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Comparison of national policies and road safety performance indicators as the key to understand major road safety problems of CEE countries

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Introduction

With the EU enlargement and the challenging aim to halve the number of fatalities in road traffic in EU25, the road safety problems of Eastern and Central European countries have come clearly into light. Having 1.5 times higher mortality rate in road traffic, than former EU15 (Table 1), the development of road safety in these countries will be crucial to realize the targets defined in White paper for the whole EU. To understand the problems and define appropriate actions in the field of road safety in these countries, one must well understand all the weakness of the present system.

CEE and EEC are often seen as a unique monotonous territory with rather same problems in all the fields of life, including road safety. However, already during the screening and negotiation process leading to an accession of 10 new members, four groups of countries become apparent among them: Baltic countries (LT, EST, LV), Mediterranean countries (CY,M), Central European countries (CZ, HU, SK, PL) and Most developed countries (SI). Based on varying political, sociological and historical developments, the countries in these groups have been exhibiting different road accident rates, which have been varying much among different road users. However the differences among accessing countries /AC/ are less complex and deep as these between them and former EU 15 countries. The question has been raised several times, whether these countries should build groups and harmonize their effort towards road safety improvements in their countries. As the successful implementation of particular road safety measures doesn't depend on recent road safety level or political and administrative background, but rather on quality of measures and its implementation, it seems to be reasonable to cooperate and learn from each other, without forming close and separated groups, which neglect the reality of other countries.

	Mortality rate	Fatality rate	Motorization
	fatalities/mio.inhabitants	fatalities/mio.vehicles	vehicles/1000 inhabitants
EU 15	101.8	167.7	607.1
AC 10	149.9	389.6	384.6

Table 1: Safety level in EU 15 vs. AC 10 (IRTAD 2002)

As foreshadowed, the four groups of countries can be identified within 10 accessing countries. Among them, the three Central European countries can be picked up as an example to demonstrate the major road safety problems the countries have to battle: The Czech Republic, Hungary and Slovenia (further referred as CEE countries). Selection of these three countries is not incident, since all of them border with EU 15 countries and serve as transit countries; therefore their infrastructure is relatively well developed among the others. Further, having similar historical, sociological and administrative background, the three countries have been dealing with rather similar problems in the road safety. In early 90's, the traffic flow has started to grow significantly as it doubled over the next 15 years. Although, its density still hasn't reached the level of EU10 countries, the validity of the Oppe's law can be observed in the road safety development of these countries.

Traffic safety problems of CEE countries

Traffic safety is a complex and multidimensional problem and needs broad knowledge to be dealt with. At the time when everybody has his/her own often "one-dimensional theory", a special attention must be given to the right understanding and explanation of the safety situation by using

multidimensional approaches allowing to assess the problem complexly and reliably. With the development of road safety in Central Europe over the last few decades, an increased understanding of the problem can be identified; however, all stakeholders in the field of road safety still fail in producing the change in driver's behavior.

To identify weak points in the complex system of the road safety of particular country, the methods based on comparisons of certain indicators/outcomes between countries have been historically used. International road accident data databases such as IRTAD or CARE became very popular since their establishment and soon become a source of data for solving huge number of road safety problems. They serve as a tool for preparing materials for policy-makers and allow researchers to drive their attention to the actual road safety problems. However the data themselves need to be appropriately used and analyzed to come to a reasonable conclusions and recommendations regarding particular road safety problems. Closer the problem should be targeted, more disaggregated data are needed. For countries comparison, not only the question of data availability has to be solved, but also the question of their compatibility has to be taken into account. Identification of concrete problems in the chain of road safety requires a very close look into national road traffic accidents databases using new approaches.

The traffic safety problem, defined as any factor that contributes to the occurrence of accidents or severity of injuries (Elvik 2004), is essentially multidimensional one. Based on this definition, the road safety problem may exist even it's not recognized. While some safety problems are widely recognized, some others, which might be hidden, deserve indeed more attention. The identification of the road safety problems, which is crucial for any further improvements, is usually done by appropriate analyses. The objective of such analyses is to identify factors, which significantly contribute to accidents and which are, in principle, amenable to treatment.

As mentioned above, the road safety problem should be treated as a multidimensional one. Two different approaches defining particular dimensions have recently been developed by Elvik [1]. The first one contains eight indicators for the following dimensions of road safety problems: Magnitude, Severity, Complexity, Inequity, Territoriality, Dynamics, Perception and Amenability to treatment.

The second approach is of a spatial nature and uses three dimensions of the road safety problem [2]. These are Exposure, Risk and Consequence. The approach is more descriptive and allows comparison unlike the first one described above. Each group of traffic user is treated by such a way, that it's exposure in traffic is taken into account. As a result, the three-dimensional drawing expressing the magnitude of a particular problem is produced as shown in Figure 1. The height of the volume is the total number of injured per million person kilometres (the risk), the width is proportional to the exposure for different transport modes and the depth is the probability of fatality if injured. The front areas are proportional to the number of fatalities per million person kilometres. The magnitude of the problem is here expressed in the volume of particular bars dedicated to the particular road user groups. The volume bars illustrate the magnitude of the exposure dimension by the width of the bars and the height of the bars represents the magnitude of the risk dimension. The depth of the bars then illustrates the magnitude of the consequence dimension. This graphical presentation is very predicative and easily understandable. Treating road safety problems then means to minimize dimensions of the problem. However, as the problem is of cubical nature and tends to behave elastically, the effort dedicated to reduce the magnitude of the problem in one dimension often results in a growth of the other dimension. The

optimal road safety measures should therefore treat all the dimensions at the same time, or, at least consider them at the time when the action is taken.

The volume is equal to the number of fatalities (marked inside the brackets) as obvious from a multiplicative relationship described by Form 1.

$$\text{Number of fatalities} = \text{Exposure} \cdot \left(\frac{\text{Fatalities \& injured}}{\text{Exposure}} \right) \cdot \left(\frac{\text{Fatalities}}{\text{Fatalities \& injured}} \right)$$

Form 1: Traffic safety problem expression

As obvious, the number of fatalities in road traffic can be expressed as a function of exposure and consequence. Multidimensional descriptions of the road safety problem, requires, however a huge amount of different data, which are not nowadays available in all the European countries. The employment of this approach is therefore possible just in few countries, such as Sweden, where it has been historically firstly applied (Nilsson, Thulin, Hyden). In many other countries, the data needed for a description of some dimensions are lacking. In this case, the former three-dimensional approach is limited into two-dimensional (one-dimensional) approach. This dimension reduction can look like disadvantage, however it doesn't have to be the true for all sort of comparisons. Indeed if the dimension of consequence and exposure is missing, a reasonable one-dimensional comparison can be made. The risk dimension can then define the traffic safety problem in terms of accidents or fatalities/injuries in relation to exposure of the defined activity. The risk can then be compared with the risk of another defined activity and the comparison of risk is independent of the difference in exposure.

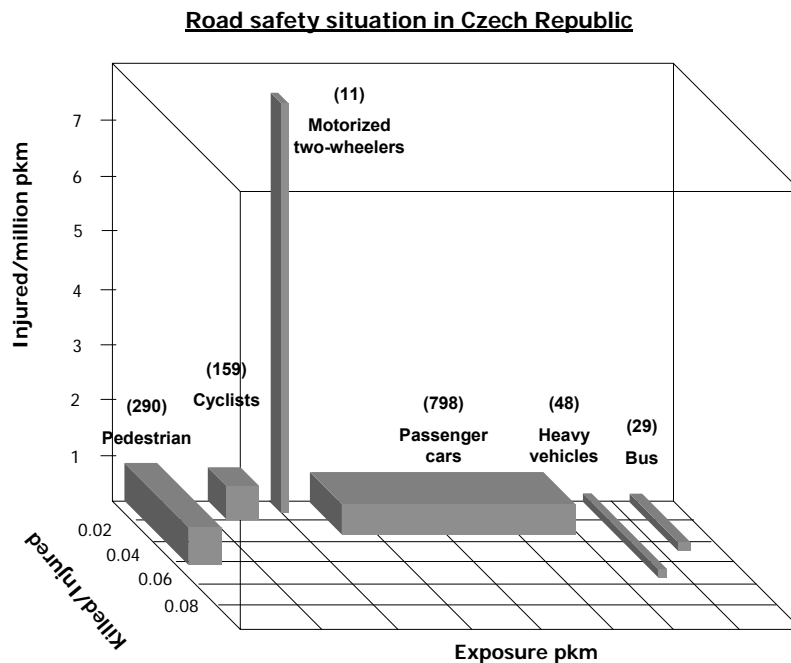


Figure 1: Road safety situation in Czech Republic

The use of three-dimensional model of road safety problem for the comparison of the three CEE countries has shown its limitations, since mobility pattern as well as road safety performance of particular groups is rather very similar. This applies especially for the Czech Republic and Hungary. Slovenia, as a typical transit country with a smaller share of ecological transport modes, exhibits problems with both heavy vehicles and passenger cars. The road safety problems of the Czech Republic and Hungary lay on the vulnerable users. Regarding exposure data, the magnitude of the road safety problem is much higher in the Czech Republic and Hungary than in Slovenia.

2003	CZ	H	SI	SUN (2001)
Pedestrians	20	22,5	15,7	20,1
Cyclists	11	13,7	5,8	7,3

SUN – Sweden, United Kingdom, Netherlands

Table 2: Vulnerable road users fatalities in % of all deaths

The consequence of the accidents in CEE countries is then showed Table 3. The consequence is the lowest in Slovenia, where due to high living standards, the vehicle fleet has been modernized over the last one and half decades and where there is nearly 40 injury accidents on one fatal accidents. Beside that, the magnitude of drinking and driving problem might be another important contributing factor. On the other side of the spectrum, Hungary can be found. Here, the rate between fatal and injury accidents is double against Slovenia. Slightly lower rate for the Czech Republic comes from minor differences in road user pattern in comparison with Hungary (higher share of motorcycles among motorized two-wheelers, etc.). Moreover, the consequence rate might be interpreted together with the use of protective systems as seat belts in passenger cars. The more detailed analysis on risk in particular age groups showed some surprising results. The group of cyclists with the highest risk lies between 55-59 years for the Czech Republic and 65-69 years for Slovenia. In contrary for the age distribution of killed pedestrians, any specific groups with a high attributable risk can be found. [7]

The age distribution for both groups rises exponentially until the age of 60, where it has its peak and then decrease until the age of 90.

CEE countries (2002)	CZ	H	SI
Consequence (Fatality/Injured) in %	5,4	7,2	2,6

Table 3: Consequence of road accident in CEE countries

The effectiveness of the model for the identification of the major road safety problems in CEE countries was but found rather limited, since the exposure data are not complete, especially for Slovenia. The two other countries collect some data for different user categories, what restraints the clear comparison, since the estimates must then have been used.

If considering the potential of the approach in describing the changes and effects of different measures in road safety, it can be stated that the descriptive value is rather low, since it's very difficult to identify particular changes resulting from the implementation of specific road safety measures.

The model used to describe road safety problem in CEE countries showed, that the problem doesn't lay on only one road user category, but on the system itself. One must then consider the system in such a way, as it was presented both in LTSA 2000 [3] and ETSC-report [4].

The model uses different blocks, which form the system as whole. The particular blocks can be grouped into the form of the chain, demonstrating the independence of each block, but more often in the form of pyramid, which better describe the relations and importance of particular block in composing the overall structure. (Figure 2)

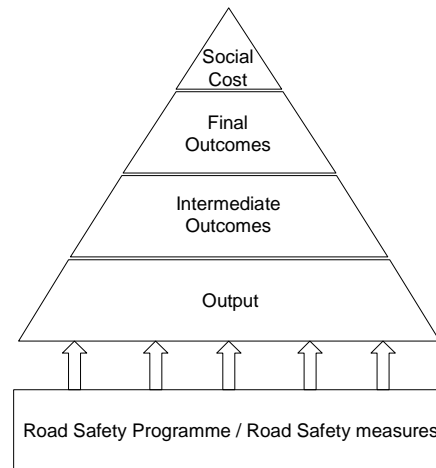


Figure 2: Pyramidal model of road safety (LTSA 2000)

In the pyramidal model, the size (width) of a level indicates not the extent in means of monetized resources, but the quantity of factors influencing the next higher level as well as how much it can be further influenced by external (side) factors. Coming from the bottom of the pyramid and trying to describe each level of the system and its influence on the higher (top) level, the Road Safety Programmes applied in the CEE countries have to be compared. This comparison, however, doesn't lead to a reasonable conclusion, since there is a clear and challenging road safety programme approved in all the three CEE countries containing many sophisticated measures being taken only recently in EU15 countries. The difference, however, comes from the different level of its engagement and transformation into the actions. Since the responsibility for the legislation frame development lays by the politicians, who still not accept the research findings, the numerous of controversial legislative measures have been historically taken. While in the Czech Republic and Hungary, the populism influenced much of the few legislative changes, in Slovenia, systematical steps were done in changing the system over the years. That's also why, the speed limits were changed numerous times in Hungary, both in favor and in disadvantages of the safety, in Slovenia, the transparent steps accompanied by media and enforcement campaigns have brought positive results.

As an output of the politic in the field of road safety, the enforcement and road conditions can be mentioned as the examples. Since the enforcement is considered as the most efficient tool in lowering road toll in CEE countries, where its inhabitants have misleadingly understood the relation between the freedom and responsibility, the level of the enforcement is considered as very important point for road safety.

The safety effects of intensified enforcement can be derived if we accept a generalized relationship between intensity of police enforcement and traffic flow violation. This relationship has been tentatively derived by Koornstra (1993) and has been used in SUNflower report [5] for the comparison of enforcement intensity and its effect in SUN countries. In the proposed model, the data for the three CEE countries were fitted, however it must be underlined, that especially police data on traffic law violence should be seen from a sufficient distance allowing critical view.

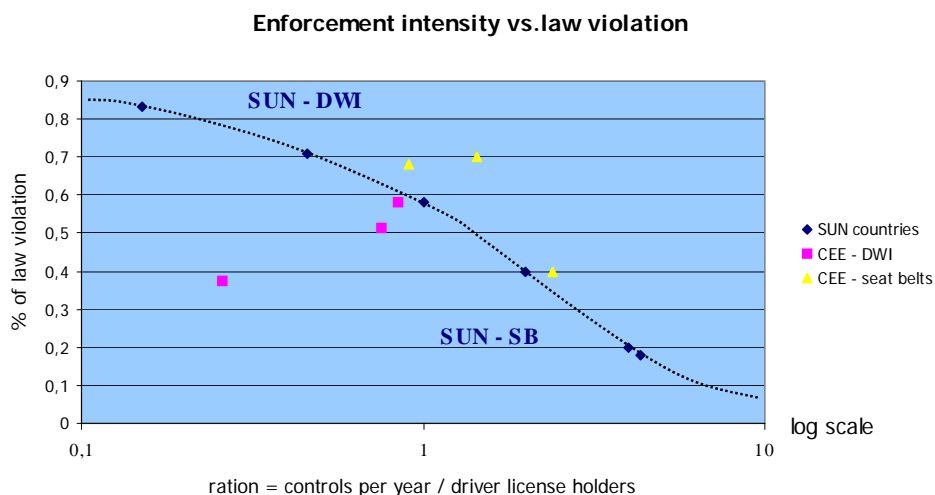


Figure 3: Enforcement intensity vs. law violation (model by Koornstra)

The violation level on seat belt use by drivers in CEE countries is generally very high. The exact values were derived from available data, considering their reliability (showed in Figure 3.). For the Czech Republic, the level of 34 % was used, for Hungary 35 % and for Slovenia 20%, as the weighted average of wearing rates on all the road types. Regarding enforcement level, for 2002, about 11.000 drivers were fined in the Czech Republic, whereas the respective numbers are 16000 for Hungary and 5373 in Slovenia (only here the exact number available). Knowing the number of driving licence holders in the respective year, the ratio of controls per drivers could be derived as 0.0017 for the Czech Republic, 0.0027 for Hungary and 0.0046 for Slovenia. Using this values together with related transformation ratios $x=520$, $z=50\%$, the values could be fitted into the Figure (triangles).

For the comparison and evaluation of the enforcement efficiency regarding drinking law, the values were derived by the following way. Despite the limits for drinking and driving law are different for the countries (0% in the Czech Republic and Hungary) and 0,5 % BAC in Slovenia, the countries could be compared on 0% BAC level, since the Slovenian Police gather information on BAC offences very precisely. In the Czech Republic 9% of the killed drivers were found under the influence of alcohol, while the annual screening level by random checks is 1 in 16 licence holders. (However, for about 25 % of them, the information on their BAC is not available from Police traffic accidents protocols and might be therefore higher.) For Hungary, 12,3 % of killed drivers were found with BAC over the limit, and the annual screening level is 1:5. For

Slovenia, 14 % of killed drivers had BAC over 0,0 % with the screening level at 1:4. Using the transformation ratios $x=4$, $z=24\%$, the points could be fitted in the Figure (squares).

Trying to fit the CEE enforcement intensity levels into the curve constructed from SUN countries values, some discrepancies have been found between CEE countries and SUN countries model. As the Slovenian reality fit the best to the model proposed, whereas the situation is more difficult with the Czech Republic and Hungary, the explanation can be twofold: Slovenian Police gives reliable information about their work, whereas the Traffic police in the two other countries offer rather general data, or estimates. The second explanation might come from the limitation of the methodology used, which efficiency has been proved only under “perfect conditions” existing in the countries with the best road safety performance in the Europe. Here it seems that different background of the countries doesn’t allow building a common model for 6 countries, as it is evident from figure 3.

Since the approach is basically bound with the safety performance indicators, their reliability and comparability must be discussed. When trying to compare safety belts wearing rates in the three CEE countries, different sources of data were available ranging from data from SARTRE project to Police random checks data. Setting together the data of different origin, the relations showed in Figure 4 have been identified. Apart from judgment of data reliability, the wearing rates are much lower than those in EU15 countries. The rates vary between all the three countries, whereas the situation is more favourable in Slovenia thanks to the increased police enforcement targeting their use in mid 90’s. Another contributing factor to the existing situation is very low fine to be paid by offenders. This is only 3 euro in the Czech Republic, and little higher in Hungary. Since the contribution effect of safety belts wearing is well known, the area desires a broader attention of both policy-makers and traffic Police.

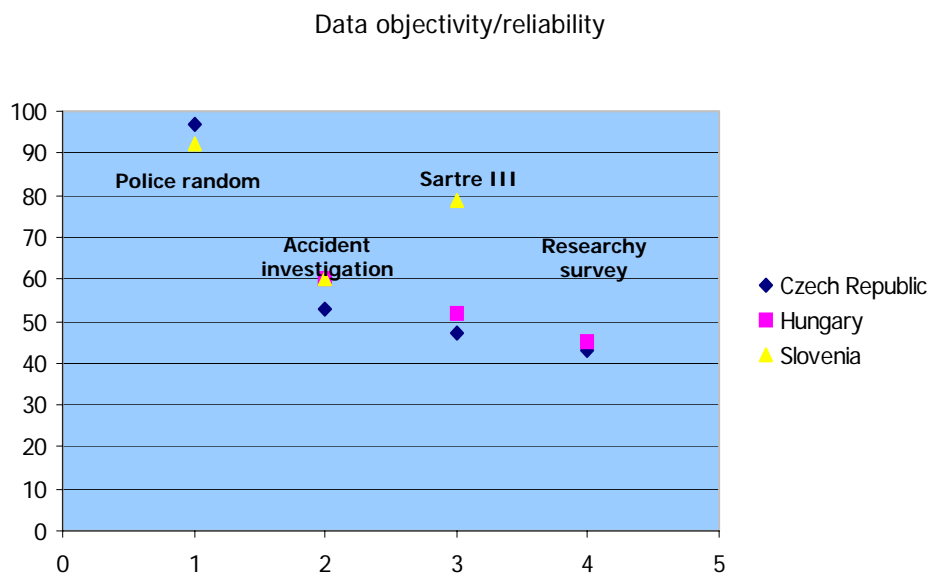


Figure 4: Seat belts wearing according different sources (2002)

Another one from comparable road safety indicators is BAC of drivers dying in road traffic accident. The level of violence has been derived from the national road traffic accident databases, whereas the BAC of the accident causers has been investigated. Figure 5 gives an overview on the situation and allows identifying in which countries the problem lies. Moreover, the Figure gives a response on one widely discussed question, weather and how to proceed in harmonization process for unique BAC limit on European roads.

In both Czech Republic and Hungary, there is a zero BAC limit for all the drivers. In Slovenia, 0.05 % BAC is allowed for passenger cars driver, whereas professional driver have to count with any tolerance for BAC. The data on alcohol consumption in all the three countries doesn't indicate that the drinking and driving should be more significant in Slovenia. However, the Police data show that. It seems that BAC limit higher than zero encourage driver to drink just a little, since it's allowed. However, the recent research shows that indeed low concentration of BAC significantly contribute to the occurrence of road traffic accidents. If compare with EU10 countries, where the BAC is usually permitted by law and limited as 0.05 %, the law violence level is rather small in CEE countries and it's despite the fact that there is a strong evidence of corruptive practices accompanying random police checks for drinking and driving. One must, however, point out, that the data from police accident investigation seems to be reliable, since there is any reason for police to tell lies on them.

Coming from an assumption, that among the young drivers, there is much more problems related to drinking and driving, one might expect that their accidental risk is higher. However, when comparing relative risk of the two different age groups 18-24 and 30-59, it was found that the risk is almost the same in all the three countries, indeed smaller in Slovenia (perhaps due to well established penalty point system, which differently treats novice drivers.)

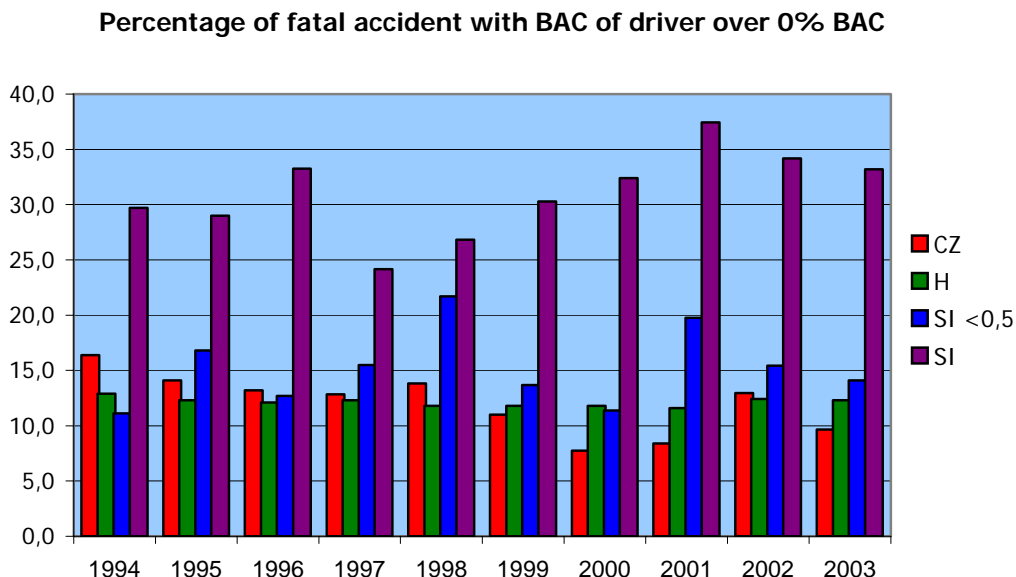


Figure 5: Involvement of alcohol in fatal accidents in CEE countries

In order to get an idea about the BAC level of the drivers causing accident, the Traffic Police of the Czech Republic and Slovenia have been contacted for appropriate comparable data. For the

Czech Republic, in-depth analysis on regional data (South-Moravia, covering almost 1/7 of the state area) for the period 1.1.2005 – 21.2.2005 were performed and 186 policy protocols studied in order to work out the exact BAC levels. For Slovenia, the national data for 2003 were used, as the more recent are not available yet.

Values of BAC level of drivers were finally used to construct histograms of discrete data available. The axis x containing actual BAC level was subdivided into class intervals of 20 mg/100 ml. The heights of particular rectangles describing densities of relative frequencies have been calculated and plotted in figure 6. Due to the limited data sample size, the both histograms are not coming in clearly interpretable shapes, but still, the basic judgment is allowed. Though the histogram describing BAC level for Czech drivers is positively skewed (and perhaps bimodal at the same time), the histogram for Slovenia is rather negatively skewed. By other words, in the Czech Republic, where there is no tolerance for DWI, the accidents with very low BAC prevail, while in Slovenia, the average BAC level is around 140 mg. As there is an exponential relationship between the actual BAC level and probability of accidents (the risk of involvement in a fatal collision is reaching 5 times the level without alcohol at a BAC of 50mg and 34 times the level without alcohol at a BAC of 110mg) [6], the commutation of class rectangles close to the zero is positive as it is to be seen for the Czech Republic. The interpretation of the both histograms can then be as follows. DWI drivers in Slovenia with BAC under 50mg /legal driving/ occur in 18 % of all DWI cases, whereas in the Czech Republic, where there is zero BAC tolerance, it occurs in 30 %. As the risk increases rapidly with BAC content, DWI in Slovenia is clearly more dangerous than in the Czech Republic.

Further, it is clear from this example that any BAC legal limit greater than zero, promotes DWI. As the message for drivers given by zero BAC limit is clear: “never drive after drinking”, the message from any other legal limit can be interpreted in many different ways.

Nowadays a wide debate on an introduction of a common BAC limit in EU25 has been launched and it seems that the majority of experts is in favour of introduction of common BAC limit at 20 mg. This might be a very positive step for those countries having recently BAC limit above 50 mg, but it might be also a step back for countries with zero alcohol tolerance, as the Czech Republic and Hungary. It is also pity that in the debate, not many rational thoughts have been heard regarding different provision for young drivers and hardcore group of drivers having problems with drinking and driving.

There is a strong need to carry out an in-depth study on DWI in Europe prior to taking decision on the introduction of a common BAC limit. This limited example shows how the legislative provisions might influence drivers' behaviour and their respect to the provision and together with the fact that alcohol contributes to a significant proportion of traffic accident in the European Union, the problem should attract more attention of road safety researchers.

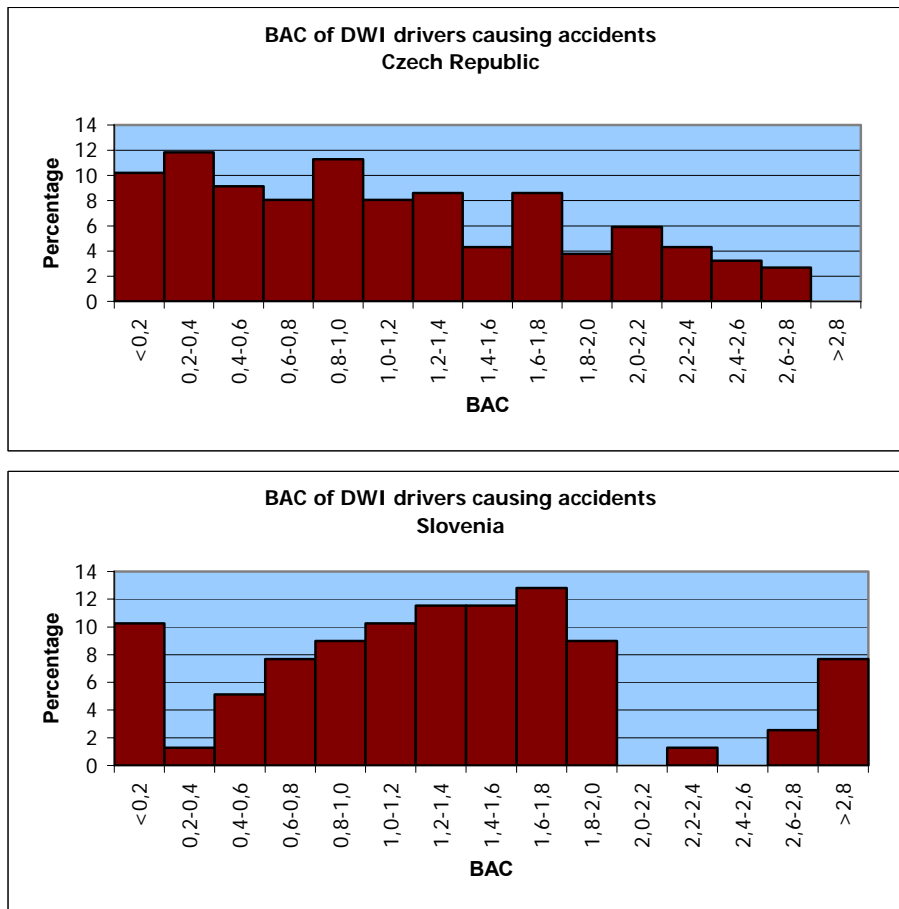


Figure 6: Histograms of BAC levels of drivers causing accidents – Czech Republic; Slovenia

However, one shouldn't omit another common road safety problem, well described by other safety performance indicator: **speeding**. It's well known from various statistical accident investigations concerning the effect on safety of changed speed limits and shows that the change in injury accidents can be regarded as proportional to the square of the relative change in speed, i.e. the kinetic energy in the system. The same seems to be valid for the proportion of fatal accidents among injury accidents. Hence, the change in fatal accidents is then proportional to the fourth power of the relative change in speed. Based on the commonly accepted hypotheses, a power model has been developed by Nilsson [2] describing the effect of the change of mean speed on injuries (fatalities). The model has been validated by meta-analysis as well as recent Swedish data and plotted as showed in Figure 6.

Trying to assess the effect of the speed limit change on road safety in the CEE countries, the effects of their introduction was described and the values fitted in Figure 7. [The three squares shows the relative change of road traffic fatalities attributable to the change of legal speed limits in the Czech Republic and Hungary.] Altogether three speed limit changes were described: The decrease of speed limit in urban areas from 60 to 50 km/h in Hungary (1993) and Czech Republic (1997) and beside that the increase of speed limits in Hungary in 2001. The reduction of the speed limit in the Czech Republic in 1997 lowered the average speed by only 1,1 km/h, because at the same time, the speed limit on motorways has been increased from 110 km/h on 130 km/h.

Number of lives saved was about 10 %, but it was the result of few other measures introduced together with speed limit changes. Another good experience described, is the lowering of inside built-up areas speed limit from 60 to 50 km/h in Hungary in 1993. Here, the speed decrease was about 2.4 km/h and the respective decrease in number of fatalities about 13 %. The increase of the speed limit outside built-up areas in Hungary in 2001 resulted in the speed increase in both outside and inside built-up areas. In average, the free speed of vehicles increased by 2.21 km/h and 0.53 km/h, respectively (in total: 1.04 km/h increase). Respective increase of fatalities in one-year period is estimated as 1.1%.

The experience with the speed limit changes show, how important is to set a credible speed limit throughout the country, as the speed significantly influences road safety records of the country.

The major road safety problems of CEE countries come from a rapid road traffic development, which hasn't been accompanied by appropriate actions. The necessary infrastructure improvements are however not realised adequately to this development and the knowledge on the importance of building safe (self-explaining and obstacle-free zones). Besides some positive experience gaining in different countries as the expansion of highways in Slovenia, rebuilding fourth-arm intersections into roundabouts in the Czech Republic and Hungary, there is a huge space for further improvements. Though the countries have already implemented in their legislation most of the effective measures, the system as whole fails in their enforcement. Also the CEE countries have several times showed their flexibility in adopting new technologies in different fields and the society is now prepared to pay for road safety by losing part of their personal freedom. This is very promising since the enforcement doesn't mean only the work of traffic police (not much effective at the moment due to weak legislation, low fines and existing corruption, which represents a major obstacle for increased public awareness), but also the work of car industry (designing vehicles that incorporate new enforcement technologies such as intelligent speed adaptation and seat belt reminders) and the work of road planners, who have the responsibility to design so-called "self enforcing roads" which facilitate safer driving.

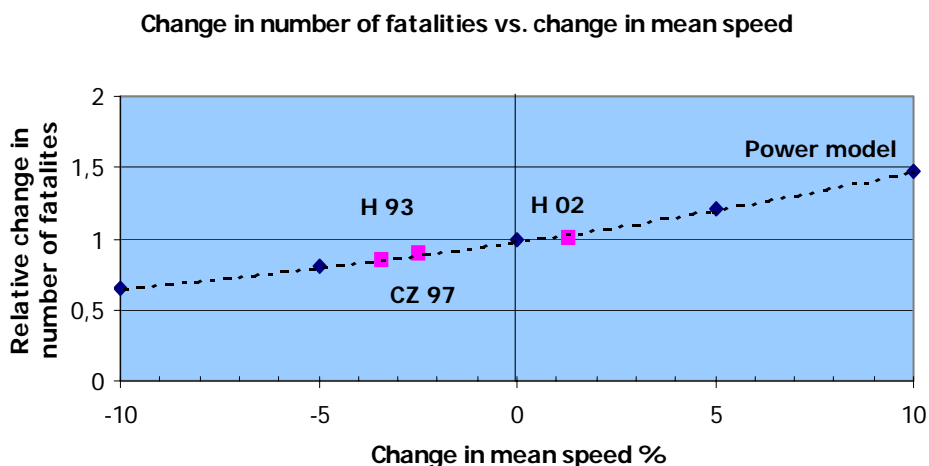


Figure 7: Effect of speed on road traffic toll

However, the situation is not so simple, as it was demonstrated at the first part of this paper, and nobody should underestimate the role of education and engagement in promoting road safety.

References:

- [1] Elvik, R.: A framework for a rational analysis of road safety problems, Institute of transport economics, Oslo, Norway 2005
- [2] Nilsson, G.: Traffic Safety Dimensions and the Power Model to Describe the Effect of Speed on Safety, Doctoral thesis Lund Institute of Technology, Lund, Sweden, 2004
- [3] Road Safety Strategy 2010 of New Zealand, LTSA 2000
- [4] ETSC (2001): Transport Safety Performance Indicators. ETSC Brussels 2001.
- [5] Koornstra, M. et al.: SUNflower: A comparative study of the development of road safety in Sweden, the United Kingdom and the Netherlands, SWOV, Leidschendam, Netherland, 2002s
- [6] Maycock, TRL Report 232 1997
- [7] SUNflower+6: A comparative study of the development of road safety in the Czech Republic, Hungary and Slovenia, to be published in summer 2005

Used abbreviations:

SUN – Sweden, the United Kingdom, Netherlands
CEE – Central European Countries
EEC – Eastern European Countries
IRTAD – International road traffic accident database
CARE – Community Road Accident Database
ETSC – European Transport Safety Council
AC – Accessing Countries