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Safety Analysis of Road Networks: Experience Aquired Using an Automated System

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Wilhelmstraße 43/43G, 10117 Berlin
PO Box 08 02 64, 10002 Berlin
unfallforschung@gdv.de
www.udv.de

Editor: Dipl.-Ing. Jörg Ortlepp
Layout: Michaela Gaebel
Technology: Monika Kratzer-Butenhof
Photo References: Insurers Accident Reserach

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Preliminary remarks

The purpose of the safety analysis of road networks, as specified by the German Guidelines for Safety Analysis of Road Networks (Empfehlungen für die Sicherheitsanalyse von Straßennetzen (ESN)) published by the FGSV (German Road and Transportation Research Association), is to identify deficiencies wherever they may be in the road network. It is used both when roads are in operation and in road planning. The entire road network is analyzed, so considerable volumes of data have to be processed. Consequently, the process has to be automated.

The aim of this project was to implement the ESN guidelines – using sections of road based on the network's structure – in a software tool and to use this in practice in a number of German federal states. It was demonstrated in the federal states of Brandenburg, Hesse, North Rhine-Westphalia, Saxony, Saxony-Anhalt and Thuringia that this was possible to do.

There are still problems associated with the quality of the underlying data and the methodology used to subdivide roads into sections. However, some of these problems can be resolved by means of analysis options and filter settings in a software tool.

Content

1 Introduction

The German Guidelines for Safety Analysis of Road Networks (Empfehlungen für die Sicherheitsanalyse von Straßennetzen - ESN) contain guidelines and calculation rules for evaluating the safety potential of roads. Based on reported accident data (category, location, type, point in time, etc.) and empirically developed general accident indicators (accident cost densities and rates as well as basic accident cost rates), a quantitative measure of the safety potential is calculated.

The aim of this project, which was carried out for the UDV (German Insurers Accident Research) by PTV AG in Karlsruhe, was to develop an automated system for the ESN safety analysis guidelines and implement it in six German federal states.

2 Input data

A number of different data sources were used to carry out the safety analysis in accordance with the ESN guidelines:

- The 2003 edition of the ESN document
- Accident data from the EUSka system (a modern software system for analyzing road accidents that portrays the accidents visually, based on the criteria of the 1- and 3-year maps, and filters the accident statistics geographically based on the attributes of the accident report and on characteristics such as the age and gender of those involved and the type of road user they are) for the federal states of Hesse, North Rhine-Westphalia, Saxony, Saxony-Anhalt and Thuringia, as well as accident data from the BASta system for Brandenburg
- Digital road data of the above-mentioned federal states
- The nationwide Navteq map of the road network
- PTV AG's Validate Germany traffic model.

2.1 ESN 2003

The ESN (Guidelines for Safety Analysis of Road Networks, published by the FGSV in 2003) provided the rules for calculating the safety potential on the basis of basic accident cost rates.

2.2 Accident data

The EUSka accident data was made available in the form of a Microsoft Access database. Generally speaking, this data covers accidents in categories 1 to 6 and the years 2006 to 2008. The accident data includes the following information:

- Date
- Road type
- Accident type
- Accident category
- Coordinates (based on the WGS84 system) of the accident location.

The accident data from Brandenburg was made available in an Excel file with similar information. The key difference lies in the location information. No coordinates were made available for the accidents in Brandenburg; instead, the associated network node-based sections and roadside distance marker posts were used.

2.3 Road data of the federal states

The road data of the federal states was available in the form of multiple GIS layers in MapInfo format. There was a layer for the following road classes (depending on the responsible road authority or public agency in each case): freeway (Autobahn), federal highway (Bundesstraße), state highway (Landesstraße or, in Saxony, Staatsstraße), district highway (Kreisstraße) and local road (Gemeindestraße). This layer contained the following information:

- The geometry of the road (polyline)
- The identifier of the section of road
- The road class (freeway, federal highway, state highway, district highway or local road)
- The road number
- The length of the section of road.

It must be taken into account that, even within a single federal state, information about the road network from different sources (information on marker posts, for example) may be vary in terms of how current it is. There may also be differences in the maps used by the police to record an accident (e.g. with EUSka) and in the maps underlying the road data of the responsible road authorities in terms of how current they are.

2.4 Road network

Navteq data for the whole of Germany was used in the project. A road network was created on the basis of all of the available sections of road. This network served as the basis for all calculations and for visualizing the calculated results and was based on both the sections of road in the road database of the various federal states and on the Navteq sections of road. The information from the road and accident databases of the federal states was transferred to the Navteq network.

2.5 Traffic model

An important component of the ESN calculations is information about the average daily traffic volume (DTV) on the sections of road where accidents have occurred. For this reason, PTV's Validate Germany traffic model was used in the project to carry out calculations in accordance with the ESN guidelines. This provides daily traffic volume data for the entire network of main roads in Germany.

Since it is based on the same Navteq digital road network as the road network used for the ESN calculation, it was relatively easy to use the model's average daily traffic volume (DTV) values for the ESN calculation throughout the federal states. In principle, however, it would be perfectly possible to use other sources for the average daily traffic volume values (e.g. data from the nationwide road traffic surveys of the Federal Highway Research Institute (BASt)).

3 Procedure for the automated system

3.1 Harmonization of the data ressources

To carry out calculations in accordance with the ESN guidelines, it was necessary to assign the accidents to the sections of road in the road database of the various federal states or the corresponding sections of road. This was done using the coordinates from the accident database. By taking the coordinates, road class and road number, each accident was assigned to a single Navteq section of road.

In order to assign the accident to a section of road, the coordinates of the accident could not be further than 50 m from the section of road, and both the road class and road number had to agree. The accidents were cross-referenced with the road class and road number assigned from the road database. This procedure ensured that the accident data and the road network data (used by the federal states) were largely in agreement.

Table 1:
Number and percentage of accidents assigned (accidents from 2006 to 2008)

	A(ID)[5)]	Outside built-up areas		Road classes Freeways, federal and state highways		Assignment to section of road possible/ ESN analysis	
Saxony	267,442	90,616	33.90%	69,718	76.90%	65,082	93.40%
Saxony-Anhalt	240,880	76,623	31.80%	59,150	77.20%	53,027	89.60%
Hesse	399,892	141,392	35.40%	124,077	87.80%	111,073	89.50%
Thuringia	154,085	51,660	33.50%	45,141	87.40%	36,309	80.40%
North Rhine Westphalia[1)]	510,847	88,099	17.20%	66,348	75.30%	47,188	71.10%
Brandenburg[2)]	63,998[3)]	23,334[3)]	36.50%	11,714	50.20%	10,507	89.7%[4)]

The percentages apply in each case to the value in the column immediately to the left
1) The accident observation period was different in North Rhine-Westphalia (2007-2009) from the one applicable in the other federal states
2) Only accidents in categories 1 to 4 and 6 (accidents involving personal injury or serious damage to property) are available for Brandenburg
3) These figures were taken from the official accident statistics (www.DESTATIS.de)
4) This is the percentage of accidents that were assigned to a section of road; it was only possible to obtain coordinates for 84.4% of the accidents
5) A(ID) stands for accidents involving personal injury or damage to property

Once this assignment had been carried out, the following information was available for all sections of road:

- The number of accidents during the observation period (three years in this case)
- The accidents subdivided into accident categories, thus allowing the accident costs to be calculated for each section of road.

Table 1 shows the assignment rates of the accidents in the road network outside of built-up areas for each of the six federal states examined. The following information can be derived from these figures:

- The number and percentage of accidents that can potentially be included in the ESN analysis for the classified road network outside of built-up areas (= the potential benefit of an ESN analysis)
- The number and percentage of accidents that are actually included in the ESN analysis (= the actual benefit of an ESN analysis)

Brandenburg is a special case in a number of respects. The accidents are derived from the BASta system (see also Höppner & Wenk, 2000 [1]). This is a MapInfo-based accident analysis system. The location of the accidents was established on the basis of the distance marker posts recorded in the official accident statistics and not, as in the case of EUSka, directly by the police. For this reason, only the accidents in categories 1 to 4 and 6 were available for Brandenburg. The police in Brandenburg did not switch to EUSka until 2010.

In Saxony, it was possible to assign over 93% of the accidents to the sections of road examined. In Saxony-Anhalt, Hesse and Brandenburg, the corresponding percentage was around 90%. In Thuringia, around 20% of the accidents could not be assigned, and in North Rhine-Westphalia it was around 30%, which was largely attributable to the fact that incomplete data had to be used for the project.

Failure to assign accidents with coordinates to sections of road can be attributed to the following causes:

- Accidents happen at service stations and in other service areas next to freeways and thus do not lie within the 50 m corridor (Figure 1). This is not critical, however, since the accidents are not really connected with the road being evaluated.

- Accidents happen on the slip roads of non-controlled intersections (Figure 1). The very intricate structure of the network at such intersections with slip roads and the fact that only accidents within the 50 m corridor can be assigned make it difficult to assign these accidents precisely. However, the fact that these sections of road are very short and that there are no average daily traffic volumes for slip roads restricts the usefulness of any safety potential values calculated for slip roads. The ESN guidelines also need to describe more precisely how these accidents are to be handled.
- As a result of the fact that the underlying maps used for accident reporting and accident analysis vary in terms of how current they are, accidents are assigned incorrectly when sections of road are reclassified or new sections of road are built (Figure 2).

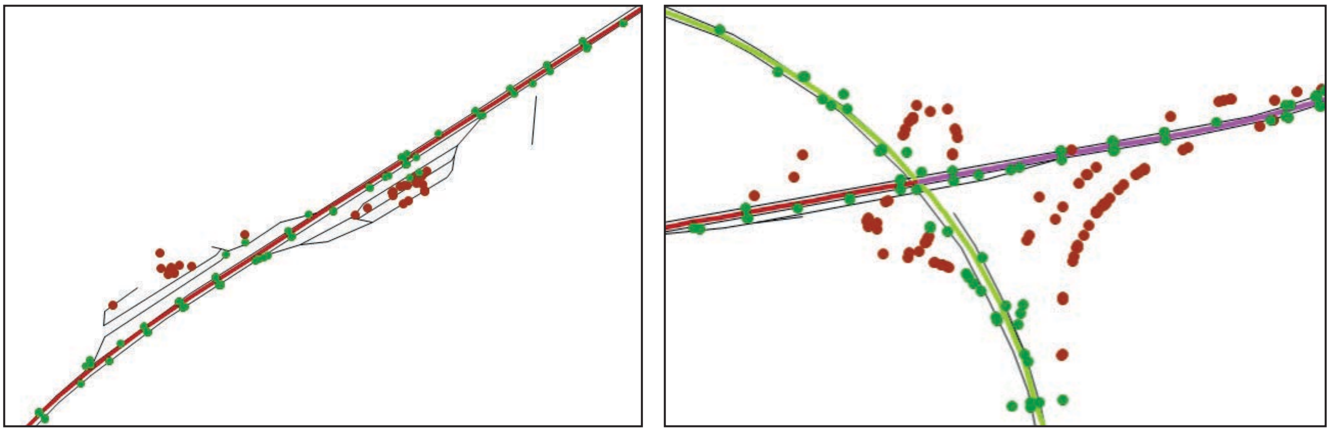

Figure 1:
Examples of unassigned accidents at service stations and in other service areas (figure on the left) and slip roads (figure on the right)

Figure 2:
Example of unassigned accidents (marked in red) as a result of the construction of a bypass and the reclassification of the road through the built-up area

Figure 3:
Examples of unassigned accidents (marked in red) as a result of the reclassification of a road during the observation period

- If a road is simply reclassified (i.e. no new construction is done and the road is not relocated) during the observation period of the ESN analysis, only some of the accidents are assigned (Figure 3). This can result in the accident costs – and thus also the safety potential – being underestimated.

3.2 Calculation of the safety potential in accordance with the ESN guidelines

To calculate the safety potential in accordance with the ESN guidelines, the following assumptions were made:

- A section is an element in the road database of the relevant federal state; it is essentially a section of road between two network nodes.
- Only accidents occurring outside of built-up areas were considered.
- Only accidents occurring on freeways, federal highways or state highways were considered.
- The observation period was three years in each case.

The safety potential was calculated using the sections of the digital road data of each federal state. In order to determine the location of potential deficiencies more precisely, the safety potential was also calculated on the basis of the Navteq sections of road.

3.2.1 Calculation of the safety potential based on the sections of road between network nodes

In order to calculate the safety potential on the basis of the sections of road between network nodes, the values obtained by assigning the accidents to the Navteq sections of road (number of accidents, accident costs, average daily traffic volumes) were aggregated if they occurred in the same section.

Accidents at intersections were assigned to the road named first in the accident report. This is generally the road with the higher classification, and the road authority or public agency responsible for this road is generally also responsible for the intersection. It is again necessary here to use the road type and road number in addition to the 50 m corridor. It is generally not possible to assign the accidents more precisely (to the access roads, for example). This is because the quality of the data is not good enough or because the requisite information is not provided in the accident report.

The section length for the calculation of the safety potential was taken from the road database of each federal state.

The average daily traffic volume value of a section was calculated as a length-weighted average of the average daily traffic volume values of the Navteq sections of road. This is stipulated in the ESN guidelines.

The relevant information was thus available for calculating the safety potential (SAFPO or SIPO) of each section. The calculation was carried out using the formulas specified by the ESN guidelines. The safety potential of a section of road was determined symmetrically in both directions. In other words, the ESN results apply to the cross-section and are identical for both directions. Although it would be possible to carry out analyses separately for each direction in the case of sections of road that are split into separate roadways with different directions of travel, this was not done in this project.

3.2.2 Calculation of the safety potential based on Navteq sections of road

The formulas in the ESN guidelines were also used to calculate the safety potential for individual Navteq sections. Sections of road of less than 300 meters were also included in the calculation to ensure that there were no gaps. The safety potential (SAFPO or SIPO) for both directions of a Navteq section of road was calculated symmetrically. It thus applies to the cross-section and is identical for both directions. The results should be understood as indicators. They indicate the points within a section where there may be deficiencies and thus provide a starting point for the subsequent use and more in-depth analysis of the results of the ESN process, including localized accident analysis. The safety potential calculated on the basis of the Navteq sections of road is not at all suitable for producing rankings. The sections of road are generally too short and accident numbers too low for that.

3.3 Visualization of the results

The results of the calculation are visualized using widely available software. The results can be displayed individually or together on the basis of the sections between network nodes and the Navteq sections.

Figure 4 and Figure 5 show typical examples of the use of visualization. The safety potential is calculated initially on the basis of the sections between the network nodes. This safety potential indicates the extent to which this section of road needs to be prioritized going forward. If initial indications are needed of the measures required to improve the accident situation, it helps to use the Navteq sections of road to determine more precisely where the problems are occurring.

In addition, as a result of the detailed consideration of the Navteq sections of road, it is also possible to check the usefulness or quality of the results. For example, if there is a high safety potential due to a large number of accidents on a particular bend, this at least calls into question the validity of assigning the safety potential to the whole section of road. In this case, measures would only need to be found for the bend, not for the entire section of road.

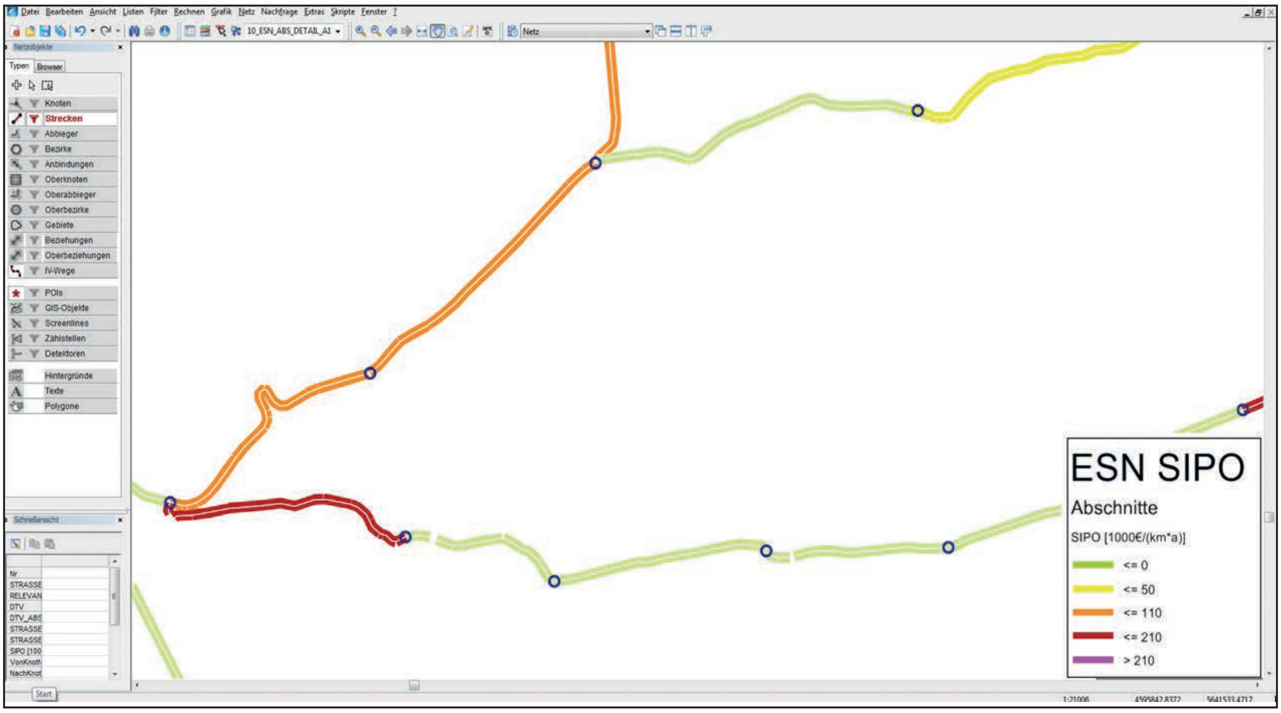

Figure 4:
Display of the results on the basis of the sections between network nodes. The blue circles are network nodes.

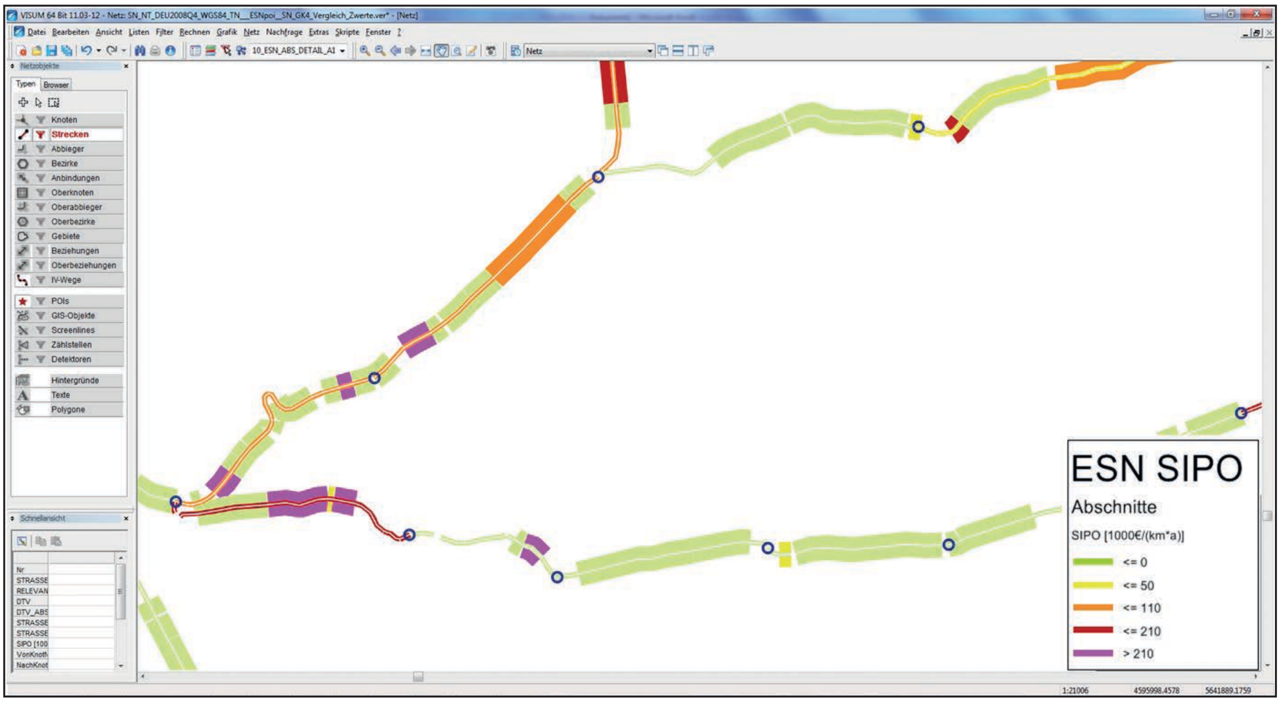

Figure 5:
Combined view of the results for sections between network nodes as well as Navteq sections of road. The shaded bar around the road shows the results on the basis of the Navteq sections of road. The width of the shaded bar around the road models the number of accidents. The blue circles are network nodes.

The underlying data for the sections of road can also be used for other display purposes. For example, the following content could be displayed by means of different graphical parameters and filter settings:

- Variables indicating the number of accidents or the number of unassigned accidents to allow an improved assessment to be made of the usefulness of the evaluation of a section
- Safety potential directly for different road classes
- Individual accidents of various kinds in order to identify information for the causes of a high safety potential (Figure 6)
- Sections with a high safety potential that meet the requirements for long section lengths and high accident numbers. Short sections or sections with a low number of accidents involving serious personal injury would not be shown.

4 Evaluation of the results

4.1 General conditions

Extensive automated evaluation of the classified road network outside of built-

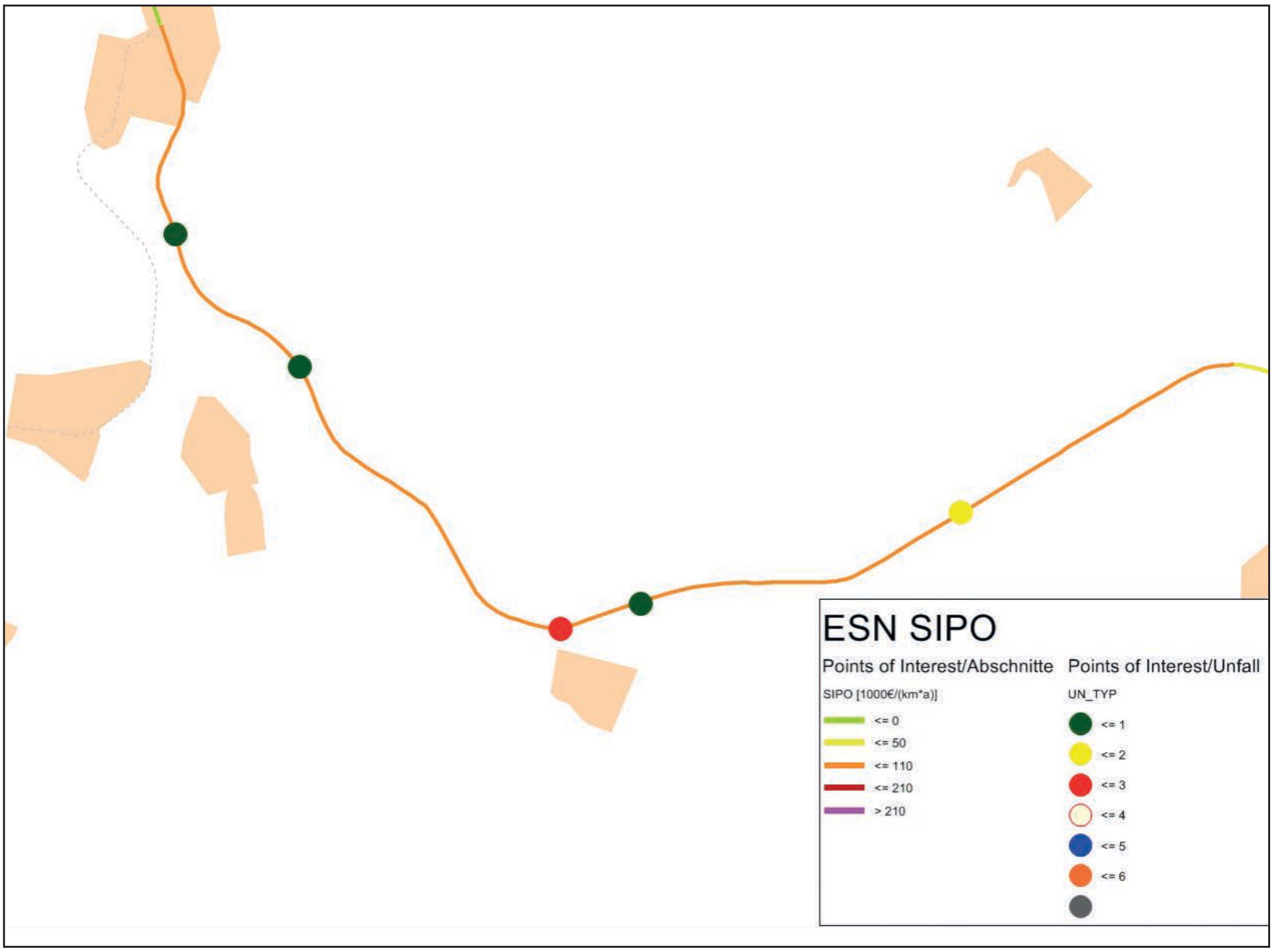

Figure 6:
Option of simultaneously visualizing safety potential and accidents differentiated by accident type (the figure only shows accidents involving personal injury).

up areas is possible in principle in all of the federal states examined. It is also possible to use the 2003 edition of the ESN guidelines on the basis of network nodes despite the limitations with regard to which accidents can be assigned in some cases. The assignment problems can only be resolved if the underlying data is updated and coordinated. There are limits to the extent to which assignment problems in an automated process can be resolved without laborious manual work subsequently.

In addition, the ESN guidelines do not yet describe adequately how roads through built-up areas are to be handled. Roads in built-up areas have to be evaluated in a fundamentally different way from roads outside of built-up areas – with a different basic accident cost rate, for example. When sections between network nodes are used, sometimes it is unavoidable that part of a section is within a built-up area – either from the boundary of the built-up area to the first network node in the built-up area or, in smaller places, even the entire road through

Figure 7:
Representation of the problems associated with the inclusion of roads through built-up areas (the length of these roads is included in the calculation of the safety potential, but accidents on roads through built-up areas are not included)

the built-up area (Figure 7). That means that some of a section between two network nodes may be in a built-up area and thus that the safety potential calculated for this section is imprecise. However, if all built-up areas were excluded, this could result in some very short sections. The problem of having short sections and low numbers of accidents is dealt with extensively in Ebersbach & Schüller, 2008 [2]. Short sections and/or sections with low numbers of accidents can lead to inappropriate results and, in particular, have a considerable effect on the safety potential calculated and the priorities in the rankings. No proposals have yet been agreed as to how such sections could be avoided or excluded in advance (i.e. when the sections are created). However, it is at least possible to reduce the impact of this problem:

- If there are sections that are shorter than a specified minimum length (e.g. 1 km), they are assigned a virtual length that corresponds to the minimum length. This levels out the negative impact of short sections.
- If a section has less than a minimum number of accidents, this section is assigned a safety potential of 0 (€1000/km*a). The specified minimum number of accidents can vary. The ESN guidelines specify four accidents involving damage to property per section (4 A(DP)) in three years, whereas Ebersbach & Schüller suggest one accident involving serious personal injury per kilometer in three years (1 A(SI)/(3a*km)).

Both measures ensure that safety potential values that are not in fact justified no longer have a high priority in the rankings, thus improving the usefulness of the analysis overall. Both of these measures can be implemented using the tool presented here.

However, since no conclusive agreement has yet been reached on this, the safety potential was calculated exclusively in accordance with the ESN guidelines.

The safety potential calculated for sections that include segments in built-up areas therefore represents an underestimate, since accidents in built-up areas are not included, yet the length of road in the built-up area is still included in the calculation of the safety potential. This must be taken into account by whoever is evaluating the individual sections. This gives some indication that automated evaluation still has limitations. In theory, the boundaries of built-up areas (the points at which roads enter them) could be considered to be “virtual network nodes” provided this does not make the sections too short. But there is no widely accepted procedure for achieving this.

4.2 Results

In Saxony it was possible to assign 93.4% of the accidents to sections of road (Table 2). The results can thus be seen as a kind of reference case for the application of the ESN guidelines in practice. Particular attention is therefore given to the results in Saxony below.

As expected, freeway sections are the longest and have the highest accident densities per kilometer and section (Table 2). There are average daily traffic volumes available for almost the entire freeway network. The results for freeway sections can thus be analyzed and interpreted without constraints.

On federal and state highways, both the average section lengths and the accident densities – particularly for accidents involving serious personal injury – are lower.

In all federal states the percentage of sections of road for which there was no data became progressively greater moving down through

Table 2:
Parameters of the road network and accident statistics for different road classes (taking Saxony as an example)

			Federal freeways	Federal highways	State highways	District highways
Road network length		[km]	541	2,421	4,762	5,884
Number of sections		[-]	108	1,295	2,296	2,577
Percentage of the road network length without average DTV values			< 1 %	10 %	13 %	-
Ø section length		[km]	5.0	1.9	2.1	2.3
Percentage of sections < 1 km based on road network length			1 %	10 %	8 %	5 %
A(SI)		[A/3a]	532	1,393	1,711	0
A(PI)		[A/3a]	1,668	3,659	4,137	0
A(DP)		[A/3a]	14,468	19,506	21,690	0
A(SI)	per kilometer	[A/km*3a]	1.0	0.6	0.4	-
	per section	[A/3a]	4.9	1.1	0.7	-
A(PI)	per kilometer	[A/km*3a]	3.1	1.5	0.9	-
	per section	[A/3a]	15.4	2.8	1.8	-

A: accidents; A(DP): accidents involving damage to property; A(PI): accidents involving personal injury; A(SI): accidents involving serious personal injury

the road classifications from major roads to minor roads. For freeways the percentages ranged from 1% to 15%, for federal highways from 6% to 15% and for state highways from 5% to 33%. The safety potential of these sections was not evaluated or calculated in the project. It should be noted, however, that the sections of road for which there was no data were quite heterogeneous. On the one hand, there were sections of road that did not have any accidents or average daily traffic volume data due to an insufficient assignment rate. This may be because, for example, the roads were reclassified or newly built or because the section of road was in a built-up area (only accidents occurring on roads outside of built-up areas were included). On the other hand, however, sections of road on which no accidents occurred were also not evaluated. These would have had to be given a negative safety potential or a safety potential of zero, which would have made it difficult to differentiate between these two types of sections of road for which there is no data. The actual number of sections of road without data is thus not quite as high as the number specified.

The percentage of very short sections (< 1 km in this case) in relation to the entire road network length for the relevant road category was less than 13% in all cases. That means that the great majority of the road network has sections that are long enough to allow a meaningful evaluation of the safety potential to be carried out.

The distribution of the safety potential or the absolutely avoidable accident costs calculated on the basis of this distribution can also be represented by means of Lorenz curves (Figure 8). The avoidable accident costs are shown in relation to the length of the networks of three different classes of road. The reason for the very strong concentration of the avoidable accident costs in Figure 8 (approximately 70% of the avoidable accident costs are attributable to 10% of the network length) is that the length of the roads through built-up areas was included in the study, but the accidents that occurred on them were not. This increases the percentage of the road network without safety potential, and shifts the Lorenz curve to the left in the chart.

Great caution should therefore be exercised when using and interpreting Lorenz curves. In addition to the above reasons, high concentrations of safety potential on a small percentage of the road network are also caused by short average section lengths. The shorter the sections are – with the same distribution of accidents and "actual" safety potential – the further the Lorenz curve shifts to the left. The ESN analysis then no longer delivers useful results.

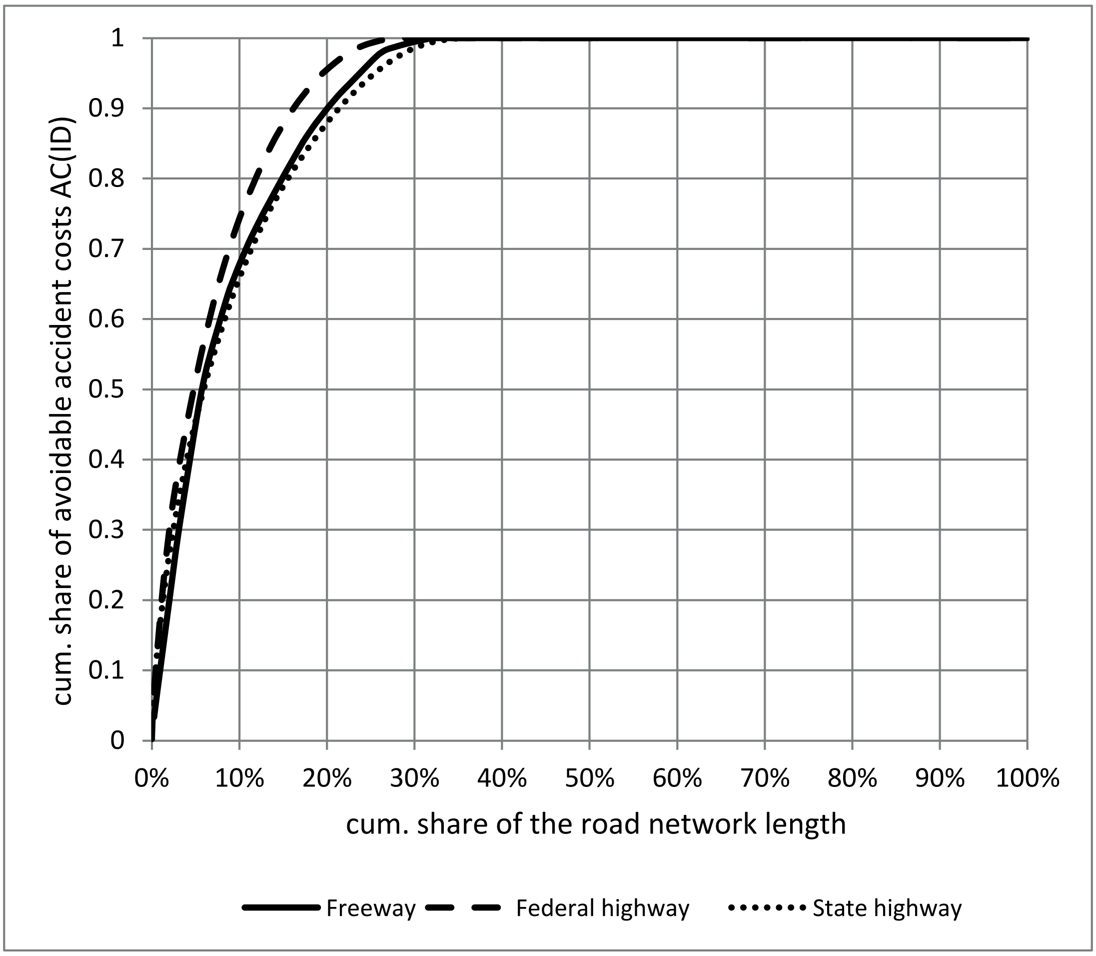

Figure 8:
Lorenz curves for avoidable accident costs in relation to the network length for the road categories examined

Road type	DTV	Length	Acc._cat._1	Acc._cat._2	Acc._cat._3	Acc._cat._4	Acc._cat._5	Acc._cat._6	A(SI)	Costs	SAFPO	Ranking
B	11488	64	0	1	0	0	9	0	1	334,000	**1593**	1
B	7691	30	0	0	2	2	7	0	0	104,000	**1057**	2
B	12654	398	0	3	3	8	28	0	3	1,166,000	**815**	3
B	2295	644	0	4	6	4	12	0	4	1,352,000	**670**	4
B	12245	274	1	1	1	1	9	0	2	645,000	**628**	5
B	8210	453	0	3	0	0	18	0	3	948,000	**593**	6
B	5762	130	0	0	4	5	18	0	0	245,000	**555**	7
B	26796	750	0	6	4	4	21	0	6	1,930,000	**515**	8
B	14878	1105	1	6	0	0	4	0	7	1,984,000	**408**	9
B	8360	1372	0	7	3	3	9	0	7	2,107,000	**405**	10
B	13766	642	0	2	12	4	45	0	2	1,098,000	**394**	11
B	16156	860	0	4	6	7	17	1	4	1,434,000	**349**	12
B	13211	1283	0	6	7	1	29	0	6	1,993,000	**349**	13
B	4010	1089	1	3	4	1	13	0	4	1,283,000	**341**	14
B	1745	319	0	1	0	0	7	0	1	322,000	**314**	15

Figure 9:
Ranking lists based on the ESN guidelines

Road type	DTV	Length	mod_Length	Acc._cat._1	Acc._cat._2	Acc._cat._3	Acc._cat._4	Acc._cat._5	Acc._cat._6	A(SI)	Costs	SAFPO	Ranking	mod_SAFPO	mod_Ranking
B	2295	644	1000	0	4	6	4	12	0	4	1,352,000	**670**	4	**421**	1
B	14878	1105	1105	1	6	0	0	4	0	7	1,984,000	**408**	9	**408**	2
B	8360	1372	1372	0	7	3	3	9	0	7	2,107,000	**405**	10	**405**	3
B	13211	1283	1283	0	6	7	1	29	0	6	1,993,000	**349**	13	**349**	4
B	4010	1089	1089	1	3	4	1	13	0	4	1,283,000	**341**	14	**341**	5
B	8558	1356	1356	0	5	3	2	37	0	5	1,702,000	**309**	16	**309**	6
B	26796	750	1000	0	6	4	4	21	0	6	1,930,000	**515**	8	**301**	7
B	16838	1507	1507	1	5	11	15	37	0	6	2,295,000	**293**	20	**293**	8
B	12863	2073	2073	1	7	9	5	50	0	8	2,767,000	**281**	21	**281**	9
B	5966	2711	2711	0	8	11	8	56	1	8	2,891,000	**279**	23	**279**	10
B	4276	1888	1888	1	5	5	1	18	0	6	1,891,000	**279**	24	**279**	11
B	7905	2064	2064	0	7	7	6	29	1	7	2,351,000	**279**	25	**279**	12
B	16156	860	1000	0	4	6	7	17	1	4	1,434,000	**349**	12	**272**	13
B	6457	1165	1165	0	4	1	2	6	0	4	1,200,000	**261**	27	**261**	14
B	9085	1698	1698	0	6	5	3	18	0	6	1,917,000	**260**	28	**260**	15

Figure 10:
Modified ranking lists

In ranking lists, the sections are sorted by the level of their safety potential (Figure 9).

As expected, the upper rankings are occupied by short sections with a low number of accidents involving serious personal injury. The usefulness of these sections in terms of their safety potential is limited. To combat this, all sections with a length of < 1 km were assigned a “virtual” length of 1 km for the purpose of calculating the safety potential (using the methodology proposed in Ebersbach & Schüller, 2008 [2]). A new ranking list was created using the modified safety potential calculated in this way (see Figure 10) and compared with the original list.

The following result was obtained:

- There are now only a few short sections or sections with a low number of accidents involving serious personal injury (A(SI)) near the top of the rankings (although the filter applies only to the lengths).
- After the filter is applied, the avoidable accident costs are concentrated on significantly fewer sections of road. In addition to an improvement in the usefulness of the high-priority sections, a greater concentration of the safety potential can be seen in fewer, longer sections with sufficiently high numbers of accidents involving serious personal injury (A(SI)).

5 Conclusion and outlook

The automated system developed in the research project can be used to create and in future update analyses of the entire road network of federal states in accordance with the ESN guidelines within a relatively short period of time. Figure 11 shows a flow chart of this automated analysis in accordance with the ESN guidelines.

The result of the calculation can be analyzed quickly and in a well-targeted manner using the analysis features of a modern graphical tool.

A ranking list can be created to identify and examine in more detail sections with a conspicuously high safety potential. Limitations resulting from poor-quality data can be tackled quickly, and the necessary adjustments can quickly be reflected in the charts and lists produced. It is even possible to compare the safety potential across multiple years in this way without significant additional effort.

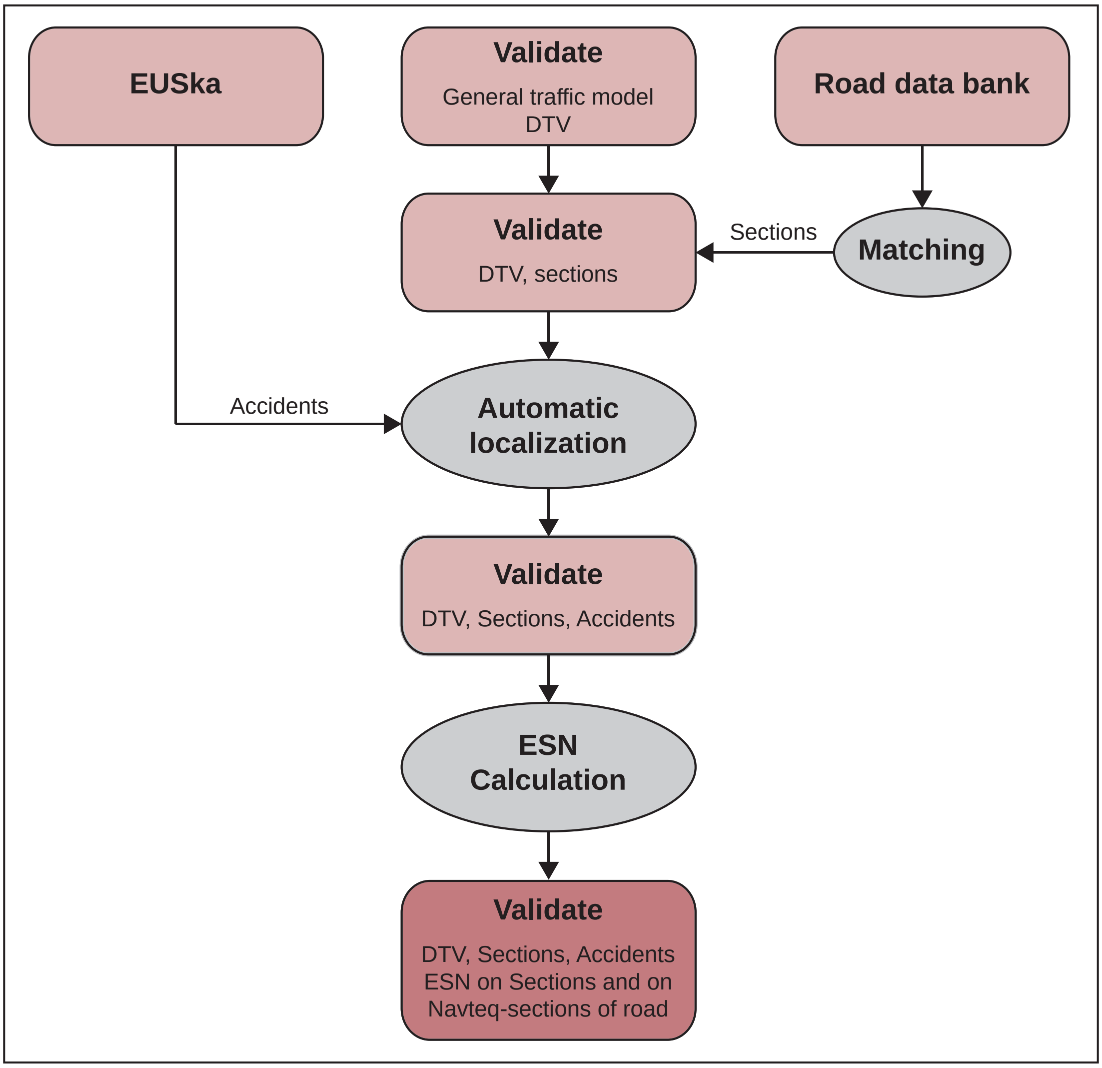

Figure 11:
Flow chart of the analysis in accordance with the ESN guidelines indicating the required input data

It is conceivable that further analysis options in accordance with the ESN guidelines could be implemented in future:

- The ESN analysis could be extended to urban road networks. Both linear evaluation of the network of main roads and an area-based comparison of residential areas would be possible.
- The ESN analysis can also be used in traffic planning. If predicted traffic volumes are used for an ESN analysis with predicted safety potential values, changes to the road network can also be assessed with road safety in mind.
- By integrating further accident attributes, the structural composition of the safety potential in terms of accident type, type of road use or other attributes can be analyzed in more detail. For example, the ESN guidelines offer comparative values for contributions to accident costs of accident types, accident situations or types of road use. This cost structure could be visualized by means of charts that could be displayed for specific sections of road on a small-scale map.
- Although the ESN guidelines describe an approach that is fundamentally different from the localized investigation of accidents, the result is that areas are identified where measures can be taken to improve road safety. To ensure that there is no overlap, parts of the road network that have been processed and in which measures have been taken should at least be updated in the two tools (EUSka and the graphical tool) via interfaces.

The project presented here clearly showed that it is possible to carry out an extensive analysis in accordance with the latest edition of the ESN guidelines (FSGV 2003), even when conditions vary. Work is still needed to ensure the availability of data of sufficient quality and produce a uniform set of guidelines on how to handle short sections and network node sections in built-up areas.

References

Höppner, M.; Wenk, S. (2000). BASta – Expertensystem zur digitalen Unfall-Auswertung im Land Brandenburg (Expert System for Digital Accident Analysis in the Federal State of Brandenburg). In: Straßenverkehrstechnik (Road Traffic Technology), (10), from page 534

Ebersbach, D.; Schüller, H. (2008). Praktische Anwendung der Empfehlungen für die Sicherheitsanalyse von Straßennetzen (ESN) – Erfahrungen mit den Verfahren der Abschnittsbildung (Practical Application of the Guidelines for Safety Analysis of Road Networks (ESN) – Experiences Acquired with the Processes for Creating Sections). In: Straßenverkehrstechnik (Road Traffic Technology), 52 (9), page 515-527

German Insurance Association

Wilhelmstraße 43/43G, 10117 Berlin
PO Box 08 02 64, 10002 Berlin

Phone: + 49 30/2020-50 00, Fax: + 49 30/2020-6000
www.gdv.de, www.udv.de