LABORATÓRIO NACIONAL
DE ENGENHARIA CIVIL

TECHNICAL AND SCIENTIFIC FOUNDATIONS FOR THE 2021-2030 ROAD SAFETY STRATEGY

Framework and potential interventions

REPORT 95/**2021 – DT/NPTS**
Revised version, July 2021

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Study for the Autoridade Nacional de Segurança Rodoviária

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The information and views set out in this report are those of the authors and do not necessarily reflect the official opinion of ANSR.

Title

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TECHNICAL AND SCIENTIFIC FOUNDATIONS FOR THE 2021-2030 ROAD SAFETY STRATEGY

Framework and potential interventions

Abstract

The Portuguese Road Safety Authority (*Autoridade Nacional de Segurança Rodoviária – ANSR*) is developing for the Portuguese Government the country's road safety strategy for the coming period of 2021-2030. The activity comprises three steps: Stage 1, laying out the guiding principles of the National Road Safety Strategy: Vision Zero 2030; Stage 2, consisting in the preparation of technical-scientific reports for the new strategy, including the diagnosis of the current situation and the identification of emerging challenges, the building up of the framework for the new strategy, and the development of a methodology for preparing biennial action plans; and Stage 3, laying out the strategic vision and establishing the Action Plan 2021-2022.

Within the scope of these activities, ANSR requested the National Laboratory for Civil Engineering (*Laboratório Nacional de Engenharia Civil – LNEC*) to provide scientific and technical support to the development of Stage 2, to be delivered jointly with Prof. Fred Wegman, from the Delft University of Technology. This report refers to the second activity of Stage 2. A summary review is made of the methods for defining strategic goals and setting operational targets, as well as a compilation of good practice road safety interventions and their effectiveness, obtained on bibliographic references. A method is proposed for building up the coming road safety strategy, which follows a management by objectives approach, with interim targets expressed by injury numbers and SPIs. It is proposed to consider in the predictions for the baseline scenario the average numbers of fatalities and MAIS3+ severe injuries for the three-year period 2017-2019, and a constant trend until 2030.

The interventions proposed by National stakeholders in their contributions are reviewed, in the light of the proposed method. It is proposed that scenarios for reducing the number of casualties take into account the differences in the traffic system due to prevailing land use features (rural and urban), with an overall emphasis on preventing speeding and drink-driving, addressing vulnerable road users (pedestrians, bicyclists and PTW) safety problems in urban areas and car and motorcycle users on rural roads. A discussion of potential benefits of intervention scenarios is provided.

Enabling institutional actions are recommended, regarding procedures for support monitoring the implementation of the strategy, which include improving the systematic collection of disaggregated exposure data, defining a set of interim targets for the key areas of the strategy, implementation of demonstration projects and setting up biennial stakeholder meetings for discussing progress.

Keywords: Road Safety / Strategy / Planning / Statistics

FUNDAMENTOS TÉCNICO-CIENTÍFICOS PARA A ESTRATÉGIA DE SEGURANÇA RODOVIÁRIA 2021-2030

Estrutura e potenciais intervenções

Resumo

A Autoridade Nacional de Segurança Rodoviária (ANSR) está a desenvolver para o Governo português a estratégia de segurança rodoviária do país para a próxima década de 2021-2030. A atividade compreende três etapas: Fase 1, na qual se estabelecem os princípios orientadores da Estratégia Nacional de Segurança Rodoviária: Visão Zero 2030; Fase 2, que consiste na preparação de relatórios técnico-científicos para apoio à preparação da nova estratégia, incluindo o diagnóstico da situação atual e a identificação dos desafios emergentes, a elaboração do quadro metodológico para a nova estratégia e o desenvolvimento de uma metodologia para a preparação de planos de ação bienais; e Fase 3, na qual se estabelecerá a visão estratégica e se elaborará o Plano de Ação 2021-2022.

No âmbito destas atividades, a ANSR solicitou ao Laboratório Nacional de Engenharia Civil (LNEC) que prestasse apoio científico e técnico ao desenvolvimento da Fase 2, a ser realizado conjuntamente com o Prof. Fred Wegman, da Universidade de Tecnologia de Delft. Este relatório refere-se à segunda atividade da Fase 2. Procede-se a uma revisão sumária dos métodos para definir objetivos estratégicos e estabelecer metas operacionais, bem como a uma compilação de boas práticas de intervenções de segurança rodoviária e sua eficácia, obtidas em referências bibliográficas. É proposto um método para a preparação da próxima estratégia de segurança rodoviária, consistindo numa abordagem de gestão por objetivos, com metas intermédias expressas em números de vítimas e indicadores de segurança (SPI). Propõe-se considerar nas previsões para o cenário de base os números médios de acidentes mortais e de feridos graves (MAIS3+) para o período de três anos 2017-2019 e uma evolução constante até 2030.

As intervenções propostas pelos *stakeholders* nacionais nas suas contribuições são revistas à luz do método proposto. Propõe-se que os cenários para reduzir o número de vítimas atendam às diferenças no sistema de tráfego originadas pelas características de uso do solo prevalecente (urbano e rural), com ênfase global na prevenção da velocidade excessiva e da condução sob o efeito do álcool, abordando os problemas de segurança dos utentes vulneráveis (peões, ciclistas e duas rodas) nas ruas urbanas e dos utentes de automóveis e motociclos nas estradas rurais. São debatidos os potenciais benefícios dos cenários de intervenção.

São propostas ações institucionais de apoio à monitorização da implementação da estratégia, que incluem a melhoria da recolha sistemática de dados de exposição desagregados, a definição de objetivos intermédios para as áreas-chave da estratégia, a realização de projetos de demonstração e o estabelecimento de reuniões bienais para debater o progresso.

Palavras-chave: Segurança rodoviária / Estratégia / Planeamento / Estatísticas

Executive summary

The Portuguese Road Safety Authority (*Autoridade Nacional de Segurança Rodoviária – ANSR*) is developing for the Portuguese Government the country's road safety strategy for the upcoming period 2021-2030. This achievement comprises three stages: Stage 1, laying out the guiding principles of the National Road Safety Strategy: Vision Zero 2030; Stage 2, preparing technical-scientific reports for the new strategy, including the diagnosis of the current situation and the identification of emerging challenges, the building up of the framework for the new strategy and the development of a methodology for preparing biennial action plans; Stage 3, laying out the strategic vision and establishing the first Action Plan 2021-2022.

This report addresses the second activity of Stage 2, building up the framework and proposing prospective key result areas for the new strategy, which was performed by LNEC and Prof. Fred Wegman, from the Delft University of Technology.

In this report a summary review is made of the methods for defining strategic goals and setting operational targets and a compilation of bibliographic references on the effectiveness of good practice road safety interventions. A method is proposed for building up the coming road safety strategy. In Chapter 3, a review is made of the interventions proposed in the contributions delivered by National stakeholders, in the light of the proposed method. Chapter 4 contains the framework and some scenarios for the next decade and a discussion of potential benefits of intervention scenarios. In the last chapter enabling institutional conditions are detailed and procedures are suggested to support monitoring the implementation of the strategy.

Recommendations were provided to address the main issues identified in the diagnosis (Cardoso *et al.*, 2021):

- The most detrimental factors to road safety performance in Portugal are found in urban areas, affect pedestrians and PTW users (mopeds and motorcycles), and relate to speeding and drink-driving;
- Road safety management in Portugal has been underfunded, running on low human resources, and lacking for the desirable support of safety indicators and key risk-exposure data;
- Ineffective stakeholder accountability to road safety commitments, and low vertical coordination with municipality intervention.

Coming challenges were also identified in the diagnosis, related to the aging population and to the impact of new technologies in driver distraction and behavioural change, and associated with new approaches to mobility, especially in urban areas.

1 – Operational targets consistent with road safety strategic goals may be set through a top-down approach, the desired mortality or morbidity numbers being established in an aspirational process for the build-up of the corresponding package of road safety interventions (OECD, 1994). Alternatively, in a bottom up approach, the design of a road safety strategy may be supported by an ex-ante

evaluation, i.e. modelling road safety past developments, and making predictions on the future trends of unchanged policies and forecasts on the anticipated effects of a designed collection of road safety interventions (Wegman and Hagenzieker, 2010).

The latter approach allows for a more realistic strategy design and provides a more sound basis for setting targets for evidence-based and data driven road safety programs. This has been the approach successfully followed by leading road safety countries, such as the Netherlands, Switzerland, the United Kingdom, Australia, Sweden and Norway. Their experiences demonstrate that it is possible to work with quantitative road safety targets, which allows to shape informed expectations concerning the total effect of a road safety program, builds the foundation for collecting good quality data, and enables a learning-by-doing development of high-level road safety management methodologies.

However, fulling embracing such a bottom-up approach would require disaggregated data on crash characteristics and exposure factors that do not yet exist in Portugal.

2 – Experiences showed that a simple target for the reduction of the number of fatalities ten years in advance does not provide sufficient guidance on the type of actions and the amount of effort required (Wegman *et al.*, 2013).

Monitoring road safety progress is best made when using both final outcome indicators (e.g. fatality and serious injury numbers or rates) and safety performance indicators (SPI), as mentioned by Wegman *et al.* (2008) and Bliss and Breen (2009), and discussed in Cardoso *et al.* (2021). SPIs are defined for specific domains of the traffic system as important means for analysing the production of crash casualties, such as seat belt and helmet use, driving speeds and prevalence of alcohol in driving.

Setting casualty and SPI related (interim) targets and monitoring progress in those indicators along the implementation of a road safety strategy supports the operational effectiveness and serves transparency and stakeholder accountability. The selected SPI's should have a satisfactory level of validity (correlation with the number of fatalities or serious injuries), be reliable (measurable consistently) and be measurable (technical and economic feasibility).

Road safety related data and statistics are essential for the success of this approach to road safety management, and it cannot be overemphasised how relevant good road safety data are (Wegman *et al.*, 2013). This includes, cost estimates (for comparing road crash socio-economic impacts with other health threats), exposure (to differentiate between the effects of changes in risk from modifications in traffic activity or composition), safety performance indicators (related to the objectives or the envisioned intervention results) and severe casualties (disaggregated fatalities and MAIS3+ severe injuries).

3 – The effectiveness of the Portuguese road safety strategy implementation in the upcoming ten years will be better achieved if an evidence-based and data-driven road safety management is fully embraced, similar to the approaches adopted by leading countries.

This entails full exploitation of the linkage potential between the police crash data register system and the health sector data, obtained in PENSE2020, and the availability of disaggregate data on severe

crash injuries (fatalities and MAIS3+), seemingly with good quality as regards both injury severity classification (medical source) and underreporting correction (Cardoso *et al.*, 2021). The EU approach in their European Road Safety Strategy, which intends to foster the use of key performance indicators for road safety (by means of the Baseline project, in which Portugal participates and is sponsored by the European Commission) is fully in line with this ambition, Portugal being supported in the collection and use of SPIs.

However, the approach described before suffers from some lack of and deficiencies in some road safety data, which prevent the full achievement of an effective road safety management by objectives or results.

Therefore, it is recommended that the upcoming road safety strategy includes actions at the institutional level and interventions at the operational level. The former, while being related to modifications in procedures and having impact on data collection, should enable actions for the intended approach, and should be designated as a priority for accomplishment in the first action plan, and selected for updating in succeeding action plans.

4 – The projection of the effects of a road safety plan can be attained by comparing the aggregated effect of its planned interventions together with a forecast of the baseline scenario.

In the baseline scenario it is assumed that the current safety policies are not changed, leading to the maintenance of present enforcement level and strictness, to the continuation of the existing campaign programme and to the prolongation of current (PENSE2020) interventions.

In the last decade two periods could be identified, in which changes in traffic casualties at the aggregate and also at the disaggregated levels varied substantially (Cardoso *et al.*, 2021): a decrease in fatalities in the first five years and stabilization in the second part of the decade. Existing macroscopic crash models are not suitable for reflecting these developments. Also, the high variability in annual travelled distance and numbers of fatalities and serious injuries does not fully support simply extrapolating from trends in the previous ten years. Finally, in 2020 the Covid pandemic has changed abruptly the human society functioning, and the development of corresponding socio-economic indicators, making it a unique year.

Having in mind these constraints, it is recommended to consider, for the predictions for the baseline scenarios, the average numbers of fatalities and MAIS3+ severe injuries for the three-year period 2017-2019. Furthermore, a constant trend until 2030 is recommended. However, based on the trend observed in 2010-2019, for PTW a yearly 7% increase in vehicle fleet is assumed, and for cycling it is suggested to take in consideration the National cycling plan target of increasing cycle share in transport from the current value of 1% to 7.5% by 2030. This may correspond to 100 PTW and 100 bicyclist additional fatalities, assuming the same fatality rates and no transfer from other modes.

As mentioned in the diagnosis (Cardoso *et al.*, 2021), there are few SPIs with continuous time series data available for recent periods (e.g., alcohol related fatalities and emergency services response times); however, for some candidate relevant SPIs spot-measurement results are available (e.g.,

speeds by road category, seat belt use and helmet use), which may be used as baseline values for predictions.

It is recommended that predictions concerning the effects of each selected intervention take into consideration the number of casualties in the targeted crashes, multiplied by the percentage of those that can be prevented by the intervention, and by the effectiveness of the intervention. Interventions with overlapping targeted crashes will have their percentage effects multiplied, to avoid double counting.

5 – Portugal is committed to the advance of several international road safety targets (ANSR, 2020). These include halving the number of fatalities and injuries by 50% (Decade of Action for Road Safety 2021-2030, launched by a 2020 UN Resolution), and reducing by 50% the number of fatalities and MAIS3+ serious injuries between 2020 and 2030, as set out by the EU transport policy, as an interim target, towards the 2050 target of zero road fatalities. It is recommended to adopt nationally those reductions.

In the case the average for the period 2017-2019 is adopted as reference, the corresponding target values would be:

- 317 fatalities;
- and 1108 MAIS3+ serious injuries.

Alternatively, if 2019 is adopted as the reference period, the corresponding target values would be:

- 313 fatalities;
- and 1044 MAIS3+ serious injuries.

Based on the target number of fatalities and the baseline estimate for 2030 (plus 100 PTW occupants and 100 bicyclists), 517 (or 513) fatalities should be prevented in that year.

As demonstrated in the scenarios presented in the report (for example, eliminating all drink-driving would merely reduce the number of fatalities by 33%), securing a 50% reduction in the number of fatalities and MAIS3+ severe injuries will require the implementation of an integrated set of numerous interventions, both at the national and the local levels. It is an ambitious endeavour, which is recommended further on to be made with a bold shifting to a data-driven and evidence-based road safety management – a novel approach. In the absence of disaggregated data on MAIS3 severe injuries, it is assumed that road safety interventions will affect equally the number of fatalities and severe injuries.

6 – Scenarios for reducing the number of fatalities by mitigating the impact of the negative factors identified in the diagnosis are presented, which take into account the differences in the traffic system due to the prevailing land use where the roadway is laid out:

- rural roads, belonging to the National Road Network (NRN) and to municipal networks;
- and urban areas, including cities, villages, and roads through small villages (these also from the NRN and municipal road networks).

Road crash indicators for these areas are considerably different: intersections in urban areas account for 30% of the crashes and 19% of the fatalities (both on streets and through roads); whilst in rural areas only 3% of the motorway fatalities occurred at interchanges, and only 9% of the single carriageway trunk road fatalities occurred at intersections.

For each of these geographical areas, strategically important interventions are identified in each of the main Safe System elements (safe roads, safe speeds, safe vehicles, safe road use; and post-crash care) as presented in Table 1.

Motorcyclists and car drivers are identified as the main focus of interventions on rural roads. In urban areas, interventions will mainly address the safety problems of pedestrians, PTW occupants (motorcycles and mopeds), bicyclists and car drivers.

Table 1 – Key areas for strategic road safety interventions

Geographical area	Injury reduction factor				
	Safe roads	**Safe speeds**	**Safe vehicles**	**Safe road use**	**Post-crash care**
Continent	High risk sites	Speed limits	Car occupants	Behaviour change programs Distraction Drugs Fatigue	Emergency service General
Rural roads	Car occupants Motorcyclists General	Car occupants Motorcyclists General	Car occupants Motorcyclists General	Car occupants Motorcyclists General	General
	Speeding	Speeding	Speeding Drink driving	Speeding Drink driving	
Urban areas	Pedestrians PTW (motorcycles/mopeds) Bicyclists	Pedestrians PTW Bicyclists	Pedestrians PTW Bicyclists	Pedestrians PTW Bicyclists	General
	Speeding	Speeding	Speeding Drink driving	Speeding Drink driving	

7 – Speeding and drink-driving (including pedestrians) are considered as critically undesirable road user behaviour, being the focus of behaviour change programs. Drug-driving – especially when in combination with alcohol and for PTW drivers – is a rising road user behaviour concern, alongside with distraction, an old problem compounded by mobile ICT; they are aspects that deserve to be further analysed and researched, to be addressed by behaviour change and other interventions.

As mentioned in the diagnosis, a quarter of the road fatalities in Portugal (25%) are related to alcohol, a percentage considerably higher than the 20% registered in the country the next highest percentage (Norway) in the period 2010-2018. Comparing the results from the most recent driver prevalence measurements (2013) and the percentage of driver fatalities with BAC above the legal limit (2010-2019), it is possible to infer that drivers with BAC above 1.20 g/l have a 100 more risk of being fatally injured than those under the legal limit. Suppressing heavy drink-driving in our roads (0.3% of drivers), for instance with alcohol interlocks, would diminish the number of driver fatalities by 24%.

Interventions to reduce travelling speeds in urban areas are likely to be at least as effective in reducing the frequency of casualty crashes as those aiming at reducing drivers' blood alcohol levels, as concluded in a study in Australia (McLean and Kloeden, 2002). Although the individual speed-risk curve was revised downwards by Elvik *et al.* (2019), Figure 1 shows that the relative risk of driving at 65 km/h (instead of 60 km/h) is similar to driving with a BAC of 0.5 g/l (instead of 0 g/l BAC), and the relative risk of driving at 75 km/h is only slightly lower than the one for driving with a BAC of 0.8 g/l.

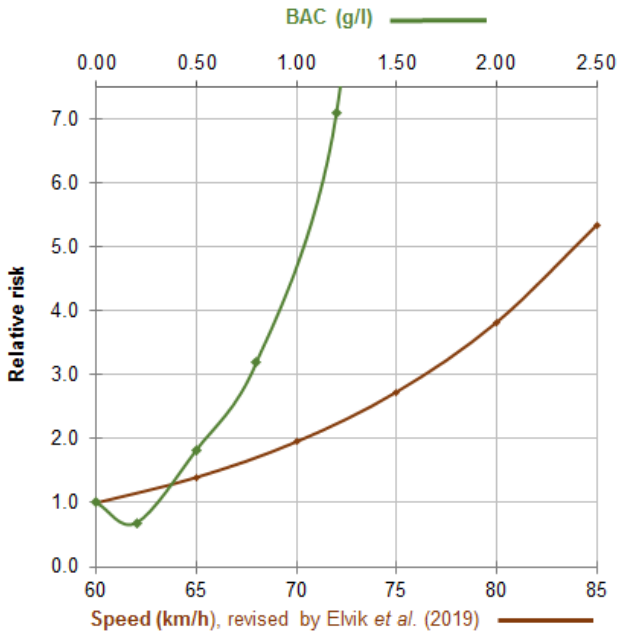

Figure 1 – Relative risk of involvement in an injury crash, by driver's blood alcohol level and choice of free travelling speed (adapted from Mclean and Kloeden, 2002, and Elvik *et al.*, 2019)

In Portugal, it is estimated that keeping the same rural road speed limit but reducing the current 30 km/h gap between light and serious violation by 5 km/h would entail a reduction of 20% in the number of fatalities on single carriageway rural roads (-32% for -10 km/h, and -40% fatalities for -15 km/h), assuming that only drivers in light violation would change speeds, and no driver behaviour adaptation (e.g. more distracted, at lower speeds) occurred.

In urban areas, the above mentioned intervention would produce just -12% fatalities for a -5 km/h in the current 20 km/h gap between light and serious violation in those areas. Experience shows that on streets a shifting of the whole speed distribution to lower values is needed, requiring more widespread interventions, for example the construction of area wide traffic calming provisions.

As a rule, the most effective way to tackle speeding is to apply "speed management", an integrated set of interventions at different levels, including legislation, infrastructure, enforcement, communication campaigns and ITS, such as ISA – intelligent speed adaptation (OECD, 2006 and EC, 2018).

8 – Due to the trend towards an increasing use of PTW, safety policies for reducing PTW users' risk need to be implemented, improving vehicle road worthiness (active safety devices and vehicle maintenance), driver behaviour (licence training and increased compliance with traffic rules, namely those on speeds and alcohol) and protection (e.g., use of additional protective equipment and raising awareness of PTW drivers and other drivers on perception limitations), and infrastructure characteristics (pavement surface evenness, road marking friction properties and roadside characteristics).

9 – It is expected that walking and cycling will take an increasing share in travel, especially in cities. Effective safety policies for reducing pedestrian and bicyclist's casualty numbers include providing separate paths in high speed (over 50 km/h) traffic corridors, deliver low traffic speed on the approach to safe pedestrian crossings, redesigning city road infrastructure for self-enforcing 50 km/h speed limits, and reducing motor vehicle traffic in 30 km/h and home zones. Policies for increasing bicyclists' protection (e.g., helmets, as research shows that over 66% of bicyclist fatalities involve head trauma), diminishing vehicle danger to vulnerable road users, and improving car driver, pedestrian and bicyclist behaviour, through increased compliance with traffic rules, are also within the scope of the Safe System approach.

10 – Several effective good practice interventions were identified in the literature, addressing elements of the Safe System, and categorized according to the Haddon matrix and the 4Es – engineering, education, enforcement and emergency response. They are briefly presented in Annex I, with the reported target crashes and their expected effectiveness. When available, results from meta-analysis were preferred to results from individual studies.

Selected PENSE2020 interventions are assumed to continue, as the baseline ('business as usual') scenario for the road safety strategy. Increasing effort in some of these interventions is also a potential type of intervention for the coming strategy; these are highlighted in Annex II.

In response to the invitation forwarded by ANSR to stakeholders, for their contribution, over 100 documents were received, with more than 400 proposals for interventions to be included in the road safety plan, addressing the strategic and operational levels and comprising actions to be delivered at the national and local level. Upon analysis and grouping of overlapping proposals, 136 interventions were retained for possible consideration, which are listed in Annex III.

The listed interventions were organized in order to provide a direct link to the key areas of strategic road safety improvement mentioned in Table 1.

11 – The effective implementation of a road safety plan depends heavily on the active contribution of all stakeholders, especially public institutions under central government ministries, the municipalities, the private sector and safety related NGO's.

As mentioned under 3, above, it is desirable that the new strategy incorporates not only road casualty targets but also a framework for implementation, providing stakeholders with objectives and interim targets, formulated in terms of SPIs, which can be used to manage and regularly monitor their road safety effort. A further agreement on a regular stakeholder meeting for presenting developments and discuss opportunities for improvements would provide momentum for close institutional cooperation.

This approach, applied in Sweden for example, requires enlarging the data collection effort (but is in line with coming requirements from the EC), and elicits modifications in procedures and stronger institutional commitments, in view of a more transparent and accountable delivery of the road safety strategy by relevant stakeholders.

Defining the list of required exposure data and of the safety performance indicators for each major key area of intervention in the strategy will be one of the first tasks for the first Action Plan, as regular and systematic collection of these data is an indispensable enabling condition for the implementation of this approach. Seemingly, travelled distance disaggregated per road user category and land use (urban or rural) will be needed. Candidate SPIs include prevalence of speed and BAC limits compliance, of seat belt and helmet use by road user category, of traffic rules compliance by motorcyclists and vulnerable road users, the share of traffic with forgiving roadside rural road rating, the share of well-maintained bicycle paths, the percentage of 30 km/h Zone streets complying with corresponding design standard (Vieira Gomes *et al*., 2020a and 2020c), and the fraction of shared-vehicle provider and public transport operator qualified according to ISO 39001 (e.g., for collecting accident and exposure data and for work-related safety).

Agreements will need to be reached, regarding the methodologies and responsibilities for collecting these data regularly and consistently, as well as for sharing the obtained results.

As expected, in this approach each Action Plan will also include the set of activities to perform at the intervention level within its time frame.

Further interventions at the institutional level would provide assistance to the implementation of the road safety strategy, namely a program for disseminating the Safe System principles and current approaches for their practical delivery among professionals and intermediate level decision makers; and the preparation of a road map for nationally relevant research questions on road safety. These could include developing a method for collecting disaggregated actionable MAIS3+ data, improving knowledge on relations between speed and fatal/MAIS3+ injuries on main Portuguese road categories, in-depth investigation of selected road user crashes, or developing new exposure indicators for vulnerable and micro mobility road users.

An important contribution to increased takeover of road safety interventions at the local (municipality) level could be the implementation of demonstration projects of good practice interventions not yet recognized as such or addressing sensitive issues (e.g. speed management at city level or the rehabilitation of a city neighbourhood complying with the urban street design standards, namely regarding 30 km/h Zones).

12 – It is expected that the described elements may combine into a framework to successfully address the most pressing road safety problems in the Country (through a data driven and knowledge based process), contributing to mitigate some past implementation problems, and to foster stronger horizontal institutional cooperation, as well as vertical coordination between national and local road safety policies. It is also expected that coordination activities will be more effective and efficient.

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1 | Introduction

The current development of the Portuguese road safety strategy 2021-2030 by the Portuguese Road Safety Authority (ANSR) comprises three steps: Stage 1, laying out the guiding principles of the National Road Safety Strategy (Vision Zero 2030); Stage 2, preparing “technical-scientific" reports for the new strategy, including the diagnosis of the current situation and the identification of emerging challenges, the building up of the framework for the new strategy, and the development of a methodology for preparing biennial action plans; and Stage 3, laying out the strategic vision and establishing the Action Plan 2021-2022.

Within the scope of these activities, ANSR requested LNEC to provide scientific and technical support to the development of Stage 2, to be delivered jointly with Prof Fred Wegman, from the Delft University of Technology.

As mentioned, Stage 2 consists of three activities:

- The assessment of the current road safety situation, providing a clear view of the most relevant safety issues in Portugal, the status of Safe System principles in the existing road traffic, as well as a discussion of future aspects, that will most likely need to be addressed in the upcoming decade.
- The establishment of the founding principles framing the advance of road safety policies for the next ten years and of the scientific guidelines for the development of the new road safety strategy, including an overview of good practice in strategic goal and operational target setting and of cost-effective Safe System interventions, as well as the proposal of prospective key result areas for 2021-2030 and viable enabling road safety interventions.
- The development of a methodology for the implementation of the envisioned biennial action plans according to the ‘Plan-Do-Check-Act’ framework, including the procedures for their development, budgeting approval and execution monitoring. A pilot measure demonstration is also envisaged.

This report addresses the second activity of Stage 2.

Following a summary review of the methods for defining strategic goals and setting operational targets (Chapter 2), a review is made of the most relevant sources of information on the effectiveness of road safety interventions and their content, and the proposed method for *VisãoZero2030* is presented. In Chapter 3, a review is made on the interventions proposed in the contributions obtained from the public and private stakeholders as well as Non-Executive Experts Board members, of which the identified problems were presented in the previous report. Chapter 4 contains a presentation of elements for building the therapy for the next decade and an assessment of their potential benefits, and in Chapter 5 a list is provided of recommended supporting measures to monitor the implementation of the strategy, which include interim targets formulated in terms of SPIs and casualty numbers, to be delivered to the stakeholders.

2 | Methods for definition of strategic goals and operational targets

2.1 Background

Strategic targets consistent with road safety strategic goals may be set through a top-down approach where the desired mortality or morbidity numbers are established in an aspirational process, firmly constraining the build-up of the corresponding package of road safety interventions. According to OECD (1994), a target selected in this way must be attractive, to be adopted by politicians and legitimise the policy process (manpower, funds, etc.) for the measures to be taken, and it is hoped that a sufficiently effective combinations of interventions will be available for that purpose.

Alternatively, in a bottom-up approach the design of a road safety strategy may be supported by an ex-ante evaluation, i.e. modelling road safety developments and making predictions of the anticipated effects of a designed collection of road safety interventions (Wegman and Hagenzieker, 2010).The latter approach allows for a more realistic strategy design, providing as well a sounder basis for setting targets.

Developments in road traffic safety, as expressed by the number of fatalities and seriously injured are subject to the influence of several factors (Fridstrom *et al.* , 1995, Fridstrom, 1999):

1. Road safety interventions, which are actions designed to target consciously chosen safety performance improvement objectives within the road transport system (Wilpert and Fahlbruch, 2002). These may address roads, vehicles, regulations and law-making, education for road users, enforcement and their interactions, as well as post-crash activities.
2. The transportation sector and its policies, which are not directly addressing traffic safety problems but influence these outcomes. These factors include, but are not limited to, transport infrastructure investment, public transportation, modal choice incentives, fuel and vehicle taxes, size and typology of vehicle fleets, and drivers' license distribution.
3. Factors external to the transport system that affect its functioning. These include autonomous factors, which cannot be influenced by a single government in the medium to long term, such as weather variations, state of technology and population structure. They also include general socio-economic factors that are a consequence of national policies not included in transportation policies, for example industrial development, employment, public education, and taxation.
4. The crash data collection system. Available statistics on crashes depend on the reporting procedures applied at each moment; modifications in these routines produce changes in crash and casualties counts and underreporting that may be misleading, if not properly accounted for.

5. Random variation. It is firmly established that crash counts for a given traffic system element have a systematic component; however, due to the involuntary nature of crashes and to the statistical rarity of their occurrence, crash and casualty counts are strongly influenced by randomness. The impact of this factor is especially important for elements with low numbers of reported crashes, meaning that randomness becomes more prominent for higher levels of disaggregated analysis and grows in importance as safety levels improve.

Theoretically, modelling road safety developments for producing quantitative assessments would involve taking into account all these factors, a task that is not always possible due to lack of data and therefore requires simplifications and careful consideration of the limitations dictated by the base assumptions and the applicability boundaries of the adopted mathematical tools.

Hauer (2010) distinguishes between Prediction, Forecast, and Estimate. The former relates to a state of the world that does not exist. It pertains to the intervention ('potential outcomes') or to the counterfactuals rang of the ladder of causation as described by Pearl and Mackenzie (2018), and is related to questions like 'what if I do?' or 'what if I had done?' A forecast corresponds to a prediction on a subject that turned out to be realized; its quality may be assessed by comparison with what happened in reality. On the other hand, estimates are related to events that occurred in the past, and they are based on historic data about crash and crash related factors– like forecasts, their quality may be assessed, as well.

Safety predictions are used for evaluating basic (zero intervention) scenarios needed for estimating the effect of an implemented intervention or the potential effect of a planned policy (Hauer, 2010). In both cases, reality (past in the former case – an estimate – and future in the latter – i.e. a forecast) will be compared with a hypothetical scenario in which no intervention took (or will take) place. Several methods have been used for considering the mentioned factors in safety predictions, either implicitly (e.g., extrapolations with and without comparison groups) or in attempts to represent causal relations between the safety outcome developments and the changes in explanatory factors (e.g., structural models), as described in detail in a Cost Action report (EU, 2004).

Prediction by extrapolation assumes that causal factors will change with time in such a way that the future is a smooth continuation of past trends (Hauer, 2010); when it is made by comparison groups, it is assumed that the effects in time of those factors not explicitly considered will be similar in the comparison group as in the analysed traffic system element.

Since knowledge about the relations between the expected long term crash frequency and causal factors is not complete, no data on all major crash causal factors exist, and some extrapolation still has to be done in complex statistical models, it is not clear if these models produce better predictions than those based on extrapolations of time trends. This is especially true in those cases when there are no quality data on explanatory variables representing key causal factors.

Despite this cautionary background, with preparative research and appropriate data, it is possible to develop predictions on the future trends of unchanged policies and forecasts for the effects of safety

intervention programmes, as demonstrated by Wesemann *et al.* (2010) in The Netherlands, Siegrist (2010) in Switzerland, Broughton and Knowles (2010) in the United Kingdom and in Western Australia (Corben *et al*., 2010). Stipdonk *et al.* (2010) further indicates two main advantages of using stratified data in predicting safety developments: differences in expected mobility between groups and dissimilarities in casualty rates trends can be considered.

A Dutch outlook (Wesemann *et al*., 2010) involved the prediction of casualty rates and the exposure level in 2010 and 2020 for a baseline scenario of unchanged safety policy; and the production of forecasts for the target year, assuming a new mobility measure (road pricing) and the effects of proposed five new safety measures. Casualties were stratified by conflict type (seven types of conflict), road category (six categories) combined with conflict type (three types of conflicts), and by age group (four age groups); these stratifications being the result of both their relevance in risk production and their availability. Distance travelled and demographic data were used as measures of exposure. Three risk scenarios were analysed, corresponding to separate functional forms for the casualty rates time trends used for extrapolation. The effects of each individual intervention were calculated independently. Then, the effects of those interventions that directed at common target crashes were multiplied, in order to calculate their combined effect. This corresponds to Elvik's *method of common residuals*, in which the interventions are assumed to be independent and not having interaction (Elvik, 2008 and 2009).

In the UK, within the development of a numerical target for casualty reduction, Broughton and Knowles (2010) applied stratified log linear regression models with intervention to the annual numbers of fatalities, killed and seriously injured (KSI), injured (any severity), and the number of road accidents involving human injury. The method for casualty prediction involved examining a range of transport scenarios and had two components: forecasts of traffic growth and predictions of casualty rates, which were prepared independently. Since road safety interventions usually affect differently each road user group, five road user categories were considered: car occupants, motorcyclists, bicyclists, pedestrians and all other road users. The modelling process also allowed to consider separately the effect on casualty predictions of three scenarios: the core safety interventions; a group of three significant interventions (reducing towards drink/driving, improving road infrastructure and improving vehicle crashworthiness); and new interventions, including both a substantial expansion of existing ones, and novel interventions.

According to Siegrist (2010) the preparation of a road safety plan entails the answers to a set of three questions, related respectively to the individual effectiveness of each intervention, to the pooled effect of the selected combination of interventions, and to the return on the corresponding investments for the national economy. Results from case studies reported by Wegman *et al.* (2013) show that socio-economic costs do not seem to play a prominent role when designing a road safety strategy, but may be relevant for decision makers, when comparing road safety with other public policies.

The method used in Switzerland for predicting the combined effect of several interventions included in the *Via sicura* safety programme involved three steps:

1. a theoretical average effect was estimated for each potential intervention, over the programme duration;
2. a downward adjustment was introduced, to account for overlapping measures (e.g. due to two or more interventions affecting the same type of crashes);
3. an upward correction was applied, due to perceived synergies created by some measures.

When determining the individual relevance of a safety intervention to the safety program, five main aspects were considered, using the following equation (Siegrist, 2010):

$$Actual\ Potential\ Reduction = A \times B \times C \times D \times E \quad (1)$$

Where:

A – Potential number of casualties that may be impacted by the intervention, which can be associated with some broad type of target crash;
B – Percentage of target crash related casualties that can be influenced by the intended intervention (%);
C – Effectiveness of the intervention, measured by the percentage of fatalities and serious injuries that will be spared if the intervention is fully applied (%) – see section 2.3;
D – Degree of implementation that is possible in practice within a given time frame (%);
E – Degree of compliance that road users will accept for a certain period of time (%).

While preparing a road safety plan, each of the above mentioned factors should be evaluated where possible by research results (especially regarding factors A and B) for each planned intervention. However, it is recognized that for factors C, D and E, one may have to rely upon an estimation by expert judgement – a decision that should be expressly acknowledged. Ideally, the degree of implementation of each intervention may be estimated by consultation with experts and authorities; and the degree of compliance by surveys on acceptance or by focus group interviews.

The number of fatalities and serious injuries preventable through an intervention can be predicted by multiplying those factors; knowing that the theoretical potential number of affected casualties (A) will not be reached due to the adverse effect of the other four factors.

The selection of retained interventions was based on a public health perspective, in which those with greatest potential for preventing fatalities and serious injuries were ranked first.

The potential lifesaving effect of the *Via sicura* program was calculated using a predicted trend determined on the assumption (base scenario) that the intensity of work in the area of road safety would have remained constant without the program.

In the State of Western Australia (WA) the road safety strategy for the period 2008–2020 was developed based on the Safe System approach, using a model to estimate the projected benefits of a combination of best-practice countermeasures. To this end, the method used in the Victoria State (METS – Macro Estimates for Target Setting) was adapted to WA conditions. This involved the development of a matrix, (Table 2.1) aiming at focusing attention to a small number of most severe

traffic injury problems and taking into account the differing road safety problems and priorities between WA's three main geographic areas.

Table 2.1 – The Western Australia Safe System Matrix (adapted from Colbert *et al.*, 2010)

Area	Injury reduction factor			
	Safe roads	**Safe speeds**	**Safe vehicles**	**Safe road use**
All WA	State-wide high crash risk location program	Review and fine tune speed limits. Enhanced speed enforcement	Promotion of crash avoidance features Promotion of advanced crashworthiness features	Development of aggregate behaviour change programs
Metro Perth	Intersection countermeasures	Adjustment of speed limits to complement infrastructure measures	-	Development of specific behaviour change for Metro issues
Regional WA	Run-off-road countermeasures Safe System transformation of strategically important routes radiating from metro boundary	Rezone all limits downwards by 10 km/h	Specific promotion of ESC in 4WDs	Development of specific behaviour change programs for regional issues
Remote WA	Safe System transformation of strategically important routes around remote centres	Rezone all limits downwards by 10 km/h	Promote ESC selection/fitment to heavy vehicles	Development of specific behaviour change programs for issues in remote areas

Predictions on the effects of the proposed programme were made for the duration of the strategy, using evidence-based estimates of effectiveness of each intervention in reducing serious casualties, and accounting for potential overlapping of targeted crashes. The baseline scenario assumed a continuation of existing safety policies and accounted for expected future growth in traffic volume (in vehicle.km) and anticipated reduction in serious casualty rates due to increasing motorization – this being predicted on the basis of precedent five-year trend in reported serious casualty rates (Corben *et al.*, 2010).

Besides the technical modelling work, an extensive community consultation on the programme proposals took place, resulting in a refinement of the programme, which was then approved in the Parliament.

In summary, it can be concluded that full evidence-based and data driven road safety programs are not yet a realistic option for Portugal, due to the absence of evidence and also to the unavailability of good quality data in its whole. However, as demonstrated by the described examples, working with quantitative road safety targets allows to shape informed expectations concerning the total effect of a road safety program, builds the foundation for collecting good quality data, and enables a learning-by-doing development of road safety management methodologies. Furthermore, it also provides beacons for monitoring the implementation of a safety strategy, through systematic regular ex-post evaluations.

Quantitative road safety progress evaluations require a base scenario, which in practice can be provided by disaggregated extrapolations of historical data, several statistical methods existing for estimating the assumed trends.

2.2 Road safety strategy management

Monitoring road safety progress is best made when using both final outcome indicators (e.g. fatality and serious injury numbers or rates) and safety performance indicators (SPI), as mentioned by Wegman *et al.* (2008) and Bliss & Breen (2009), and discussed in Cardoso *et al.* (2021).

A Safety Performance Indicator (SPI) – currently designated in the EU as Key Performance Indicator (KPI), for road safety – is any measurement of a variable that is causally related to crashes or injuries, used in combination with a count of crashes or injuries in order to indicate safety performance or understand the process that leads to accidents (ETSC, 2001; Vis *et al.*, 2005; and Hakkert *et al.*, 2007).

SPIs are defined for specific traffic system domains that are important for analysing the production of crash casualties, such as seat belt and helmet use, driving speeds, prevalence of alcohol in driving, distraction (e.g., cell phone use), infrastructure design and planning characteristics, vehicle crashworthiness and road worthiness, and post-crash care (Vis *et al.*; EC, 2017). According to Hakkert *et al.* (2007), direct measurement of unsafe operational conditions is possible for some of those domains (e.g. the percentage of excessive speeding drivers – above the speed limit). For others it is not feasible due to technical (e.g. the percentage of inappropriate speeding drivers – too fast for the prevailing) , economical or ethical reasons, in which cases proxies for the problem may be used or even substitutes based on related interventions (e.g. percentage of failed alcohol roadside checks, i.e. above the legal limit) are also possible.

In Sweden, the evaluation of the strategy followed between 1997 and 2007 showed that a simple target for the reduction of the number of fatalities ten years ahead does provide sufficient guidance on the type of actions and amount of effort required (Wegman *et al.*, 2013). As a result, the new strategy incorporates not only road casualty targets but also a framework called ‘Management by Objectives’ which, provides to the stakeholders several objectives and interim targets (operational targets), most of them formulated in terms of SPIs (combined with final outcomes), which are used to manage and monitor annually their road safety effort.

The SPI’s were selected in order that they have a satisfactory level of validity (correlations with the number of fatalities or serious injuries), they are reliable (measurable consistently) and are easy to quantify (economic and technical feasibility). These indicators are intended for the duration of the strategy, and the assessment of their progress is made every year. Table 2.2 presents the indicators currently used, and their assessment in 2017 (STA, 2018).

Use of SPIs in safety management through ex-post evaluations allows to link the observed progress towards fatality and severe injury targets with the level of intervention accomplishment and a proper understanding of why progress was made (Wegman *et al.*, 2013). This is essential for developing effective new interventions, for improving on-going interventions and for properly addressing transferability of interventions from one context to another.

Moreover, the benefits of targeted SPI’s are not limited to operational effectiveness. As emphasised by Wegman *et al.* (2013) a key component of a Safe System approach is the concept of shared

responsibility, not only between the road users on the one hand and road traffic designers and operators on the other, but also between all transport stakeholders, including municipalities, police forces, road authorities, driver training and testing institutions, and the private sector. When the contributions of different stakeholders are identified in a road safety strategy, periodic progress monitoring is an excellent means of assessing if one is complying with its commitments and if those are appropriate for the intended goals.

Table 2.2 – Evaluation of Swedish interim operational target compliance in 2017 (STA, 2018)

Safety Performance Indicator	Starting Points (2007)	2017	2020 target	Assessed development towards target
Number of fatalities on the roads	440	253	220	In line with the required trend (*)
Number of seriously injured on the roads	5400	4400	4100	In line with the required trend
Share of traffic volume within speed limits, national road network	43 %	45 %	80 %	Not in line with the required trend
Share of traffic volume within speed limits, municipal road network (started in 2012)	64 %	67 %	80 %	Not in line with the required trend
Share of traffic volume with sober drivers	99.71 %	99.74 %	99.90 %	Not in line with the required trend
Seat belt use in the front seat of passenger cars	96 %	98 %	99 %	In line with the required trend
Share of cyclists wearing a helmet	27 %	44 %	70 %	Not in line with the required trend
Share of moped riders using a helmet correctly	96 %	98 %	99 %	In line with the required trend
Share of traffic volume for passenger cars with highest Euro NCAP rating	20 %	72 %	80 %	In line with the required trend
Increased rule compliance among motorcycle riders	-	-	-	Not yet measured, no target defined (**)
Share of traffic volume with median barriers on national roads with speed limit above 80 km/h	50 %	76 %	90 %	Not in line with the required trend
Share of safe pedestrian, bicycle and moped crossings	19 %	27 %	35 %	In line with the required trend
Share of municipalities with good maintenance of bicycle paths	18 %	36 %	70 %	Not in line with the required trend
Systematic traffic safety work in line with ISO 39001	-	-	-	Not yet measured, no target defined (***)

(*) – The functional form of the trend depends on expectable implementation timeline, between the initial stage and the sustained operation (e.g., linear or logistic function between initial and final year.
(**) – Swedish Transport Administration's in-depth studies are expected to provide detailed information for this motorcyclist indicator.
(***) – ISO 39001 is applicable to all organizations that are willing to improve road safety, regardless of the type, size and product or service they provide.

In summary, setting casualty and SPI related targets and monitoring progress in those indicators along the implementation of a road safety strategy supports its operational effectiveness and serves transparency and stakeholder accountability. Rational management of road safety (by objectives of results) is assisted by having the following conditions are satisfied (Elvik, 2008):

- Strong endorsement of the targets by top government decision makers and their firm commitment to realising them.
- The targets set should be both challenging and achievable.
- The number of targets should not be too numerous, in order to ensure the corresponding policy instruments designed to realise them are focused and clearly recognized.
- The institutions responsible for choosing how best to realise the targets should have authority to determine the priority to be given to the corresponding available policy instruments.

- Responsible agencies should be supplied with sufficient funding and human resources to implement all cost-effective road safety interventions.
- Procedures for monitoring progress towards the targets and providing feedback to responsible institutions on their performance should be agreed and established beforehand.
- Incentives should exist to ensure commitment to targets from all institutions responsible for realising them.

Road safety related data and statistics are essential for the success of this approach to road safety management, and it cannot be overemphasised how relevant good road safety data are (Wegman *et al.*, 2013). This includes, cost estimates (for comparing road crash socio-economic impacts with other health threats), exposure (to differentiate between the effects of changes in risk from modifications in traffic activity of composition), safety performance indicators (related to the enabling objectives or the envisioned results interventions) and severe casualties (disaggregated fatalities and MAIS3+ severe injuries – see Figure 2.1).

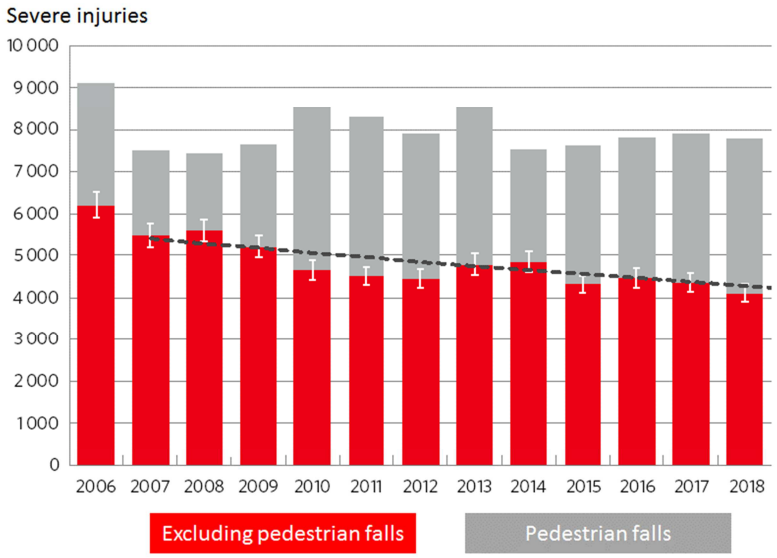

Figure 2.1 – Forecast of severe injuries in Sweden, 2006-2018 (adapted from STA, 2019)

2.3 Safe System interventions

Road safety interventions may be directed at any road system element: patterns of land use, the road itself, road furniture, traffic control devices, motor vehicles, police enforcement, and road users and their behaviour (Elvik *et al.* 2009). In the EU SUPREME project, best practice interventions were categorised in a different way: education and campaigns; driver training, testing and licensing; rehabilitation and diagnostics; vehicles; infrastructure; enforcement; statistics and in-depth analysis (data); institutional organisation; post-accident care; bundles of interventions (SUPREME, 2007a).

Another common way for approaching road safety intervention refers to the 4 E's: Education, referring to raising risk awareness, teaching road safety to professionals, training road users, and changing behaviour through communication and public discourse; Engineering, ensuring proper design, construction, maintenance and management of roads (including road and land use planning) and vehicles; Enforcement, providing a legislative regulatory framework and ensure its general compliance, through policing and judicial procedures; and Emergency response, guaranteeing a timely emergency medical response and appropriate injury treatment.

Previously, Haddon (1970, 1972) had developed an injury-prevention matrix to categorize road safety interventions according to two dimensions: the timeline chain of events, encompassing three phases, pre-crash, crash and post-crash; and the targeted traffic system elements, the environment (including the road infrastructure and sociocultural aspects), the vehicle and the human element. Interestingly Haddon already explicitly mentioned the interactions between cells in his matrix, and how to represent them, in a timely and early warning against silo responses to the phenomenon.

The descriptions of practical implementations of the Safe System approach usually involve elements revealing the importance of these interactions and the stakeholders shared responsibility, such as the Road Safety Management pillar of the UN's Decade of Action and Safe Speeds intervention element of the World Bank report (Bliss & Breen, 2009). Other pillars or elements (e.g., safer vehicles and safer road users) may be mistakenly seen as addressable through traditional single-disciplinary approaches; however, both safety management and speed management (safe speed) are more easily identified as requiring multidisciplinary approaches, if total quality is indeed sough in these areas.

Theoretically, Safe System interventions are preventive, their application not requiring knowledge of local crash outcomes. Nevertheless, the literature search was not limited to this type of intervention, as there are reactive interventions with favourable cost-benefit relation (e.g. hazardous road locations and network screening) and helpful for prioritizing, especially in view of the incomplete characterization of secondary road network inventory.

To help identifying available good practice interventions that may be applied in the next Portuguese road safety strategy, a comprehensive review of international literature was performed, collecting the most relevant studies on the application of measures in urban areas, on those intended to improve pedestrians and powered two-wheeled vehicle road users' safety, as well as on those aiming at diminishing speeding and drink-driving. These were the most important road safety issues identified in the diagnosis (Cardoso, *et al*., 2021); nevertheless, other types of interventions (e.g., applicable in rural areas, involving vehicles and other road users) were identified, as well.

This review intended to summarize what is known about the crash and casualty target groups for each identified intervention, as well as their reported effect, with a special focus on those coming from meta-analysis. Scopus and TRID (Transport Research International Documentation) scientific literature databases were searched for, and several reference documents were consulted, including "The Handbook of Road Safety Measures" (Elvik *et al*. 2009) and relevant reports from the EU research projects such as ROSEBUD (*Road Safety and Environmental Benefit-Cost and Cost-Effectiveness Analysis for Use in Decision-Making*), SUPREME (SUmmary and publication of best Practices in Road

safety in the Eu MEmber States), SafetyCube (*Safety CaUsation, Benefits and Efficiency*), and SaferAfrica (*Innovating dialogue and problems appraisal for a safer Africa*). A focused search on the FHWA's Crash Modification Factors Clearinghouse Crash was made; and related documents from the Cochrane Database of Systematic Reviews were analysed.

Good practice interventions that have been found to reduce the number of accidents include road design and road equipment, traffic control, driver training and regulation of professional drivers, public education and information, police enforcement and sanctions, and general-purpose policy instruments. A list of these interventions is presented in Annex I. Not all listed interventions are Safe System compliant, as they include both preventive and reactive interventions.

2.4 Proposed method for VisãoZero2030

From the review presented in the previous sections (2.1 and 2.2), it is concluded that applying an evidence-based and data-driven road safety management, similar to the approaches adopted by leading countries, is a promising way to guarantee an effective implementation of the Portuguese road safety strategy in the coming ten years. This will be partially facilitated by two developments concerning data availability on final (numbers of victims) and intermediate (SPIs) crash outcomes.

As a result of PENSE2020, procedures were implemented that potentially enable the linkage between the police crash data register system and the health sector data. Starting in 2021, detailed disaggregate data on severe crash injuries (fatalities and MAIS3+) will be available, seemingly with good quality as regards both injury severity classification (medical source) and underreporting correction (Cardoso *et al.*, 2021). This entails the disaggregated analysis of both fatalities and MAIS3+ casualties and the use of these data for monitoring the implementation of the strategy.

In the diagnosis, deficiencies were identified regarding availability of disaggregated time series data for potential SPIs, exposure and accident costs (Cardoso *et al.*, 2021). For the successful application of a management by results approach, new procedures for systematic collection of good quality data on relevant SPIs, exposure and accident costs will need to be formulated, implemented and routinely applied. Issues related to these aspects, which are considered to be fundamental for the VisãoZero 2030 strategy, will be addressed in Section 5 |. The opportunity and relevance of instigating the use of SPI is further supported by the EU approach to the European Road Safety Strategy, which intends to foster the use of key performance indicators for road safety (as stated in the document Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero").

The effect of the road safety plan will be projected by comparing the forecast for the aggregated effect of its planned interventions with the prediction of the expected number of fatalities under a business as usual situation (baseline scenario), as explained in section 4.1.

In the baseline scenario it is assumed that the current safety policies are not changed, leading to the maintenance of present enforcement level and strictness, to the continuation of the existing campaign programme and to the prolongation of existing interventions, namely those in execution within PENSE2020, as described in Annex II.

The development of new crash prediction models for calculating forecasts and predictions was not included the road safety strategy, given its tight timeframe. As mentioned in the diagnosis stage, developments in the last decade were considerably influenced by economic and traffic variability (Figure 2.2), and two periods could be identified, in which changes in traffic casualties at the aggregate and also at the disaggregated levels varied substantially (Cardoso *et al.*, 2021). This means that known existing macroscopic crash models, such as those developed by Ribeiro *et al.* (2012) and those mentioned in Cardoso (2007), are not easily updated and cannot be adapted for the preparation of this strategy. On the other hand, the high variability of travelled distance (Figure 2.2) and numbers of fatalities and serious injuries does not fully support the required assumptions for extrapolating from trends in the previous ten years. However, taking as base scenario the constancy of last three to five-years' average numbers of fatalities or severe injuries is not an obviously advantageous (or disadvantageous) approach, either.

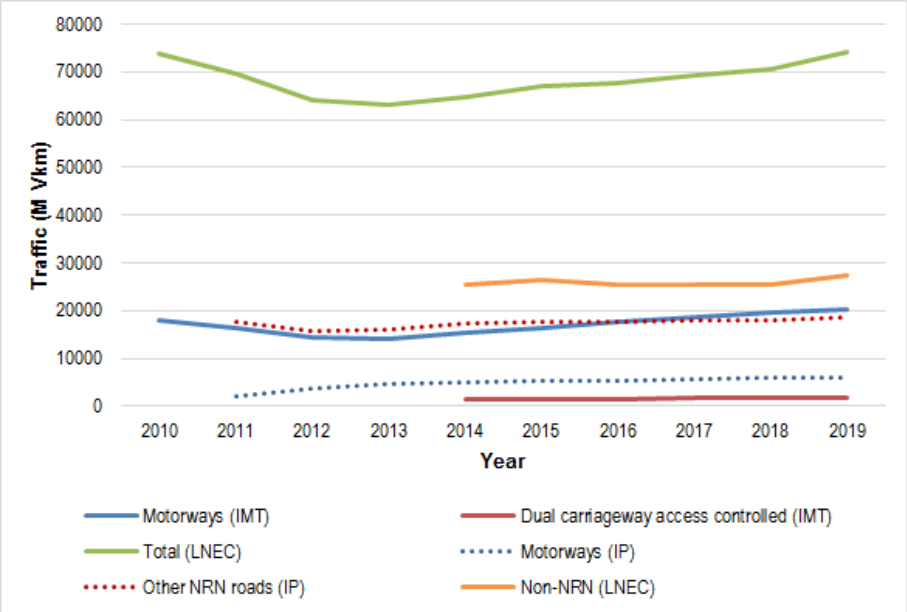

Figure 2.2 – Developments of travelled distance in Portugal and on the dual carriageway NRN, 2010-2019 (sources: LNEC, IMT and IP)

It is widely recognized that the Covid pandemic has changed abruptly human society way of living in 2020, and the development of corresponding socio-economic indicators. Assuming that some form of normal functioning will be resumed in the implementation period of the road safety strategy, data from 2020 will not be used for framing the base scenarios.

Taking into consideration the above mentioned constraints, it is recommended to consider in the prediction for the baseline scenario the average numbers of fatalities or severe injuries, in the three-year period 2017-2019, and assume constancy in those numbers until 2030.

While analysing the scenarios for interventions, it is recommended to use the same assumptions. However, for scenarios in which population data is used as exposure (mainly interventions directed at pedestrian safety) INE's forecasts for 2021-2030 are recommended; and when analysing scenarios for interventions targeting PTW and bicycles the following two indicators are recommended:

- the average number of fatalities or severe injuries, for the three-year period 2017-2019, as a starting point;
- the average yearly trend, taken from log linear (casualties) or linear (SPI and exposure data) regression with no constraint on origin.

These different approaches are justified by the robustness of population trend estimates; and by the expected effect of mobility policies, especially in cities which actively promote walking and cycling for small distances (typically less than 6 km) as well as public transport, and effectively reduce the allocated space for cars. Regarding cycling, there is a strategy aiming at multiplying by three in 2025 and by 7.5 by 2030 the bicycle share in transport (Table 2.3). In what concerns PTW, the trend has been for an increase on sales and fleet (Table 2.4), which is assumed to have a direct correlation with travelled distance – for lack of data.

2.4.1 Reference values

In the following tables reference values are provided for travelled distance and vehicle fleet, which may be used for analysing intervention scenarios (see section 4.3.1). Additional reference values for exposure variables (e.g. population) and safety related indicator measurements (e.g., seat belt use) are presented in Annex IV.

Table 2.3 presents reference values for travelled distance, on the whole Portuguese road network and on motorways, and the change in bicycle travelled distance targeted in the National strategy for cycling (ENMAC).

Table 2.3 – Annual variation (2010-2019) and forecast of travelled distances

Traffic volume	2010-2019	2015-2019	2021-2029
Motorways	0.02%	6.40%	-
National total	-1.04%	2.20%	-
Bicycles	-	-	Increase in traffic share, from <1%, to 3% in 2025 and 7.5% in 2030 nationally (ENMAC)

Table 2.4 presents the reference values for vehicle fleet: data from cars, vans and motorized vehicles are based on estimates by the automobile trading association (ACAP), while data for motorcycles and mopeds were obtained from the Insurance Supervising Authority (ASF).

Table 2.4 – Reference values for vehicle fleet developments

Vehicle fleet	Yearly rate	
	2010-2019	2015-2019
Cars	1.08%	3.45%
Vans	-1.08%	0.10%
Light vehicles	0.62%	2.79%
Motorized vehicles	0.59%	2.79%
Motorcycles (ASF)	7.03%	13.83%
Mopeds (ASF)	-0.92%	-1.09%
Bicycles (*)	-	+2.70%
e-bikes (*)	-	+315%

(*) Production of bicycles (source ABIMOTA) – overall, 8% of the production

2.4.2 Potential effects of an intervention

Calculation of the potential effects of selected interventions will be made using a shortened version of the approach described by Siegrist (2010). At this stage, it is considered that there is no sufficient information to assess the degree of implementation that is achievable at each moment along the implementation of the strategy; the same reasoning applies to evaluating the degree of compliance that road users will accept for a certain period of time. As a result, a reduced version of equation 1 (section 2.2) will be used:

$$Actual\ Potential\ Reduction = A \times B \times C \quad (2)$$

Where:

A – Number of casualties associated to the intervention target crashes;

B – Percentage of target crash related casualties that can be influenced by the intended intervention (%);

C – Effectiveness of the intervention (see section 2.3), measured by the percentage of fatalities and serious injuries that will be spared if the intervention is fully applied (%);

Factor A corresponds to the casualties related to the crashes targeted by the intervention, which depends on the disaggregation, i.e. on the specific area of application, crash type or road user category being considered.

Availability of information concerning factor B depends on existing crash data, as it relates to the active mechanism of the intervention. In some cases it is readily available (e.g. the percentage of victims in crashes related to alcohol); in some cases the quality of base data is unknown (e.g. the percentage of non-helmet wearing victims with head injuries preventable by a helmet); and in other cases there is uncertainty on the quality of the existing data (e.g. prevalence of speeding or seat belt wearing in crashes).

Reference values for the effectiveness of each intervention (factor C) can be found in section 2.3.

It is further proposed to use the method of common residuals to take account of interventions targeted at the same group of crashes, as in a previous evaluation (Vieira Gomes and Cardoso, 2013). Therefore, the percentage effects of all interventions affecting the same target group of crashes are multiplied and the resulting product applied to the corresponding numbers of casualties.

Given the current constraints to extrapolation, it is recommended to use mainly disaggregated predictions, and consider aggregation results with caution.

3 | Interventions proposed in the contributions from public and private entities and from the Non-Executive Council of Experts

In the first phase of the RSS 2021-2030 (“VisãoZero2030”), in which the guidelines of the new strategy were defined, ANSR opened a period to collect written contributions from experts and stakeholders. Over 100 documents were received, with several proposals for objectives, at the strategic and operational levels and actions, encompassing national and local areas. A summary list of the most relevant proposals is presented in Annex III.

The contributions from the 35 members of the Non-Executive Council of Experts can be clustered in three broad groups:

1. Infrastructure and Innovation;
2. Emergency, Education, Vehicles, Dissemination, among others;
3. Urbanism and Soft Transport Modes.

In the first group, the contributions covered both types of objectives (strategic and operational), stressing the need to intervene in the following areas:

- The protection of vulnerable road users (VRU);
- The regulation, design, and management of road networks, including locality crossings and the review and update of the existing set of guidelines and standards (e.g., regarding VRU) for infrastructure design or the maintenance and repair of the existing network;
- The definition and implementation of a coherent speed management policy at the municipal and national networks;
- The Directive transposition (EU) 2019/1936, 23/10/2019 on infrastructure safety management and its implications in national road legislation,
- The systematic implementation of Road Safety Audits and Road Safety Inspections;
- The classification of the safety level of a road on a scale from 1 to 5;
- The planning of the integration of autonomous vehicles in the traffic system;
- The implementation of innovative driving support strategies, in particular those relying on support systems based on road and driver monitoring, including Advanced Driver Assistance Systems (ADAS), and Intelligent Speed Assistance (ISA);
- The integration of sensor devices on infrastructures, allowing for an increase in market penetration of connected mobility, including V2I and C-ITS, and more data collection, and how these may be used to enhance system safety;
- The development and systematic collection of new performance indicators directly related to road safety;
- The implementation of vehicle electrification and infrastructure massification.

The second group emphasized several interventions, including some of the proposals mentioned in the first group. In addition, the following areas were highlighted:

- The improvement of knowledge about the crash phenomenon, through multidisciplinary teams to investigate fatal and serious road crashes, identify their causes, and recommend and implement preventive measures for the continuous improvement of road system safety;
- The need for broad control of weights of heavy goods vehicles;
- The introduction of tax benefits for those who choose to purchase vehicles equipped with specific active and passive safety systems or reach the highest levels of the Euro NCAP;
- Tax benefits also for those who renovate and re-equip their farms, modernizing the national tractor fleet;
- Adequate driver training and updating, ensuring that drivers can use vehicles that have reached the highest Euro NCAP levels or were equipped with ADAS as they appear on the market;
- The promotion of definitive or temporary occupation of public space, mainly for children, and the need for pedagogical resources to support teachers and students (for ages over 12 years old) in their activities related to road safety and sustainable mobility;
- The drawing of campaigns on behaviour-change theories and their routine evaluation;
- The accident prevention and injury protection of power two-wheelers.

The third group highlighted several of the previous proposals, e.g., the need to improve the collection and analysis of road crash data and its monitoring, to analyse and investigate the causes and consequences of crashes, or to reduce speed in cities in order to make city streets safer. The experts also mentioned the following issues:

- The need to strengthen the Highway Code enforcement, by detecting and deterring infringements more efficiently;
- New legislation to help city councils take the necessary steps to ensure safety in their streets and the Road Safety Management Systems' adoption (e.g., ISO 39001, which was translated to Portuguese in PENSE2020);
- The promotion of road safety for cities as a whole (multimodal, sustainable, accessible, and safe), and in areas where it can most easily be promoted (speed, crossroads, illegal parking, school areas, public transport areas, and residential areas);
- The adoption of incident detection systems;
- The "retrofitting" of advanced driver assistance systems in the current vehicle fleet's recent vehicles;
- The commitment of the municipalities, namely at the level of Municipal Road Safety Plans.

In the diagnosis stage, urban areas, pedestrians and powered two wheeled vehicles (PTW) road users, as well as speeding and drink-driving, were found to be the most negative factors to road safety performance in Portugal in recent years (Cardoso *et al.*, 2021).

Overall, the contributions revealed a widespread awareness of Vision Zero's meaning and supported its ultimate goal and the Safe System concept. Nevertheless, some contributions also exposed unfamiliarity with the Safe System concept and flawed notions about its underlying principles and how these can be reliably applied in practice. This is especially evident about speed management, the risk of severe head injury for low speed unprotected road users, shared responsibility and the preventive nature of the Safe System approach.

Out of the 415 contributions received, those interventions dependent on car industry regulations, too ambiguous, extending out of the road safety scope, unclear or referring to existing regulations were not considered; resulting in 258 interventions being retained for consideration in the road safety plan. These were further on reduced to 136 interventions, due to elimination of overlap and bundling of related or sequential interventions. A summary of these contributions is presented in Annex III (Table III.1).

Within this last group of retained suggested interventions, 8% covered urban areas, 7% interurban roads, and the large majority (74%) could be applied in both. Several contributions were focused on vulnerable road users (3% related to pedestrians and 4% with cyclists), and 10% were dedicated to powered two-wheelers. Only 4% of the contributions concerned speeds, and 5% were related to drink or drug-driving.

Besides, approximately one-fifth of the contributions (23%) were related to road infrastructure, 13% concerned vehicles, 24% concerned road users, and 13% were related to post-crash care. Monitoring and evaluation, research, and knowledge transfer were also covered by 17%, 9%, and 8%, respectively. Only 1% of the contributions were focused on public transport. Enforcement related interventions accounted for 11% of the total, communication campaigns 13% and driver training 8%.

Table III.1 in Annex III contains also an indication of the estimated relation of each proposed intervention to the institutional level of VisãoZero2030 and its 12 operational level key areas (distraction; alcohol; drugs; post-crash care; fatigue; speeding, car occupants and motorcyclists in rural roads; and speeding, pedestrians, PTW, and cyclists in urban areas – see Table 4.1).

4 | Road safety scenarios for the next decade

4.1 Methodology

The road safety plan will aim at achieving a general improvement in road safety situation of the country that can be measured by means of two predefined targets, corresponding respectively to the maximum yearly number of fatalities and to the MAIS3+ number of casualties, by the end of the implementation period.

To reach these targets, a prediction has to be made on the expected developments in road safety outcomes, if no changes to current safety policies are made – this corresponds to the baseline scenario, The strategy is prepared by setting a programme of road safety interventions, which is iteratively built up in such a way that the forecast of the combined effect due to these interventions applied to the baseline prediction results in final outcomes within the desired target.

Candidate interventions for the new road safety plan could be considered from those identified in the literature review (section 2.3 and Annex II), from those proposed within the stakeholders' contributions (section 3 and Annex III) and from further advances in particular baseline scenario interventions (Annex I). Assessing the potential effects of the selected interventions is calculated using equation 2, and the procedures described in section 2.4.

The predictions are estimated at an aggregated level, and the average numbers of fatalities and MAIS3+ severe casualties for 2017-2019 will be used as the base for departure. It is recommended that a stationary trend for development of these numbers is assumed. As explained in section 2.4, current data limitations, the observed variability in recent developments and the unpredictability of the current situation do not justify the selection of a more complex extrapolation process.

With a view to support an evidence-based and data-driven road safety management, details on the elements of this methodology are presented in the following sections, such as target setting, scenarios for outlining intervention approaches to be specified in action plans, and means to mitigate new challenges.

4.2 Target setting

Due to its participation in international fora, Portugal is committed to the advance of several international road safety targets (ANSR, 2020). These include halving the number of fatalities and injuries by 50% (Decade of Action for Road Safety 2021-2030, launched by a 2020 UN Resolution), and reducing by 50% the number of fatalities and MAIS3+ serious injuries between 2020 and 2030, as set out by the EU transport policy, as an interim target, towards the 2050 target of zero road fatalities. Furthermore, to help achieve progress towards those targets the EU intends to integrate into the European Road Safety Strategy the use of key performance indicators for road safety, as stated in the 2019 *Road Safety Policy Framework 2021-2030 - Next steps towards "Vision Zero"* policy document.

National targets do not have to mirror exactly the overall European targets; however, as the current mortality rate of Portugal (64 fatalities per million inhabitants) is above the EU average (51 fatalities per million inhabitants), a higher reduction target for fatalities is needed, if convergence towards the EU average is intended. For example, assuming equal developments in the population, to reach a mortality rate equal to the average mortality rate aimed by the EU (25.5 fatalities per million inhabitants) Portugal will need to reduce its mortality rate by 60% in the same period.

In the diagnosis stage, urban areas, pedestrians and powered two wheeled vehicle (PTW) road users, as well as speeding and drink-driving were found to be most negative factors to road safety performance in Portugal, in recent years (Cardoso *et al.*, 2021). Furthermore, international comparisons of road fatality data also show a disadvantageous position of the Country, as relates to these aspects:

- the burden of road safety in urban areas, contributes to 53% of the fatalities in Portugal, as compared to the average of 38% in the EU (in the period 2015-2017);
- the percentage of fatalities related to alcohol, which are around 25% in Portugal and 20% in the next highest percentage country (Norway) in the period 2010-2018;
- pedestrian fatalities, the rate being 32% higher in Portugal, when compared to the EU average EU, for the period 2016-2018.

These are issues in which fatality targets more challenging than those mirroring the EU overall road safety goal may be decided upon, if convergence with the EU is envisaged. However, it is recommended that decisions in this direction ought to be preceded by careful evaluation of the additional required interventions.

As demonstrated in the next sections, securing a 50% reduction in the number of fatalities will require the implementation of an integrated set of numerous interventions, both at the national and the local levels. As Portuguese history on road safety learns, and what is shown in other European countries as well, it is already an ambitious endeavour. Furthermore in the current strategy it is recommended to change the high level road safety management process by adopting a data-driven and evidence-based one, mandating an initial investment for creating and enduring the necessary conditions. Therefore, it is reasonable to aim at the EU 50% reduction target for fatalities.

Unfortunately, no similar analysis can be performed for MAIS3+ serious injury numbers and rates, due to lack of a convenient disaggregated historical data set. Therefore, no scientific foundation may be developed for proposing a different target, from the European one. Nevertheless, the proposed additional effort in the near future in the field of data collection (see Section 5), will create the conditions to make this work possible for serious injuries during the implementation of the new road safety strategy.

The base for the calculations has not yet been defined. As mentioned in section 2.4, it is proposed to use the average numbers of fatalities and MAIS3+ severe casualties in the period 2017-2019 as the base for setting the target for 2030. The resulting values are:

- Fatalities: (602+675+626)/3 = 634

- MAIS3+ casualties: (2296+2264+2089)/3 = 2216

Alternatively, the numbers of fatalities and MAIS3+ serious casualties registered in 2019 can be used as base for setting the target for 2030:

- Fatalities: 626;
- MAIS3+ casualties: 2089.

4.3 Scenarios for intervention

4.3.1 Introduction

In this section, different scenarios are discussed for reducing the number of fatalities by mitigating the impact of the negative factors which were identified in the diagnosis.

Several road safety problems are best addressed by the general application of common intervention throughout the whole country. That is, for instance, the case for reforming basic driver training and licensing, training of school children (e.g. bicycle use), public information and campaigns, setting safe and credible speed limits, and mandating Euro NCAP minimum rating for new vehicles in the State fleet

However, the traffic system is not uniform across the whole geographical area; road safety problems may be specific to certain areas, and their characteristics may vary from one area to the other, meaning that differences in the appropriate intervention may exist.

As mentioned in the diagnosis (Cardoso *et al.*, 2021), rural roads accounted for 47% of the registered fatalities in the period 2017-2019; 53% occurred in urban streets and through roads.

Rural roads and urban streets have differences, regarding the operation of the traffic system and the relative importance of their *movement* and *place functions*, as highlighted by Vieira Gomes *et al.* (2019). Interferences from activities on adjoining areas are less expected on interurban roads than in urban areas. The former present higher percentage of heavy goods vehicle traffic and less pedestrian and bicyclists, rare parking manoeuvres, and a general expectation towards higher traffic speeds – even on secondary roads. Conversely, urban streets are integrated in areas where the *place function* is important, even when of moderate or low significance. Vulnerable road users are expected in streets, the same happening with low and very low traffic speeds, intersection density, uncontrolled access, and general interference of human activities with traffic operation. Quality of life and urban space are fundamental criteria in street design, maintenance and operation.

As a result, these two settings have diverse road safety problems, differences in road safety intervention priorities being anticipated for rural roads and for urban streets. To take this into account, two different scenarios were considered, according to the urban characteristics of the geographical area: rural roads, belonging to the National Road Network and to municipal networks; and urban areas, including cities, villages, and roads through small villages.

The Central Government and the Municipalities are intervening road administrations in both these areas. On the one hand rural roads are not only those classified as interurban NRN roads, since there exist rural municipal roads, as well; and on the other hand, urban streets include some NRN through roads across small villages.

For each of these geographical areas, strategically important interventions are identified in each of the main Safe System components: safe roads, safe speeds, safe vehicles, safe road use; and post-crash care.

Car drivers (66%) and PTW riders (20%) are the majority of driver fatalities in rural roads; while the majority of driver fatalities in urban areas occurred in cars (40%), PTW (36%) and other vehicles (15%). Furthermore, 60% of PTW and 58% of bicycle driver fatalities occurred in urban area, whereas 66% of car driver fatalities occurred in rural roads. Motorcyclists and car drivers are identified as the main focus of interventions on rural roads. In urban areas, interventions will mainly address the safety problems of pedestrians (18% of total fatalities), PTW occupants (motorcycles and mopeds) and bicyclists, and to a lesser extent those of car drivers.

Speeding and drink-driving (including pedestrians) are considered as an undesirable road user behaviour, being the focus of behaviour change programs, and dedicated interventions. A summary discussion on these two risk factors is presented in section 4.3.2. Two other aspects of user behaviour deserve attention, as mentioned in the diagnosis: in view of recent trends, drug-driving is a potential issue to consider in the near future (especially as relates to PTW drivers); and distraction, mostly generated by new technologies, is becoming a prominent issue for all road user categories, for which there are still no established good practice interventions, although expectations exist concerning technology-based countermeasures.

The described approach is summarized in Table 4.1.

Table 4.1 – Key areas for strategic road safety interventions in VisãoZero 2030

Geographical area	Injury reduction factor				
	Safe roads	Safe speeds	Safe vehicles	Safe road use	Post-crash care
Continent	High risk sites	Speed limits	Car occupants	Behaviour change programs Distraction Drugs Fatigue	Emergency service General
Rural roads	Car occupants Motorcyclists General Speeding	Car occupants Motorcyclists General Speeding	Car occupants Motorcyclists General Speeding Drink driving	Car occupants Motorcyclists General Speeding Drink driving	General
Urban areas	Pedestrians PTW (motorcycles/mopeds) Bicyclists Speeding	Pedestrians PTW Bicyclists Speeding	Pedestrians PTW Bicyclists Speeding Drink driving	Pedestrians PTW Bicyclists Speeding Drink driving	General

Ideally, only Safe System (preventive) interventions would take place in a Vision Zero compliant strategy. However, at the current stage, state of the art reactive interventions are an effective way for defining priorities for infrastructure safety redesign, such as a program for the correction of hazardous locations or sections on the rural road network based on the concept of the expected number of accidents.

The key areas matrix is flexible enough to accommodate either new challenges, such as micro-mobility in cities, acceleration of market uptake of connected and automated vehicles on motorways and smoother geographical distribution of trauma units; or changes in strategic road safety priorities (e.g., prioritizing ISO 39001 embracing by organizations).

4.3.2 Addressing speeding and drink-driving

Speeding and driving under the influence of alcohol are two issues with well established relationships with crash risk (being, indeed, serious road safety problems), and for which there is a strong body of proven practical interventions addressing speeding and drink-driving. For these reasons, it is proposed that VisãoZero 2030 will focus on these two behaviour problems. In the following paragraphs scenarios for interventions aiming at these two problems are discussed, illustrating the opportunity and potential effects of a comprehensive approach to these domains.

Following a study developed in the city of Adelaide (Australia), involving case control studies on BAC involvement in crashes and on traveling speed and risk of crash involvement, McLean and Kloeden (2002) used the results to compare the effects of the two factors on driver's crash risk. The relationships between BAC and crash risk were in accordance with the results from Borkenstein (1974) and Lacey *et al.* (2016). Their original relationships between travelling speed and crash risk were revised by Elvik *et al.* (2019), downwarding especially the relative risks for higher speed differentials.

In their comparison, the reference risk corresponded to a BAC=0.0 g/l while travelling at the general legal speed limit in the city (60 km/h). The results thus obtained allowed the authors to conclude that measures which reduce travelling speeds are likely to be at least as effective in reducing the frequency of casualty crashes in Adelaide as measures which reduce drivers' blood alcohol levels. Figure 4.1 presents the comparison between the original BAC-crash risk and the revised speed-crash risk curves.

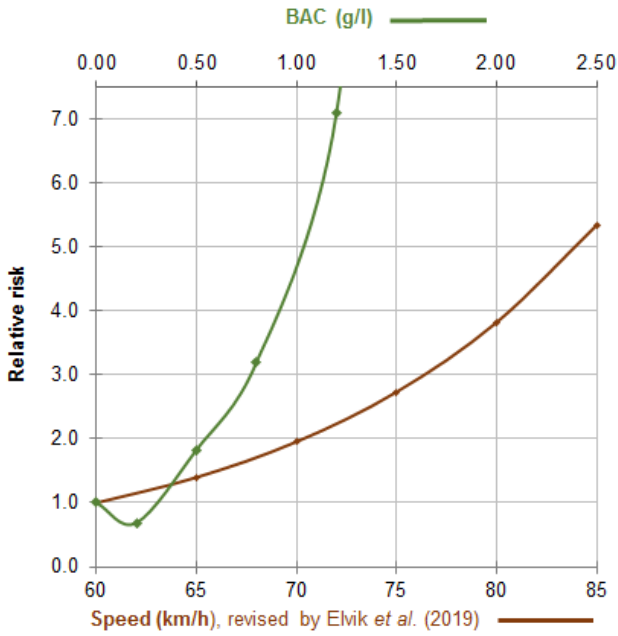

Figure 4.1 – Relative risk of involvement in an injury crash, by driver's blood alcohol level and choice of free travelling speed (adapted from Mclean and Kloeden, 2002, and Elvik *et al.*, 2019)

In fact, the relative risk of speeding by 5 km/h (65 km/h, instead of 60 km/h) is similar to a BAC of 0.5 g/l (instead of 0.0 g/l); and speeding by 15 km/h is comparable to a BAC of 0.8 g/l.

These relations are not specific to Adelaide, as the revised exponential curve is similar to the more general exponential model fitted to data from other countries (Elvik *et al.*, 2019).

Road safety research shows a direct relation between traffic speed and the frequency and the severity of crashes, and the resulting permanent trauma, both in individual terms (the crash risk as explained by the speed of each vehicle, as compared to the remainder traffic) and for traffic as a whole (i.e. the aggregated traffic stream risk as explained by the characteristics of its speed distribution). See, for example, TRB (1998), Aarts & van Shagen (2006), Cardoso (1996 and 2012), Jurewicz *et al.* (2016) and Castillo-Manzano *et al.* (2019); and Nilsson (2004), who developed the power model for estimating the change in fatalities and injuries resulting from changes in the average traffic speed.

Relations between changes in the average speed as a result of changing the speed limit were studied using meta-analysis by Elvik (2012), who reported a reduction of 3 km/h (with some variability), following a 10 km/h decrease in the speed limit. In France, following the reduction of speed limit for cars on single carriageway dual lane roads from 90 km/h to 80 km/h (80 km/h limit for trucks), the average speed diminished 3.1 km/h (to 83.3 km/h) and a 12% reduction in the number of fatalities (389 out of 3238 fatalities) was obtained. More than 400000 km of rural roads were affected by this intervention (CEREMA, 2020).

Results from Elvik *et al.* (2019) were applied to the existing Portuguese speed data (section 2.4), to calculate the required speed limit reduction to secure a 50% decrease in the number of fatalities. In these calculations, it was assumed that the Elvik's exponential for the Power model is applicable to Portuguese roads, that there is a uniform decrease across the whole speed distribution, that -10 km/h speed limit entails -3.4 km/h in the average speed, that there are no changes in the intensity and severity of enforcement, and that no driver behaviour adaptation occurs (e.g., driver will remain equally attentive to traffic). The results are presented in Table 4.2.

Table 4.2 – Required change in speed for a 50% reduction in fatalities

Area	Road category	Average speed (km/h)		Change in speed (km/h)	
		Initial	Target	Average	Limit
Rural	Motorway	118	104	-14	-41
	IP	92	81	-11	-32
	EN	71	63	-8	-24
Urban	Through road	54	48	-6	-18
	Level II*	56	49	-7	-21
	Level III*	48	42	-6	-18

(*) see Viera Gomes *et al.*, 2019

The required average speed reductions range from -6 to -14 km/h, which correspond to -20 km/h to -40 km/h.

However, analysing the whole speed distribution, it can also be shown that in some road categories considerable reductions may be obtained by reducing the speed of a limited percentage of drivers, and these are not necessarily the highly excessive speeders. For instance, in some single carriageway rural roads decreasing the speeds of mild violators (less than 10 km/h above the speed limit) may originate a sizeable portion of the theoretical potential fatality reduction. In practice this may be obtained by diminishing the speed at which a violation is considered as serious, while keeping the speed limit – currently the difference is 30 km/h. Calculations were made for Portuguese single carriageway non-access controlled roads with the following assumptions: normal speed distribution, constant speed limit, only drivers in light violation would change speeds, no change in standard deviation of speed, and no driver behaviour adaptation. The results showed that diminishing the serious violation limit by 5 km/h a reduction of 20% in the number of fatalities may be obtained (-32% fatalities for -10 km/h, and -40% fatalities for -15 km/h in).

On the other hand, similar calculations for urban streets showed that full speed distribution translation for lower speeds is needed (meaning all drivers need to reduce their speeds) to obtain significant reduction in the number of fatalities. This is the reason why low speeds in urban areas are best obtained with area wide traffic calming and infrastructure intervention, rather than by regulatory instruments and enforcement.

The relationship between a driver's blood alcohol concentration (BAC) and the risk of involvement in a crash was first established quantitatively by Borkenstein *et al.* (1964 and 1974) in a case control study

developed in the Grand Rapids area, in the USA. Subsequently, a geographically wider study in the late 1990s provided more precise estimates of the risk of driving at different levels of BACs (Blomberg *et al.*, 2005), and in 2015 a national case control study (including all police reported crashes, irrespective of their seriousness) provided further evidence on the subject (Lacey *et al.*, 2016). In Europe, the relationship was studied in the EU research project DRUID-Driving Under the Influence of Drugs, Alcohol and Medicines (Hels *et al.*, 2010, and (Houwing *et al.*, 2011). The DRUID results, summarized in Table 4.3, are in accordance with earlier findings.

Table 4.3 – Relative risk of getting seriously or fatally injured in a crash in Europe due substance (Adapted from Hels *et al.*, 2010)

Risk level	Risk	Alcohol	Substance group
Slightly increased	1-3	0.1 g/l ≤BAC < 0.5 g/l	Cannabis*
Medium increased	2-10	0.5 g/l ≤BAC < 0.8 g/l	Benzoylecgonine* Cocaine Illicit opiates Benzodiazepines and Z-drugs Medicinal opioids
Highly increased	5-30	0.8 g/l ≤BAC < 1.2 g/l	Amphetamines Multiple drugs
Extremely increased	20-200	1.2 g/l ≤BAC	Alcohol in combination with drugs

* Cannabis and amphetamines: due to very different single country estimates, the risk estimate must be treated with caution.
** Benzoylecgonine, cocaine and illicit opiates: due to few positive cases and controls, the risk estimates must be treated with caution

It is worth mentioning that the comparison of Portuguese data on driver alcohol prevalence measured in 2013 with the BAC distribution on driver fatalities for the period 2010-2019 (see Figure 4.2) showed that the relative risks of driver fatality due to alcohol are well in the middle of the corresponding DRUID intervals (Table 4.4). Statistics show that road deaths attributed to alcohol account for slightly over 25% of the total number of fatalities.

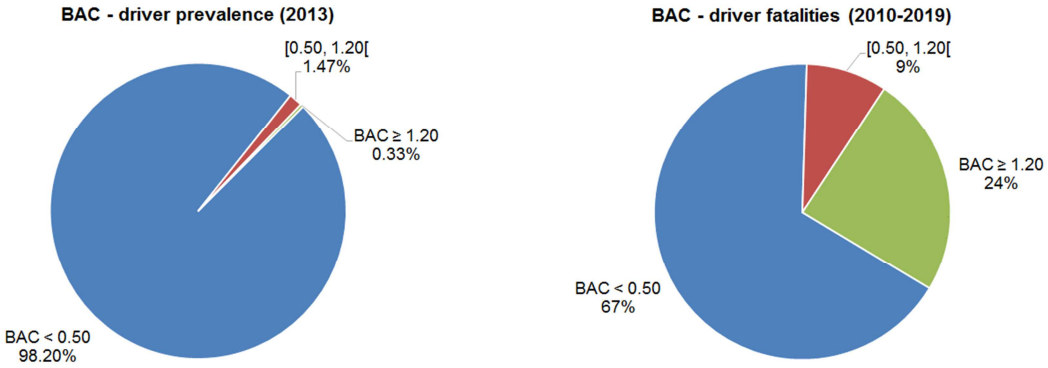

Figure 4.2 – Prevalence of alcohol and distribution of driver fatality by BAC (g/l) level in Portugal

Table 4.4 – Relative risk of driver fatality in Portugal due BAC

BAC (g/l)	Prevalence	% driver fatality	Relative risk	
			Portugal	DRUID
0 - 0.49	98.20%	66.86%	1	1-3
0.5 - 0.79	0.80%	8.84%	9	2-10
0.8 - 1.19	0.67%			5-30
1.2	0.33%	24.30%	108	20-200

No easy solution can be found to reduce excessive speed, since under normal conditions drivers choose the speed they prefer and consider to be safe, rarely considering that their selected speed is excessive or dangerous, at the moment of the decision. As a rule, the most effective way to tackle this problem is to apply "speed management", an integrated set of interventions at different levels, including legislation, infrastructure, enforcement, communication campaigns and ITS, such ISA – intelligent speed adaptation (see, for example, OECD, 2006, and EC, 2018).

Speed management is based on a functional classification of the road network (hierarchy), assigning to each road stretch a function (attending to its characteristics of place and movement – fruition of place, access, distribution or mobility) and a corresponding Safe Speed (see, for example, Aarts *et al.*, 2009). The configuration of the road environment (the road geometric design and its roadside) must be set to facilitate the correct perception of the appropriate speed by drivers (and the general public), by means of the application of self-explaining and forgiving roads concepts, and the systematic application of consistent marking systems specific to each class of road, in order to foster an almost automatically recognition and adoption of the appropriate speed on each road (see Cardoso, 2010). Issues such as design consistency, visibility, approach speed at intersections and obstacle free zones are important for rural roads (see for example MASTER, 1998, and SUPREME, 2007b); land use, public transport, area wide traffic calming, and transition zones are key aspects to consider in streets (e.g., Greibe *et al.*, 1999).

As highlighted in Table 4.1, speed management involves interventions on all Safe System elements: safe roads, safe speeds, safe vehicles and safe road use. A proper configuration of the road environment is fundamental for drivers to select appropriate speeds; but this role of the infrastructure has to be complemented by appropriate enforcement, rehabilitation courses for speeding recidivists, suitable public communication and education efforts, as well. Furthermore, on sensitive areas, infrastructures may be equipped with dynamic advisory and mandatory local speed limit devices, and penetration of ISA equipped vehicles in the fleet can be accelerated, by fiscal incentives applicable to new and imported vehicles, and by retrofitting repeating speeding drivers.

Attempts to decoupling drinking and driving have involved setting limits to the maximum level of alcohol allowed in the blood of drivers, communicating these limits to drivers and the general public – fostering a change in attitudes towards the issue in the process – and enforcing compliance with them (Allsop, 2020). Furthermore, public education and diverse rehabilitation measures are applied to drivers found to be exceeding the limits.

An important step towards improved knowledge of the impact of this phenomenon was achieved in the European research programme SafetyNet, with the definition of drink-driving related fatality: death from a collision where any driver, rider, or pedestrian involved has a BAC above the legal limit (Hakkert *et al.*, 2000).

Setting alcohol limits and communicating them is a continuous task, because drinking is not a driving specific problem but a cultural aspect of European societies. The driving population comprises two main groups: those who largely “don’t drink and drive”, and those who sometimes choose to drive after having drunk alcohol. In the second group, there is a minority that do not view drink driving as a socially unacceptable risky behaviour; these drivers need medical or psychological support to change their behaviour, or be legally restrained from driving.

Consistent and visible police enforcement is a powerful deterrent to drink driving, discouraging breaking the law (Calinescu and Adminaite, 2018). Research has shown that increased drink driving enforcement contributes to a decrease in drink driving deaths and injuries (ESCAPE, 2003). Targets should be set for minimum levels of alcohol checks of the motorist population per year; being human resource intensive, drink-driving enforcement should be intelligence led and coupled with public communication activities, in order to increase its effectiveness,.

Furthermore, proper enforcement allows to detect offenders, triggering the application of penalties, and provides an opportunity to take steps towards preventing behaviour repetition, through rehabilitation courses or alcohol interlock programmes. A Europe-wide study of rehabilitation courses for drink drivers (non addicts) found that halving of reoffending could be achievable (Bartl, *et al.*, 2002). According to the DRUID project, two levels of rehabilitation intervention have to be provided: less intense rehabilitative measures for non-dependent offenders; and intense treatment for dependent offenders.

An alcohol interlock fitted to a motor vehicle is a device which requires the driver to provide a breath sample, estimates a BAC from the sample and allows the vehicle to be started only if the BAC is below a certain limit; during a journey, the driver is required to repeat the test periodically.

Studies have shown that alcohol interlock programmes, combined with rehabilitation programmes, cut reoffending rates both during and after the driver has been required to install the device in its vehicle (Ecorys, 2014). ETSC (2020) reviewed seven European alcohol interlock programmes and concluded that these have several positive impacts, such as securing the jobs of people who rely on being able to drive for work, making drivers aware of their responsibilities, and helping offenders to remain integrated in society. Affordable costs and accompanying rehabilitation actions are key elements of success for these programmes. Evaluation of the Finnish programme showed that only 5.7% of the 1687 involved drivers have reoffended during or after the probation period (the usual recidivism rate for drunk-driving offenders being 30%), and that over 12000 offending situations were prevented.

4.3.3 Pedestrian and cyclist protection

The arguments discussed in section 4.3.2 showed that, despite speeding and driving under the influence of alcohol being two major issues with well established relationships with crash risk, VisãoZero 2030 needs to include interventions addressing other identified safety problems, to obtain the envisioned targets.

Urban streets and through roads account for more than half (53%) of the fatalities in the Continent, a percentage higher than the average in the EU (Cardoso et al., 2021). In the baseline period (2017-2019) almost 80% of pedestrian fatalities occurred inside urban areas – 85 fatalities (61%) on streets and 20 (17%) on through roads; in the same period, 38 bicyclist were killed inside urban areas (63%). The majority of bicycle fatalities involved a collision (80%).

It is expected that walking and cycling will take an increasing share in travel, especially in cities, which will result in increased exposure. For instance, assuming that the targeted national increase in the share of bicycle mobility is reached by 75% in urban areas, and that this corresponds to a 5.63 times increase in bicycle travelled distance, if no change in risk were obtained with the strategy, the number of bicyclist fatalities in urban areas would be 71=(5.63 x 38/3) in 2030. This would correspond to increasing the number of fatalities by 9.2%=(634-38/3+71)/634. Thus, in order to reach the road safety target, considerable effort is needed for decreasing bicyclists' risk.

Effective infrastructure safety policies for reducing pedestrian and bicyclist's casualty numbers in city streets, requires providing separate paths in high speed (50 km/h or more) traffic corridors, ensuring low traffic speed on the approach to safe pedestrian crossings, redesigning city road infrastructure for self-enforcing 50 km/h speed limits, and reducing motor vehicle traffic in 30 km/h Zones and in Home Zones – namely by means of traffic calming and area-wide schemes (Vieira Gomes *et al.*, 2020b).

Area-wide traffic calming is the co-ordinated use of traffic control provisions in a large, clearly defined area, in order to improve traffic safety and urban living conditions. This type of intervention includes reorganizing motorized vehicle routes, directing through traffic to distributer roads, and rearranging the infrastructure to protect the residential areas, limiting speed to 30 km/h zoning, applying speed-reducing provisions and creating pedestrian areas (Elvik *et al.*, 2009). As referred in Annex I, 15% reduction in the number of crashes are expected in area-wide traffic calming interventions.

Assuming that this reduction applies equally to all injury crashes, irrespective of their severity, a widespread application of this intervention would result in a -15% x 53%(urban) x 66% (streets) = -5.2% reduction in the total number of fatalities (all road users).

Interventions on roads through small villages may involve constructing by-pass roads for through traffic and redesigning the existing road, applying traffic calming measures, in order to slow down traffic speeds and provide more importance to vulnerable road users and their reclaiming of urban space. Under appropriate conditions, however, a mixed solution may be applied, in which through traffic is permitted but at slower speeds – environmental streets. In these cases, the road is redesigned in order that low speed is ensured and through traffic drivers are raised to a high degree of alertness and consideration with regard to local traffic and vulnerable road users: namely, speed

reducing provisions are installed, cycle tracks and sidewalks are built, carriageways are narrowed, and refuges for pedestrian crossings installed (Elvik, et al., 2009). Reductions of 35% in the number of accidents may be obtained with this type of intervention (Annex I).

Assuming that this reduction applies equally to all injury crashes, irrespective of their severity, a widespread application of this intervention on national and municipal through roads would result in a -35% x 53%(urban) x 30% (EN and EM through roads) = -5.6% reduction in the total number of fatalities (all road users).

Elvik *et al.* (2009) refer to a reduction of 21% in the number of crashes involving bicyclists, as a result of providing cycle lanes – a protected space on the carriageway, separated from motor traffic by means of road markings and road signs. It is clear that dedicated space to bicyclists should be treated as a road network, and not as a set of individual stretches, as there are driver behavioural adaptations (car drivers and bicyclists) that may offset the potential benefits of the infrastructure. This is evidenced by the small reduction in bicycle crashes reported in the document (-2%) and the accompanying considerations, regarding cycle tracks, which are separated from the main carriageway and, intuitively are safer than cycle lanes.

Policies for increasing bicyclists' protection (helmet use) and better compliance with rules would provide further reductions, but not so important as those previously mentioned. Research shows that over 66% of bicyclist fatalities involve head trauma, and that helmets reduce the risk of head injuries by 41% to 64% (Annex I), meaning that the relative risk of a non-helmet wearing rider having head trauma is between 1.7 and 2.8 times the risk of a helmeted rider. Unfortunately, crash data for bicycle fatalities lack information concerning the use of helmets by fatal victims (in 95% of the cases) in urban areas, which does not allow for a clear estimate of the target casualty population for this intervention. It is known that there were 9 driver bicyclist fatalities per 1000 injury crashes involving bicyclists.

There are no references to bicycle behaviour observations at the national level. However, observations in the city of Lisboa (2017) indicate that helmet use (50%) by cyclists was low, that the same happened as regards the compliance with traffic rules (56% of red-light violation at intersection), and that headset use was not negligible (10%).

In the period 2010-2018, 26% of the fatalities have involved a pedestrian in a marked pedestrian crossing or walking on the shoulder or sidewalk; and 44% involved some form of undesirable pedestrian behaviour. The most recent pedestrian behaviour observations (2013) showed that most pedestrians (78%) take advantage of existing pedestrian crossings, and that a large proportion (25%) of drivers did not give way to pedestrians. Over 15% of the pedestrians showed some form of distracting use of mobile phones, when crossing a street. Alcohol related interventions are also relevant for cyclists: between 2010 and 2019, 5.4% of the cyclists involved in crashes and 20.7% of the killed pedestrians had BAC over 0.50 g/l.

It must be recognized that interventions for improving pedestrian and bicyclist's road safety overlap with those addressing speeding and drink-driving, as much of their success depends on successfully coping with traffic situations and with low impact forces upon unprotected human beings.

4.3.4 Powered two wheeler vehicle users' protection

The motorcycle fleet has been increasing at a yearly rate of 7.03%; if this trend continues, in 2030, the fleet will grow by 102%. Assuming that the average yearly travelled distance is constant and no changes occur in crash risk, the number of motorcycle fatalities would be 220=109x(1+1.02); this highlights the need for decreasing crash risk for motorcyclists. For this purpose, disaggregated PTW exposure data has to be collected and additional studies on PTW safety in Portugal are required, to obtain more in-depth knowledge on PTW risk factors, both in urban areas and on rural roads.

In a European wide study, it was concluded that PTW riders have 9 to 30 times greater risk than car occupants to be fatally injured, the multiplying factor being 68 for MAIS3+ injuries (OECD/ITF, 2015).

Portuguese registered data shows that most PTW fatalities have occurred inside urban areas (70% for mopeds and 62% for motorcyclists), in line with other Southern Europe countries (e.g. Italy and Greece), and involved collisions (58%) or single vehicle crashes (40%), this latter value indicating potential influence of speeding or alcohol.

The most recent observations (2013) showed that almost all motorcyclists (99.3%) and the majority of moped riders (94.4%) used helmet. However, the overall percentage of fatal motorcycle drivers without helmet is 4.4% (7.1% inside urban areas and 0.5% in rural roads). Helmetless PTW drivers are a sizeable percentage of the fatalities in Portugal, despite corresponding to a residual prevalence (Figure 4.3). Keeping constant all other aspects, if unhelmeted driver fatalities had been wearing the device, 39% would not have been killed (WHO, 2006), leading to a reduction of 2.7% in the number of fatalities; it is worth mentioning that the helmet effectiveness depends on the speed involved and that most helmetless fatalities occurred in urban areas.

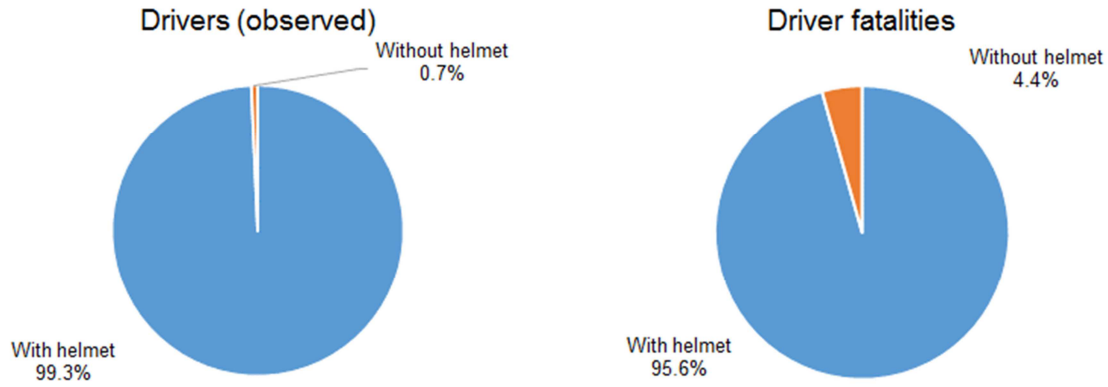

Figure 4.3 – Helmet in PTW driving (2013) and fatalities in Portugal (2015-2019)

According to Portuguese data (PRP, 2021), in 2010-2018, 4.2% of motorcycle and 10.7% of moped drivers involved in crashes had BAC above 0.5 g/l (4.1% for cars); lighting deficiencies were observed in 41% of mopeds and 10% of motorcycles, these having impact on visibility from other road users. In comparison to car drivers, PTW drivers under the influence of substances have higher risk, both for alcohol (8.5 times) and cannabis (2 times), as resulting from an ITF study (2015).

PTW main risk factors include speed and acceleration (weight/power ratio), alcohol, compound age and inexperience (doubling the risk for motorcyclist aged less than 25 years), weather conditions, road defects, lack of protection and conspicuity (ITF, 2015). PTW-car crashes mostly result from a combination of PTW driver prognosis and execution failures (related to confidence in being seen, trust in priority rules and overconfidence in their control capacities) and perceptual failures from car drivers.

Addressing PTW safety involves increasing their detectability (including daylight running lights), protective devices, active safety systems (ABS, collision warnings, curve assist), improved consideration of PTW in road layout design, improved training (towards prevention), communication campaigns and traffic rule compliance enforcement (ITS, 2015).

Experience shows that allowing PTW on bus lanes increases their injury crash risk (doubling in London, and 3.25 times in Marseille). Also, when riding between lanes the risk of injury crash PTW per travelled distance is four times higher than normal; in this case, the risk of hitting a pedestrian is six times higher.

PTW airbags and motorcyclist's airbag jackets are effective countermeasures to minimise the injuries especially in frontal collisions.

PTW enhanced braking systems is a proven countermeasure to avoid PTW road accidents. ABS has been proven to be very effective in reducing crash risks (from -8% to -38%). Collision warning and curve assist systems were tested reducing the risk of injury accident by 23% and 16%, respectively.

4.3.5 Other aspects

As mentioned earlier, Annex I contains a set of 50 good practice interventions, with the corresponding target group of crashes of victims, and reported mitigating effect. The interventions are presented in nine tables, corresponding to main safety factors: urban streets, rural roads, all road categories, vulnerable road users, motorcyclists, speed, education and driver training and licensing, alcohol, exposure and travel mode.

Annex II contains the PENSE2020 interventions continuing in the idealized baseline scenario, in which it is assumed that the same level of effort would be maintained. Effort in some of these interventions could be intensified, to increase their contribution to safety improvement; those interventions are highlighted in the Annex II Table1. They mainly refer to improving road user behaviour, comprising widespreading risk awareness through education at Pre-School, Elementary and Secondary levels, as well as promoting initiatives targeting local communities 'adults, especially elderly drivers, informing on age-related problems, diseases, medication and their potential effects on driving and walking.

Investigating the prevalence and assessing the risk of driving under the influence of psychoactive substances (alcohol and psychotropic substances) is taken into account, as well as preparing the introduction of alcohol interlocks. Increasing enforcement actions towards distracted driving, with mobile phone and other electronic devices, is also foreseen.

Measures to foster active municipal participation for road safety improvement deserve to be reinforced. These include supporting the elaboration and implementation of Municipal Road Safety

Plans, and promoting legislative procedures which may clarify the role and responsibilities of municipalities regarding the Road Transport System, as well as road sign installation and maintenance. In this domain, it is recommended that support ought to be provided to municipalities in setting up their own targets for the reduction of pedestrian fatalities and serious injuries, and for implementing interim targets for local SPIs.

The in-depth study of crashes involving bicyclists and measures to improve vulnerable road users protection deserve reinforced interest, as well. These measures include campaigns aimed at bicycle riders, warning on risky behaviour (including non-use of protective equipment); campaigns directed to car drivers, focusing on their interaction with bicycle and motorcycle users. Enforcement activity towards improving bicyclist compliance with traffic rules and deterring their high-risk behaviour (e.g. as red-light running and failure to use lighting at night) is worth to be reinforced, as well.

Intensifying communication campaigns targeting PTW road users is also recommended.

PENSE2020 safer roads interventions that deserve to be strengthened include the following: to prepare and implement an evaluation and classification program for the National Road Network (RRN), finalizing the necessary legislative conditions for carrying out road safety audits of road design schemes and road safety inspections of existing roads; to identify priority through road locations for intervention (both in the NRN and in municipal networks); and to prepare and implement road safety intervention projects (NRN and municipal networks).

It is recommended, as a preliminary activity, that the results obtained with the infrastructure related interventions carried out during the PENSE2020 strategy are analysed, to identify the most effective ones. From the stakeholders' suggestions (see section 3), it may be inferred that results from these evaluations are not yet available to all relevant technical decision makers.

As described in section 3, the 136 intervention suggested by stakeholders are presented in Annex III, with an indication of its estimated relation to the institutional level or the operational level key areas.

5 | Enabling conditions

In the existing Portuguese institutional setting, road safety is directly under the scope of six ministries (Internal Administration, Infrastructures and Housing, Health, Justice, Environment and the Climatic Action, and Education), the 278 Mainland municipalities and several road concessionaires. The effective implementation of a road safety plan depends heavily on horizontal coordination between those ministries and the close alignment of the acting institutions under the ministries of Internal Administration and of Infrastructures and Housing, as well as vertical coordination with the 278 municipalities. Equally important for the implementation of a road safety plan is the commitment and effective accountability of relevant stakeholders to their agreed role and tasks.

Besides the involvement of the public sector, the implementation of a road safety strategy calls for the participation of the private sector, as well as the general public, individually or through NGO's, further adding dimensions for vertical coordination.

As previous road safety strategies, the new one will comprise a large set of interventions, closely aligned and intertwined, that will be implemented by many and diverse entities, from the public and the private sectors. Orchestrating the execution of the strategy will require the close alignment of the acting institutions and a great coordination effort between the involved Ministries, which entails political engagement at the highest level and accountability at the operational level.

Experience with past strategies has shown that flimsy accountability procedures, funding uncertainty and low human resources weaken full commitment to action implementation by responsible entities. Other countries experienced similar coordination difficulties, which were addressed (e.g. in Sweden) by adopting a 'Management by Objectives' framework, which supports stakeholders with several objectives and interim targets, formulated in terms of casualty targets (final outcomes) and SPIs (intermediate outcomes), which are used to manage and monitor regularly their road safety effort.

It is desirable that such a framework be adopted in the new strategy, and that the fatality and MAIS3+ serious injuries targets are complemented by a set of interim SPIs (in the worst case scenario, policy outputs), allowing for a regular assessment of progress. It is also considered that an agreement on regular stakeholder meetings (e.g., at the end of each biennial action plan) for presenting developments and discuss opportunities for improvements would provide momentum for close institutional cooperation.

This approach requires enlarging the data collection effort (which is in line with coming requirements from the EC), and elicits modifications in procedures and stronger institutional commitments, in view of a more transparent and accountable delivery of the road safety strategy by involved stakeholders.

Necessary detailed disaggregated crash data on severe crash injuries (fatalities and MAIS3+) is available, as a result of PENSE2020; and the quality of this data may be improved by fully exploiting the linkage potential between the police crash data register system and the health sector data, namely to reduce underreporting.

Defining the list of required exposure data and of the safety performance indicators for each major key area of intervention in the strategy will be one of the first tasks for the first Action Plan, as regular and systematic collection of these data is an indispensable enabling condition for the implementation of the proposed approach.

Seemingly, travelled distance disaggregated per road user category and land use (urban or rural) will be needed. This is in accordance with overall risk assessment disaggregated by key area of road safety intervention (Table 4.1) and main relevant road user categories (pedestrians, bicyclists, PTW, and car occupants).

Candidate SPIs include prevalence of speed and compliance with BAC limits, of seat belt and helmet use by road user category, of traffic rules compliance by motorcyclists and vulnerable road users, the share of traffic benefitting from forgiving roadside rural road rating, the share of well-maintained bicycle paths, the percentage of design standard complying 30 km/h zone streets, and the percentage of shared-vehicle provider and public transport operator qualified according to ISO 39001 (e.g., for collecting accident and exposure data and for work-related safety).

Agreements will need to be reached, regarding the methodologies and responsibilities for collecting these data regularly and consistently, as well as sharing the obtained results.

As expected, in this approach each Action Plan will also include the set of activities to perform at the intervention level within its time frame.

Further interventions at the institutional level would provide assistance to the implementation of the road safety strategy, namely as regards extending knowledge on the domain:

- A knowledge transfer program for disseminating the Safe System principles and current approaches for their practical delivery among professionals and intermediate level decision makers.
- The preparation of a roadmap for nationally relevant research questions on road safety. These may include developing a method for collecting disaggregated actionable MAIS3+ data, improving knowledge on relations between speed and fatal and MAIS3+ injuries on main Portuguese road categories, in-depth investigation of selected road user crashes, a comprehensive cross sectional analysis of PTW safety, and developing new exposure indicators for city traffic, and vulnerable and micro mobility road users.

An important contribution to increased takeover of road safety interventions at the local (municipality) could be the implementation of demonstration projects of good practice interventions not yet recognized as such or addressing sensitive issues. That is the case for: speed management at city level; implementation of 30 km/h Zone design standard compliant rehabilitation of a city neighbourhood; the assessment of rural municipal roads design consistency, and signing of detected dangerous curves; and the pilot implementation of alcohol interlock in a judiciously selected region. Similar demonstration projects may be applied in concessioned rural roads (already one concessionaire has started a program for upgrading road restraint systems to EN 1317 and EN 12767 compliance).

It is expected that the described elements may be combined into a framework to successfully address the most pressing road safety problems in the Country (through a data driven and knowledge based process), contributing to mitigate some past implementation problems, and to foster stronger horizontal institutional cooperation, as well as vertical coordination between national and local road safety policies. It is also expected that coordination activities will be more effective and efficient with such an approach.

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ANNEXES

ANNEX I
Good practice road safety interventions

Table I.1 – Interventions on urban areas

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Environmental streets	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-35	Elvik et al. (2009)									X	X	X	X
Urban play streets	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-25	Elvik et al. (2009)									X	X		
Implementation of woonerven	Annual average number of crashes across 12 home zone sites		Reduction in the net annual number of crashes across the 12 home zone sites when the home zone was implemented	3.41	Quigley (2017b)									X	X		
Implementation of 30 km/h zones	All crashes	All crashes		-43	Quigley (2017a)									X	X	X	X
Area-wide traffic calming:																	
The whole area where area-wide traffic calming has been introduced (main streets and local streets)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-15	Elvik et al. (2009)									X	X	X	X
To assess the effects of area-wide traffic calming for preventing traffic related crashes, injuries, and deaths.		Number of road traffic crashes resulting in injuries	Pooled rate ratio	0.85	Bunn et al. (2003)									X	X	X	X
Local roads in the area where area-wide traffic calming has been introduced (residential streets)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-24	Elvik et al. (2009)									X	X	X	X
Main roads in the area where area-wide traffic calming has been introduced (main streets)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-8	Elvik et al. (2009)									X	X	X	X

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Traffic signal control at junctions																	
Three-arm junctions	Injury crashes	Crashes at junctions	Percentage change in number of crashes (Best estimate)	-15	Elvik et al. (2009)									X	X	X	X
Four-arm junctions	Injury crashes	Crashes at junctions	Percentage change in number of crashes (Best estimate)	-30	Elvik et al. (2009)									X	X	X	X
Street lighting for preventing road traffic injuries																	
Comparison between street lighting and an area control	All crashes		Pooled rate ratio (RR)	0.45	Beyer and Ker (2009)										X	X	X
Comparison between street lighting and an area control	Injury crashes		Pooled rate ratio (RR)	0.78	Beyer and Ker (2009)										X	X	X

Table I.2 – Interventions on rural roads

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Hazardous road location treatment																	
Urban areas spot or section	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-30	Elvik et al. (2009)										X	X	X
Rural spot or section	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-43	Elvik et al. (2009)						X	X					
Spot (~100 m)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-33	Elvik et al. (2009)						X	X					
Section(~1 km)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-26	Elvik et al. (2009)						X	X					
Reconstruction and rehabilitation of roads																	
In rural area	Injury crashes	Crashes	Percentage change in number of crashes (Best estimate)	-20	Elvik et al. (2009)						X	X	X				
In urban area	Injury crashes	Crashes	Percentage change in number of crashes (Best estimate)	-7	Elvik et al. (2009)									X			
Roadside safety treatment																	
Flattening slope from 1:3 to 1:4	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-42	Elvik et al. (2009)						X	X					
Flattening slope from 1:4 to 1:6	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-22	Elvik et al. (2009)						X	X					
Guardrails and crash cushions																	
New guardrail along embankment	Injury crashes	Running-off-the-road	Percentage change in number of crashes (Best estimate)	-47	Elvik et al. (2009)						X	X					

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Changing to softer guardrails	Injury crashes	Running-off-the-road	Percentage change in number of crashes (Best estimate)	-32	Elvik et al. (2009)						X	X					
Median guardrail on multi lane divided highways	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-30	Elvik et al. (2009)						X	X					
Concrete guardrail in median	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	15	Elvik et al. (2009)						X	X					
Steel guardrail in median	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-35	Elvik et al. (2009)						X	X					
Wire guardrail in median	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-29	Elvik et al. (2009)						X	X					
Automatic queue warnings with variable signs on motorways	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-14	Elvik et al. (2009)						X	X	X				
Anti-dazzle screens in central reservations on motorways	Injury crashes	Crashes in darkness	Percentage change in number of crashes (Best estimate)	-11	Elvik et al. (2009)						X	X					
Village bypasses	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-25	Elvik et al. (2009)						X	X		X	X	X	X

Table I.3 – Interventions on all road categories

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Road safety audits and inspections																	
Removing sight obstacles	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-2.5	Elvik et al. (2009)						X	X				X	X
Flattening side slopes	Injury crashes	Road departure crashes	Percentage change in number of crashes (Best estimate)	-15	Elvik et al. (2009)						X	X					
Providing clear recovery zones	Injury crashes	Road departure crashes	Percentage change in number of crashes (Best estimate)	-25	Elvik et al. (2009)						X	X				X	X
Guardrails along embankments	Injury crashes	Road departure crashes	Percentage change in number of crashes (Best estimate)	-45	Elvik et al. (2009)						X	X					
Guardrail end treatment	Injury crashes	Vehicles striking guardrail ends	Percentage change in number of crashes (Best estimate)	-5	Elvik et al. (2009)						X	X				X	X
Frangible light poles	Injury crashes	Vehicles striking poles	Percentage change in number of crashes (Best estimate)	-50	Elvik et al. (2009)						X	X				X	X
Signing of hazardous curves	Injury crashes	Road departure crashes in curves	Percentage change in number of crashes (Best estimate)	-17.5	Elvik et al. (2009)						X	X					
Correcting erroneous signs	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-7.5	Elvik et al. (2009)						X	X					
Roundabouts	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-46	Elvik et al. (2009)						X	X	X	X		X	

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Road lighting																	
Crashes in darkness in rural areas	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-14	Elvik et al. (2009)					X	X	X					
Crashes in darkness in urban areas	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-29	Elvik et al. (2009)					X					X	X	X
Crashes in darkness on motorways	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-4	Elvik et al. (2009)					X	X	X					
Increasing the level of lighting by up to double the previous level of lighting	Injury crashes	Crashes in darkness	Percentage change in number of crashes (Best estimate)	-8	Elvik et al. (2009)					X	X	X			X	X	X
Increasing the level of lighting by up to 2–5 times the previous level of lighting	Injury crashes	Crashes in darkness	Percentage change in number of crashes (Best estimate)	-13	Elvik et al. (2009)					X	X	X			X	X	X
Increasing the level of lighting by 5 times the previous level of lighting or more	Injury crashes	Crashes in darkness	Percentage change in number of crashes (Best estimate)	-32	Elvik et al. (2009)					X	X	X			X	X	X

Table I.4 – Interventions protecting vulnerable road users (VRU)

Intervention description	Crash		Results		Source	Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#							Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Cycle lanes	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-21	Elvik et al. (2009)												X
Cycle tracks	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-2	Elvik et al. (2009)												X
Pedestrian streets																	
Crashes in pedestrian streets	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-60	Elvik et al. (2009)										X		
Crashes in streets adjoining pedestrian streets	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	5	Elvik et al. (2009)										X		
Crashes both in pedestrian streets and adjoining streets around the pedestrian street	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-25	Elvik et al. (2009)										X		
Implementation of Safe Routes to School Program	All crashes	Vehicle/pedestrian	CRF	13.9	FHWA's Crash Modification Factors Clearinghouse										X		X
	All crashes	Vehicle/bicycle	CRF	11.6	FHWA's Crash Modification Factors Clearinghouse										X		X
Population-based interventions (coordinated, community-wide, multi-strategy initiatives) for the prevention of fall-related injuries among older people		Fall-related injuries	Relative reduction	6% to 33%	McClure et al. (2005)										X		

Intervention description	Crash		Results		Source	Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#							Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Signalised pedestrian crossings																	
Signalised pedestrian crossing vs. no crosswalk	Injury crashes	Pedestrian crashes mid-block	Percentage change in number of crashes (Best estimate)	-49	Elvik et al. (2009)										X		
Signalised pedestrian crossing vs. no crosswalk	Injury crashes	Pedestrian crashes at junctions	Percentage change in number of crashes (Best estimate)	-2	Elvik et al. (2009)										X		
Signalised pedestrian crossing vs. marked crosswalk	Injury crashes	Pedestrian crashes	Percentage change in number of crashes (Best estimate)	-27	Elvik et al. (2009)												
Pelican crossing vs. no crosswalk	Injury crashes	Pedestrian crashes	Percentage change in number of crashes (Best estimate)	-20	Elvik et al. (2009)										X		
Pelican crossing vs. marked crosswalk	Injury crashes	Pedestrian crashes	Percentage change in number of crashes (Best estimate)	3	Elvik et al. (2009)										X		
Hard bicycle helmet	Unspecified	Head injuries	Percentage change in number of crashes (Best estimate)	-64	Elvik et al. (2009)												X
Hard bicycle helmet	Unspecified	Facial injuries	Percentage change in number of crashes (Best estimate)	-34	Elvik et al. (2009)												X
Hard bicycle helmet	Unspecified	Neck injuries	Percentage change in number of crashes (Best estimate)	36	Elvik et al. (2009)												X
Hard bicycle helmet	Unspecified	Other than head injuries	Percentage change in number of crashes (Best estimate)	5	Elvik et al. (2009)												X
Soft bicycle helmet	Unspecified	Head injuries	Percentage change in number of crashes (Best estimate)	-41	Elvik et al. (2009)												X

Intervention description	Crash		Results		Source	Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#							Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Soft bicycle helmet	Unspecified	Facial injuries	Percentage change in number of crashes (Best estimate)	14	Elvik et al. (2009)												X
Helmets for preventing head and facial injuries in bicyclists		Reduction in the risk of head, brain and severe brain injury for all ages of bicyclists		63% to 88%	Thompson et al. (1999)												X
Non-legislative interventions for the promotion of cycle helmet wearing by children																	
Community-based interventions			Odds ratio	4.3	Owen et al. (2011)												X
Providing free helmets			Odds ratio	4.35	Owen et al. (2011)												X
School-based interventions			Odds ratio	1.73	Owen et al. (2011)												X
Interventions providing education only			Odds ratio	1.43	Owen et al. (2011)												X

Table I.5 – Interventions for PTW occupants

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Reflective materials and protective clothing for motorcyclist																	
Gloves: hand injuries		Motorcycle crashes	Percentage change in number of crashes (Best estimate)	-50	Elvik et al. (2009)							X				X	
Boots: foot injuries			Percentage change in number of crashes (Best estimate)	-33	Elvik et al. (2009)							X				X	
Leather jackets or trousers: arm/leg injuries			Percentage change in number of crashes (Best estimate)	-33	Elvik et al. (2009)							X				X	
Anti-lock brakes on motorcycles	Damaged	All motorcycle crashes		-29	Martin (2016)							X				X	
Helmets for preventing injury in motorcycle riders			Percentage change in risk of death	-43	Liu et al. (2008)							X				X	

Table I.6 – Speeding related interventions

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Speed limits			Percentage change in number of crashes (Best estimate)	see pp.449 Elvik et al. (2009)	Elvik et al. (2009)								X	X			
Stationary and manual speed enforcement																	
Visible enforcement with radar/laser	All	Unspecified	Percentage change in number of crashes (Best estimate)	-17	Elvik et al. (2009)								X	X			
Visible enforcement with radar/laser and vehicle chasing	All	Unspecified	Percentage change in number of crashes (Best estimate)	-1	Elvik et al. (2009)								X	X			
Composite method	All	Unspecified	Percentage change in number of crashes (Best estimate)	-1	Elvik et al. (2009)								X	X			
Visible fixed automatic speed enforcement	All	Unspecified	Percentage change in number of crashes (Best estimate)	-16	Elvik et al. (2009)								X	X			
Visible fixed automatic speed enforcement	All	Fatal crashes	Percentage change in number of crashes (Best estimate)	-39	Elvik et al. (2009)								X	X			
Mobile (hidden) speed cameras	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-10	Elvik et al. (2009)								X	X			
Mobile (hidden) speed cameras	Injury crashes	Fatal crashes	Percentage change in number of crashes (Best estimate)	-16	Elvik et al. (2009)								X	X			
Visible fixed section control	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-30	Elvik et al. (2009)								X	X			
Fixed speed cameras for the prevention of road traffic injuries and deaths			Relative reduction in average speed	-1% to -15%	Wilson et al. (2010)								X	X			

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Patrolling with no focus on a specific kind of violations	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	0	Elvik et al. (2009)								X	X			
Patrolling with a special focus on speeding – marked car	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-2	Elvik et al. (2009)								X	X			
Patrolling with a special focus on speeding – unmarked car	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	6	Elvik et al. (2009)								X	X			
Red-light cameras	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	13	Elvik et al. (2009)								X	X			
Red-light cameras			Rate ratio	0.71	Aeron-Thomas and Hess (2005).								X	X			
Dynamic speed limit system	Injury crashes	All crashes		-18	Daniels and Focant (2017),								X	X			

Table I.7 – Interventions related to education and driver training and licensing

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description		Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Driver rehabilitation courses for excess alcohol offenders (not being problem drinkers)			Recidivism rate	-50%	Bartl, et al. (2002)		X										
Graduated driver licensing (GDL) for reducing motor vehicle crashes among young drivers			Crash rates of teenage drivers (i.e. crashes involving fatalities, injuries, and property damage only - PDO).	-15	Russell et al. (2011)	X	X	X		X	X	X	X	X	X	X	X
Post-licence driver education for the prevention of road traffic crashes		Injury crashes	Relative risk	1.12	Ker et al. (2003)	X	X	X		X	X	X	X	X	X	X	X
Education in schools on the right way to cross a street/road	Injury crashes with children 5–9 years	Crossing the road	Percentage change in number of crashes (Best estimate)	-11	Elvik et al. (2009)										X		
Education in schools on the right way to cross a street/road	Injury crashes with children 9–12 years	Crossing the road	Percentage change in number of crashes (Best estimate)	-20	Elvik et al. (2009)										X		
Cycling proficiency training	Injury crashes with children 6–16 years	Cycling crashes	Percentage change in number of crashes (Best estimate)	-6	Elvik et al. (2009)												X
Road user information and campaigns (thematic)																	
Drink-driving campaigns	-	All crashes	Percentage change in number of crashes (Best estimate)	-14	Elvik et al. (2009)		X				X	X				X	
Speeding campaigns	-	All crashes	Percentage change in number of crashes (Best estimate)	-8	Elvik et al. (2009)								X	X			
Other single-theme campaign	-	All crashes	Percentage change in number of crashes (Best estimate)	-10	Elvik et al. (2009)	X		X		X	X	X			X	X	X

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description		Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Pedestrian campaigns (reflector use)	-	Pedestrian crashes	Percentage change in number of crashes (Best estimate)	3	Elvik et al. (2009)										X		
Driving off the road campaigns	-	Road departure crashes	Percentage change in number of crashes (Best estimate)	-3	Elvik et al. (2009)						X	X				X	
Keep your distance campaigns	-	Rear-end collisions	Percentage change in number of crashes (Best estimate)	-9	Elvik et al. (2009)						X	X				X	
Multi-theme campaigns	-	All crashes	Percentage change in number of crashes (Best estimate)	1	Elvik et al. (2009)	X	X	X		X	X	X				X	
Combination with enforcement											X	X			X	X	X
Campaign only (no enforcement)	-	All crashes	Percentage change in number of crashes (Best estimate)	1	Elvik et al. (2009)						X	X			X	X	X
Campaign and enforcement	-	All crashes	Percentage change in number of crashes (Best estimate)	-13	Elvik et al. (2009)	X	X	X		X	X	X			X	X	X
Campaign and enforcement and education	-	All crashes	Percentage change in number of crashes (Best estimate)	-14	Elvik et al. (2009)	X	X	X		X	X	X			X	X	X
Local “tailor-made” specific campaign	-	All crashes	Percentage change in number of crashes (Best estimate)	-39	Elvik et al. (2009)	X	X	X		X	X	X			X	X	X
Safe community programmes (1)																	
Special records	All crashes	Traffic crashes	Percentage change in number of crashes (Best estimate)	-29	Elvik et al. (2009)										X	X	X
Special records	All crashes	Non-traffic crashes	Percentage change in number of crashes (Best estimate)	-17	Elvik et al. (2009)										X	X	X
Official accident record	All crashes	Traffic crashes	Percentage change in number of crashes (Best estimate)	8	Elvik et al. (2009)										X	X	X

(1) Safe community programmes are accident prevention programmes that have the following characteristics: 1) The systematic recording of accidents in a local community over a given period of time, normally by hospitals or other health institution. On the basis of the obtained accident records, the dominant accident problems in the local community are identified and published; a steering group for accident prevention is set up, with participation from all parties that are presumably able to contribute to preventing accidents, including the municipality (administration and politicians), schools, the health service, the police, the fire brigade, representatives of trade and industry and voluntary organisations). 2) A quantified target for accident reduction is defined for a stated period, and an integrated program of measures is developed to achieve this target. 3) Changes in the number of accidents and injuries are monitored and

information on new developments is given to all those participating in the programme. 4) The effects of the programme on the number of accidents are analysed, the results being published and targets update of changes may be made. Programmes containing these elements have been introduced in a number of local communities, and have been directed towards both crashes and other types of accidents (Elvik *et al*., 2009).

Table 1.8 – Alcohol related interventions

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
DUI laws - reduced BAC limit for young drivers. Young	Injury crashes	Crashes involving alcohol (young drivers)	Percentage change in number of crashes (Best estimate)	-3	Elvik et al. (2009)		X										
DUI enforcement - stationary DUI police enforcement	All crashes	All crashes	Percentage change in number of crashes (Best estimate)	-14	Elvik et al. (2009)		X	X									
Restrictions for DUI-convicted drivers																	
Licence suspension of multiple DUI offenders	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-35	Elvik et al. (2009)		X	X									
Licence suspension of first-time DUI offenders	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-16	Elvik et al. (2009)		X	X									
Licence suspension of all DUI offenders	All crashes	All crashes	Percentage change in number of crashes (Best estimate)	-65	Elvik et al. (2009)		X	X									
Vehicle impoundment (law): General effect	All crashes	All crashes	Percentage change in number of crashes (Best estimate)	-19	Elvik et al. (2009)		X	X									
Vehicle impoundment as a sanction for driving without a licence: Specific effect	All crashes	Crashes with drivers whose vehicle was impounded	Percentage change in number of crashes (Best estimate)	-29	Elvik et al. (2009)		X	X									
Sticker on registration plate of vehicles of drivers with a suspended licence: Specific effect	All crashes	Crashes with drivers whose vehicle was impounded	Percentage change in number of crashes (Best estimate)	-7	Elvik et al. (2009)		X	X									
Alcohol ignition interlock programmes for reducing drink driving recidivism		Recidivism rates when the interlock device is installed	Relative risk	0.36	Willis et al. (2004)		X										

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description	#	Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Interventions for preventing injuries produced by problem drinkers		injury-related deaths	Relative risk	0.65	Dinh-Zarr et al. (2004).		X										
Patrolling with a special focus on DUI	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-2	Elvik et al. (2009)		X	X									

DUI – Driving under the influence

Table I.9 – Interventions related to exposure and travel mode

Intervention description	Crash		Results			Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban			
	Severity	Affected type	Description		Source						Car occupants	Motorcyclists	Speeding	Speeding	Pedestrians	PTW	Cyclists
Exposure control																	
Compacting towns from ca. 600m2 per inhabitant to ca. 300m2 per inhabitant	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-30	Elvik et al. (2009)										X	X	X
Traffic calming in residential areas (local streets are closed to through traffic)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-25	Elvik et al. (2009)									X	X	X	X
Introducing toll roads, etc. in Oslo, Bergen, Trondheim and Tromsø	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	-5	Elvik et al. (2009)										X	X	X
Building new main roads with increased road capacity in cities (Norwegian data)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	10	Elvik et al. (2009)										X	X	X
Abolition of all vehicle taxation (purchase, ownership and use)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	37	Elvik et al. (2009)						X	X			X	X	X
Changes in the modal split of travel																	
Public transport strike (very limited public transport)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	18	Elvik et al. (2009)										X		
Higher fares (transition from public to private transport)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	4	Elvik et al. (2009)										X		
Lower fares (transition from private to public transport)	Injury crashes	All crashes	Percentage change in number of crashes (Best estimate)	0	Elvik et al. (2009)										X		

ANNEX II
Baseline scenario

Table II.1 – PENSE 2020 interventions continuing in the base scenario

Strategic Objective	Operational Objective	Ref.	Measure (*)	Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban				
									Car occupants	Motorcyclists	Speeding (rural)	Speeding (urban)	Pedestrians	PTW	Cyclists	Institutional
2. Safer road users	4. Promote education and training for the development of a Road Safety Culture in liaison with the framework of the implementation of the National Strategy for Citizenship Education	A07. 24.	To disseminate and encourage the use of Road Education textbooks for Pre-School, Elementary and Secondary Education and Adult Education/Promoting Road Education Practices	X	X	X		X	X	X	X	X	X	X	X	
	5. Develop specific programmes to promote safe behaviour	A08. 27.	To establish legislative procedures impacting the obligations of municipalities regarding the Road Transport System and road sign installation and maintenance						X	X	X	X		X	X	
		A08. 29.	To encourage the elaboration of Municipal Road Safety Plans and their implementation	X	X	X	X	X	X	X	X	X	X	X	X	
		A10. 35.	Carry out a prevalence study and risk estimation of driving under the influence of psychoactive substances, in particular alcohol and psychotropic substances, taking into account the gender dimension													X
		A10. 38.	To study the introduction of alcohol-locks													X
		A11. 44.	To prepare and implement a plan for the execution of rumble strips as lane departure warnings	X				X	X	X						
		A11. 46	To carry out systematic driving enforcement actions using the mobile phone and other devices illegally	X					X	X			X	X	X	
		A14. 65.	Setting up targets by municipal councils for the reduction of pedestrian fatalities and serious injuries in their municipal road safety plans													X
		A15. 66.	Carry out a study on the characteristics of accidents involving bicyclists													X
		A15. 67.	To develop campaigns aimed at bicycle users warning on risky behaviour, including non-use of protective equipment, and aimed at car drivers focusing on interaction with biker users, taking into account the gender dimension										X		X	

Strategic Objective	Operational Objective	Ref.	Measure (*)	Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Rural			Urban				
									Car occupants	Motorcyclists	Speeding (rural)	Speeding (urban)	Pedestrians	PTW	Cyclists	Institutional
		A15. 68.	To ensure that users of bicycles comply with the rules by means of enforcement aimed at high-risk behaviour, such as failure to observe traffic lights and failure to use lighting		X								X		X	
		A16. 72.	To execute awareness campaigns targeting PTW road users							X				X		
		A17. 74.	To foster awareness education targeting elderly drivers, delivered by health professionals. To raise awareness of age-related problems, diseases, medication and their potential effects on driving, taking into account the gender dimension													X
	7. Improving the effectiveness of communication campaigns	A17. 75.	To deliver awareness campaigns aimed at older drivers						X	X			X	X	X	
3. Safer roads	8. Promoting the improvement of the National Road Network	A19. 79.	To prepare and implement an evaluation and classification program for the National Road Network (RRN)													X
		A21. 82.	To identify priority through road locations for intervention (National Road Network and municipal networks)													X
		A21. 83.	To prepare and implement road safety intervention projects (National Road Network and municipal networks)									X	X	X	X	
		A22. 84.	To create the necessary legislative conditions for carrying out road safety audits of road design schemes													X
		A23. 88.	Disseminate the manual "Recommendations for setting and signing maximum speed limits", applicable to all road sections, both inside and outside urban areas													X

ANNEX III
Proposed interventions received

Table III.1 – List of proposals for intervention received in the initial public consultation process

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
1	- In view of the recent publication of the documents "Residential and Coexistence Zones" and "30km/h Zones", it is important, in close cooperation with municipalities, to define an implementation programme that includes a set of pilot studies, which will allow, in due time, to test the application of the concepts, and to assess, in quantitative terms, the level of effectiveness associated to each implemented measure/action. These results should feed into the updating/revision of these basic documents and the existing legal framework						X			X	X	X	X	
	- Promotion of low speed zones (e.g. "30 zones"), in densely populated areas and where public transport coexists with vulnerable users													
	- Massively implement low-speed traffic zones (zones 30 and zones 20 with sharing spaces) in residential and other urban areas with high pedestrian use, and the corresponding closure or limitation of access to car traffic													
4	- Commitment to the systematic implementation of solutions for the hierarchical functional organisation of urban and rural municipal networks						X			X	X	X	X	X
	- Reducing the average speed on urban roads, particularly those through villages													
	- Adapting urban road networks to the safe use of all modes of transport, especially the most environmentally and socially friendly, in order to increase the number of trips on foot and by bicycle (non-polluting modes with a beneficial impact on health).													
5	- Revision of the local framework for Road Safety Audits (RSA), making this instrument compulsory in both the rural and structuring urban networks.													X
	- Promote the safety conditions of roadways by auditing projects and inspecting roads through:													
	◦ The effective implementation, within IMT's scope, of the Ministerial Order (to be published) regarding the certification of training entities, the certification/recognition of courses and other road safety training actions, and the certification and registration of Road Safety Auditors;													
	◦ The transposition and implementation of Directive (EU) 2019/1936 of the Parliament and of the Council of 23/10/2019 on Road Infrastructure Safety Management, enhancing and encouraging the implementation of road safety management procedures both on Trans-European Network roads (already mandatory) and on other roads in the National Road Network.													
	◦ Publication and subsequent implementation of the Order on Road Safety Auditors, namely the certification of training entities, certification / recognition of courses and other training actions in road safety and certification and registration of these professionals, whose draft diploma was made under Measure A22.84 of PENSE 2020;													
	◦ The revision or replacement of the following documents and methodologies (within or outside the scope of the transposition of the above-mentioned Directive) (see justifications in Annex I): Road Safety Inspections - Manual of application, Adjacent Area to the Carriageway - Manual on safety aspects, Manual of Road Safety Audits, Determination of Accident Accumulation Zones, Assessment of the social costs of road crashes with victims													
	◦ Regulating the activity of independent road safety audits. Creation of an independent and comprehensive forum responsible for verifying the widespread implementation of road safety audits, ensuring that they are carried out on all urban and interurban roads and not only on those forming part of the trans-European road network.													
	◦ At the level of new road or rehabilitation projects, there should be a legal obligation to prepare road safety audits;													

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	- Road Safety Audits should extend their scope of action to road infrastructures where there is a higher incidence of accidents, such as National Roads and the most important municipal roads (rural and urban).													
	- Make better inspections - train professionals to do this, reports should be public.													
9	- Support measures for fleets implementing driving support strategies, in particular Support systems based on road and driver monitoring.													X
11	- Review and update the existing set of normative documents: The Vertical Signalization Standard (NSV, from JAE) adding to it the new vertical signs and all road markings in similar ways, making it the Traffic Signalization Standard. All the Normative Provisions of traffic signs of InIR (DN-InIR, of the current IMT) in view of the amendments to the EC and the RST, converting it into the Traffic Signs Manual. The Tourist Signs Standard (NST).													X
	- As with in the Manual on Uniform Control Devices (U.S. Department of Transportation, Federal Highway Administration) and other manuals, it would be more practical to have a single volume, called the "Traffic Sign Manual", which incorporates all the necessary updates of those texts in light of the amendment of the RST													
16	- Streamlining homologation processes for new types of (light) vehicles for new urban services and their passive and active safety systems (ADAS, collaborative systems based on C-ITS, etc.);													X
18	- Familiarisation and preparation of security and rescue forces for electric/electrified vehicle assistance.				X									X
19	- Creation of reference framework for generalization of C-ITS systems and smart infrastructure, including smart signs and signals;													X
	- The implementation of the regulation for allowing connected and autonomous vehicles to be tested, as it is expected that autonomous and connected driving will produce benefits in terms of road safety, and here with a particular focus on the selection of the sections of infrastructure deemed suitable, and their progressive evolution as European and national regulations evolve.													
	- Creation of a multidisciplinary working group to prepare the introduction of automated vehicles in Portugal.													
32	- Review national legislation to enable connected and autonomous mobility;													X
33	- National diagnosis of the high road crash risk;													X
34	- Legal obligation to carry out road safety inspections of high road crash risk sites													X
35	- Build a national plan to implement measures that eliminate high road crash risk sites and implement traffic calming measures that, through low-cost measures, have a high impact on the reduction of accidents;													X
43	- Municipal Road Safety Plans, with mapping of the accident risk in municipal road networks, but also of soft and pedestrian mobility, with road safety audits and inspections, and subsequent municipal plans for the elimination of high road crash risk sites and implementation of traffic calming zones; Plans for the introduction of connected and autonomous mobility; Plans for infrastructure resilience to climate change;													X
	- Encourage the drafting of Sustainable Urban Mobility Plans (SUMPs) that promote sustainable travel modes, in accordance with the European Commission's SUMP Guidelines and existing national and European strategies on mobility, climate change and carbon neutrality, which enable a holistic vision of the territory, without losing their essential focus on improving the quality of urban life, public health and citizen safety.													

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	- Legislate that Municipal Road Safety Plans must be drawn up, regularly updated and monitored, always taking into account information on all types of accidents, whether with or without victims, in order to eliminate all existing crash risk sites in public spaces.													
48	- Issue guidelines to have a complete digital model by 2030 of the roads with the highest AADT and those with the highest incidence of high risk sites;													X
49	- Provide, until 2030, all roads with highest AADT and those with the highest incidence high risk sites with sensors enabling road users, including VRUs, to be counted and classified;													X
51	- Pursue, with the various stakeholders, the adoption of Connected Mobility solutions, to be completed by 2025, aimed at equipping all roads with highest AADT demand and those with high risk sites with the V2I/I2V10 communication infrastructure that enables the implementation of use cases defined by the C-ROADS platform;													X
52	- Apply solutions for automatic detection of infractions in all high risk sites on the road network by 2030, namely those corresponding to intersections/road conflict points;		X				X			X				X
	- Generalised speed control, through a very extensive coverage of the national road network by radars, making it possible to establish a culture of respect for speed limits;													
	- Promote the adoption of automatic systems for monitoring the rules of the road (e.g., video systems to control red lights, illegal parking, and illegitimate use of bus lanes).													
	- Explore changes in the legislation and practice of the enforcement agencies in order to automate fines with photographs and OCR with automated production of citation notes (speeding, but especially fines easily verified by photographs, such as vehicles parked on sidewalks and pedestrian crossings, as well as dangerous overtaking of cyclists). Equip GNR and PSP patrol cars which still do not have the equipment to immediately process the fines.													
	- Increase the number of fixed radar posts on roads, especially on motorways, national roads and in locations near schools and black spots we have previously identified. Along with alcohol, speed is a factor dependent on the driver's choice for which there should be no tolerance.													
55	- Publication and subsequent implementation of the Order on Road Safety Auditors, namely the certification of training entities, certification / recognition of courses and other training actions in road safety and certification and registration of these professionals, whose draft diploma was made under Measure A22.84 of PENSE 2020;													X
	- The revision or replacement of the following documents and methodologies (within or outside the scope of the transposition of the above-mentioned Directive) (see justifications in Annex I): Road Safety Inspections - Manual of application, Roadside area - Manual on safety aspects, Manual of Road Safety Audits, Identification of High Risk Sites, Assessment of the social costs of injury road crashes													
	- Regulating the activity of independent road safety auditors. Creation of an independent and comprehensive forum responsible for verifying the widespread implementation of road safety audits, ensuring that they are carried out on all urban and interurban roads and not only on those belonging to the Trans-European road Network.													
56	- The monitoring of the results of Measure A11.44 - Define and implement an implementation plan for rumble guideline markings for warning running-off the carriageway, which was still in progress at the end of 2020;					X								X

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
57	- The transposition and implementation of Directive (EU) 2019/1936 of the Parliament and of the Council of 23/10/2019 on Road Infrastructure Safety Management (enhancing and encouraging the implementation of road safety management procedures both on Trans-European Network roads (already mandatory) and on other roads in the National Road Network, namely motorways that are not part of the Trans-European Network). This transposition should lead to the amendment of Decree-Law no. 138/2010, of 28 December, Decree-Law no. 123/2014, of 11 August (which establishes the rules applicable to the carrying out of Road Safety Inspections) and, possibly, Decree-Law No. 122/2014 (establishing the rules applicable to the conduct of Road Safety Audits), of 11 August, and Law No. 49/2014, of 11 August (establishing the regime for access to and the exercise of the profession of road safety auditor, for the issue of the respective professional titles and for access to and the exercise of the professional training activity of auditors).													X
60	- The implementation of the regulation for permitting tests of connected and autonomous vehicles, as it is expected that autonomous and connected driving will produce benefits in terms of road safety, and here with a particular focus on the selection of the sections of infrastructure deemed suitable, and their progressive development, as European and national regulations evolve.													X
61	- Promoting the development of the eCall system (already implemented in Portugal) with integration in the traffic control centres of the road infrastructure managers, so as to improve and speed up the provision of emergency / signalling services and dissemination of information, also enhancing the communication of the infrastructure with the vehicle.				X									X
64	- To raise awareness on adoption of safe behaviour by all users when sharing road space, with a special focus on pedestrians, cyclists and other micro-mobility modes.								X	X	X	X	X	X
	- Healthy road coexistence in which everyone respects each other is essential in terms of safety, especially when there are users travelling in vehicles that are characterised by their fragility. Road safety campaigns to promote and encourage this good coexistence and respect among all users are a priority.													
	- Operational objective: revitalise and evaluate programmes and campaigns to prevent accidents and raise road safety awareness.													
	- Specific enforcement and user information campaigns. These include, in particular, information and awareness-raising actions for car drivers, but also for young people, senior citizens, motorcyclists, users of soft modes of transport and cyclists.													
	- Encouraging the use of retro-reflective material, particularly by pedestrians and other more vulnerable road users, has proved to be a very effective tool in reducing the risk of accidents.													
	- Creation of a 3-5 year strategic communication plan aligned with nationally defined priorities/risk factors, aimed at behaviour change, with campaigns developed based on theoretical models of behaviour change, and subject to evaluation of effectiveness													
65	- To study the implementation of Road Safety Plans developed by the actors of the mobility and transport system (e.g. road transport companies, transport coordination centre managers, shared mobility companies, etc.).													X
67	- Strengthen the national electronic register of road transport companies licensed by IMT, with connection to the EC ERRU platform and the competent national authorities, in order to enhance the effective sanctioning of entities that repeatedly fail to comply with the regulations in force;													X
68	- Strengthen surveillance in the road transport sector and promote capacity building of surveillance entities in the area of safe transport.		X			X								X

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
69	- A (concerted) review and update of the entire legal framework for transport, in alignment with the new Mobility Package and other Community regulations, in order to foster harmonisation of understanding and uniform application of the legal provisions by all supervisory bodies;													X
72	- To promote the strengthening of monitoring in the training and assessment of driving instruction professionals and professional drivers in areas with relevance to road safety;													X
74	- Strengthen skills for maintaining safe driving in senior drivers;													X
75	- Strengthen the quality of physical, mental and psychological assessment of drivers.													X
	- To increase IMT's intervention and response capacity in terms of psychological evaluation of drivers;													
	- Promote references to support the physical, mental and psychological assessment of drivers.													
	- Operational objective: to establish accredited bodies for the medical and psychological assessment of drivers.													
76	- To accompany and raise awareness of driving schools to the need to reinforce the syllabus on road safety, in particular as regards the Common Modules on Road Safety and the Supplementary Theoretical and Practical Modules, and to the use of learning techniques and methods that endow driver candidates with a greater awareness of the driving task demands (e.g., by commented driving, coaching), that appeal to higher alertness and improved detection of dangers in driving, and to the awareness and responsibility for driving decisions;								X			X		X
	- Increasing the number of road safety questions in the theoretical test for learner drivers and in the theoretical test for accessing the profession of driving instructor and also for professional drivers;													
	- Promote the reinforcement of monitoring in the training and assessment of new drivers in areas with relevance to road safety;													
	- Introduce specific content on drink-driving in driving instruction, with compulsory questions on the subject in the theory test.													
	- Driver training, including vehicle handling, familiarisation with traffic rules, assessment of risk factors in road traffic and assessment of their own skills and limitations													
	- Professional motorbike driving instructors should provide practical evidence of extensive motorbike experience and not mostly theoretical knowledge of little relevance to the practice of driving 2-wheeled vehicles.													
91	- Implement the regulation for permission to test connected and autonomous vehicles, since autonomous and connected driving will produce benefits in terms of road crashes, and here with a special focus on the selection of the sections of infrastructure considered suitable, and their progressive preparation, as European and national regulations evolve.													X
92	- Promote the possible evolution of the eCall system already implemented in Portugal, with integration in the traffic control centres of the road infrastructure managers, in order to provide better and faster emergency/signalling services and information dissemination, also enhancing the communication of the infrastructure with the vehicle.				X									X
93	- Implement technical inspection of motorbikes, tricycles and quadricycles with an engine capacity greater than 125 cm3, through CITVs; - Implement, as with automobiles, a plan to test motorbikes with different cylinder capacities (while respecting the possibility of adapting these vehicles, as long as safety rules are not violated).								X			X		X
95	- To foster the installation of 3-point safety belts in seats in buses in categories II and III;													X
96	- To regulate the conditions of approval and traffic of mobility devices, which are not covered by European regulations in the area of road vehicles													X

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
97	- Awareness campaigns (including relaunching): ◦ on the risks associated with distracted driving ("THE BEST SAFETY IS OUR BRAIN. DON'T DISTRAIN IT.")	X	X	X		X	X	X	X	X	X	X	X	
	◦ Awareness campaign for drivers in general regarding the potential reduction in capacity (physical, mental and psychological) to drive safely, in particular from the effects associated with the pandemic caused by COVID19.													
	◦ Communication and awareness campaigns for specific risk groups, namely young people, the elderly, motorbike drivers, due to the number of accidents in these groups / Campaign re-launched.													
	◦ Campaign to raise awareness of the risks associated with speeding/over-speeding / Relaunch campaign.													
	◦ Campaign to raise awareness of the risks associated with driving under the influence of alcoholic beverages and psychotropic substances / Relaunching the campaign.													
	◦ Awareness-raising campaigns targeting the drivers of two-wheeled vehicles /													
	◦ Holding a television competition similar to what happens in Spain, in the programme produced by TVE called "*Arranca en Verde*" https://www.rtve.es/rtve/20180226/1-estrena-arranca-verde-concurso-sobre-seguridad-vial-presentado-sara-escudero/1684728.shtml - a weekly interactive competition, in which a guest (public figure) is asked questions related to road safety, with the simultaneous and active participation of the viewer, with the aim of playfully disseminating traffic rules and raising awareness of road prevention.													
	◦ Periodic and regular awareness-raising campaigns in the media, in partnership with ANSR, regarding the correct use of vehicles and accessories: speed, loading, reflectors, tyres, fitting child seats													
	◦ Collaborate in the development of a communication strategy, from the prioritised selection of the themes to be addressed (speeding, fatigue, alcohol, mobile phone use, drugs, ...), to the segmentation of the target groups by identifying their motivations and their vulnerabilities, developing the brief/s for the selection of advertising and media agencies. ▫ Identify each target group, i.e. groups of people who share some key characteristics. ▫ Identifying motivations and beliefs, which may be the genesis of approaches to generate behavioural change ▫ Development of a detailed brief on the objectives, target group, core strategy and supporting rationales, enabling creative agencies to develop campaigns ▫ Pre-test of the developed campaign: 1. attention; 2. impact; 3. affinity; 4. behavioural change; ▫ Development of a detailed briefing on the objectives, target group, core strategy and supporting rationales, allowing media agencies to select the media considered most effective to achieve the desired coverage and frequency ▫ Monitoring of the production of advertising pieces													
	◦ Carrying out communication campaigns that promote safe behaviour and good coexistence among all road users, segmented according to the recipients identified as being at greater risk.													
	◦ Carry out campaigns that effectively convey a better understanding of the risks of car mobility, in particular the concrete consequences of risky behaviour and non-compliance with safety rules.													
	◦ Use of quantitative studies to assess the effectiveness of the campaign on the target group													
	◦ Improve the knowledge and dissemination of data on the blood alcohol content of those involved in road crashes with bodily injury.													

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	Healthy road coexistence where everyone respects each other is essential in terms of safety, especially when there are users circulating in vehicles that are characterised by their fragility. Road safety campaigns to promote and encourage this good coexistence and respect among all users are a priority													
	◦ Assume the need to invest in information and awareness-raising for the population in general, in a more incisive and sustained manner, with regular publicity campaigns. Similarly to what has occurred in other countries, the use of graphic and explicit images in the transmission of the consequences of accidents (especially those resulting from the human factor) is defended.													
101	- Campaign to raise awareness of the risks associated with driving under the influence of alcoholic beverages and psychotropic substances / Relaunching the campaign.		X	X										
	- Collaborate in the development of a communication strategy, from the prioritised selection of the themes to be addressed (speeding, fatigue, alcohol, mobile phone use, drugs, ...), to the segmentation of the target groups by identifying their motivations and their vulnerabilities, developing the brief/s for the selection of advertising and media agencies.													
	- Improve the knowledge and dissemination of data on the blood alcohol content of those involved in road crashes with bodily injury													
105	- Project "Road Safety Ambassadors" who, in a voluntary and committed way, get involved in actions that help reduce the number of deaths and serious injuries on the roads (e.g. on-site actions with peers to dissuade driving under the influence of alcohol and/or drugs).		X			X	X	X	X	X		X	X	
	- Peer education programmes, raising awareness of the consequences of inappropriate behaviour, namely those related to factors such as age and gender, age and peer group motivations, lifestyle, alcohol and drug habits, speed and the use of mobile phones or similar (e.g. "Close To", with the aim of reducing the typical risks of the 17 - 24 age group and recidivism, and at the same time preventing risks for other young people and future drivers).													
	- To follow-up on drivers' driving after qualification (follow-up), through forums/discussions that allow for the sharing of experiences, namely difficulties in driving and accidents during the first 2-3 years, identifying common risk factors and safer driving decisions for all. Involving, namely, Road Safety Ambassadors and recent graduates.													
109	- Develop/increase data interoperability, namely with regard to the driver's cycle, so that the various entities intervening in this cycle may interact effectively and efficiently in the exchange of information													X
110	- Generalised speed control, through a very extensive coverage of the national road network by radars, making it possible to establish a culture of respect for speed limits;						X			X				X
	- Explore changes in the legislation and modus operandi of the enforcement forces in order to automate fines with photographs and OCR with automated production of fines (speeding, but in particular fines easily verified by photographs, such as vehicles overtaking pavements and pedestrian crossings, as well as dangerous overtaking of cyclists). Equip patrol cars GNR and PSP do not have the equipment to immediately process the fines.													
	- Increase the number of fixed radar posts on roads, especially on motorways, national roads and in locations near schools and black spots we have previously identified. Along with alcohol, speed is a factor dependent on the driver's choice for which there should be no tolerance.													

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
111	- An extensive control of heavy goods vehicles weights, currently degrading not only road safety but also the life service and maintenance of road infrastructure.													X
119	- Use of quantitative studies to assess the effectiveness of the campaign on the target group					X								
	- Road safety statistics to assess the real impact of changing behaviour													
127	ANSR's accident reports of 2020 no longer contain important data that allow us to assess the evolution of accidents in two-wheeled motor vehicles, namely the total number of deaths, serious injuries and light injuries of this category of users. It is important to re-disclose this data because without it we cannot accurately assess the evolution and outcome of the implementation of preventive measures to combat accidents involving two-wheeled motor vehicles.											X		X
128	Professional motorbike driving instructors, should provide practical evidence of extensive motorbike experience and not mostly theoretical knowledge of little relevance to the practice of driving 2-wheeled vehicles.													X
131	Basic road safety knowledge should be taught from primary school age (6 years old), with a special focus on pedestrian behaviour;	X	X	X		X	X	X	X	X	X	X	X	
	- To raise awareness of the adoption of safe behaviour by all users when sharing road space, with a special focus on pedestrians, cyclists and other means of micro-mobility.													
	- Specific enforcement and user information campaigns. These include, in particular, information and awareness-raising actions for car drivers, but also for young people, senior citizens, motorcyclists, users of soft modes of transport and cyclists.													
	- Encouraging the use of retro-reflective material, particularly by pedestrians and other more vulnerable road users, has proved to be a very effective tool in reducing the risk of accidents.													
135	- In order to eliminate this problem, it is necessary to ensure that the marking and horizontal signposting of the roads is done exclusively with fluorescent paints and with an anti-slip characteristic with high adherence and mechanical resistance.								X			X		
	- Improving the performance of road markings and vertical road signs, including their placement, visibility and retro-reflectivity													
	- Use suitable materials for road markings on the pavement, such as zebra crossings and continuous lines, to avoid loss of adhesion in rain.													
138	There is a serious failure in the identification and listing of risk locations where the application of safety barriers to unprotected rails is required. To this end, it is important to know who is responsible, namely: the survey of black spots related to this problem; the list of protection devices on the safety rails already applied on the roads, to date; the planned schedule for placing the remaining protections on the safety rails; the application of the sanctions referred to in article 6 of Law 33/2004 for non-compliance with the same.								X			X		X
139	- The delimitation of urban space in order to avoid the misuse of spaces which are not authorized for vehicles, has motivated municipalities throughout the country to install in an intensive way vertical metallic posts. Regardless of its justification in the management of urban spaces, the use of devices on roads cannot disregard the safety factor for some categories of users of these roads. Users of two-wheeled vehicles (with or without motor) are by nature the most exposed to road equipment, whose characteristics may become counterproductive and even quite dangerous in the event of an accident. Whatever their profile, this type of equipment makes urban roads particularly unsafe for cyclists and PTW occupants.								X			X		
	- The installation of equipment on public roads must not pose a threat that endangers the lives of road users. There are marker posts made of plastic derivatives which, due to their flexibility, prevent physical damage and return to their original shape after a shock.													

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							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	- Favour the use of flexible rather than rigid bollards or marker posts near to the carriageway.													
149	- Setting up a multidisciplinary group for investigating road crashes													X
	- Multidisciplinary teams to analyse accidents. More data involving the causes of accidents is needed													
	- Set up multidisciplinary teams to investigate serious road crashes, identify their causes and recommend and implement concrete preventive measures, for the continuous improvement of road system safety.													
	- Definition of applicable scientific and technical analysis models and training of specialists.													
	- Construction of a computer platform for data compilation and analysis.													
	- Analysis of compiled data and advocacy of preventive measures.													
	- improving the collection and analysis of road crash data and its monitoring, enabling the development of new road safety measures.													
	- analyse and investigate the causes and consequences of accidents and possibilities of minimising them.													
	- Investigating the causes of potentially more serious accidents (frontal collisions and pedestrian collisions) by analysing images taken by frontal video cameras installed in vehicles													
	- Investigation of accidents, incorporating geo-referencing, to determine black spots and accident typology in order to take mitigating decisions													
	- Create conditions for the (multidisciplinary) investigation of road crashes.													
	More investment in accident investigation.													
151	Review and update legislation on the Collective Transport of Children													X
	Create a "working group" responsible for analysing and discussing the application of existing legislation in order to guarantee its homogeneous interpretation and application (example: Law of Collective Transport of Children, Article 55 of the Highway Code). This should be able to issue binding opinions or interpretative documents													
157	Create a network of municipalities (similar to the Portuguese Healthy Cities Network or Child-Friendly Cities) adherent to this programme										X		X	X
161	- Create a continuous, safe, convenient and inclusive pedestrian network around educational establishments										X			X
	- Design and disseminate to local authorities a Manual of Good Practices for the promotion of safe mobility of children and adolescents in educational establishments													
	- Promote the creation of zones 20 and 30 near educational establishments and residential areas													
	- Define a minimum critical zone around schools free of motor vehicle traffic or with major restrictions on their speed (through traffic calming measures) and parking													
	- To promote a more sustainable and active school and child mobility considering mainly home/school commuting, particularly through the creation of safe routes, the promotion of walking or cycling on short distances and the use of collective transport vehicles instead of individual car transport on long distances.													
164	- Promote the creation of zones 20 and 30 near educational establishments and residential areas									X	X	X	X	
	- Define a minimum critical zone around educational establishments free of motor vehicle traffic or with major restrictions on their speed (through traffic calming measures) and parking													
166	Promote road citizenship education for children and young people													X
	- Promote the use of ANSR's Digital Educational Resources on Road Safety, Júnior Seguro													

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							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	- Support children and youth education initiatives already underway (e.g. promoted by APSI, A-CAM, Estrada Viva, Gare, Mubi)													
	- Elaborate a training programme for teachers and early childhood educators and promote/support the realisation of training actions for these professionals													
	- Elaborate a training programme for higher education students attending courses with access to professions in the area of mobility and traffic planning and management (engineering, architecture) and promote/support the realisation of these training actions													
	- Create in Portugal a similar initiative or in articulation with Youth for Road Safety													
	- Promote the correct and systematic use of seatbelts and restraint systems by children and young people													
	- Strategic Goal- To promote education and training for the development of a Road Safety Culture in articulation with the framework in which the National Strategy for Education for Citizenship is developed.													
	- Operational Objective 2- Encourage the creation of networks of schools that develop road safety education projects;													
	- Operational Objective 3 - Foster spaces and diverse modalities of training in Road Safety. "													
	- Operational objective: deepen road safety education in school curricula and driver training/certification													
178	Creating an integrated support system for victims of road crashes													X
182	Integrate first aid training into the mandatory syllabus of the training for obtaining a driving licence				X									X
189	- To know and disseminate statistics on Road crashes occurring in the context of work or home-work commuting, so as to allow the creation of indicators for monitoring and management;													X
	- To know and disseminate the characteristics, causes and circumstances that are at the origin of these accidents (in the context of work or home-work commuting) and their consequences as a tool to support the creation of public campaigns/policies that enable safer users/infrastructure and/or vehicles.													
	- Know and disclose the time (hour, day, month) and geographical (municipality) location where most accidents occur in order to adjust the response to the demand for immediate assistance services;													
	- Knowing and publicising the consequences of accidents in order to be able to tailor the response to victims' needs.													
200	Operational objective: continue surveillance actions, especially focused on the areas of greatest risk.	X	X	X		X	X	X	X	X	X	X	X	
205	Multidisciplinary teams to analyse accidents. More data involving the causes of accidents is needed													X
206	As qualifying training actions, drivers should attend the training action "Driving and operating the tractor safely (COTS), of 35 hours, provided in paragraph d) of Article 2, of Order 3232/2017, of 18-02, or the Short Duration Training Unit (UFCD) 9596, of the National Qualifications Catalogue, of 50 hours; The training actions should be taught by entities previously certified as training entities, being the training actions approved and the trainees evaluated, as provided in art.In Portugal about half of the tractors in circulation on the road have no protective structure - safety arch, safety frame or cab - or restraint systems, because they are not mandatory. Moreover, these tractors are unlikely to be replaced or be subject to legislation that makes it mandatory to install these structures that protect the driver in cases of overturning;													X
212	- Introducing speed limitation systems in vehicles, with reference to the values allowed for traffic in each country.						X			X				X

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							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
	- Promoting the use of modern technologies to enhance road safety has an important effect on road safety. The widespread adoption of incident detection systems, notably Collision Warning and Pedestrian Recognition Systems with automatic braking, can be instrumental in reducing accidents and their effect in urban environments, as well as in inhibiting excessive speed. Retrofitting these advanced driver assistance systems to newer vehicles in the current car fleet should be considered.													
213	Ensure that drivers are trained and up-to-date, ensuring that they are able to use vehicles equipped with new technologies to support driving, as and when they appear on the market.													X
219	Reduce the average speed on our roads, particularly those through villages;						X			X				X
221	Ensure that drivers respect the legal limit for driving under the influence of these substances;		X	X										
222	Creates conditions for all establishments authorised to sell alcoholic beverages to provide their customers with free equipment to measure the blood alcohol level		X											X
223	Discourage the use of mobile devices while driving.	X												
224	Ensure that all occupants of four-wheeled vehicles are wearing seatbelts properly, particularly in the rear seats;							X						
225	Ensure that all drivers and passengers of two-wheeled motor vehicles wear an approved helmet that is properly fitted and fastened;								X			X	X	
226	Ensure that no child under 135 cm in height and under 12 years of age is travelling without a suitable restraint system;							X						
227	Encourage cyclists to wear helmets, particularly when riding outside cycle paths.												X	
228	Invest in campaigns that encourage users of scooters and bicycles to respect road rules and promote the peaceful sharing of road space and safeguard the safety of other road users.	X									X	X	X	
229	- Completion of the regulation process of the Legal Regime of Driving Education, publishing the missing legislation since 2014, so that its full implementation is possible;													X
	- Publication of the ordinance that regulates the training of driving school instructors and directors, adapting them to the legislation in force;													
	- Creating a rule to allow drivers who, by choice, have taken a practical test in an automatic gearbox vehicle to remove restriction 78 (automatic gearbox) from their driving licence by taking the training and test in a manual gearbox vehicle;													
232	Creation of regulations guaranteeing that driving agricultural vehicles on public roads depends on prior training in a driving school and passing a specific driving test, thus extinguishing the possibility of driving this type of vehicle by "equivalence";								X					X
233	Introduction of Advanced Driver Support Systems (ADAS) in the syllabus of driver training, so that new drivers are aware of the functionalities and limitations of the technologies equipping the vehicles currently in circulation;													X
234	- Implementing the monitoring of the practical driving test, introducing a system that allows the automatic recording of the duration and route taken, the faults committed by the candidate and the place where they occurred, using tablet-type equipment for this purpose;													X
	- Updating of the practical test report model, adapting it to the legislation in force and filling in the device indicated in the previous sub-paragraph;													
	- Implementation of measures to prevent/minimise examination fraud, namely: Installation of equipment that inhibits communication with the outside (cameras, mobile phones, smartwatches, etc); Creation of procedures to prevent the access of "stuntmen" to the examination papers													

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	The fact that theoretical tests are carried out using translators (hired by the trainees themselves) raises strong suspicions as to the seriousness of the system. The test with translators should be eliminated, making it possible to answer the test in other languages on the computer, as happens in other European countries.													
	- Completion of the examination procedures manual (in preparation since 2015), in order to promote uniformity of assessment criteria													
	- Reformulation of the system of driving tests, in terms of content, the way they are conducted, and the structure responsible for conducting them													
240	- The driving of two-wheeled motor vehicles will now require specific training and a driving test, and the possibility of driving category AM and A1 vehicles simply because one is qualified to drive category B will be removed;								X			X		X
	the possibility of direct access to category A should be removed, and a system of gradual and sequential access should be introduced (A1, A2, A), enabling drivers to gain experience on less powerful motorbikes, thus helping to reduce the number of deaths on this type of vehicle													
	- Changes to the training of motorbike drivers, particularly as regards practical aspects													
242	Drivers must now attend training to update their knowledge on traffic rules, road signs and signals, new technologies and other key aspects of driving on a regular basis.													X
250	In the case of medicines, the therapeutic use of which may be compatible with driving, it will be important to define which drugs, therapeutic concentration intervals and clinical framework should be considered in the context of supervision. This study should be carried out by specialists in the health area (medicine, psychology, pharmacy) regarding the potential effects of drugs with an impact on driving performance, and in the operational area (GNR, PSP, INMLCF) regarding the ability to detect the substances defined.			X										X
253	Stepping up enforcement of the Highway Code, verifying and deterring infractions in a more efficient manner, where the widespread adoption of electronic traffic control instruments is absolutely critical and will perhaps be among the measures with the greatest short-term impact.	X					X			X				
257	RST does not respond to the current needs of cities, being neither adjusted to the model of public space, with less dependence on vertical signs (which compromises the traffic of pedestrians in particular of reduced mobility), nor adjusted to the protection of vulnerable users in the road space (in particular cyclists).												X	X
259	At school level, there are ways to increase the autonomy of children, either through specific training or through a thorough review of the conditions of traffic and road requirements in the surroundings of these facilities.										X			X
261	- Safety and consequence of accidents associated with mopeds/motorcycles is relevant, and improvements in this field could be linked to type approval, integrated safety devices (e.g. airbags), possible vehicle performance inhibitors and equipment and clothing for drivers (and passengers).								X			X		X
	- Promote the use of safety airbags incorporated in protective clothing for motorcyclists. New safety systems should be adopted in the regulation of clothing that promotes the protection of the rider.													
262	- Promoting the use of modern technologies to enhance road safety has an important effect on road safety. The widespread adoption of incident detection systems, notably Collision Warning and Pedestrian Recognition Systems with automatic braking, can be instrumental in reducing accidents and their effect in urban environments, as well as in inhibiting excessive speed. Retrofitting these advanced driver assistance systems to newer vehicles in the current car fleet should be considered.						X			X				X

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	- Introducing speed limitation systems in vehicles, with reference to the values allowed for traffic in each country.						X			X				X
265	Funding and support for the implementation of the objectives and subsequent measures and actions that may be proposed under the Strategic Plan for Road Safety 2021-2030 - Vision Zero 2030, namely those that fall within the scope of municipalities' actions.													X
266	The Municipal Police must be considered as one of the relevant entities with a view to pursuing the objectives, measures and actions that may be defined, given their responsibilities in terms of regularisation, traffic control and road parking.													X
281	- To obtain and analyse evidence-based information on people's behaviour in the road system: to identify the types of errors that drivers and other participants in the traffic system make; to define the effects of such errors on the road system; to define measures to prevent these errors.				X									X
	- To define the methods and resources needed to increase the self-awareness of drivers and other participants in the road environment.													
	- Define the methods and resources needed to provide users with feedback on the safety of their behaviour.													
	- Investigate and analyse new behaviours and ways of user interaction with vehicles and road environments, in light of new intelligent and automated technological tools and systems													
	- To promote collaborative R&D projects between universities, research centres, companies and public institutions in the area of testing and demonstrating new technologies in the field of road safety.													
	- Develop studies associated with different risk factors (mobile phone use, use of restraint systems, alcohol consumption), as well as risk assessment by age group, mode of transport and geographical context.													
	- To promote the study of road trauma, its effects and wider consequences, among higher education and scientific research institutions dedicated to health sciences;													
300	- Promote the use of data generated by driving and/or eco-driving support systems (geo-referencing) to identify high risk sites or areas where infrastructure may be enhancing the occurrence of road safety accidents or incidents													X
305	- Adoption of ignition interlock systems, for early detection of the alcohol level in the blood, by the driver.		X			X		X	X					X
	- Develop the use of "alcoolock" as part of rehabilitation programmes for repeat offenders, for offenders with a BAC of 1.2 g/l or above (first time) and for those responsible for traffic accidents with illegal BAC.													
306	- Promote the adoption of Road Safety Management Systems, preferably using the "ISO 39001" reference.													X
309	- Approve the creation of 'Technology Free Zones' (TFZs) for testing innovative solutions for promoting road safety. In particular these TFZs should comprise a legislative framework that promotes and facilitates the conduct of research, demonstration and testing activities, in a real environment, of innovative technologies, products, services, processes and models.													X
310	- Facilitate, through the creation of appropriate legislation, the carrying out of tests and pilot projects for the use of autonomous vehicles.								X					X
314	- Quantitative indicators - collect how many kilometres are driven by the user, or by mode, to be used for risk measures.													X
317	- Public availability of accident databases (raw).													X
	- Create a dynamic online platform that makes it possible to consult statistical information on road crashes (with the possibility of different breakdowns and crossing of variables, for example, by age, mode of transport and geographical context)													
	- Create a rapid, effective and reliable system for collecting, processing and consulting relevant information													

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		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
324	- Critical steps - know the guidelines. Four priorities: speeding, junctions, illegal parking, highly vulnerable areas (schools).					X	X			X	X			
327	- Intensifying the training of magistrates in the field of Road Crime, integrating this theme in the annual planning of the CEJ (Centre for Judicial Studies), in a non-case-by-case perspective.													X
329	- Drawing up a multi-year plan to reinforce the emergency resources allocated to the Integrated Medical Emergency System, providing INEM's budgets with the necessary financial resources to meet the goals set out in that plan.				X									X
330	- Institutionalisation of a network to support victims of road crashes and their families, supported by a programme and resources that make it operational, taking up an objective enshrined in PENSE 2020 that was completely ignored.				X									X
343	- Training sessions for police officers to enable them to constantly update their knowledge in the areas of road risk control and sustainable mobility, thus enabling them to perform better in terms of enforcement and in terms of education and awareness-raising, whether through the Safe School programme or other programmes and projects aimed at other target audiences.													X
350	- Increase the rate of seat belt use in the back seat, through a campaign showing that if a body is loose in the back seat, its weight will be multiplied by 20 in a crash at 50 km/h, endangering all occupants of the car.							X						
353	- Reduce the potential negative impact of distracting equipment on drivers (mobile phones, music players with headsets, GPS), through campaigns, and legislation mandating the availability of mobile communication device usage data from telecom operators in case of post-disaster investigations.	X												X
356	- To promote a more sustainable and active school and child mobility considering mainly home/school commuting, particularly through the creation of safe routes, the promotion of walking or cycling on short distances and the use of collective transport vehicles instead of individual car transport on long distances.										X		X	X
360	- Adapting urban road networks to the safe use of all modes of transport, especially the most environmentally and socially friendly, in order to increase the number of trips on foot and by bicycle (non-polluting modes with a beneficial impact on health).										X		X	
362	- Creation of continuous pedestrian networks within urban areas that are obstacle free, accessible, well designed and signposted with good visibility and lighting.										X			
366	- Creation of a financing fund for municipal road safety plans.													X
373	- Creation of a multidisciplinary working group to prepare the introduction of driverless vehicles in Portugal.													X
375	- The improvement of trauma victim care, the standardisation of health procedures through the creation of Regional Trauma Networks, a National Trauma Register, with continuous monitoring and quality assessment tools.				X									
376	- Creation of an integrated network to provide psychological, social and legal support to the victims of road crashes and their families, including the creation of a specific phone number, local social support, lawyers specialised in the defence of the traumatised person, therapeutic support for the traumatised person and their family, and support in the area of rehabilitation and social reinsertion.				X									X
384	- To promote the study of road trauma, its effects and wider consequences, among higher education and scientific research institutions dedicated to health sciences;				X									X
387	- Promotion the World Day of Remembrance for Road Traffic Victims at the national level, and creation of national memorial and municipal memorials.													X
391	- Improving the judicial culture of road crime assessment;													X
	- Promote training sessions, colloquia or meetings, inviting the participation of judges, lawyers and magistrates, on the topic of support/compensation to victims;													

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							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
394	- Invest systematically in Primary and Secondary Education by including road safety issues in the subjects related to Citizenship and First Aid. As most accidents depend on the human factor, it is essential to invest in the attitudes of future generations.													X
	- Increase awareness-raising actions among primary and secondary school students by organisations such as the INEM, Fire Brigade and Security Forces, all of which already have programmes of this kind to be strengthened. The entities responsible for responding to occurrences should also play a role in preventing them.													
	- Development of teaching resources to support teachers and students in their activities on road safety and sustainable mobility for ages 12+													
	- Continue the training process for Basic Education teachers and Early Childhood Educators, which is being implemented with the coordination of the DGE (*Direcção Geral da Educação*)													
	- Deepen the training process for Basic Education teachers and Early Childhood Educators													
398	- Systematically and consistently analyse the main high risk sites on national roads (considering the number of accidents and resulting fatalities), in an integrated process between the INEM, the Fire Department, the Security Forces and the Portuguese Infrastructures, under the aegis of ANSR, in coordination with Civil Protection. For the most striking situations (the "top +") there should be a specific intervention plan, which identifies the responsibilities of those involved and schedules the actions in order to enable the later evaluation of the success of the measures. More than identifying the problematic situations (which sometimes already happens), it is necessary to make the relevant actors responsible for solving the problems identified (which does not always happen).				X									X
399	- Increase roadside enforcement actions regarding alcohol and drugs, with the implementation of a zero-tolerance policy towards offences in this field. Criminalisation must be reinforced in a field that derives solely from the conscious choice of the driver. Considering the dimension of alcoholism in society and in accidents, this issue deserves priority in the national panorama.		X	X										X
400	- Increase the number of fixed radar posts on roads, especially on motorways, national roads and in locations near schools and high risk sites previously identified. Along with alcohol, speed is a factor dependent on the driver's choice for which there should be no tolerance.		X				X			X				X
401	- Heavy penalties for using a mobile phone while driving. Again, this is a driver's choice which should not be tolerated. With the existence and ease of implementation of "hands free" systems for using a mobile phone in the vehicle, it is important to combat mobile phone use without these devices.	X												X
408	- Implement maximum response time targets for accidents occurring along motorways. This measure may imply the relocation of rescue means, but in an important way it will shorten the time until the start of the rescue (as it has happened in other countries).				X									X
409	- Invest in the increasing qualification of the minimum rescue services, encouraging the professionalization of the rescue ambulance teams, standardizing minimum criteria between the Firemen and the INEM for the Pre-hospital Emergency Technician level training (as already existent in some INEM means). It is not legitimate to perpetuate the serious asymmetry of criteria in the qualification of the rescue teams comparing the urban environment in large cities of the country and the rest of the national scene.				X									X

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		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
410	- Assume the concept of "first responder", as has been the case in more developed countries, where the Security Forces assume a role in first responder assistance (including the use of automated external defibrillation in cardiac arrest situations, with AEDs in patrol vehicles). All first responders have a duty to contribute to saving lives.				X									X
411	- Incorporate the teaching of Basic Life Support within the mandatory training for the Type A and B driving licence. A measure that would add only 4-6 hours of time and a charge of less than about 100 euros, but which would increase the culture and effective capacity of the next generation in responding to any serious health occurrence, including in the context of the road accident.				X									X
412	- Increase the articulation between the Security Forces and the INEM in order to facilitate even more the early use of heli-transport teams in support of road crashes. Airborne means can not only shorten the response time to the scene, but also take the patient immediately to the most appropriate destination, although not necessarily the closest one (e.g. the burn patient). The German ADAC system could be a good example to analyse, with response times studied for any point along German motorways.				X									X
413	- Improve the capacity for secondary (inter-hospital) transport of critically ill patients within the trauma network. In particular, standards of good practice defined since 2008 and legislation published in 2014 on regional critical patient transport networks should be respected.				X									X
414	- Implement an integrated registry between the Security Forces and INEM resources (or at its service), in order to foresee the interoperability of information systems. Given the technological possibilities, it is not acceptable to perpetuate islands of knowledge or hinder the process of transforming data into information.				X									X
415	- Implement a National Trauma Register (as already recommended in the Plan 2010-2020), with the possible adoption in the hospital network of the German Register already tested since 1993 (subject recommended by the National Trauma Commission, by several Professional Associations and a wide range of Medical Scientific Societies).				X									X
417	- Define quantitative objectives for enforcement of driving under the influence of alcohol, combining with these actions, communication campaigns developed for specific targets, according to the good practices defined in the CAST project.		X	X		X								X
419	- Introduce specific content on drink-driving in driving instruction, with compulsory questions on the subject in the theory test.		X											X
421	- Improving the initial and continuing training of teaching professionals (driving instructors) and driving examiners so that they are competent to apply such measures, whether in training or in assessment.													X
422	- Encourage the use of specific safety equipment when driving two-wheeled vehicles, such as gloves, jackets, backpacks or equipment with airbag systems, by promoting the importance of their use and tax incentives (e.g. VAT reduction).								X			X		
	- Safety and consequence of accidents associated with mopeds/motorcycles is relevant, and improvements in this field could be linked to type approval, integrated safety devices (e.g. airbags), possible vehicle performance inhibitors and equipment and clothing for drivers (and passengers).													
	- Promote the use of safety airbags incorporated in protective clothing for motorcyclists. New safety systems should be adopted in the regulation of clothing that promotes the protection of the rider.													
	- Encourage the use of specific safety equipment when driving two-wheeled vehicles, such as gloves, jackets, backpacks or equipment with airbag systems, by promoting the importance of their use and tax incentives (e.g. VAT reduction).													

#	Description	Operation												Institutional
							Rural			Urban				
		Distraction	Alcohol	Drugs	Post-crash care	Fatigue	Speeding	Car occupants	Motorcyclists	Speeding	Pedestrians	PTW	Cyclists	
423	- Encourage the purchase of vehicles with active safety systems, namely traction control and brake distribution.								X			X		X
426	- To control the state of conservation and dimensions of the number plates, in order to enable the identification of the drivers in speed enforcement actions - application of 161, Paragraph H of the Organic Law.								X			X		
427	- Intensification of speed enforcement with special actions targeting motorcycles.						X		X	X		X		
435	- Initiate the training of Secondary School and Adult Education teachers within the Framework of Road Education for Secondary School and Adult Education and Training.													X

ANNEX IV
Reference values for exposure and safety indictors

Table IV.1 – Reference values for the developments in Mainland Portugal population (INE)

Age group	2010-2019	2015-2019	2020-2029
0 – 19	-1.15%	-0.93%	-1.02%
20 – 24	-1.01%	-0.03%	-1.52%
65 – 74	1.42%	1.90%	1.24%
75 +	1.99%	1.32%	2.32%
National total	-0.36%	-0.16%	-0.21%

Table IV.2 – Annual variation (2010-2019) and forecast of travelled distances

Traffic volume	2010-2019	2015-2019	2020-2029
Motorways	0.02%	6.40%	-
National total	-1.04%	2.20%	-
Bicycles	-	-	Increase in traffic share, from <1%, to 3% in 2025 and 7.5% in 2030 nationally (ENMAC[1])

(1) – ENMAC – National Cycling Strategy

Table IV.3 – Reference values for vehicle fleet developments

Vehicle fleet	Yearly rate	
	2010-2019	2015-2019
Cars	1.08%	3.45%
Vans	-1.08%	0.10%
Light vehicles	0.62%	2.79%
Motorized vehicles	0.59%	2.79%
Motorcycles (ASF[1])	7.03%	13.83%
Mopeds (ASF)	-0.92%	-1.09%
Bicycles (*)	-	+2.70%
e-bikes (*)	-	+315%

(1) – ASF – the Insure Supervising Authority
(*) – Production of bicycles (source ABIMOTA) – overall, 8% of the production

Table IV.4 – Reference values for percentage of driver fatalities with BAC ≥ 0.50 g/l (Source: Portuguese Institute of Legal Medicine and Forensic Sciences - INMLCF).

Alcohol	Average (2017-2019)	Yearly rate	
		2010-2019	2015-2019
Killed drivers w/BAC ≥ 0.50 g/l	34%	-1.83%	2.38%
Killed pedestrians w/BAC ≥ 0.50 g/l	26%	-4.41%	5.22%

Table IV.5 – Most recent measurements of variables related to safety devices

Variable	Measurement	
	Result	Date
Seat belt use		
Car front seat	96%	2013
Car rear seat	77%	
Car rear seat (city)	28%	
Bus	22%	
Child restraint use		
< 2 years	100%	2013
2 – 5 years	98%	
6 – 11 years	93%	
Wearing helmet		
Motorcycle	99%	2013
Moped	94%	
Bicycle (city)	55%	2017

Table IV.6 – Most recent measurements of variables related to speed (2013)

Setting	Variable	Speed (km/h)			In violation	
		Limit (*)	Average	Standard deviation	≥ Speed limit	Serious offence (**)
Rural	**Motorway**	120	118	18.0	45%	4%
	Single carriageway access controlled trunk road	90	92	17.6	28%	2%
	Single carriageway, no access control NRN road	90	71	16.0	15%	1%
Urban	**Through road**	50	54	12.8	56%	9%
	Urban level 2 street	50	56	11.9	66%	12%
	Urban level 3 street	50	48	10.3	39%	4%

(*) For cars
(**) ≥ [Speed Limit+20 km/h] in urban streets; ≥ [Speed Limit+30 km/h] in rural roads

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