SETTING UP AN INDICATOR SYTEM FOR MONITORING ROAD SAFETY USING THE ROAD SAFETY TARGET HIERARCHY

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ABSTRACT

Road safety is a relevant theme to study, due to the human as well as financial suffering caused by road crashes. To improve the level of road safety in a country, it is important to gain insight into this complex phenomenon. The development of a diverse set of road safety related indicators is valuable in this respect. Here, the concept of the road safety target hierarchy is used as a theoretical framework for presenting essential indicators of the safety management system. Special attention goes to final outcomes, intermediate outcomes, policy output and policy input. By listing indicators on the different levels of this hierarchy, not only final outcomes can be captured and monitored but also various aspects of road safety such as human behaviour, prevalent laws and economic background. This study aims at developing an appropriate indicator system for monitoring road safety in Europe. Possible indicators are formulated on each level of the hierarchy and subsequently evaluated using several criteria such as relevance and data availability. The final indicator set helps in offering a more complete picture of the road safety situation in a country or region and enables policymakers to better understand the underlying phenomena and take appropriate action at an early stage.

1 INTRODUCTION

Worldwide, an estimated 1.2 million people are killed in road crashes each year. The World Health Organization ranks road traffic injuries as 9th in the leading causes of death (WHO, 2009). In 25 countries of the European Union a total of almost 39,500 fatalities was registered in 2006, which is a decrease of 21.8% compared to the number in 2001 (SafetyNet, 2008). Despite the fact that positive results are achieved, the European Commission's goal of halving the number of fatalities between 2001 and 2010 will probably not be achieved given the trend in the past.

Possibly, more complex problems need to be handled to further improve the road safety performance (e.g. Sivak and Tsimhoni, 2008). Therefore, it is important to gain insight into the underlying factors influencing the road safety level (often expressed by means of 'final outcomes') in a country or region. In this respect, we use the target hierarchy for road safety - originated in New Zealand (NRSC, 2000) and widely adopted in European projects such as SUNflower (Morsink et al., 2005) and SafetyNet (Vis, 2005) - which offers insight in the road safety processes that lead to casualties and social costs (Morsink et al., 2007). This by describing the road safety problem as a hierarchy consisting of five vertical levels from structure and culture (policy input) over safety measures and programmes (policy output), safety performance indicators (intermediate outcomes) and number of killed and injured (final outcomes) to social costs due to road unsafety (see:

Figure **1**).

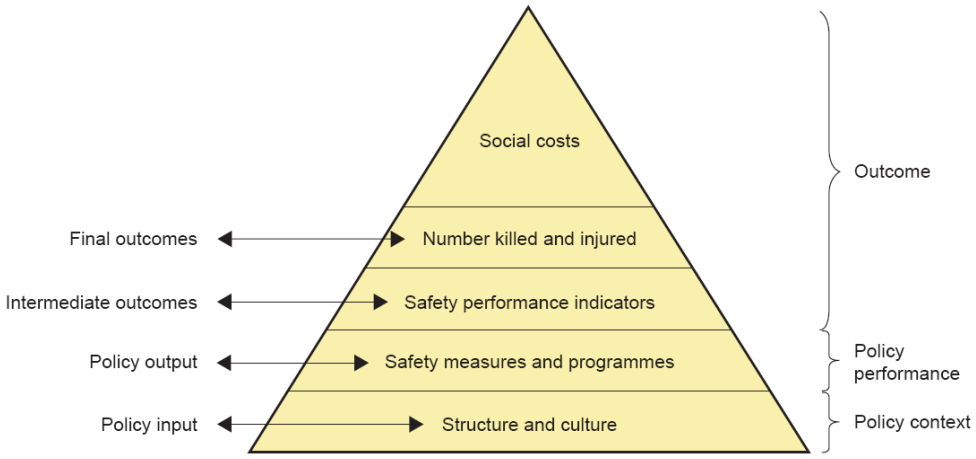

Figure 1: Target hierarchy for road safety (Morsink et al., 2005)

Important road safety aspects can be identified throughout the pyramid (e.g. Morsink et al., 2007). At the horizontal level, each aspect can be specified in a disaggregated way such as per transport mode, road type or region. Furthermore, the pyramid contains a time dimension which allows the study of developments of factors over time (Morsink et al., 2007). In this paper, we concentrate on the components of the vertical dimension of the target hierarchy for road safety. Next, we briefly describe the vertical layers from top to bottom.

The *social costs* resulting from road unsafety are at the top of the target hierarchy for road safety. These are the costs that crashes impose on the community, on road users, emergency service providers and others (NRSC, 2000). The World Health Organization (2004) estimates the cost of road crashes and casualties to be 1 to 2% of the gross national product. In the European Union countries alone, the annual cost of road safety injury is approximated to exceed € 180 billion (WHO, 2004). Because some costs included in the estimation of the social costs are ambiguously measured in various countries (for example the quality of life loss), comparison of the social cost of crashes and casualties between countries or regions is limited (e.g. Elvik, 2000; Morsink et al., 2005; ETSC, 2007). Therefore, we do not address the quantification of the social costs in this paper. Nowadays, road safety is discussed in terms of *final outcomes*. Usually, the road safety level in a country or region is described and compared to that of others in terms of the number of casualties that need to be as low as possible (Morsink et al., 2007; Hermans, 2009). Because crash data do not provide insight in the safety problem areas of a country, we also take the underlying layers leading to crashes into account. *Safety performance indicators (SPI's)* representing main risk factors (such as speed) are interesting since they are causally related to crashes or injuries and can predict safety levels before crashes happen (ETSC, 2001; Morsink et al., 2007). In the European SafetyNet project (Vis, 2005), safety performance indicators were formulated with respect to seven risk factors: alcohol and drugs, speed, protective systems, daytime running lights, vehicle, road infrastructure and trauma management. The SPI's are influenced by the *policy output* layer that refers to the nature and content of national road safety plans, action programmes and safety related standards and legislation (Morsink et al., 2005). To achieve improvements in the SPI's, it is possible that new laws or measures need to be created, enforcement need to be increased, etc. (e.g. Elvik, 2008). In order to come up with successful road safety actions, the structure and culture in a country or region has to be taken into account (*policy input)*. Background differences between countries may imply that some measures will need to be customized in order to have the desired effect.

In this paper, we use the target hierarchy as a framework to develop an indicator system for monitoring road safety within Europe. By creating an indicator set including indicators on the final outcome, intermediate outcome, policy output and policy input level, the road safety situation within and between countries can be described and compared. Moreover, targets can be set on all levels of the target hierarchy. Nowadays, targets are often expressed in terms of a desired reduction in final outcomes. Nevertheless, it is interesting to set targets on the underlying levels as well because they allow closer management of the range of interventions by which goals set at a higher level can be reached (e.g. Elvik, 2008; ERSO, 2008).

When considering a diverse (final outcome, intermediate outcome, policy output and policy input) road safety indicator set, a country can obtain an enriched view on its current road safety situation, it can draw attention to main problems and help policymakers in setting targets and priorities (e.g. Hermans, 2009). The final indicator set generated from this study can be a first step to achieve the goal of a scientifically established set of safety indicators for the European Union (ETSC, 2001).

2 METHODOLOGY

To establish a harmonized set of road safety indicators using the target hierarchy for road safety as the theoretical framework, we go through several steps. First, we study each layer of the hierarchy in detail. Next, for each layer (except the 'social cost' layer) possible indicators are listed from international literature among which ETSC (2001); Sartre 3 (2004); Al Haji (2005); Morsink et al. (2005); Vis (2005); Morsink et al. (2007); Hermans (2009). Because a large number of potential indicators exist for each layer, implying excessive data collection efforts in a later stage, we will evaluate each indicator based on a set of criteria. As a result, a smaller (i.e. better manageable) and more valuable indicator set is obtained. In literature (e.g. Al Haji, 2005; Farchi et al., 2006; Hens et al., 2005; Ledoux et al., 2005; Litman, 2007 in: Hermans, 2009), several criteria defining a 'good' indicator can be found, e.g. understandable, clear definition, measurable, cost effective, reliable, stable.

After checking the possible conditions that an indicator should meet and taking the road safety context into account, eight selection criteria were identified, namely: the degree to which the indicator is relevant (and valid), measurable, understandable, has data available, is reliable, comparable (and coherent), specific and sensitive (Hermans, 2009). Below, we briefly describe each criterion by listing some questions that need to be asked to determine whether the indicator meets the criterion or not (Hermans, 2009):

- RELEVANT/VALID: is the indicator suitable for establishing targets? Does the indicator provide a good picture of the phenomenon that we want to measure?
- MEASURABLE: is the indicator quantifiable and measurable?
- UNDERSTANDABLE: is the indicator clearly defined? Does the indicator have a comprehensible and acceptable interpretation?
- AVAILABLE DATA: are data available for a large set of subjects (countries or regions in this case) within an acceptable term and at reasonable cost? Can the indicator be updated on a regular basis?
- RELIABLE: do the data come from a reliable source? Have the data been collected in a scientific way?
- COMPARABLE/COHERENT: is the indicator coherent over time (i.e., has the same definition, method, … been used) and over space (i.e., do the subjects apply the same definition, …)?
- SPECIFIC: does the indicator focus on a certain level? Is the indicator detailed enough?
- SENSITIVE: is the indicator capable of reflecting changes over time?

Based on these eight criteria, a distinction between best available indicators and best needed indicators can be made (European Commission, 2005). Best needed indicators can be seen as the most ideal indicators; they score best on five – not data related – criteria (relevance, measurability, interpretability, specificity and sensitivity) (Hermans, 2009). On the contrary, best available indicators take all eight listed criteria into account, including the availability of indicator data of an acceptable quality. Several European databases and reports (such as ERF, ETSC, Eurostat, IRTAD, OECD, SARTRE, …) are consulted in this respect. In the evaluation, indicators that meet the considered criterion are pointed by a '+' sign; indicators that fall short by a '-' sign. The sign '0' refers to a score in between. Other possibilities are '0/+'; '-/0'; and '/' where the last symbol is used for rating reliability; in case no data are available, the degree of reliability is not applicable and not indicated (as a result only seven criteria are used then for identifying best available indicators). For each indicator scores are computed by quantifying these signs as follows: '+'= 1, '0/+' = 0.5; '0' = 0, '-/0' = -0.5; '-' = -1. Consequently, a set of best needed indicators and best available indicators will be created with respect to each layer. Because the maturity of indicators as well as the availability and quality of indicator data differ between the layers, some layers will be represented by a more elaborated set of indicators than others.

To overcome the current partial lack of indicator data and assure the creation and collection of necessary data for road safety policymaking in a longer time perspective, best available as well as best needed road safety indicators are identified. The overall best available road safety indicator set can be used in the short run for indicator analysis (e.g. Wilmots et al., 2009) while for the best needed indicator set the collection of road safety data is the first step to take (after agreement on the indicator set).

3 FINAL OUTCOME INDICATORS

In this section, we formulate and evaluate final outcome indicators. The process of evaluation will be illustrated for this layer whereas for the other layers, the same procedure is used but only the proposed best available and best needed indicator sets will be shown (due to space limitations). Of all layers in the target hierarchy for road safety, the final outcome layer has received most attention. Although the information on this layer is relevant, it only allows benchmarking at a macro level and does not reveal differences at a more detailed level (Morsink et al., 2007). Registered crash data say nothing about the processes that produce crashes and therefore do not indicate on which aspects an underperforming country should focus in order to improve its road safety level (ETSC, 2001; Hermans, 2009). In addition, the number of crashes or injuries is subject to random fluctuations. For these reasons, we create a monitoring system that includes indicators on all layers of the target hierarchy for road safety.

Comparisons based on 'final outcomes' can be limited, given differences in definitions and registration rates of injury crashes among countries (Morsink et al., 2005). To eliminate any problems related to biased underreporting of crashes with less serious outcomes and to avoid considerable differences in the definitions among countries, final outcome indicators usually refer to fatal crashes and fatalities (Morsink et al., 2007). To enable comparisons between countries or regions differing in size and mobility behavior, the number of fatalities is often expressed with respect to population (mortality rate), number of vehicles (fatality rate), or number of motorized vehicle kilometres or person kilometres (fatality risk) (Morsink et al., 2005; Morsink et al., 2007). Furthermore, final outcomes can be categorized (or disaggregated) in terms of transport mode, road user features (such as age), location and type of crash, etc.

Indicators related to final outcomes are listed from international literature (e.g. Morsink et al., 2007; Wegman et al., 2008), and subsequently evaluated using the eight selected criteria.

We concentrate on indicators that are related to the number of fatalities and are preferably expressed in terms of a relative measure.

Indicator		Evaluation based on eight criteria								Selected indicators	
		Relevant/ valid	Measurable	Understand-dable	available data	reliable	comparable/ coherent	specific	sensitive	Best needed indicators (/5)	Best available indicators
# fatalities / million inhabitants		0	+	+	+	+	+(1)	-	0(2)	1	4/8
	Per age class	+	+	+	0	0/+	+	+	0	4	**5.5/8**
# fatalities / 1000 registered motor vehicles		0	+	+	+	+	+	-	0/+	1.5	4.5/8
# fatalities / 100 million passenger kilometers		+(3)	+	+	0(4)	0(5)	+	-	+	**3**	4/8
	Per road type	+	+	+	-/0	-/0	+	+	0/+	**4.5**	4.5/8
	Per age class	+	+	+	-	/	+	+	0/+	**4.5**	4.5/7
	Per transport mode	+	+	+	-	/	+	+	0/+	**4.5**	4.5/7
# fatalities / 100 million vehicle kilometers traveled		0/+	+	+	0/+(6)	0	+	-	+	2.5	4/8
% road fatalities out of total fatalities:											
	Per road type	+	+	+	0	0	+	0/+	0/+	4	**5/8**
	Per age class	+	+	+	0/+	0/+	+	0/+	0/+	4	**6/8**
	Per transport mode	+	+	+	0	0	+	0/+	0/+	4	**5/8**
# injury crashes per fatality		0	+	+	0/+	+	+	-	-(7)	0	2.5/8
# hospitalized injuries per fatality		0/+	+	0/+(8)	-(9)	/	0	-	-	≤ 0	≤ 0
% of fatalities resulting from crashes in which someone was drinking and driving		0/+	+	+	0/+	0(10)	+	+	-/0 (11)	**3**	4.5/8
% of road users involved in fatal crashes impaired by alcohol and drugs		0/+	+	+	0/+	0	+	0/+	-/0	2.5	4/8
% of fatalities due to excessive speed		0/+	+	+	0	-/0	0/+	0/+	-	2.5	2/8
% of car occupants fatalities not wearing a seat belt		0	+	+	-(12)	/	+	+	-/0	2.5	2.5/7

(1) The number of fatalities is less subjected to differences in definitions and underreporting than the number of seriously and slightly injured.
(2) A change in this indicator might be due to a change in population rather than an actual change in road safety risk.
(3) The number of traveled passenger or vehicle kilometers is the exposure to risk measure to prefer in the context of road safety.
(4) In some countries data on passenger kilometers traveled are not available, especially not the nonmotorized kilometers traveled.
(5) The number of passenger kilometers traveled is often obtained in a different way. In some cases, it is based on inaccurate estimates.
(6) More countries have data on the amount of vehicle kilometers than on the amount of passenger kilometers traveled.
(7) A change in this indicator might be due to a change in the degree of reporting.
(8) The concept of 'hospitalized' needs to be clearly defined and harmonized.
(9) Centralized data are unavailable yet.
(10) In some countries only a small part is tested.
(11) A change in this indicator value might not be due to a better performance.
(12) Most countries do not report these data.

Figure 2: Best available and best needed final outcome indicator set

The evaluation process resulted in a best available indicator set consisting of the following indicators: the number of fatalities per age class per inhabitants in the particular age class, the share of road traffic fatalities per age class, road type or transport mode out of the total number of fatalities. The best needed indicator set for this layer is represented by the number of fatalities per 100 million passenger kilometers per road type, age class or transport mode.

4 INTERMEDIATE OUTCOME INDICATORS

Safety performance indicators provide the link between the actions ('policy output') and the 'final outcomes' (e.g. Vis, 2005; Morsink et al., 2007; Tingvall et al., 2010). The European Transport Safety Council (2001) describes a safety performance indicator as "any measurement that is causally related to crashes or injuries and is used in addition to numbers of crashes or injuries, in order to indicate safety performance or understand the process that leads to crashes". A main advantage of SPI's is that they can point out the emergence of new problems at an early stage, before these problems show up in the form of crashes (ETSC, 2001). Because these intermediate outcomes are influenced by 'policy output' they are useful for monitoring and understanding the impact of road safety measures or programmes taken by policymaking authorities on a particular risk factor (ETSC, 2001).

In the European SafetyNet project (Vis, 2005), seven risk factors have been identified for which safety performance indicators are formulated. Some of these factors are related to behavioral characteristics (speed levels, the rate of drink driving, the use of seat belts), while other indicators refer to daytime running lights, the infrastructure, the vehicle or trauma management (ETSC, 2001; Vis, 2005). Various SPI's can be quantified for these risk factors bearing in mind that the SPI should have a proven and well-documented relationship with the number of casualties and can be influenced by measures (ETSC, 2001; Tingvall et al., 2010).

For each risk factor, indicators were found in international literature such as Vis (2005); Morsink et al. (2007); Elvik (2008); Wegman et al. (2008); Hermans, 2009. Next, the best available and best needed indicator(s) for each risk factor are given.

Risk domain	**Best available indicator**	**Best needed indicator**
Alcohol & drugs	% of surveyed car drivers disrespecting the alcohol limit	% of road user population impaired by alcohol or drugs
Speed	% of surveyed car drivers exceeding the speed limit on ≠ road types	Average speed per road type and vehicle type, during daytime and at night
		Variation in speed per road type and vehicle type
Protective systems	% of persons wearing a seat belt in the front seats of a car or van	% of persons wearing a seat belt in the front respectively rear seats of a vehicle (per vehicle and road type)
		% of persons < 12 years (correctly) sitting in a child's seat in the front or rear seat of a car
		Helmet wearing rate of cyclists, moped riders and motorcyclists
Daytime Running Lights	Existence of a law – fully or partially – obligating the use of daytime running lights	Usage rate of daytime running lights per road and vehicle type
Vehicle	Age distribution of the vehicle fleet: % of vehicles ≤5 years; between 6-10 years, between 11-15 years and >15 years in the total # of registered vehicles (per vehicle type)	Age distribution of the vehicle fleet: % of vehicles ≤5 years; between 6-10 years, between 11-15 years and >15 years in the total # of registered vehicles (per vehicle type)
		% cars rated 4 or 5 stars in EuroNCAP
Roads	Motorway density	% of road length with wide obstacle-free zone or roadside barrier
		% of road length with wide median or median barrier
Trauma management	% Gross Domestic Product spent on health care	Share of road casualties who died during hospitalization

Figure 3: Best available and best needed intermediate outcome indicator set

5 POLICY OUTPUT INDICATORS

As mentioned before, policy output refers to the nature and content of (national) road safety plans, action programmes and safety related standards and legislation (Morsink et al., 2005). The extent to which policymakers successfully organize safety policy in goals, strategies, and activities will be captured by means of indicators (Morsink et al., 2007). Good policy performance should result in a better safety performance and fewer final outcomes and lower social costs.

According to Elvik (2001) enforcement is an effective way to ensure better compliance with road traffic laws. Frequent police interventions that are unpredictable, well published and highly visible should raise the (objective and subjective) probability of being caught (ETSC, 2003). Moreover, the type and severity of sanctions play an important role. It is important to note that the quality of legislation and standards as well as the degree of compliance with them will determine the performance with respect to a particular risk factor (described by SPI's). However, high-compliance with a low-quality law or standard will not improve safety outcomes and vice versa (Morsink et al., 2007). Furthermore, attitudes towards action programmes, laws, etc. need to be considered on the policy input layer to ensure compliance with these laws (Sartre 3, 2004; ERSO, 2006).

Road safety performance can also be improved by means of education with regard to road safety. Not only the basic skills on how to control a vehicle can be considered under 'education' but also the knowledge a person is taught by road safety education in primary school, by driver training programmes, by road safety campaigns, etc. (e.g. WHO, 2004). According to the World Health Organization (2004) informing and educating road users can improve knowledge about the rules of the road and the safety of vehicles. Further, education can influence attitudes towards interventions (see: policy input) and the behavior of road participants. For example, the risk of injury when not wearing a seat belt can be highlighted in educational programmes which can increase the seat belt wearing rate (WHO, 2009).

Furthermore, engineering measures can be taken to improve the safety of the road infrastructure and the vehicle fleet. These measures can be taken to reduce the crash risk (e.g. collision warning systems) or the crash severity (e.g. anti whiplash protection). Possible infrastructural measures are the separation of slow vulnerable traffic and other motorized traffic, the removal or protection of obstacles, etc (Elvik, 2008). Measures related to infrastructure can depend on a country's background (see: policy input). Starting from a Sustainable Safety principle, the Netherlands have a clear categorization of roads build on principles such as functionality, homogeneity, recognizability and predictability ('self-explaining' roads) and forgiveness (Wegman et al., 2005).

Next, we present the best available and best needed indicator set for this layer of the target hierarchy for road safety. Possible policy output indicators, classifiable according to the 3 E's (Enforcement, Engineering and Education) were found in literature (such as Sartre 3, 2004; Morsink et al., 2007; Elvik, 2008; Berg et al., 2009; ETSC, 2009). In this paper, we concentrate on measures formulated at the European level. However, it is possible that a country extends this particular indicator set from a more national point of view.

	Best available indicator	Best needed indicator
Enforcement	% of surveyed car drivers who have been checked for alcohol over the last three years	Number of persons annually checked with regard to a risk factor (use of alcohol/drugs; speeding; protective systems; …) per million licensed drivers per transport mode
	Legal maximum speed limit per road type	
Engineering	% of the new cars (completely) equipped with seat belt reminders	% of vehicles (per vehicle type) (completely) equipped with seat belts and seat belt reminders
		% of trucks provided with an emergency breaking system
		Gross Domestic Product share spent on the treatment of black-spots
Education	# annual road safety campaigns	# hours driving experience at the moment the driver gets his final driver's license (per category)
		% of available course hours in the primary and secondary school spent on road traffic and mobility education

Figure 4: Best available and best needed policy output indicator set

6 POLICY INPUT INDICATORS

Policy input indicators refer to the policy context, such as emotions and public attitudes towards risk and safety, the organization of a country and its historical and cultural background (Morsink et al., 2005). These aspects need to be taken into account by policymakers when designing measures and setting up road safety programmes. For example, cultural differences in terms of the social acceptance of unwanted behavior such as drinking and driving can affect the success of a measure related to drunk driving.

So far, not much research has been carried out concerning this layer. Moreover, apart from restricting this layer to culture and structure (see Figure 1), a broader perspective is used. More specifically, external factors such as a country's geographical features, demographic characteristics, etc. are also included under 'policy input' (e.g. Wegman et al., 2008; Wilmots et al., 2009). Although these aspects are not directly and solely related to road safety and are hard to influence within the scope of road safety alone they can contribute to a better understanding of the sources of road crashes and enable the application of more effective road safety policies (Eksler, 2008). Wilmots et al. (2009) found that besides SPI's, four background indicators play a role in the explanation of the number of road fatalities per million inhabitants, namely 'the gross domestic product', 'the average number of persons per household', 'the number of passenger cars per 1000 inhabitants' and 'the average number of kilometers travelled by a driver'. The last PIN report published by the European Transport Safety Council (ETSC, 2009) concludes that the economic recession and the high petrol prices have reduced the traffic volume in some European countries and partly resulted in a reduction in road fatalities in 2008. Also, the age distribution of the population can influence the road safety level since inexperienced drivers (often young drivers) have a higher crash risk and older drivers a higher injury risk. Below, we present the best available and best needed policy input indicator set (based on an evaluation of indicators found in international literature such as Sartre 3, 2004; Morsink et al., 2007; Wegman et al., 2008; Berg et al., 2009; Wilmots et al., 2009).

	Best available indicator	Best needed indicator
Economic	Gross Domestic Product	Unemployment rate
Demographic	Age distribution of the population	Age distribution of the population
	Average number of persons per household	
Transport	Number of passenger cars per 1000 inhabitants	Average number of passenger kilometers travelled per transport mode per age group
Infrastructure	Density of motorways	% road length per road type
Attitude	% surveyed drivers supporting more severe penalties for speeding or drink driving	% surveyed drivers supporting more severe penalties for speeding or drink driving
Characteristics of national safety programmes	The availability and ambition of national road safety targets	Systematical monitoring of the national road safety targets

Figure 5: Best available and best needed policy input indicator set

For this layer, we can conclude possible background and context indicators with regard to road safety are difficult to find. Furthermore, data availability is a problem and indicators are not easy to quantify. Future research concerning this layer can expose more suitable indicators.

7 CONCLUSIONS AND FUTURE RESEARCH

In this paper, we developed a best needed and best available indicator set for road safety as a first attempt in developing a harmonised indicator system for describing, comparing and monitoring road safety within Europe. The evaluation of a number of indicators on each level of the target hierarchy for road safety resulted in the following best available and best needed indicator set:

Best available indicator set	
Final outcomes	
# fatalities / million inhabitants per age class	
% road fatalities out of total fatalities per road type, age class or transport mode	
Intermediate outcomes	
Alcohol & drugs	% of surveyed car drivers disrespecting the alcohol limit
Speed	% of surveyed car drivers exceeding the speed limit on ≠ road types
Protective systems	% of persons wearing a seat belt in the front seats of a car or van
Daytime Running Lights	Existence of a law fully or partially obligating the use of daytime running lights
Vehicle	Age distribution of the vehicle fleet: % of vehicles ≤5 years; between 6-10 years, between 11-15 years and >15 years in the total # of registered vehicles (per vehicle type)
Roads	Motorway density
Trauma management	% Gross Domestic Product spent on health care
Policy output	
% of surveyed drivers who have been checked for alcohol over the last three years	
Legal maximum speed limit per road type	
% of the new cars (completely) equipped with seat belt reminders	
# annual road safety campaigns	
Policy input	
Gross Domestic Product	
Age distribution of the population	
Average number of persons per household	
Number of passenger cars per 1000 inhabitants	
Density of motorways	
% surveyed drivers supporting more severe penalties for speeding or drink driving	
The availability and ambition of national road safety targets	

Best needed indicator set	
Final outcomes	
# fatalities / 100 million passenger kilometers per road type, age class or transport mode	
Intermediate outcomes	
Alcohol & drugs	% of road user population impaired by alcohol or drugs
Speed	Average speed per road type and vehicle type, during daytime and at night
	Variation in speed per road type and vehicle type
Protective systems	% of persons wearing a seat belt in the front respectively rear seats of a vehicle (per vehicle and road type)
	% of persons < 12 years (correctly) sitting in a child's seat in the front or rear seat of a car
	Helmet wearing rate of cyclists, moped riders and motorcyclists
Daytime Running Lights	Usage rate of daytime running lights per road and vehicle type
Vehicle	Age distribution of the vehicle fleet: % of vehicles <5 years; between 6-10 years, between 11-15 years and >15 years in the total # of registered vehicles (per vehicle type)
	% cars rated 4 or 5 stars in EuroNCAP
Roads	% of road lengths with wide obstacle- free zone or roadside barrier
	% of road lengths with wide median or median barrier
Trauma management	Share of road casualties who died during hospitalization
Policy output	
Number of persons annually checked with regard to a risk factor (use of alcohol/drugs; speeding; protective systems; …) per million licensed drivers per transport mode	
% of vehicles (per vehicle type) (completely) equipped with seat belts and seat belt reminders	
% of trucks provided with an emergency breaking system	
# hours driving experience at the moment the driver gets his final driver's license (per category)	
% of available course hours in the primary and secondary school spent on road traffic and mobility education	
Policy input	
Unemployment rate	
Age distribution of the population	
Average number of passenger kilometers travelled per transport mode per age group	
% road length per road type	
% surveyed drivers supporting more severe penalties for speeding or drink driving	
Systematical monitoring of the national road safety targets	

Figure 6: Best available and best needed indicator set

On the basis of literature and the assumption of causality between the layers of the target hierarchy for road safety, we assume that the indicators listed above have a strong relevance for road safety. As data issues currently limit the use of best needed indicators, best practices in terms of data collection need to be advocated. A manual developed at the European level, specifying the measuring of indicators and sampling designs (Hakkert & Gitelman, 2007) is a valuable tool contributing to uniform high-quality data collection in Europe. At this moment, first results can be obtained using the set of best available indicators. In particular, best-in-class countries or groups of similar countries can be identified, using an extensive and diverse set of final outcome, intermediate outcome, policy output and policy input indicators; each country could gain insight in its best and worst aspects; further, the interrelationships between indicators of a particular layer can be investigated (for example as tested by Tingvall et al. (2010) on the SPI's layer) and the degree of correlation between indicators on different levels studied. The extent of the causal relationships between bottom layers and top layers is yet to be further explored (e.g. Morsink et al., 2005; Morsink et al., 2007; Wegman et al., 2008) to answer the question if and to which extent changes at the bottom affect the top layers of road safety. Moreover, in the future, targets could be assigned to each indicator and the evolution towards them monitored on a regular basis.

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