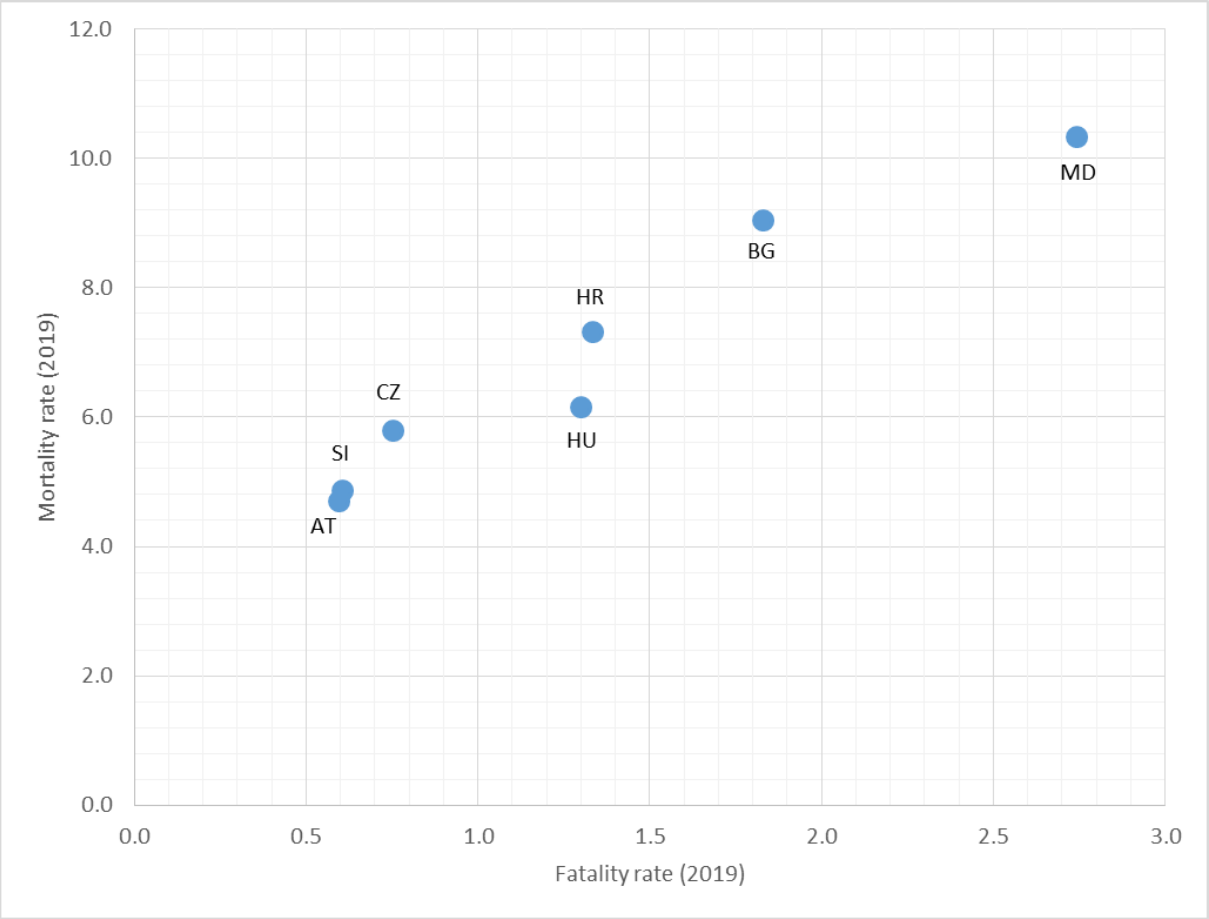



*Figure 5 Combined mortality and the fatality rates (2019) in the partner countries (Trinca model)*

This Figure can be considered the most detailed and most realistic ranking of partner countries. Here the distances between the points should be also taken into account.

The ranking is the following:

1. and 2. with very small difference: Austria and Slovenia,
3. closer to the leading two countries, than the 4. one: the Czech Republic,
4. closer to the 5. one (Croatia) than to the 3. one (Czech Republic): Hungary,
5.: Croatia (only the mortality rate is higher significantly than the Hungarian one, the fatality rate is almost identical with the Hungarian one,
6.: Bulgaria, well above the values of Hungary and Croatia
7. last one with great difference (distance): Moldova.

According to the results, Austria is the leading country among the partner countries. The obvious explanation is: high level of motorization, long term experience in theory and practice, long term high level independent research activities, good cooperation among stakeholders, with leading international organizations, etc.

# 3. Road safety targets of the EU

The European Union has already set out its' road safety policy framework for the years 2021-2030 (EC, 2019).

The document points out the achievements in road safety in Europe between 2001 and 2018, however it highlights that still many people lost their lives or injured seriously (approx. 25150 and 135000, respectively) on EU roads at 2018, which is an unacceptable and unnecessary price to pay for mobility.

The targets are formulated clearly in the document. It reaffirms the ambitious long-term goal to move close to zero road deaths by 2050. Based on the Valletta Declaration on road safety (Council of the EU, 2017), EU transport ministers set a target of reducing the number of road deaths by 50 % between 2020 and 2030, and for the first time, the reduction in the number of serious injuries (by 50 %) is also a defined goal (EC, 2019).

To be able to reach the defined aims, the following approaches are recommended (EC, 2019):

- the mind set of "Vision Zero" needs to take hold,
- the "Safe System" approach need to be implemented at EU level,
- new trends in safety related issues need to be handled.

RADAR project contributes to the strategic goals by all the implemented work in the project focusing on infrastructure safety of the Danube Region.



## *3.1. Assessment of the EU Road Safety Policy Orientations 2011-2020*

The quantitative target of the previous Policy Orientations 2011-2020 was 50 % decrease in the number of road fatalities. Figure 6 shows the development of the number of road fatalities between 2010 and 2020.

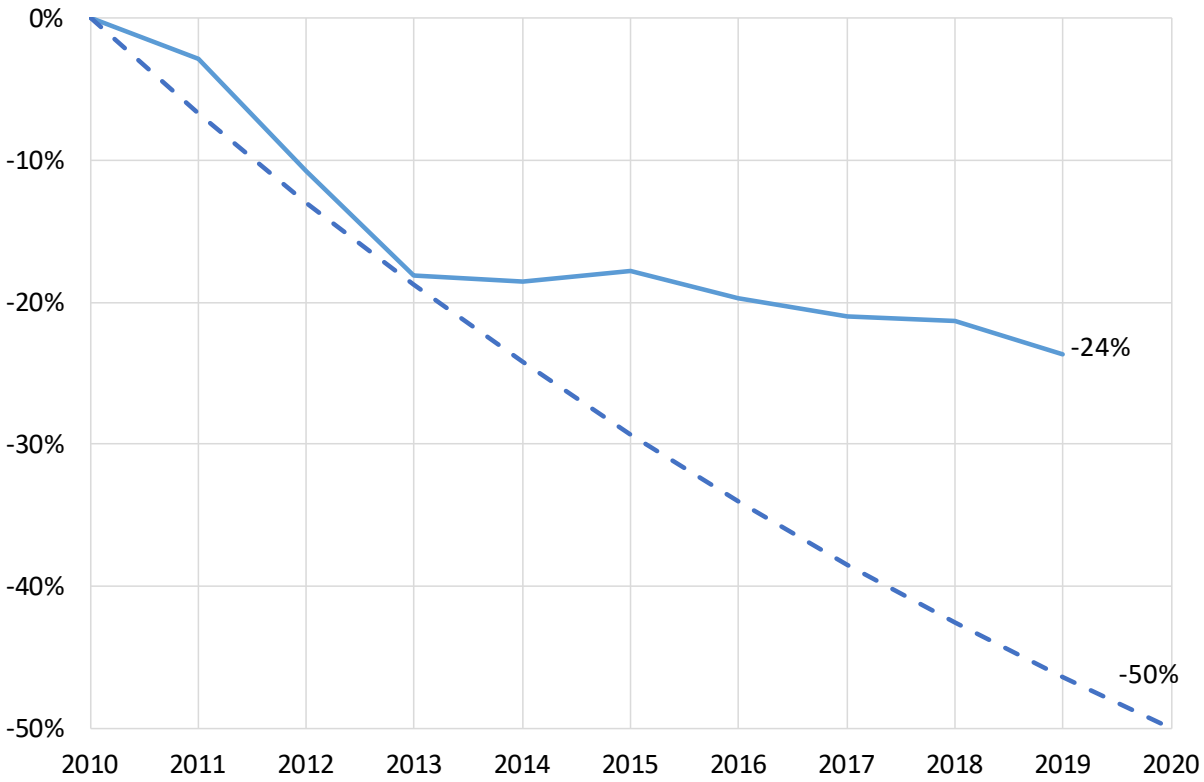



*Figure 6 Real and planned development of the number of road fatalities in the EU between 2010 and 2020 (continuous line: real numbers, dashed line: target)*



It can be said that the first EU road safety action programme (2001-2010) was very successful. The average number of the road fatalities decreased by more than 40 % within 10 years. Although it is less than the planned 50% but can be considered as a great success.

Based on the Figure 6, the 2011-2020 EU programme does not seem as successful as the first one. Until 2019 only 24 % decrease could be reached in the number of road fatalities. Even though the number decreased bigger in 2020 due to the lower traffic volumes because of the COVID-19 pandemic, the desired target was not met.

There are opinions saying the following: if 10 years are necessary to reach a 50 % reduction in the number of fatalities, 20 years will be necessary to reach the next 50 % reduction. This statement seems to be considerable especially based on the Figure 6: between 2010 and 2019 only 24 % decrease could be achieved. It is less than the half of the originally planned reduction.

It is suggested to strengthen the methodology of the target setting in order to get a target which is not only ambitious but realistic as well.

Related to the current EU targets (-50% in the number of road fatalities and -50% in the number of serious injuries in the decade), it has to be highlighted that in recent years (recent decades) the number of seriously injured persons decreased slower than the number of fatalities.

- According to the results of accident analysis, passive vehicle safety was more successful than the active one (in the number of fatalities there was a dramatic decrease). In other words: it seemed to be more successful to save lives than to avoid personal injury accidents.
- A part of people saved from death will be seriously injured.

All this means that the prerequisite of reaching the 50 % decrease in the number of deaths and serious injuries is the same efficiency of the active and passive road safety measures.

## 3.2. The safe system approach at EU level

The Safe System approach is the most effective way of considering and responding to fatal and serious casualty crash risks on a network. "According to the Safe System approach, death and serious injury in road collisions are not an inevitable price to be paid for mobility. 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" (EC, 2019). The PIARC Road Safety Manual (PIARC, 2020) formulates the following key messages in connection with the safe system approach:

- The approach is based on an ethical position (the so-called „zero vision") where it can never be acceptable that people are seriously injured or killed on the road network. It provides a set of design and operating principles to guide action on the journey to the long term elimination goal.
- The long-term Safe System goal is the elimination of death and serious injuries on a country's roads. (The difference between goal (target) and vision will be discussed later)
- The Safe System is being adopted by an increasing number of countries and forms the basis for the UN Decade of Action for Road Safety.
- The Safe System requires strong governmental leadership, as well as the engagement of a wide range of sectors.
- The prime responsibility of a road authority and other agencies is to support road users to reach the end of their trips safely.
- The Safe System is based on well-established safety principles — of known tolerance of the human body to crash forces, speed thresholds for managing crash impact energies to survivable levels, and the capacities of vehicles and forgiving and self-explaining infrastructure to reduce crash impact energy transfers to humans.
- A focus on key crash types occurring on a network helps to identify the role and intervention options for each Safe System element.
- System-wide intervention strategies are required to avoid fatal and serious injury crash outcomes, including emergency and medical care for crash victims.
- There is a shared responsibility between system designers (who design and operate the roads) and road users, for safe travel outcomes on the road network.
- The Safe System approach compels system designers to provide a safe environment, and to consider the combined system as the major factor in crashes rather than the traditional approach that placed most responsibility for safety on the road user.

- The system design and operation must become forgiving of routine human (road user) error.

The present EU road safety policy framework 2021-2030 includes the following main intervention areas:

- Infrastructure - safe roads and roadsides
- Safe vehicles
- Safe road use
- Fast and effective emergency response

Also, crucial horizontal issues related to all of these areas are enforcement and training. In the referred document, the planned steps of the Commission and key performance indicators are defined related to the intervention areas.

# 4. Strategic recommendations on the focus areas

As an integral part of the Safety System approach and one of the defined key intervention areas, RADAR project aims at infrastructure safety fostering infrastructure-based safety assessments of roads and bringing improved safety levels in the Danube region. **RADAR focused its activities on 6 thematic areas**:

- TA1: General suitability of the road sections for safety and maintenance upgrading using **Safer Roads Investment Plans;**
- TA2: Provision for **vulnerable road users** (pedestrians and cyclists);
- TA3: **ITS and** other techniques for **speed management** strategies;
- TA4: **Road safety near schools;**
- TA5: **Effects of the COVID-19** pandemic on the status of road safety;
- TA6: **Road Infrastructure Safety Management Directive** 2019/1396/EC (RISM) in Danube area.

Using information outlined in the Thematic Reports, the information collected during the study visits and Pilot Actions of the RADAR project, the next sub-chapters provide strategic recommendations at different levels, aiming to improve the road safety in the Danube area.

## *4.1. Investing in safe infrastructure*

TA1 is oriented into optimisation of using of limited road upgrade investment funds and road safety investment funds, by supporting most cost-benefit effective engineering solutions at the most appropriate locations / road sections.



Financial limitations are expected, which suggests that not all good, worthy or necessary projects will be able to receive funding. Hence, a method which would single out a high-priority programs and/or projects is a necessity. Furthermore, since quite a lot of possibilities for addressing a risk are available, it is essential to comprehend which of these possibilities offer highest safety cost-benefit ratio. Economic evaluations are a valuable tool for comparison, prioritization and selection of the interventions in the field of road safety and it can be a method of identification of measures which offer highest economic and social returns over a selected period of time.

Safer Roads Investment plans (SRIPs), based on relevant input data, such as road inspections or road surveys, road data coding and road assessment, provide a set of available and cost-effective proven countermeasures for improving infrastructure road safety, in terms of preventing potentially dangerous situations, prevention of road crashes and in event of road crash, reducing seriousness of injuries for accident participants.

SRIP is the concept, that was one of the outputs of the SENSoR project and is used in iRAP (International Road Assessment Programme) methodology, which foresees the selection of infrastructural countermeasures with a cost-benefit analysis, considering losses generated by fatal or serious injuries, to produce implementation-ready investment plans of high return measures.

Benefit-cost analysis of infrastructure projects is often calculated in the view of alternatives comparison and/or comparison of alternative(s) against “do nothing” scenario - usually basic user costs, in the field of infrastructure project typically over many years. Costs and benefits,

that are included in "classic" assessment, are construction costs and user costs, such as value of time, congestions and environment impacts, vehicle usage costs and similar.

Having added statistical value of life, costs of fatal and serious injuries saved or even costs of property damage accidents reduced, more comprehensive benefit-costs analysis is enabled. Even more, if upgrades of existing roads in operation are in question.

Across the Danube region procedures for improving infrastructure safety differs widely and are 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 field of improving road safety statistics to nearer or better than the EU average.

With the goal of reasonable and rational money spending/investing in road safety and most effectively reducing fatal and serious injuries on roads, an evidence based fast implementing and relatively low cost and highly cost-effective countermeasures are available. There are many experiences from world's leading and top-performing countries, which may be used as a good-practice examples that may be adapted and implemented in the Danube region to contribute to safer road traffic.

There are also roads with high seasonal variations in traffic volumes and traffic accidents, which should be taken into consideration when performing road safety data analysis.

Based on the work done related to TA1, the following strategic recommendations have been defined in RADAR project.



**Recommendations for state governments/ministries/agencies:**

- to define a national minimal standard for existing and new roads based on internationally recognized methodology for road infrastructure safety rating;
- 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.

**Recommendations for road authorities:**

- to form own special road safety funds within regular or investment funds dedicated for direct investments in road safety upgrades in terms of road safety equipment and measures at locations with most effectiveness;

- to follow the road safety trends and good practices to plan maintenance and upgrades of existing road network in operation;
- to use the methodologies for selecting most critical locations with highest potential savings;
- to ensure public accessibility to the list of high accident concentration road sections / hot spots.

## 4.2. Provision for vulnerable road users

The Thematic Report of RADAR project on TA2 gives an overview of the leading causes and the main types of fatal and serious road traffic accidents involving pedestrians and bicyclists and provides the information about existing methodologies which are currently used in the selected EU and Danube region countries for identifying the high-risk locations for vulnerable road users on the road network as well as for defining and implementing the appropriate countermeasures in order to reduce the number of pedestrian and bicyclist casualties across the observed road network.

The report also gives insight into key results and conclusions drawn from the relevant Case Studies and Projects, primarily related to the safety of vulnerable road users (pedestrians and bicycles), which were recently performed or are currently underway in the EU countries, gives the information about relevant EU legislative framework and defines the best ways for improving the road safety for pedestrians and bicyclists.



The information obtained based on the analysis of relevant methodologies, Studies and Projects are used to select the appropriate methodologies for assessing the road safety and define appropriate countermeasures for vulnerable road users. This can be used in order to provide the implementation-ready road layout concept plans and designs that will effectively reduce road risks for pedestrians and bicyclists on the Danube road network, enhancing higher knowledge and the common use of best practice methodologies and tools in the different countries, which will result in reduced deaths and serious injuries for all road users.

RADAR project aims to increase the road safety in the Danube region by contributing to the establishment of safer transport network which enables safe transport accessibility and mobility for all road traffic participants, both in urban and rural areas. One of the main goals of the RADAR project is to promote active mobility for all, making cities and human settlements inclusive, safe, resilient and sustainable, by improving road safety especially for vulnerable road users and consequently increasing the trips done on foot and by bicycle where before was not possible. In order to reach this goal, it is, among other things, necessary to tackle the problem of high rates of casualties among vulnerable road users, particularly on the regional and tertiary road network where high pedestrian and bicycle activity is present. This can be done by enhancing transnational cooperation and exchange of best practice among countries in the Danube region.

Results obtained in the relevant road safety assessment projects clearly show that risk of fatal and serious traffic accident occurrence is unacceptably high on a large part of Danube road network. The number of killed and seriously injured persons in road traffic accidents on the most of Danube region countries is significantly higher than the EU average. This is particularly true for vulnerable road users, which are on large parts of observed road network directly exposed

to motorised traffic due to the lack of adequate pedestrian and bicyclist infrastructure. For example, the results of the SENSoR project showed that 93% of the roads with speed limit of 40 km/h or more do not have footways, regardless of the fact that high pedestrian activity was observed along the road. It was also determined that 97% of roads where significant number of bicyclists was observed had no dedicated provision for cyclists. Besides that, many locations within Danube region do not have sufficient provision for pedestrians on their way to school. The provision for pedestrians and bicyclists is often of poor quality or absent. Many lives can be saved by implementing the appropriate countermeasures primarily on roads that pass through urban areas or villages where vehicles travel at high speed, but pedestrian/cyclist infrastructure is lacking or of poor quality or there is no appropriate segregation between motorised and non-motorised traffic.

High rates of casualties among vulnerable road users on Danube roads are mainly the result of the fact that most of the countries within Danube region lack professional capacity and knowledge in using appropriate road risk assessment methodologies in the process of defining, selecting, prioritizing and implementing the appropriate countermeasures on the critical parts of the road network. It is therefore necessary to transfer this knowledge to the responsible road safety organisations in the Danube area, so that they can identify and systematically reduce the risks on their road networks.

Based on the work done related to TA2, the following strategic recommendations have been defined in RADAR project, to ensure the maximum reductions in the number of vulnerable road users' fatalities and serious injuries in the countries of the Danube Area.

**Recommendations for state governments/ministries/agencies:**



- to incorporate the principles and concepts of Safe System approach in relevant legislation and VRUs countermeasures selection criteria;
- to develop/incorporate a unified protocol for assessment of the risks of VRUs, which will ensure that results are understood and comparable between countries;
- the countermeasures selection, prioritization and implementation process for VRUs should not in any case be performed only based on subjective criteria but primarily based on official, standardized, objective methodology which considers all relevant road safety indicators (AADT, peak-hour pedestrian/cyclist flows, operating speed, traffic accidents characteristics);
- to define a national minimal standard threshold values of relevant road safety indicators based on which high-risk road sections for VRUs will be identified;
- to ensure that available funds are primarily invested in low-cost, high-impact countermeasures, by considering the concepts of tactical urbanism and space-wise planning;
- to develop/restructure and link datasets on road traffic accidents and road network in order to increase their precision and provide free and easy access to all stakeholders;
- to link the police database on road traffic accidents with hospital data in order to minimize the VRUs accidents under-reporting issue;
- to change traffic culture and public awareness by disseminating relevant information to the public by various media sources;
- to make knowledge transfer with demonstrations of good practices and approaches for road authorities and to regional/local governments.

**Recommendations for local governments:**

- to ensure that results obtained by road safety assessments performed in individual municipalities at local level are standardized and comparable between different municipalities and on the National level;
- to start systematic, high-quality road safety data collection and analysis to plan interventions/investments on most critical locations.

**Recommendations for road authorities:**

- to use the official, standardized, objective methodology for selecting most critical locations for VRUs with highest potential savings;
- to ensure that types of pedestrian/cyclist facilities and crossing arrangements are selected based on the operating speed of traffic flow and pedestrian, cyclists and vehicle peak-hour flow volumes;
- to periodically collect relevant supporting data on characteristic locations on the road network on a mandatory basis and update relevant databases;
- to periodically perform analysis of effectiveness and efficiency of implemented countermeasures for VRUs;
- to engage all stakeholders in the process of the road design (engineers need to collaborate with different stakeholders and NGOs).

## *4.3. ITS and other techniques for speed management*



TA 3 of RADAR project focused on producing a roadmap for implementation of specific speed management techniques (such as average speed cameras). 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.

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).

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.

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, such as

- improving the design process;
- setting appropriate and consistent speed limits;
- applying speed management measures (e.g., speed display signs, traffic calming solutions);
- enforcing speed limits.

Based on the work done related to TA3, RADAR project put out the following strategic recommendations in the field of speed management.

**Recommendations for state governments/ministries/agencies:**

- 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;
- to exploit 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.

**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.).

## 4.4. Safe infrastructure near schools

Among vulnerable road users, there are some specific groups such as the elderly, the disabled and children that could be considered more vulnerable than others. These groups often have less resilience to falls or collisions, limited mobility and/ or reduced ability to understand the road environment and behave in a safe way when interacting with other, non-vulnerable, road users.

Especially for children, there are multiple risk factors that together lead to an increased risk for them in traffic, with either physical or behavioural nature. The traffic environment around schools attracts a high number of students daily and is quite complex for them. The analysis of the RADAR projects' survey indicates that the majority of the countries in the Danube Region do not collect data specifically on road crashes near schools and there are no specific guidelines for road infrastructure safety around them. However, there are some measures "traditionally" used near schools aiming to enhance road safety.



Road safety education is essential in today's world as road traffic is becoming more and more complex. There are many educational institutions organising road safety education programs and campaigns for improving students' road safety. However, in addition to the provision of road safety education to students, a safe and friendly road environment around schools is also essential.

Within the Thematic Report of RADAR project on TA4, several infrastructure engineering interventions that can potentially be implemented near schools in order to increase the safety level of road users and especially of children have been identified and discussed. Many interventions concern speed management and aim to ensure low speeds around schools. Moreover, other commonly used countermeasures concern the installation of warning signs, parking management around schools, safe design of pedestrian crosswalks etc.

Each case of road safety improvement around schools is unique and needs to be carefully considered by road safety and traffic management experts. As a first step, hazardous locations near schools and the causes of road safety problems should be identified. Undoubtedly, systematic collection of data on road crashes near schools and related casualties would contribute positively to the identification of the hazardous locations. Afterwards, intervention priorities should be defined and then the selected interventions should be implemented. Finally, studies based on "before and after" comparisons should be conducted in order to evaluate the road safety effect of implemented interventions.

Although road safety near schools is critical or children and young adolescents, the absence of special consideration is evident in the results of surveys of RADAR project. In all but one of the

responses no data on road accidents and related casualties near schools are collected, in more than half of the investigated Danube Area countries there are no specific guidelines for road infrastructure safety around schools, and in none of the responding countries does the Road Traffic Code suggest specific maximum speed limits around schools.

The collection and analysis of road safety data and key performance indicators on the road network around schools is an essential step to support and enhance road safety decision making and cost effective interventions. The assessment of international case studies on road infrastructure countermeasures around schools, as included in this report, can also assist in comparing intervention alternatives and help to highlight road safety best practices for safer roads around schools.

The main strategic recommendations of the RADAR project related to TA4 are the followings.

**Recommendations for state governments/ministries/agencies:**

- develop and support specific design guidelines for road sections in the vicinity of schools;
- define in the Road Traffic Code special speed limits to be applied on road sections in the vicinity of schools;
- ensure adequate funding for road safety interventions in primary roads in the vicinity of schools;
- start systematic collection of data on road crashes near schools and related casualties;
- systematically estimate and publish key performance indicators on the road network around schools;
- ensure embedding of the Safe System approach into the mainstream of road design/investment and maintenance legislation and practice;
- to transfer Safe system approach to local governments and local road authorities;
- support knowledge transfer with demonstrations of good practices and approaches towards road authorities and regional/ local governments.



**Recommendations for local governments:**

- ensure adequate funding for road safety interventions in local roads in the vicinity of schools;
- start systematic collection of data on road crashes near schools and related casualties;
- organize educational campaigns to promote safer transport to/ from schools.

**Recommendations for road authorities:**

- form own special road safety funds within regular or investment funds dedicated for direct investments in road safety, to implement upgrades in the vicinity of schools;
- follow the road safety trends and good practices to plan maintenance and upgrades of existing road network in the vicinity of schools;
- use appropriate methodologies to identify hazardous locations near schools and the causes of road safety problems, identify intervention priorities and implement countermeasures;
- conduct “before and after” studies to evaluate the road safety effect of implemented interventions.

## 4.5. Transport safety and COVID-19

The COVID-19 pandemic and the related measures to contain and reduce its spread in countries all over the world had extensive impact on many areas of our lives. Staying at home requirements, closures of educational institutions, non-essential businesses and events, working from home restrictions and travel bans are characterizing the period since March 2020 when the World Health Organization declared COVID-19 a world-wide pandemic. These measures together with social distancing, i.e., reducing interactions between individuals to slow down the spread of the virus, have led to a sharp decline in economic and social life and in some areas even to a complete standstill (de Vos, 2020).

The implementation of containment measures at the beginning or the first wave of the pandemic in March and April 2020, i.e., mostly very stringent lockdowns in many countries, and also the re-introduction of (parts of) these measures at the beginning of the following waves of the spread of the pandemic (e.g. autumn 2020 in Europe) also had traffic impacts and changed the number and types of out-of-home activities people performed, and how people reached these activities (Boroujeni, Saberian & Li, 2021; de Vos, 2020). Overall, traffic volumes and mobility activities have dropped, and this also had impacts on traffic safety, as with the reduction of traffic volumes exposure to road traffic accidents was reduced (Katrakazas et al., 2020, Yannis et al., 2020). However, effects of COVID-19 and the related containment measures have been varied in several countries: because of the reduction in traffic volumes, streets became less crowded, potentially increasing opportunities for speeding and stunt driving (Vingilis et al., 2020). In addition, as social distancing has also influenced travel mode choice, some transport modes – particularly individual means of transport – have been used to a greater extent (e.g. passenger cars) than others (e.g. public transport), which might also affect road safety (de Vos, 2020; Campisi et al., 2020, ITF, 2021). Moreover, the increased stress and anxiety brought about by the pandemic could affect driving behaviour and increase aggressive or risky driving and collision risk. Furthermore, an increase in alcohol sales and substance use has been observable during the pandemic in some countries, which might affect the prevalence of impaired drivers (Vingilis et al., 2020).



It can be assumed that some effects of COVID-19 and related containment measures are temporal and that travel demand will rise again when the measures are lifted – which will also have impacts on traffic safety (de Vos, 2020). However, some of the changes may be structural and long lasting, e.g., people might still fear social contact when travelling even after social distancing rules are no longer in force, which might affect activity participation and travel.

The development of road safety strategies in relation to the new reality of COVID-19 and considering the respective changes are needed and was also addressed in RADAR project. The main observations related to the impacts of COVID-19 on traffic safety (at least for some countries, based on the international literature) were the followings:

- the number of road crashes and fatalities as well as mobility, transport volumes and the number and distance of trips decreased; occasionally, an increase of shorter trips was noted.
- the number of injuries was reduced at similar rates as kilometres driven.
- the number of fatalities was reduced less than the reduction rate of kilometres driven (hence fatality risk increased); some countries even reported an increase of fatalities on rural roads.

- a comparatively higher share of vulnerable road user travel was noted on the urban and suburban system, and the number of cyclist (but usually not pedestrian) fatalities partly increased.
- after the first lockdown, the use of public transport did not recover as fast as other transport modes.
- the impact of the 2nd lockdown on mobility was less severe than the 1st.
- average driving speeds increased slightly – whereas the share of extensive speed violations increased more substantially.
- the share of inadequate speed as prime causal crash factor increased, especially for fatal crashes.
- the share of killed car occupants not using the seatbelt increased.
- for alcohol and distraction as primary crash causes, little change was noted.

These observations and other considerations led the project consortium to draw up the following strategic recommendations on TA5.

**Recommendations for state governments/ministries/agencies:**

- to review the default speed limit for rural roads and consider adaptations where necessary (possibly only on sub-sets of the network, e.g. roads with narrow cross-sections, or roads with vulnerable road user traffic), with a view to preventing collision forces that humans cannot survive or would cause serious injury;
- to take gradual steps to implement a Safe System, with emphasis on rural roads, so that they eventually become self-explaining and forgiving to human error;
- to provide police forces and other enforcement entities with adequate resources and legal precautions for re-instated & intensified and effective speed enforcement; this may include section (average speed) controls – also on rural roads;
- to consider tougher legal sanctions for excessive speed violations, such as higher/ income-dependent fines, licence withdrawal, and confiscation of vehicles;
- to encourage the use of seatbelts in passenger cars through awareness and enforcement measures.



**Recommendations for local governments:**

- to put high priority on enforcement and educational & awareness-raising activity to curb inappropriate speeds;
- to consider the implementation of local safe zones (30 km/h) around educational and medical institutions, area-wide 30 km/h limits in urban areas (potentially excluding major urban thoroughfares) and other traffic calming measures;
- to help making the increased usage levels of active mobility (walking, cycling) sustainable by providing them with safe facilities and an adequate share of road space;
- to set the necessary promotive steps to re-establish the modal share of public transport – by far the safest and most sustainable transport mode – at least to pre-pandemic levels.

**Recommendations for road authorities:**

- to establish an evidence base to prioritise infrastructure investments based on safety indicators: crash locations, traffic flows, speed levels, road infrastructure design & safety data;
- to make sure that for each road construction, reconstruction or maintenance project, the implementation of Safe System principles is considered.

## 4.6. Road infrastructure safety management

TA6 was focused on implementation of the EC Directive 2019/1936/EC Amendment in countries of the Danube Area Region. All of the Member States, with some states outside EU, successfully implemented the EC Directive 2008/96/EC and set up procedures throughout which RSIA, RSA and RSI are being performed on newly designed and existing road infrastructure. Since European Commission amended the mentioned directive, Member States need to amend respective national laws in order to include newly set requirements.

Some of the requirements set by the Directive include the extension of road safety inspections to the overall national main road network, whereas previously the safety inspections were mandated on TEN – T road network only. Member states are also obliged to define which roads represent the national main road network and need to deliver a list of roads to the Commission. Another aspect of the Directive is the increased focus on vulnerable road users during safety assessments. Results of the above mentioned safety inspections should also be delivered in a common format which would allow for comparison between states.

Analysis, recommendations and action plans related to the guidelines on the implementation of the amended Road Infrastructure Safety Management Directive has been conducted in RADAR project (see Thematic Report on TA6). 2019/1396/EC (RISM). This document serves as a support towards stakeholders and countries participating within RADAR project in their attempt to transpose and implement amended RISM Directive, as it holds relevant information regarding RISM directive and its' requirements, analysis of RISM Directive implementation status and achievements in the Danube Area, compatible network wide safety assessment analysis, common methodologies which are used, as well as data availability analysis. The assessment of requirements related to the implementation of the amended RISM directive is presented, and the document can be utilised as a pathfinder manual with recommendations which can be used by national, regional and local stakeholders in their processes to establish systems, mechanisms and methodologies to implement RISM directive during 2021 and 2022.



Related to the DIRSI Strategy, the following recommendations have been done related to TA6.

**Recommendations for state governments/ministries/agencies:**

- in the process of definition of Primary road network, national authorities should encourage including roads where at least 50% of fatal and serious accident s occur;
- country specific national classification criteria should be encouraged in order to enable proper classification of high, medium and low risk roads, based on accident reduction potential as a direct consequence of road infrastructure improvements;
- safe System concept should be built in in all road infrastructure related legal acts;
- special attention needs to be given to protecting the Vulnerable Road Users and promoting Active modes of Transport by developing dedicated road infrastructure;

- all investment plans in road infrastructure safety improvements should be made based on cost/benefit analysis with modelling of savings in terms of fatal and serious injuries prevented;
- raise the minimal road safety design standards for new and existing road infrastructure.

**Recommendations for local governments:**

- road safety audit and inspection procedures should be performed on regional road network based on crash occurrence analysis;
- special attention needs to be given to protecting the Vulnerable Road Users and promoting Active modes of Transport by developing dedicated road infrastructure in urban and suburban areas;
- promote and expand 30 km/h speed limit zones in residential areas.

**Recommendations for road authorities:**

- significantly increase weight of road safety priorities in investment and maintenance plans development;
- define clear strategy and action plan to reduce 50% of fatal and serious accident on managed road network by 2030;
- set internal guidelines above the minimal road safety standards.

# 5. Action plans

Complementing this document which is RADAR's core strategy (Danube Infrastructure Road Safety Improvement Strategy - DIRSIS) **country-specific Danube Infrastructure Road Safety Improvement Action Plans (DIRSIAP) have been elaborated.** The Action Plans were drafted by the partners individually, referring to the current situation of the countries.

For the preparation, a common template was used containing the above presented strategic recommendations. Each of the Action Plans follows the structure of RADAR's Thematic Areas and is tailored to the national, regional and local requirements as well as based on a thorough analysis of road safety problems (and potentials for solutions) of the specific Danube Area country. It describes road safety interventions to be implemented over the decade 2021-2030 and provides, for each measure, details on

- **time frame**: an estimate in which year(s) (during the decade 2021-2030) the uptake or implementation will take place. If activities are already ongoing, start and estimated end year are indicated. Activities which have already been finalised are not included;
- **financial resources**: an estimate of costs required for the intervention (in Euros);
- **main actors**: the ministries, authorities or other parties who will be mainly concerned with the given activity;
- **explanatory notes**: description and rationale/justification for the intervention in the specific country;
- **uptake plan**: a short list and description of national uptake activities and/or targeted national documents acknowledging the intervention.



All DIRSIAPs has been presented to – and discussed with – stakeholders in **National Uptake Workshops organised** in each RADAR partner country. The aim was to feed into, respectively be aligned with, the respective national road safety strategies of RADAR countries.

Due to space constraints, **Action Plans** were produced as separate documents but they are an **integral part of the present strategy**.

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