THE TURKISH APPLICATION OF SAFETY IMPACT ASSESSMENT TOOL

Cumhur Aydin
Department of Civil Engineering, Atilim University, Turkey
CAYDIN@ATILIM.EDU.TR

ABSTRACT

As a consequence of urbanization growth and traffic volume increases on arterials, the road safety concept and its improvement are becoming a major policy for the road authorities. Road accidents create huge amount of costs on the country's economy. While trying to maximize the road safety, the cost effectiveness values of different solution alternatives have to be questioned.

In order to manage road safety, policy makers and road authorities need to have a good insight in the safety level of their roads, the variables that explain these levels and the expected effects of their road safety plans. A Road Safety Impact Assessment (RIA) is a methodology to assess the impact of plans on safety. This can be major road works. that may be intended to raise the safety level.

The objective of this paper is to present the application results of the "Decision Support Tool (DST)" in Turkey which was originally developed by the Dutch Road Engineers. It could be evaluated as a road safety impact assessment instrument in which road safety measures are evaluated by referring to their cost effectiveness values. The tool displays cost effectiveness value of the studied countermeasure for a defined road safety problem and enables to make comparison among the different improvement alternatives.

1. INTRODUCTION

1.1. Why Road Safety Efforts Are Still Essential?

Every year more than 1.17 million people die in road accidents around the world. The majority of these deaths, about 70 percent occur in developing countries. It has been estimated that at least 6 million more will die and 60 million will be injured during the next 10 years in developing countries unless urgent action is taken [1].

In Turkey every year, more than nine thousand people die and approximately two hundred thousand people injured in traffic accidents. In other words, about twenty five people have been killed and over five-hundred people have been injured everyday because of traffic accidents [2].

In 2001 the European Commission defined the ambitious objective in their Road Safety Policy to halve the number of fatalities in main European Union (EU) land from over 40,000 to 20,000 in 2010 [3]. Thus EU has tried to support research and application activities in the road safety area.

Among several efforts and precautions concerning different disciplines, road infrastructure related safety measures offer a large potential that could be exploited for a significant reduction of a road accidents and their consequences. Ripcord-Iserest was the road safety project (2005-2007) supported by the EU grants in which 17 parties from 14 different countries were taken part. The objective of that project was to collect and evaluate different road safety approaches in order to make them accessible throughout Europe and to develop tools, which could be used to improve traffic safety [3].

1.2. Safety Impact Assessment

Once the road safety problems or deficiencies and their sources are identified, then the second step is the selection of the correct and adequate countermeasures to implement. Before finalizing the treatment decision, all the cost and accident reduction factors of the different improvement scenarios should be analyzed. The most cost-effective countermeasure has to be applied. The word cost-effectiveness generally stands for the net resource cost of a measure per year of life saved. Effectiveness evaluation considers the safety impact of the measure or the scenario.

On the other hand, a Road Safety Impact Assessment (RIA) is a methodology to assess the impact of plans and measures on safety. For a RIA on single road works, several methods are available. It is best to use as much scientific evidence as possible, using handbooks, cost-benefit analyses, and taking into account network effects. For RIAs on wider schemes or even national levels, specific recommendations are given on methodology. In general a RIA is best used in comparing policy options and setting ambitious but realistic road safety targets. Absolute numbers that are predicted are usually not very reliable and in general highly dependant on high quality databases that are usually not available [4].

Four ways of assessing the impact can be identified: a) Expert Opinion, b) Handbooks, c) Including (local) network, d) Cost benefit analysis.

Expert opinion is a qualitative assessment by experts who can for instance score each relevant safety aspect negative, neutral or positive. This is easy to apply and will guarantee an outcome but its validity and reliability are questionable.

The effects of road safety measures can also be estimated by using international handbooks. In general these are science based but have large confidence intervals. In the third way; the effects on the adjacent network are considered. Usually this is done by modelling traffic volumes and applying risk factors per road type. The effects on the adjacent network can be quite relevant and therefore this is better but more costly method. Finally, cost benefit analysis can be part of the first three methods or done in a more vigorous way by taking into account the effects on the environment, accessibility, spatial planning, etc. This could be disadvantageous when applied to road safety measures that have an adverse effect on environment or accessibility [4].

The second type of RIA is used on a network or area level. In general five steps can be identified in this type. The first step is related with the baseline situation. This describes the current situation with respect to traffic volumes and accidents per road type. The second step is arranging the future situation without the measures. In most plans the function of roads will be changed, for instance by introducing 30 km/h-zones in residential area's. This will result in re-directing traffic. This step also includes traffic growth. The third step concerns applying road safety measures. Within this stage, the effects of measures are assessed per road type and road user groups. The fourth step consists of a monetary valuation of safety impacts which is related to the costs of the measures. The final step is the optimisation. In this stage the plans are changed in order to reach the optimal safety effect or the best cost/benefit ratio [4].

2. DECISION SUPPORT TOOL

2.1. The basic tool structure

The DST evaluates the cost and the safety impact of the measure or the improvement. The program displays cost effectiveness value of the proposed action. It also enables to make several evaluation runs with the other proposed measures having different project costs with different safety impacts.

The tool is based on different digital data. The DST needs road network (X and Y coordinate of a road, the geographical length of a road), road characteristics (name of the road, road classification, road manager, amount of the traffic) and accident data (only focused on deaths and hospital injured, X and Y coordinate of the accident, the year of the accident) information. The X and Y coordinates of the accidents are used to determine the location of the accidents on the digital road data. For introducing the influence of traffic flows on road safety, the Average Annual Daily Traffic (AADT) of the road section is used [5].

In the DST the digital format consists of X and Y coordinates. Other information like digital road network data, road classification and road manager is also necessary. At the moment there is no such digital road network available for European Commission. Some countries have regional and national digital road network databases. It is hard to join them in one database because of having differences in the structure of the available databases. So these different databases are evaluated and studied deeply.

Average Annual Daily Traffic (AADT) is one of the necessary data in DST calculations. There are two different AADT values in the calculations. AADT Basis, which shows the average annual daily traffic value for the years that the accidents happen and AADT Scenario, that is calculated average annual daily traffic value for the years that the measures will be implemented.

The accidents and their severity’s are also an important data for DST. In the outputs of the DST, after applying a safety measure; the reductions for the accidents as number of deaths and number of hospital injured victims are listed with referencing the initial values.

2.2. The scope and aim of the tool application

As mentioned above, the Decision Support Safety Tool (DST) helps road authorities to select appropriate safety intervention measures and develop different scenarios for road safety problems. The tool also helps to contemplate road safety level and cost effectiveness to alternate the scenarios to improve road safety according to the policies of road authorities [5].

To develop the DST successful, data like road network, accident and applicable measures must be circumstantially gathered and evaluated. In the EU member countries the data and its collecting and filing methods are different. It is important and necessary to combine the data and make them available for different countries. On the other hand cost of different measures and their safety effects are different under different road and traffic conditions. Therefore besides it is development, it is also beneficial to check the validity of the tool in the different European regions.

While using DST, to determine a problem or to select a measure, dependable identification of the accident types play an important role. This information is collected by road authorities for the evaluation of the problems. Types of accidents (e.g. head-on collision, rear-end collision etc.) are labelled by numbers for a practical use. It is obvious that different accident types with different majorities can be observed in different traffic environments.

Accident information is also important while selecting measures thus problem definitions and improvement scenarios are related with the accident types. Accident reports filled by the police are the important source for collecting necessary information for the accidents types and the mechanism.

Since the countermeasures types can vary with countries having different traffic and accident patterns, the DST should have enough measures to apply at different regional road and traffic environments. After having lots of measure alternatives in the data set; the selection process becomes important. The tool creates different alternative scenarios for the road authorities and that helps them to make sound decisions regarding the effectiveness of the measures. In other words, applying different measures for the same road section, the tool evaluates the differences between costs, reduced number of deaths and reduced number of hospital injured victims. As a result of the output of the DST run; cost effectiveness values, which are calculated with the above mentioned data are displayed. With these outputs, decision makers or road authorities can select the most effective measure for the selected road section [5].

3. THE TURKISH (SOUTH-EAST EUROPE) APPLICATION OF DST

3.1. The Pilot Application of DST in Turkey

In order to evaluate the different road safety situations and to select proper countermeasures under local conditions, the Decision Support Tool (DST) was applied in three different regions during the Ripcord-Iserest Project study. These regions were selected as the Netherlands (The west Europe region), the Poland (The middle Europe region) and the Turkey (The south-east Europe region).

This paper considers the application of DST in the selected road sections in Turkey. In the subsequent paragraphs, the technical definitions for the road sections, explanations for the gathered road safety data and finally result of the DST application will be given [6].

3.1.1. Selected Roads and The Basic Traffic Data

For the Turkish case study, different road sections from the different parts of the Turkey were selected. While selecting these road sections the following circumstances were considered:

- Two lane roads that contain safety problems although they are not primarily important,
- Roads that have high amount of traffic and have accidents,
- The locations that have present and potential black spots.

As a result of these considerations and points, the following roads were selected in Turkey.

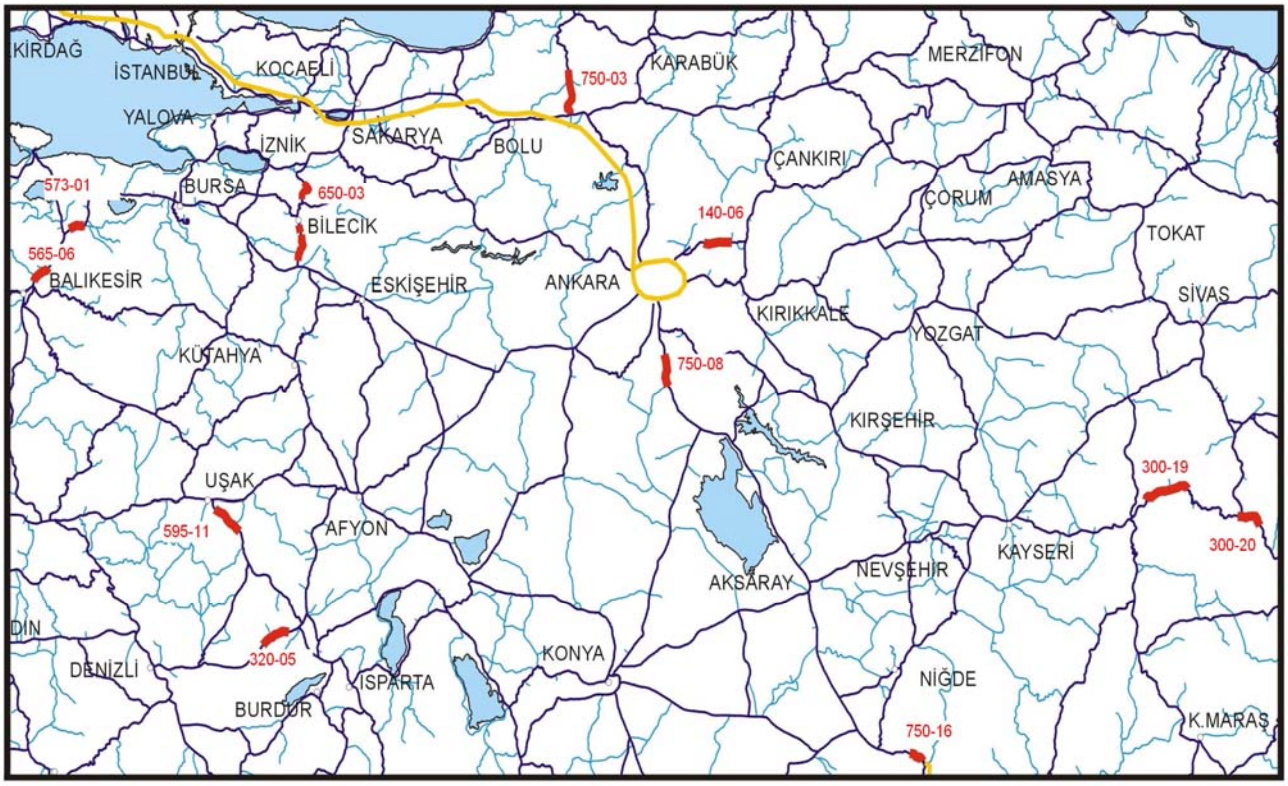

Figure 1: Selected Roads for DST Application inTurkey (6)

Road Number	Name
40-06 between Km.23+000-47+000	Ankara-Kalecik
320-05 between Km.23+000-42+000	Dinar-Dazkırı
565-06 between Km.32+000-44+000	Karacabey Int.-Balıkesir
573-01 between Km.18+000-32+000	Karacabey Int.-Balıkesir
595-11 between Km.4+400-31+600	Uşak-Sivaslı Int
650-03 between Km.14+400-31+000	Mekece Bozüyük
650-03 between Km.49+200-51+800	Mekece Bozüyük
650-03 between Km.52+150-73+000	Mekece Bozüyük
750-03 between Km. 0+000-29+000	Zonguldak Province Border- Mengen- Yeniçağa Int
750-08 between Km.15+000-33+000	Bala Int.-Kulu Int.
300-20 between Km.50+000-67+000	Gürün- Malatya Prov.Border
750-16 between Km.42+000-52+000	Ulukışla-Pozantı

Table 1: Location Information of the Selected Roads for DST Application in Turkey (6)

As mentioned before DST needs specific data for the application of the tool. The geographical data for the roads and their environment was prepared for the road regions. Besides the geographical data, the accident locations, accident causalities and the AADT's of the selected roads were also gathered around for the DST application. The scenario AADT values were calculated by the program by referring the base year AADT values of the road sections (Table 2). The DST program was also fed with the accident and causality data belongs to three years of period (2003- 2005) (Table 3)

After this arrangement, a new important step was carried out. The proper countermeasure proposals have to be identified. In the Turkish pilot study, this selection was made by evaluating the Expert System (Another safety analysis tool which developed during the Ripcord-Iserest Project.) and by also referring to the original DST countermeasure data bank together. This proposal selection was achieved on the technical relevance base. The "reference year" for this study was selected as 2010. The cost of improvement and its probable safety effect values were directly taken from the program's original development. The calculations for the cost-effectiveness of countermeasures have been made by the run of the DST itself.

ROAD	AADT Basis	AADT Scenario
750-03 (0+000 – 29+000)	2867	3659
650-03 (14+440 – 31+000) 650-03 (49+200 – 51+800) 650-03 (52+150 – 73+000)	8371	10684
573-01 (18+000 – 32+000)	10392	13263
595-11 (4+400 – 31+600)	3129	3993
320-05 (23+000 – 42+000)	5117	6530
750-16 (42+000 – 52+000)	11952	15254
750-08 (15+000 – 33+000)	11228	14331
140-06 (23+000 – 47+000)	3413	4357
300-20 (50+000 – 67+000)	1478	1886

Table 2: Base and the Scenario Year AADT Values (6)

ROAD	Hospital Injured	Dead
750-03 (0+000 – 29+000)	46	0
650-03 (14+440 – 31+000) 650-03 (49+200 – 51+800) 650-03 (52+150 – 73+000)	311	18
573-01 (18+000 – 32+000)	153	14
595-11 (4+400 – 31+600)	103	7
320-05 (23+000 – 42+000)	196	5
750-16 (42+000 – 52+000)	72	6
750-08 (15+000 – 33+000)	122	8
140-06 (23+000 – 47+000)	23	0
300-20 (50+000 – 67+000)	80	3

Table 3: Base Year Casualty Figures (6)

3.1.2. Safety Situation of the Selected Road Sections

a) Road Section 140-06
The main accident types for this road section were “run off the road” and “side collision”. To evaluate these accidents the alignment of the road design was analysed. From the detailed analysis on the accidents reports, it was found technically reasonable to select countermeasure “construction of guardrails” to reduce the effects of “run off the road accidents”. The other alternative countermeasure for this road section is “construction of a passing lane” that prevents the head on collision accidents.

b) Road Section 300-20
Because of the high number of “run off the road accidents”; the best way to reduce the effects of accidents at that section was decided to “apply guardrails” as a countermeasure.

c) Road Section 320-05
The main accident type for this section of the road was “run off the road” but from the accident report analysis it was observed that the run off the road accidents have generally been occurred in curves. Horizontal road design should be considered and analyzed. To reduce number of accident, the countermeasure alternative “construction of painted guardrails at curves” was selected as a suitable implementation for the safety improvement at the site. The other alternative was mentioned as, “recommended speed in curves”.

d) Road Section 573-01
Besides “run off accidents”, “head on collision” could be the other main accident type for this section. The vertical design of the road plays an important role in this section. To reduce the occurrence rate and the severity of the accidents it was an option to select “increasing shoulder width”. Another countermeasure could be the “construction of passing lane on both sides” to prevent the accidents that occur on the climbing lanes. These mentioned alternatives were tried for the section.

e) Road Section 595-11
The main accident type for this road section was “run off the road”. For this section of road “flattering side slopes” can be a countermeasure to reduce the severity of accidents. The countermeasure “construction of guardrails” could be selected as an alternative.

f) Road Section 650-03
At this section of the road, most accidents have been occurred at junctions. Horizontal road design should be considered and analyzed. From analyzing the accident reports the main reason for the accidents was clarified as the poor sight conditions at junctions. “Improving sight conditions” can possibly prevent this kind of accidents. The countermeasure “construction of staggered junctions”, to prevent the accidents at four-legged junctions, could be the other alternative. These alternatives were tried in the DST evaluation.

g) Road Section 750-03
Most of the accidents at this section of the road have been occurred at curves. Horizontal road design should be considered and analyzed. From analyzing the accident reports it was observed that “run off the road” and “turn over accidents” were the main accident types at this section, thus “improving road surface friction” and “construction of painted guardrails” were selected as countermeasures.

h) Road Section 750-08
This road section had a similarity with the road section 595-11 referring to the accident reasons. So the countermeasures “flattering side slopes” and “construction of guardrails” were selected.

i) Road Section 750-16
At this road section, through the analysis of the accident reports; it was observed that due to the overtaking needs, the occurrence of the accidents were high. “Increasing number of lanes” could be a good solution for these kinds of accidents. For the all sections, since the accidents were not concentrated at the certain locations but instead were spread over almost the whole section, the countermeasures that can contribute the improvement on the whole sections were considered.

4. DST AND RSI ASSESMENT EVALUATION

4.1. Evaluation of the Results

After selecting the proper countermeasures, runs with the selected countermeasures were made. The outputs of the DST run were then evaluated. In the outputs of DST, the estimated appraisal number of deaths and injuries according to the reference year (2010), reduction of these numbers if the countermeasure is applied, the cost and the cost-effectiveness value of the proposed countermeasures could be seen. It is supposed that the base year was 2004, which represents the accident record’s year. The year 2007 was selected as the year that the countermeasures were going to be applied.

These topics were evaluated to understand if the selected countermeasure was effective. The alternative countermeasures for the same road sections were also compared in this way. Calculated cost-effectiveness values in the DST output file have positive effect if the value is close to zero. Cost-effectiveness has adverse effect if the effectiveness increases by means of value. Cost-effectiveness means the amount of money in million euros to save one victim. On the other hand, it is necessary to mention that when applying DST, since the whole of the road section were selected for the implementation, this selection could affect the results.

Some of the results that were obtained for the selected road sections through DST runs are given in Appendix1**.** The evaluation of the whole result set is displayed in the subsequent paragraphs.

a) Road Section 140-06
The countermeasures selected for this section are “construction of guardrails” and “passing lane”. If the application results of these two countermeasures are compared with each other, the reductions for hospital injuries are 4.6 for guardrails and 1.8 for passing lane. It can easily be concluded that the construction of guardrails is more effective. The cost effectiveness values are 0.00135 for guardrails and 0.0497 for passing lane, which also means guardrail application is more effective than passing lane construction.

b) Road Section 300-20
At this section of the road, implementation of guardrails can reduce the amount of deaths 0.2 and amount of hospital injuries 7.6. The cost-effectiveness is 0.00184 which means this countermeasure could be an effective treatment.

c) Road Section 320-05
The important part of this section is laid on the curves. For this reason selected countermeasures are “painted guardrails in curves” and “recommended speed in curves”. As it was analyzed the reductions for amount of deaths and injuries are 0.8 and 29.6 for painted guardrails and 0.3 and 10.1 for recommended speed. The cost-effectiveness values are similar as they are 0.0000145 for painted guardrails and 0.0000424 for recommended speed. When these results are compared, the painted guardrails alternative is found to be a better choice.

d) Road Section 573-01
The result for the selected countermeasure “increasing shoulder width” displays reduction amount of deaths and injuries 1.1 and 11.9 respectively. On the other hand the other alternative “passing lane on both sides” reduction factors are 2.0 for deaths and 22.6 for injuries. The cost-effectiveness values are 0.0251 for increasing shoulder width and 0.0130 for passing lane on both sides, thus the countermeasure “increasing shoulder width” can be selected as a comparatively better solution than “increasing shoulder width”.

e) Road Section 595-11
When the selected countermeasures “flattering side slopes” and “guardrails” for this section of road are compared, it can be seen that the implementation of guardrails is a better solution as the reductions are 1.2 for deaths, 18.8 for injuries. On the other hand countermeasure flattering side slopes have 1.1 reduction for deaths and 16.8 for injuries. The situation occurs in cost-effectiveness values as they are 0.01 for flattering side slopes and 0,0017 for guardrails. As a result it can easily be said that the “guardrail application” countermeasure is much more effective than the “flattering side slopes” alternative.

f) Road Section 650-03
Different from the other road sections; this section had problems which were occurred at junctions. Implementation of two alternative countermeasures, i.e “improving sight conditions” and “staggered junctions” were investigated. The first was resulted in 0.5 injury reduction and no death reduction the second displayed 0.2 death reduction and 3.1 injury reduction. The cost-effectiveness values were found as 0.9937 and 0.0248 respectively. This result also proves the countermeasure “staggered junctions” is a better solution.

g) Road Section 750-03
Again the accidents have generally been occurred on the curves at this road section as a result of “run off the road” or “turnover” accidents. For this reason, the countermeasures “improving road surface friction” and “painted guardrails in curves” were selected. Both two countermeasures can not reduce the amount of deaths but reduction of injuries is 1.9 and 5.0 respectively. Costs effectiveness values are 0.00567 and 0.000049 respectively. These results indicate selection of the countermeasure “painted guardrails application in curves” affects more positively and thus it is a better solution.

h) Road Section 750-08
As in the road section 595-11, selected countermeasures are “flattering side slopes” and “guardrails” for this road section. When selected countermeasures are compared it can be seen that the implementation of guardrails is a better solution as the reductions are 2.0 for deaths, 31.6 for injuries. On the other hand countermeasure flattering side slopes have reductions of 1.8 for deaths and 28.2 for injuries. The same situation occurs in cost effectiveness values as they are 0.00338 for flattering side slopes and 0,000572 for guardrails. As a result it can easily be said that the guardrail application is much more effective than the flattering side slopes.

i) Road Section 750-16

Selected countermeasure for this road section is “increasing number of lanes”. The amounts of reductions that are shown in the output are 0.8 for deaths, 8.3 for injuries. The cost effectiveness value is 0.0178. Considering the high amount of implementation cost, this countermeasure should be evaluated carefully since increasing the number of lanes can increase the number of accidents that are occurring due to the high speeds.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

The conclusions that are drawn from the study can be summarized as follows:

a) For the all road sections used in the study, since the accidents were not concentrated at the certain locations but instead were spread over almost the whole section lengths, the countermeasures that can contribute for the improvement of the whole road section were considered. This also affected the cost-effectiveness values of the alternatives.

b) Lack of long term and dependable local accident and countermeasure data limited the process of this study. These limitations forced the study either to make reasonable acceptations or to use international data in some stages of the calculations.

c) The Decision Support Safety Tool (DST), can effectively be used for the evaluation of the safety improvement schemes in Turkey as a valuable safety impact assessment instrument.

d) Cost-effectiveness evaluations as a part of safety impact assessment agent can help road authorities to efficiently use the limited budget.

e) The methods and the runs of DST used in this study yield approximate results. Therefore more detailed analyzes and evaluation should be executed in order to decide on the improvement alternatives.

5.2. Recommendations

Recommendations for the future studies can be listed as follows:

a) The accident data collected by the different authorities in Turkey such as Turkish Road Authority, Gendarme, Police and Health Department should be accumulated together to have more accurate and dependable information.

b) A dependable long term local data bank formation has to be started immediately through collecting necessary information about road section improvements from before and after studies.

c) The values that are presently used in original DST can further be tried in Turkey but it should be more reasonable to calculate the local costs of accidents and countermeasures together with local accident reduction factors for the more dependable DST runs. For this purpose a comprehensive research for estimating the local costs of accidents and countermeasures and also accident reduction factors of the different safety measure alternatives should be started immediately.

d) The numbers of injuries that later die in the hospital should be considered to understand the severity of accidents and evaluate the severity of the accidents more adequately.

e) The accident, road and the road environment data should be collected regularly in order to have accurate data bank for the road safety analysis. This will help the researchers to know about the changes and the fluctuations so that they have better understand and evaluate road users' behaviours before and after the implementation of the countermeasures.

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APPENDIX-1

Table 1-140-06 Guardrails (side collision – run off the road)
(Secondary Roads Outside the Urban Areas -high-)

Deaths		*Hospital Injured*		*Costs*	
Scenario		*Scenario*		*Scenario*	
total	*reduction*	*total*	*reduction*	*costs*	*cost-effectiveness*
0.0	0.0	0.0	0.0	€ -	0.00
34.9	0.0	629.7	4.6	€ 216,000	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
34.9	**0.0**	**629.7**	**4.6**	**€ 216,000**	**0.00135**

Table 2-140-06 Passing Lane
(Secondary Roads Outside the Urban Areas -high-)

Deaths		*Hospital Injured*		*Costs*	
Scenario		*Scenario*		*Scenario*	
total	*reduction*	*total*	*reduction*	*costs*	*cost-effectiveness*
0.0	0.0	0.0	0.0	€ -	0.00
34.9	0.0	632.5	1.8	€ 3,041,826	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
0.0	0.0	0.0	0.0	€ -	0.00
34.9	**0.0**	**632.5**	**4.6**	**€ 3,041,826**	**0.0497**

Table 3-300-19 Guardrails (run off the road)
(Secondary Roads Outside the Urban Areas -high-)

Deaths		*Hospital Injured*		*Costs*		
Scenario		*Scenario*		*Scenario*		
total	*reduction*	*total*	*reduction*	*costs*		*cost-effectiveness*
0.0	0.0	0.0	0.0	€	-	0.00
32.5	2.4	589.9	44.4	€	1,154,286	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
32.5	**2.4**	**589.9**	**44.4**	**€**	**1,154,286**	**0.00073**

Table 4-300-19 Flattering Side Slopes
(Secondary Roads Outside the Urban Areas -high-)

Deaths		*Hospital Injured*		*Costs*		
Scenario		*Scenario*		*Scenario*		
total	*reduction*	*total*	*reduction*	*costs*		*cost-effectiveness*
0.0	0.0	0.0	0.0	€	-	0.00
32.7	2.1	594.6	39.7	€	6,083,648	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
0.0	0.0	0.0	0.0	€	-	0.00
32.7	**2.1**	**594.6**	**39.7**	**€**	**6,083,648**	**0.0043**

Table 5-Road – Measure – Cost Effectiveness

Road	Selected Measure	Cost-eff.
320-05	Painted Guardrails in Curves	0,000015
320-05	Recommended Speed in Curves	0,000042
750-03	Painted Guardrails in Curves	0,000049
750-08	Guardrails	0,00057
300-19	Guardrails	0,00073
140-06	Guardrails	0,00135
595-11	Guardrails	0,0017
300-20	Guardrails	0,0018
750-08	Flattering Side Slopes	0,00338
300-19	Flattering Side Slopes	0,0043
750-03	Improve Road Surface Friction	0,00567
595-11	Flattering Side Slopes	0,01
573-01	Passing Lane on Both Sides	0,0132
750-16	Increasing Number of Lanes	0,0178
650-03	Staggered Junctions	0,0248
573-01	Increasing Sholder Width	0,0251
140-06	Passing Lane on One Side	0,0497
650-03	Improve Sight Conditions on Junctions	0,9937