What is the target population and the effectiveness of the highway chauffeur? Are the used methods applicable to other scenarios?

Target population of the highway chauffeur:
~35% of all cars in motor-ways crashes could have activated the highway chauffeur
~27% of all car fatalities on highways could have activated the highway chauffeur

Effectiveness of the highway chauffeur in cut-in scenarios and comparison of the human driver (in the real-world crash) and the highway chauffeur

Proof that the computation of the target population is transferable
Proof that the computation of the effectiveness analysis is transferable

Venn diagram of the used filter to compute the target population: Each ellipse illustrates one (set of) filter and the numbers of the intersections are these cars which fulfill this filter, i.e. 916 cars fulfill all filter and, therefore, these cars could had activated the highway chauffeur during the crash.

Example of a real-world crash in GIDAS: The upper video shows the original situation with the human driver in the crash. The lower video shows an implementation of a highway chauffeur which could avoid the crash by increasing the safety distance and braking.
TARGET POPULATION OF THE HIGHWAY CHAUFFEUR

Additional to domain restrictions (cars without trailer on highways and highway-style roads) five main filters are applied:
1. The velocity was ≤130 km/h
2. Markings are in good cond.
3. The road has no potholes
4. No driving on a ramp
5. No bad weather conditions

With these system restrictions:
- 35% of cars on highways in GIDAS crashes could have activated the highway chauffeur,
- 33% of injured persons in cars on highways in GIDAS crashes could have activated the highway chauffeur.

Proposed extension based on this analysis is to ensure intact lane markings (or a function, which doesn’t need markings any more). With that and increasing the ego speed to 160 km/h, the target population could be nearly doubled.

An analysis of human factors shows that ~84% of these cases are caused by human factors and have a large potential to be prevented by the highway chauffeur.

### Table: Excerpt of the results of computation of the target population

<table>
<thead>
<tr>
<th>Category</th>
<th>All</th>
<th>Highway Chauffeur</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIDAS</td>
<td>Target Population</td>
<td>Ratio to all highways</td>
</tr>
<tr>
<td>Cars</td>
<td>33 024</td>
<td>916</td>
</tr>
<tr>
<td>Injured Persons</td>
<td>3 671</td>
<td>184</td>
</tr>
<tr>
<td>Severe injured Persons</td>
<td>1 116</td>
<td>52</td>
</tr>
<tr>
<td>Fatalities</td>
<td>362</td>
<td>21</td>
</tr>
</tbody>
</table>

Excerpt of the results of computation of the target population: For four categories the total number in GIDAS (column “All”) and of the target population (first column of “Highway Chauffeur”) are given. The fourth column gives the ratio to highways and the fifth gives the ratio all cases in GIDAS.

### Table: Excerpt of the human factor analysis

<table>
<thead>
<tr>
<th>Category</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol, drugs, fatigue</td>
<td>329</td>
</tr>
<tr>
<td>(maybe) Distraction</td>
<td>367</td>
</tr>
</tbody>
</table>

Excerpt of the human factor analysis: Alcohol, drugs and fatigue are directly evaluated on GIDAS variables, but we don’t investigate the number of unreported cases. The distraction group is based on the assumption that all cases in which a car leaves the road or crashes to a preceding vehicle without any lane change maneuvers are caused by distraction. Crashes caused by lane change interactions could be caused by distraction, but there could be several other reasons, therefore, it is not clear, if a human factor causes the crash.
Effectiveness of the highway chauffeur

The effectiveness of the HAF is determined by means of a simulation, in which challenging situations can be replayed and could be solved by the examined driving function.

The start and target speed of the vehicle is set from the accident data. As soon as the initialization phase has expired, the highway chauffeur takes over the lateral and longitudinal control of the vehicle and drives the car in the simulation.

The highway chauffeur is able to solve accident situations from the GIDAS database.

There are situations where an intervention by the highway chauffeur does not prevent the collision from happening.

The comparison is based on the original situation in the GIDAS database. As already shown in the human factor analysis, most of the accidents are caused by human factors (e.g. distraction). That shows that in GIDAS the human driver don’t behaves ‘normal’ and, therefore, we don’t compare with an normal driver in this consideration.
Transferability of the computation of the target population

The proof of transferability of the derived methods is done by on five functional scenarios, which are briefly described by:

- E01: Free/Casual driving on rural roads
- E02: Animal crossing
- E03: Drive through a junction
- E04: Turning left at a junction
- E05: Overtake with oncoming traffic

The method “computation of the target population” was tested and applied to these five scenarios and E01 was the scenario with the highest predicted benefit.

11% of all car collisions on rural roads happened while free driving and 19% of all fatalities on rural roads are in this scenario, if the system restrictions of the highway chauffeur are used.

With this analysis the applicability of the computation of the effectiveness field to rural road scenarios is shown. Furthermore, we assume that this method is applicable to all other scenarios, if the used data is representative and detailed enough.

Excerpt of the results of computation of the target population on rural roads: For four categories the total number in GIDAS (column “All”) and of the target population (first column of “Rural Chauffeur”) are given. The fourth column gives the ratio to rural roads and the fifth gives the ratio all cases in GIDAS. The same system restrictions from the highway chauffeur are used, but no further restrictions to E01 – E05 scenarios are applied.

<table>
<thead>
<tr>
<th>Category</th>
<th>All</th>
<th>Rural Chauffeur</th>
<th>Ratio to all rural roads</th>
<th>Ratio to GIDAS All</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>33 024</td>
<td>1153</td>
<td>31%</td>
<td>3,5%</td>
</tr>
<tr>
<td>Injured Persons</td>
<td>3 671</td>
<td>348</td>
<td>27%</td>
<td>9,5%</td>
</tr>
<tr>
<td>Severe injured Persons</td>
<td>1 116</td>
<td>137</td>
<td>26%</td>
<td>12%</td>
</tr>
<tr>
<td>Fatalities</td>
<td>362</td>
<td>46</td>
<td>26%</td>
<td>13%</td>
</tr>
</tbody>
</table>

Example of a target population of one of the five functional scenarios on rural roads. E01 includes all free driving scenarios on rural roads.

<table>
<thead>
<tr>
<th>Category</th>
<th>All</th>
<th>E01 Chauffeur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cars</td>
<td>33 024</td>
<td>388</td>
</tr>
<tr>
<td>Injured Persons</td>
<td>3 671</td>
<td>151</td>
</tr>
<tr>
<td>Severe injured Persons</td>
<td>1 116</td>
<td>51</td>
</tr>
<tr>
<td>Fatalities</td>
<td>362</td>
<td>14</td>
</tr>
</tbody>
</table>

Example of a target population of one of the five functional scenarios on rural roads. E03 includes all scenarios of cars driving through a junction without turning. Because of the concrete description of the scenarios the target population becomes small. However, it can be seen that the most and severe crash on rural roads are while free driving and not at junctions.
The proof of transferability of the derived methods is done by the same five functional scenarios.

The E01 was exemplarily regarded and was simulated with an unchanged highway chauffeur.

Most of the other scenarios cannot be evaluated, because of several reasons:
- E02: GIDAS contains no simulatable case of crossing animals
- E03/04: Because of missing traffic markings in the area of junctions the highway chauffeur could not be used.
- E05: Overtake scenarios with oncoming traffic were only meaningful, if three participants could be simulated. In the GIDAS/PCM data only contains only two participants.

With these simulation results the applicability of the computation of the effectiveness to rural road scenarios is shown. Furthermore, we assume that this method is applicable to all other scenarios in principle, if the data are available and the function is specified for these scenarios.

**Definition of the five functional scenarios:** E01 is the scenario with the highest target population and was tested exemplarily in the simulation framework.

**Example of a scenario on rural roads:** The human driver cuts the corner and collides with the oncoming motorcycle. The implementation of a highway chauffeur can be used unchanged and will avoid this crash.
References


- German in-depth accident study, GIDAS, [https://www.gidas.org](https://www.gidas.org)


- Schabenberger, R., ADTF: Framework for driver assistance and safety systems, 2007