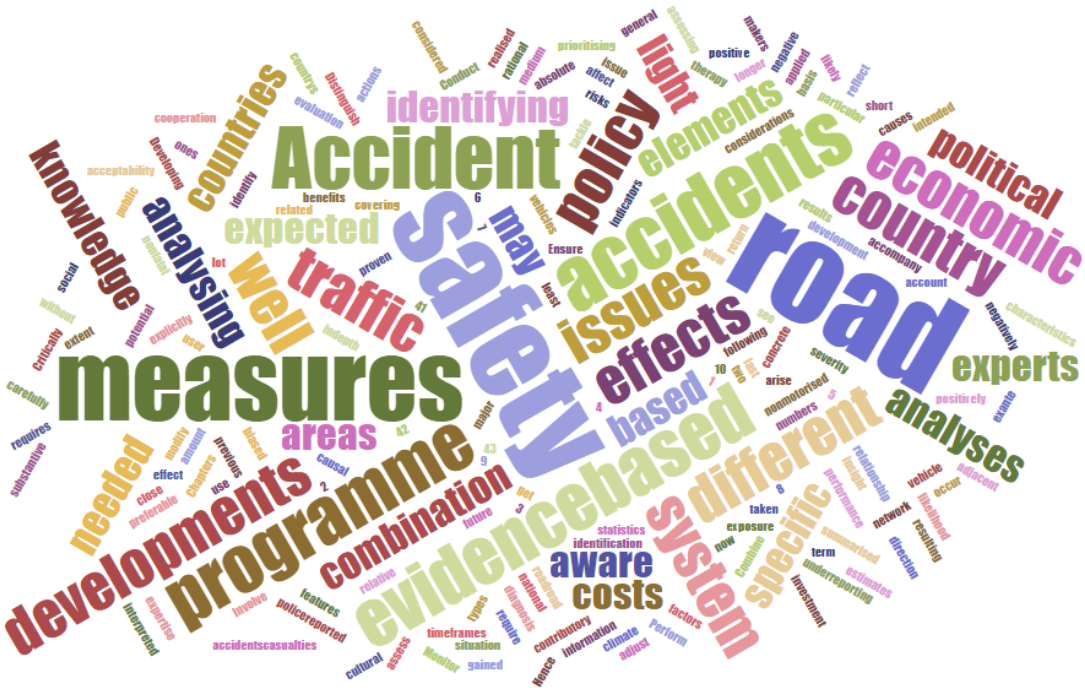
FERSI
Road Safety Research

Towards an evidence-based national road safety programme

A two-stage approach

FERSI position paper, January 2020



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1. Introduction

Road safety in Europe has been improving for decades. Several countries already reached a high level of road safety, considering the number of accidents and fatalities on the roads. Other countries are still on their way. The EU has always been a fierce promoter and supporter of a road safety policy that leads to a fewer number of deaths on European roads. The EU is indeed very ambitious in this area, aiming for halving the number of road fatalities and serious injuries between 2020 and 2030, and moving towards zero fatalities in 2050[1]. Reaching this objective, however, will be a huge challenge, especially since in many countries road safety improvements seem to stagnate and some countries even faced an increase rather than a decrease in fatalities[2].

In order to realise these ambitions, stringent actions are needed. In this framework, the EU sets up comprehensive road safety programmes with international significance. In addition, the EU offers guidance for programmes at national levels and provides a platform for knowledge exchange. This has proven to be a very successful approach in the past decades. For the future it is important to take into account that the world of mobility is changing, bringing about additional challenges to road safety. Road safety programmes need to take into account changing societal trends like the demographic changes, which imply cognitive impairments and frailty of elderly road users, a higher degree of urbanization and thus, different mobility patterns, and the promotion of (electric) cycling and electric micro mobility modes as an environmentally friendlier and physically healthier, but generally more vulnerable transport modes. On the other hand, the developments in driver assistance and vehicle automation technology are expected to affect the road safety developments in a positive way. However, new technologies come along with new topics including big data and privacy issues, and the increased use of smartphones, resulting in an increase of distraction in traffic.

With this paper FERSI intends to offer guidance to Member States on how to develop an evidence-based strategy and programme to continue enhancing road safety. Central to this is that any successful policy strategy needs to be based on scientifically sound evidence in order to ensure that it focuses on the right issues and implements the right solutions.

Following this, FERSI recommends to apply a two-stage approach when developing a road safety programme. In the first stage, a scientifically sound ***diagnosis*** of the most important road safety issues is needed. As discussed in Chapter 2, for this stage the main sources of information are accident statistics and relevant performance indicators. The results form the basis for the second stage, the ***therapy***. As described in Chapter 3, this stage includes the identification and implementation of appropriate road safety measures. First of all, appropriate means that the measures address the primary road safety issues, as identified in diagnosis stage. Furthermore, appropriate means that the measures are (cost-)effective; and this assessment needs to be based on available sound evidence and confirmed for the own situation by closely monitoring the safety effects. Only the harmonious

1. EC (2018) Europe on the move; sustainable mobility for Europe: safe, connected and clean. COM(2018) 293 final. Brussels, European Commission:
2. Adminaité-Fodor, D., Heilpern, C. & Jost, G. (2019) Ranking EU progress on road safety; 13th Road safety performance index (PIN) report. Brussels, European Transport Safety Council.

interplay of focused direction and effectiveness will ensure an optimal strategy for the improvement of road safety.

Chapter 4 provides a summary in terms of a series of concrete recommendations for Member States for developing an evidence-based road safety programme.

2. Identification of road safety issues: the diagnosis

There are several indicators that help to identify the most important current road safety issues. They can be divided into two main categories:

- Accident statistics, i.e. number of road traffic casualties or accidents, whenever needed weighted for exposure (Section 2.1).
- Performance indicators, i.e. safety related features of the various components of the traffic system and its operation (Section 2.2).

In addition to current road safety issues it is also very important to anticipate possible upcoming road safety issues and act on them (Section 2.3).

2.1 Based on accident statistics

The most widely used information when it comes to assessing the state of road safety in a defined area is the number of fatalities. Compared to less serious injuries, road fatalities are fairly well registered and hence give a more or less reliable picture of the road safety situation in a country, especially when it comes to motorised traffic[3]. Analysis of the accident characteristics and circumstances help to identify important road safety issues, at least when you are interested in absolute numbers of road casualties. When the number of fatalities can be linked to information about how often a road user is exposed to a specific traffic situation, this gives an indication of the risk of that situation. It should be noted though that some situations may have a very high risk, i.e. a high chance of getting involved in a (fatal) accident when in that specific situation, but result in relatively few fatalities because ending up in that specific situation is very rare. Generally, national road safety targets are defined in numbers of road fatalities. This type of targets, and also a public health perspective, would require the identification of situations or circumstances with high fatality numbers (and possibly lower risks) rather than high risk situations with relatively few fatalities. From an ethical point of view though, it can be completely justified to focus (also) on high-risk situations. A similar way of reasoning applies when looking at road user groups, e.g. related to age or to particular transport modes.

Road fatalities are of course only part of the story. Each year, our road traffic system results in many more serious injuries. Serious injuries are more and more taken into account when considering road safety, as can be concluded from the 2017 Valletta Declaration on road safety in which national governments of the EU Member States decided to set a target of halving their number in the EU by 2030 from the 2020 baseline[4]. When identifying the most important road safety issues, these non-fatal, but serious injury accidents should not be forgotten. Accidents resulting in serious injuries can have other characteristics, and consequently might need other remedial measures than fatal

3. Reporting rates for vulnerable road users (especially pedestrians and cyclists) are generally lower and accident statistics are less complete.
4. Valletta Declaration on Road Safety (2017) https://www.eu2017.mt/en/Documents/Valletta_Declaration_on_Improving_Road_Safety.pdf

accidents[5]. When analysing the data of serious injuries, it is important to realise that by no means all serious injury accidents are reported to and registered by the police[6]. In particular, it has been found that particular types of serious injury accidents are reported substantially less than other (notably accidents without the involvement of motorised vehicles, e.g., single bicycle accidents)[7]. Hence, analysis of just the reported injury accidents may give a biased view of the important road safety issues. Comparing police data with information from hospitals can help to get an indication of the real number of serious injuries in different accident types[4].

Hospital data are not only useful for getting a better understanding of the real number of injuries, they are also a very important source of information in itself. First, by looking at injury severity and the actual or estimated longer term effects, these data provide insight in the overall impact of road traffic accidents on the health of citizens. Secondly, information from hospitals give insight in the typical injury outcomes of specific accident types and as such give direction to the identification of relevant measures for mitigating these injury outcomes.

Accident statistics and hospital data provide limited information about accident causes and contributory factors, such as distraction and fatigue. Moreover, in several countries the information about accidents is predominantly collected for legal and liability reasons, not for understanding accident causes. In-depth accident studies can provide much more information about the (combinations of) factors that have contributed to the occurrence of an accident and the related injuries, and consequently about relevant mitigating measures. In-depth accident studies collect detailed information about accidents, sometimes about a specific accident type, by extensive inspection of the accident location and the vehicles involved, supplemented with interviews with those concerned (see e.g., [8]). In addition, knowledge from targeted scientific studies can help to complement the information from accident statistics and point at relevant road safety issues.

2.2 Based on performance indicators

Several features of the road traffic system and its operation are known to be directly and causally related to the occurrence of an accident or the injury consequences of an accident. As such they can be used as indirect indicators of the safety of the road traffic system. Traditionally, these indicators are known as Safety Performance Indicators (SPIs), but more recently also as Key Performance Indicators (KPIs). The European Commission aims to make more use of these additional indicators for road safety[9] and is in the process of making agreements with Member States.

5. Wegman, F. (2012) Driving down the road toll by building a Safe System. Adelaide, Government of South Australia. https://www.dpti.sa.gov.au/__data/assets/pdf_file/0006/259251/FredWegman_drivingdowntheroadtoll.pdf
6. OECD/ITF (2011). Reporting on serious road traffic casualties : combining and using different data sources to improve understanding of non-fatal road traffic crashes. Paris, OECD/ITF.
7. Shinar et al. (2018) Under-reporting bicycle accidents to police in the COST TU1101 international survey: Cross-country comparisons and associated factors. Accident Analysis and Prevention, Vol. 110, 177-186. https://doi.org/10.1016/j.aap.2017.09.018
8. Davidse et al. (2019). Scenarios of crashes involving light mopeds on urban bicycle paths. Accident Analysis & Prevention, 129, p. 334-341 https://doi.org/10.1016/j.aap.2019.05.016
9. EC (2018) Road Safety Newsletter 29, January 2018

SPIs particularly relate to road user behaviour (e.g., speeding, drink-driving, mobile phone use, seat belt/helmet wearing), road infrastructure (e.g., roadside safety, junction type and design, pedestrian and cyclist facilities), and vehicles (e.g., average age of car fleet, availability of driver support systems). Also the procedures and facilities for post-accident response (e.g., specialisation of ambulance crew, use of trauma helicopters, available trauma care centres) can be important indicators. The use of SPIs and examples of SPIs were extensively discussed as part of the European SafetyNet project[10].

Measuring SPIs on a regular basis and monitoring their developments over time help to identify relevant road safety issues[11]. They indicate which elements of the road system have the most potential for improvement in order to prevent accidents or mitigate their consequences. Hence, the use of SPIs allows for a proactive road safety policy rather than a reactive policy when using data of accidents that already happened. SPIs also form a good basis to set road safety targets, in addition to targets for road casualties, for example related to the share of drink drivers or the share of unprotected roadsides. Finally, SPI-based targets help to define the road safety policies and the responsible parties to meet these targets. This is called management by objectives, and already common practice in Sweden[12]. The use of performance indicators might require the input from road safety experts to help identifying the most relevant SPIs and ensuring reliable data collection and interpretation.

2.3 Looking into the future

Analyses of accident data and performance indicators help to identify current road safety issues. However, from a road safety policy point of view, it is also very important to anticipate possible upcoming road safety issues and act on them. Clear examples are the likely effects of an ageing society, environmental policies, and vehicle automation on mobility patterns and road accident risks.

Obviously, objective factual information about future developments and their effect on road safety and road safety issues is not available. Educated estimations have to come from road safety experts in conjunction with experts in the various policy areas. National experts have to be involved to analyse the often more internationally oriented findings and conclusions and tailor them to the national situation.

2.4 In summary

Figure 1 summarises the main sources of information for identifying the key road safety issues.

10. See https://erso.swov.nl/safetynet/content/safetynet.htm. The SafetyNet project also prepared an SPI manual: Hakkert, A.S. & Gitelman, V. (Eds.) (2007) Road Safety Performance Indicators: Manual. Deliverable D3.8 of the EU FP6 project SafetyNet.
11. FERSI (2019) FERSI supports EC's policy on KPIs. FERSI statement April 2019, see https://fersi.org/2019/05/07/fersi-supports-ecs-policy-on-kpis/
12. Swedish Transport Administration (2018) Analysis of road safety trends 2017. Management by objectives for road safety work towards the 2020 interim targets.

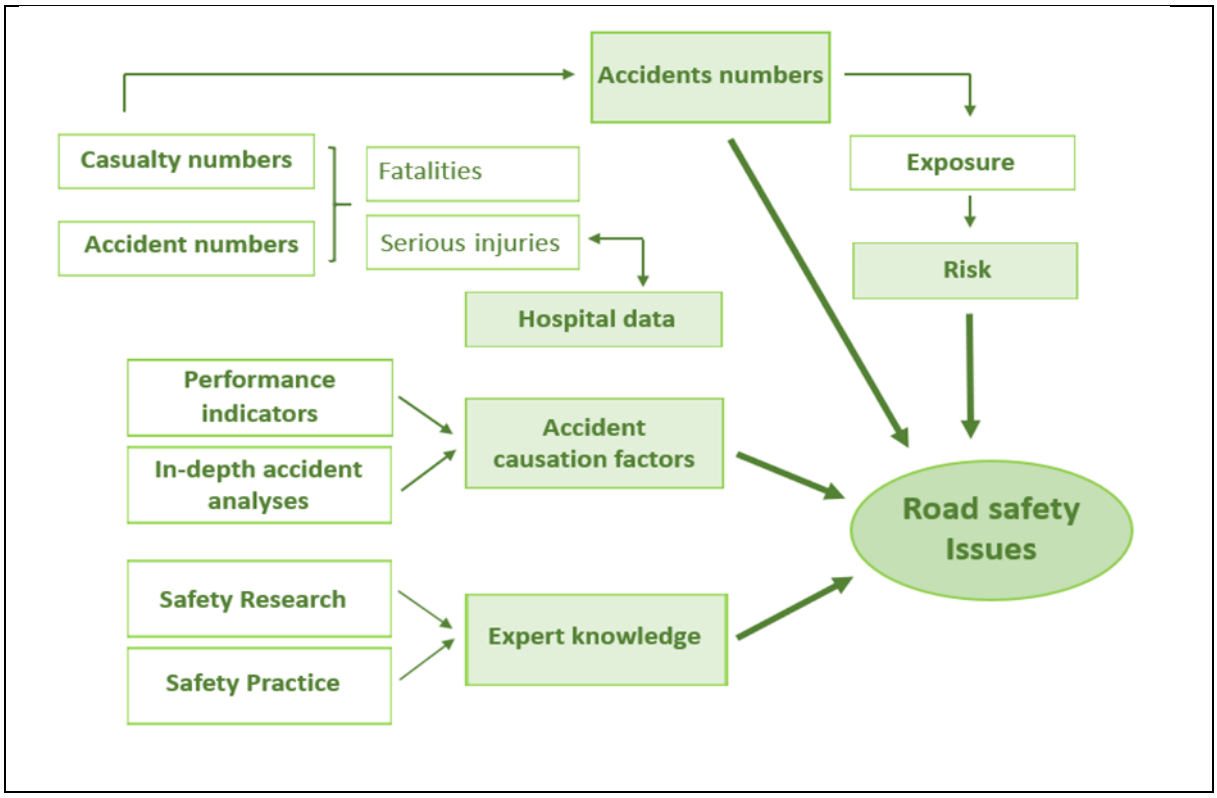

Figure 1: Information for the identification of road safety issues

3. Identification of road safety measures: the therapy

Having identified the main road safety issues, the second step is to identify solutions for them. Three aspects are important:

- Identifying the most appropriate (combination of) measures (Section 3.1)
- Weighing the expected costs against the expected benefits (Section 3.2)
- Monitoring implementation and safety effects of measures, adjusting policies if needed (Section 3.3)

3.1 Identifying (combination of) measures

Basically, either existing measures can be implemented or – if existing measures are inappropriate – new measures need to be developed. Road safety issues can seldom be solved by a single measure; generally, they require a combination of measures covering different elements of the traffic system: the road user, the road/road network, the vehicle, as well as their interactions.

Distinguishing between the four E's of road safety work can be of help here. This can be considered as a fundamental principle in road safety work and has played a significant role in influencing road safety since a long time: Engineering of roads and vehicles, and Education, Enforcement and Encouragement of road users (as well as road safety practitioners and policy makers). Measures from all four fields influence and ideally reinforce each other and therefore need to be closely interlocked. Just as an example: General road safety publicity campaigns, for example on speeding or mobile phone use, hardly have an effect on road user behaviour if used as a stand-alone measure. However, especially local campaigns can be very useful to accompany new traffic laws and police enforcement actions[13].

When identifying suitable measures, it is important not just to look at the short term, but also at the longer term. Preferably, measures with an impact at the short or medium term are accompanied by measures with an impact at the longer term. For example, whereas legislation and related enforcement measures have an immediate effect, infrastructure measures require more time to realise and affect road safety, while many vehicle measures usually need at least a decade to show their effect due to a slow turnover of the vehicle fleet. However, in the end infrastructure and vehicle measures lead to more sustainable benefits, and do not require continuous personnel effort, justifying an investment already now.

Road safety is not an entirely new discipline and a vast amount of measures for all kinds of road safety issues exist. Thus, the implementation of existing measures is the most common approach and a road safety programme can build on the experience gained in decades of road safety work. When selecting measures for an evidence-based road safety programme, it is important to check whether they have

13. Phillips, R.O., Ulleberg, P. & Vaa, T. (2011) Meta-analysis of the effect of road safety campaigns on accidents Accident Analysis and Prevention, Vol. 43, p. 1204-1218. https://doi.org/10.1016/j.aap.2011.01.002

proven to be effective in similar situations. A few useful sources are available – in order of year of publication:

- 2009: The handbook of road safety measures[14]
- 2010: Best practices in road traffic; handbook for measures at the country level (available in 21 languages)[15]
- 2017/2018: The European Road Safety Observatory[16]
- 2018: The online European Road Safety Decision Support System[17]

3.2 Weighing benefits and costs

A road safety programme cannot be based exclusively on the effectiveness of the individual measures in similar situations. In fact, the development of a road safety programme has to be supported by what is called an ex-ante evaluation, answering three questions regarding the expected effect of the intended safety measures[18]:

1. What is the estimated effect of a measure in a given situation?
2. What will be the net effect of a set of measures ('a safety programme')?
3. What will be the return on investments for the national economy?

Information on effects and costs can often be deduced from experiences in other countries. However, it is important to critically assess to what extent these finding are likely to be transferable to one's own country or region.

3.2.1 Estimating the effect of a single measure

The effect of a single measure is determined by five factors. It starts with identifying the potential number of (severe and fatal) injuries that could be prevented by the measure (A). The theoretical potential A (total number of casualties to be prevented) for prevention will not be reached because of the factors B to E: area of theoretical impact (B), effectiveness (C), degree of implementation (D), degree of compliance (E). The estimated actual effect of a measure on the number of casualties or accidents can be calculated by the formula:

$$\text{Actual reduction} = A \times (B/100) \times (C/100) \times (D/100) \times (E/100)$$

The box below gives a hypothetical and simplified example to illustrate the application of this formula.

14. Elvik, R., Høye, A., Vaa, T. & Sorensen, M. (eds.) (2009) The handbook of road safety measures [2nd edition]. Bingley, Emerald Group: https://www.emerald.com/insight/publication/doi/10.1108/9781848552517
15. Schagen, I. van & Machata, K. (2010) Best practices in road safety: handbook for measures at the country level. Luxembourg, Publications Office of the European Communities Eur-OP, available via https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/projects/supreme.pdf
16. The European Road Safety Observatory (ERSO), road safety syntheses, available at https://ec.europa.eu/transport/road_safety/specialist/observatory/analyses_en
17. Developed in the framework of the EC H2020 research project SafetyCube: https://www.roadsafety-dss.eu
18. Siegrist, S. (2010) Towards a method to forecast the effectiveness of national road safety programmes. Safety Science, vol. 48(9), 1106-1110. https://doi.org/10.1016/j.ssci.2009.11.007

Estimating the effect of a road safety measure: a hypothetical and simplified example

Measure: Introduction of a zero BAC-limit for novice drivers

A. Potential number of fatal and serious injuries to be saved: 27/240
Currently, there are 27 fatalities and 240 serious injuries among novice drivers per year. The annual number is in fact the average of the number of the last 3 or 5 years in order to reduce the effect of statistical fluctuations.

B. Theoretical potential for savings: 65%
In theory, based on knowledge of the attributable risk of alcohol for novice drivers, 65% of all serious and fatal injuries could be prevented by a zero BAC-limit.

C. Effectiveness: 100%
The effectiveness of the measure is 100%, since no alcohol consumption means that the risk factor is completely eliminated.

D. Degree of implementation: 100%
A zero BAC-limit would be introduced as a nationwide law, applying to all novice drivers.

E. Degree of compliance: 40%
Based on experience in other countries or on similar laws, it is estimated that 40% of the novice drivers will actually obey the law.

So, the expected effect of a zero BAC-limit for novice drivers is an annual saving of:
27 * 0.65 * 1 * 1 * 0.4: = 7 fatal injuries
240 * 0.65 * 1 * 1 * 0.4 = 62 serious injuries

For more information see: Siegrist, S. (2010) Towards a method to forecast the effectiveness of national road safety programmes. Safety Science, vol. 48(9), 1106-1110. https://doi.org/10.1016/j.ssci.2009.11.007

3.2.2 Estimating the net effect of a road safety programme

In order to estimate the net effect of a safety programme that comprises a set of X different measures, three subsequent steps are needed. In step 1, the theoretical benefit is estimated by simply adding up the effects of the single measures 1 to X. Since different measures might target the same accident type or road user groups, step 1 is likely to result in an overestimation of the effects. Step 2 identifies and corrects for this potential overlap. The other way around, it is also possible that the combination of measures induce synergies which can increase the effects of single measures. Step 3 identifies and corrects for this type of effect.

3.2.3 Estimating return on investment for the national economy

From a public health perspective the expected number of prevented fatalities and severe injuries is the major criterion for a road safety programme. However, from an economic perspective the expected return on investment is also an important aspect: to what extent do the expected benefits of a measure justify its costs? Cost-benefit analyses are important at the single measure level as well as at the programme level. This information allows decision makers to prioritise measures that have a good cost-benefit ratio. Information about effects and costs of measures from other countries might

need to be adjusted to reflect specific features of the traffic system and the economic situation in the target country.

The monetary benefits can be calculated by multiplying the expected number of prevented fatalities and injuries by the social costs of a fatality or an injury. These costs include costs related to medical treatment, loss of production, and property damage and many European countries also include human costs due to suffering, pain, sorrow and loss of quality of life[19]. The potential benefits must be set off against the economic costs related to the implementation of the intended measures. Generally, all resources diverted from the community for the realisation of the safety measures are counted as economic costs. They include expenditures for research and development, publicity, technical equipment, personnel, etcetera. The difference between cost and benefit corresponds to the profit/loss caused to the public by the realised safety measure.

3.3 Monitoring implementation and effects

Even if a road safety programme is thoroughly based on available evidence and estimated effects, it is of eminent importance that the implementation of the measures and their actual effects are being monitored. Monitoring implementation refers to quantitative indicators of for example the number of junctions reconstructed into roundabouts, the increase in length of bicycle lanes, the time policemen are involved in traffic enforcement. Monitoring effects can be effectuated in terms of accidents/casualties, in general or a particular type relevant for the implemented measure(s), or in terms of relevant performance indicators (see *Section 2.2*). The results of these monitoring activities help to assess the programme in force and decide on possible extensions, reductions, or changes in focus. It prevents that money is being spent in an ineffective way.

It should be noted that assessing the effects of a measure or a series of measures in terms of number of accidents or casualties is very challenging. In the end, accidents are statistically rare events, and as a consequence numbers tend to fluctuate over time randomly. As a result, identifying changes in accident numbers in a statistically sound and reliable way requires very long periods of accident data. Monitoring the development of relevant safety performance indicators can be a good alternative, provided that definitions of what is to be measured and how are well documented and do not change over time. Moreover, the interpretation of developments always needs to be based on a thorough understanding of other relevant developments, e.g. changes in legislation, mobility or modal shift.

3.4 In summary

Figure 2 summarises the iterative process of identifying the most cost-effective measures to tackle the identified key road safety issues.

19. Wijnen, W., Weijermars, W. et al. (2017) Crash cost estimates for European countries. Deliverable 3.2 of the H2020 project SafetyCube. http://www.safetycube-project.eu/publications/

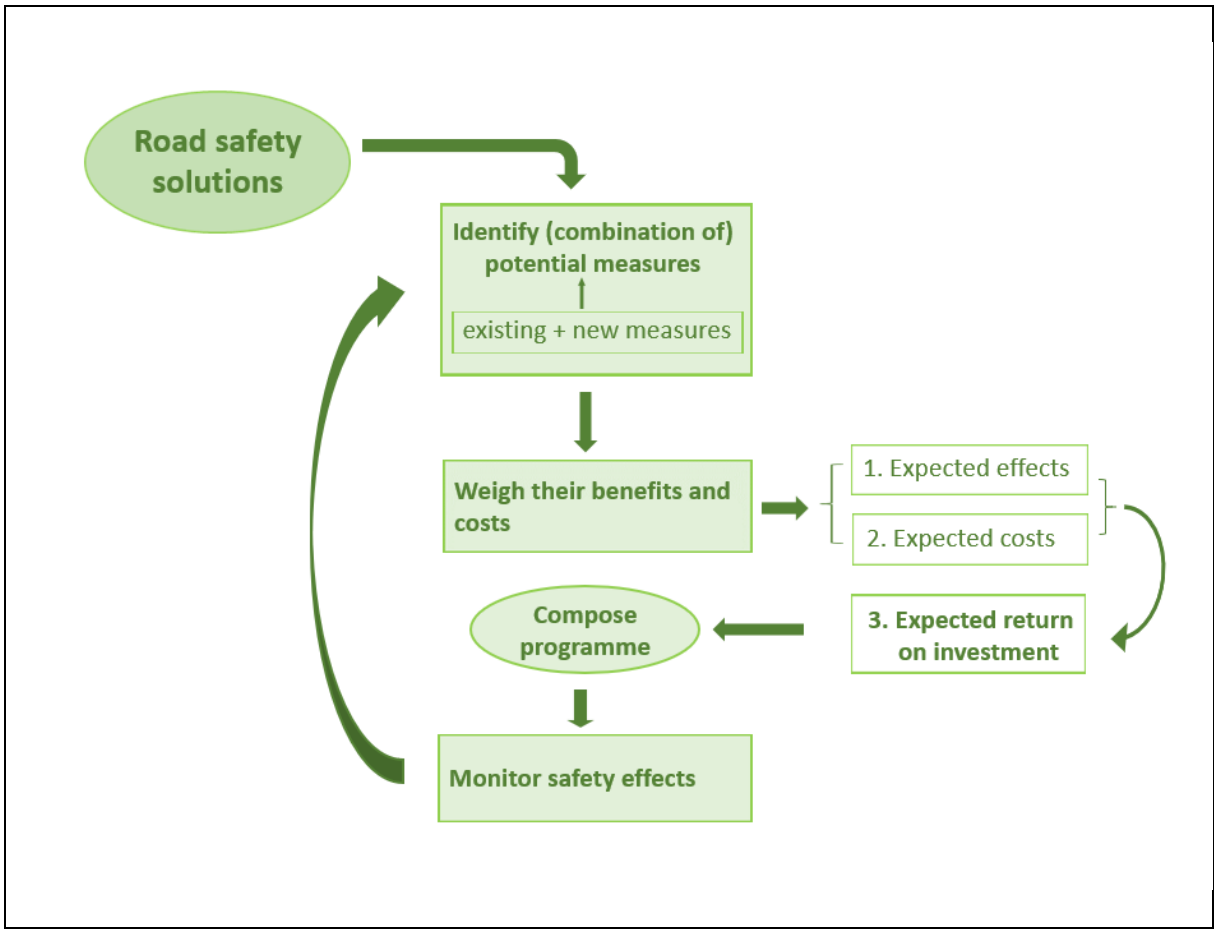

Figure 2: The iterative process of identifying (cost-effective) road safety solutions

4. FERSI's recommendations

The considerations in the previous Chapters can be summarised in the following concrete recommendations for the development of an evidence-based national road safety programme.

4.1 Recommendations for identifying road safety issues (diagnosis)

1. Ensure that the identification of road safety issues is evidence-based, by analysing accident statistics - absolute numbers and weighted by exposure (risks) – as well as safety performance indicators that have a proven causal relationship with accidents or accident severity.
2. Be aware of underreporting of accidents, in particular non-fatal accidents and accidents involving pedestrians and cyclists, and the biased view that may arise when analysing only the police-reported accidents.
3. Be careful when interpreting changes in accident numbers over short periods of time (few months or years), especially if it concerns small numbers; these changes may be just the result of random fluctuations (chance).
4. Conduct or use results from in-depth accident analyses for major accident types to get insight in their causes and contributory factors.
5. Involve experts from different policy areas to identify potential future developments that may positively or negatively affect road safety and require actions now.

4.2 Recommendations for identifying road safety measures (therapy)

6. Use combinations of road safety measures to tackle a road safety issue, taking account of the road user, the road/road network, the vehicle, and their interactions.
7. Be aware of the different timeframes of measures and preferably combine measures with short and medium term effects with measures with a longer term effect.
8. Perform an ex-ante evaluation as a rational basis for prioritising measures, assessing the expected benefits of the intended (combination of) safety measures as well as their costs, and the related return on investment.
9. Critically assess the likelihood that information about effects and costs of measures from other countries can be applied to your country; if needed adjust the estimates, in positive or negative direction, to reflect specific features of the traffic system and the economic situation.
10. Monitor road safety developments to see to what extent the proposed measures have been implemented and expected effects occur; and modify elements of the programme if needed.

4.3 And last but not least ….

Developing an evidence-based road safety programme requires a lot of expertise and knowledge of road safety in general, the road traffic system in one's own country, the likely developments in adjacent policy areas, as well as the social, political, cultural and economic climate of the country. Accident analyses and knowledge gained in other countries have to be interpreted carefully in the light of the country's specific characteristics, and resulting recommendations have to be considered in the light of political, public and economic acceptability. Hence, an evidence-based road safety programme cannot be realised without close cooperation between policy makers and road safety experts.