INTERNATIONAL COMPARISON OF THE EXECUTIVE ACTIVITIES FOR THE TRAFFIC SAFETY

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Scope of work

Within the frame of this work it was tried to find out how efficient the executive works in behalf of traffic safety activities in different countries and states. To assess the efficiency of the executive body the assessment methods and indicators developed in a research study named „Optimisation of the efficiency of the executive body in the field of traffic safety out of a traffic technique point of view“ were used.

Basic data

At the level of nations the data of following countries were analysed:
- Denmark
- Germany
- Finland
- France
- Netherland
- Austria
- Sweden
- Slowenia

The basic data out of varying sources were converted to a comparable basis with methods worked out in the named research study. Subsequently decisive values were established. Concerning Germany we had to fall back on datas on the level of states: For the states: Baden- Württemberg, Bayern, Berlin-Brandenburg, Bremen, Hamburg, Hessen, Mecklenburg-Vorpommern, Niedersachsen, Nordrhein- Westfalen, Rheinland-Pfalz, Saarland, Sachsen, Sachsen-Anhalt, Schleswig-Holstein, Thüringen, with numbers of inhabitants between 0,7 and 18 millions following data were collected:
- Numbers of inhabitants
- Data about road network within the observation period
- Data about road traffic, numbers of vehicles, car ownership rate
- Data out of the field of the executive body

Out of the field of the executive body were collected:
- Data about the technical equipment
- Data about vehicles
- Number of executive officers
- Number of executive officers in the traffic staff
- Number of controls carried out
- Examined accidents
- Vehicles inspection
Theoretical approach for empirical analysis

The work bases on the empirical estimated fact that we can reach a change in accident occurrence by changing the activity and intensity of surveillance. The independent variable „surveillance“ has an influence to the variable „traffic accident occurrence“. Proceeding on the assumption that increasing surveillance leads to a reduction of accidents, this function must be a decreasing one (Figure 1).

![Figure 1](image)

Designating the risk of accidents with the index „Ü“ and the surveillance with the index „U“ for our assumption must be valid

\[ \frac{\partial U}{\partial Ü} \leq 0 \]

Starting from the assumption that the effectivity of surveillance decreases with increasing frequency, we can determine out of this relationship the required „optimum“ concerning surveillance actions. Designating the „specific costs of traffic accidents“ with „K_U“ and the „costs of surveillance“ with „K_Ü“ then between saved traffic accidents and additional surveillance activities following relationship is given:

\[ > \# \# \# \cdot K_U = \# \# \# \cdot K_Ü \]

In case of a balance between both sides the moment of a optimized surveillance activity is given. We get the equation

\[ Δ_Ü = Δ_U \cdot \frac{K_U}{K_Ü} \]

The result is the key formula for the economic foundation of surveillance activities. An additional expenditure of surveillance then might be justified when –at the same level of
accident costs and the same level of accident reductions the specific cost of surveillance become lower. The higher the specific expenditure of costs, the quicker it will be necessary to stop at a certain level of accidents additional surveillance activities. That means a surveillance activity with strong effect to accidents can be justified better then one with lower effect. In a similar way the costs for traffic accidents must be taken into account. The costs of surveillance consist of the frequency of surveillance, the expenditure of time for surveillance in hours per officer, days per officer or month per officer, the specific costs for staff and materials minus the fines which must be subtracted.

\[ K \_\_ = h \_ \_ \_ t \_ \_ \_ k \_ \_ \_ \_ \_ e \_ \_ \_ \_ \_ \]  
\[ K \_\_ = h \_\_ \_ t \_\_ \_ k \_\_ \_ \_ \_ e \_\_ \_ \_ \_ \] (4)

\( h \_\_\_\_ \) frequency of surveillance  
\( t \_\_\_ \) expenditure of time for surveillance in hours per officer, days per officer, month per officer, etc.  
\( k \_\_\_\_ \) specific costs for staff and materials.  
\( e \_\_\_\_ \) fines

In theory it would be possible let the income increase in a way that the total costs will be compensated and no tax means well be used for the police actions. On the other hand it can be assumed that this source of income will dry up very quick by adjusted behaviour.

In the sense of behaviour adjusted to law raised velocity is a disruptive element.

As a result of traffic technical investigations it is known that the width (as an indicator for all other elements of alignment) has a considerable influence to the velocity. Figure 2 shows the empirical average velocity increasing with the width of lanes. The width appears as information respectively value of irritation for velocity (related to sensation). /5/

Learning by adaptation to the information of the traffic construction means to choose velocity in a way that is given as information by the elements of alignment to the driver. That means, the elements of tracing traffic constructions, induce together with the power of the respective vehicles certain velocities.

If maximum speeds are indicated or prescribed, which do not correspond to the elements of alignment, the driver must learn to avoid the velocities suggested by the traffic construction and by his own vehicle. In this case the executive has to help him. Therefore, if limits of
speed have to be prescribed this means always that the driver does not get the necessary information about velocity by the elements of the road – in this way there is a demand for executive activities. Outsized road constructions require additional surveillance activities by executive if we want to reach a desired lower level of velocity. A detailed description is given in the research assignment. /1/

\[ v = -\ln(U) \]

Figure 3: Decreasing velocity as a (schematic) function of the frequency of surveillance in /2/

The countries and their special qualities

Germany, Austria and Switzerland show a federal structure. The data of executive activities are in these countries available in the federal states. In Switzerland for instance the data are allocated to 20 full cantons and 6 half cantons, distributed to resident numbers between 14.800 (Innerrhoden) and 1.200.000 (Zürich). Because of the difficulties to interpret these data we had to cut out Switzerland. From Denmark and Sweden in spite of inquiries we could get only in partial areas useable data, so in fact important questions could not be treated.

But in fact not only the administrative machinery of the countries is different but also the priorities in structure of the single executive bodies and their scopes of duties. All named countries have a police which is mainly orientated to settlement areas but also a executive body mainly acting on a higher level (e.g. France: Gendarmerie Nationale, Finnland NTP-National traffic police, Netherland: KLTP) or units for special scopes of duties. Beyond it there are in all these countries in some cities surveillance bodies provided by the communities. These bodies also influence the behaviour of traffic users by dresses like uniforms.

To combine the subjects „accident situation“ and the subject „executive activities“ analysing the accidents over a period of three years it was necessary to work out the corresponding data for the traffic infrastructure, for the development of motorization and so on. The subject „executive activity“ covers among other things data of the personal staff of executive, equipment, organisation in the field of traffic surveillance and the frequency of executive activities. To find out these relevant indicators a questionnaire was designed and sent out to the responsible authorities of the single countries, filled out and sent back. Here we would like to thank all departments for this extensive work and for their cooperation.

The spectrum of the car ownership rate was in the cities of Germany (without the cities Berlin, Bremen and Hamburg) between 500 and 640 vehicles per 1.000 residents, the average was at the time of investigation about 587 vehicles. The new states of Germany had not reached the average of Germany at that time. In these states the car ownership rate was
between 504 and 548 cars per 1000 inhabitants. In the cities Berlin, Bremen and Hamburg the car ownership rate was between 400 and 480 vehicles per 1000 residents.

The population densities vary between 15 inhabitants per km² (Finland) and 366 inhabitants per km² (Netherlands) resp. 3897 residents per km² (Berlin). The total length of road network related to inhabitants varies between 18.2 meter in Finland and 6.9 meter in Germany resp. 1.5 meter in Berlin. Another characteristic influencing the accident occurrence is the share of road net length in settlement areas in comparison to the total road net length. The shares differ between 16% in Finland and 83% in Denmark.

Further the collected data give information about the different behaviours of traffic participants and the legal circumstances. The behaviour concerning use of safety belts is highest for Germany, Finland and France (about 90% in rural areas, in settlement areas the shares of using safety belts is about 10% to 20% lower).

**Results of Evaluation**

**Speeding on highways, rural roads and in settlement areas**

The higher the indicated speed limit – the lower is the share of those who overtake the limits – this is a repeated proved fact (Fig.4). The figure shows the extent of speeding in dependence on speed limit. The relative highest exceedings can be seen in France, the relative lowest in Finland (figure 4).

![Percentage exceeding speed limits 1995](image)

**Figure 4:** Percentage of speed limit exceedings 1995 for different countries, in /2/

The indicator used for an international comparance of the activity of executive was the „height of incomes by fines“. These total fines result out of different heights per penalty and the frequencies of penalties. In Austria, Germany, Finland and France this values were between 500 to 700 ATS (36-50 Euro), in Slovenia about 250 ATS (18 Euro). Among the different states of Germany there are clear different heights of fines.
Outgoing from the collected data the costs of surveillance for the single analysed communities were derived.

**Figure 5:** Radar and laser equipments per officer, in /2/

**Figure 6:** Radar and Laser equipments per kilometer road net length, in /2/
The resources of the executive body concerning radar and laser speedometers per kilometre as well as per officer can be seen in Figure 5 and 6. A comparison of total costs of surveillance per year and fines resp. shares of fines to total costs of surveillance can be seen in figure 7 and 8.

**Figure 7:** Comparison of annual costs of surveillance and relating fines in ATS, in /2/

**Figure 8:** Percentage of total sum of fines to the costs of surveillance, in /2/
The effect of fines to the cost of accidents can be seen in Figure 9 and 19.

**Figure 9:**  *Connection of the accident costs per inhabitant and the taken fines per inhabitant, in /2/*

**Figure 10:**  *Connection of accident costs per inhabitant and the taken fines per officer, in /2/*

By this figure the relationship found out for Austrian provinces could be proofed on an international level. The main statement that the activity of executive is essential for traffic safety – not only out of moral reasons, but also out of economic reasons – could be confirmed. For each unit of money citizens pay for fines as a result of delicts against traffic safety, he will spare himself 10 units of money of accident costs – apart from the human sorrows!
Analysis of a multiple approach

Investigations in Austria showed that there was no significant influence of the car ownership rate to the accident costs per inhabitant. Even in the international comparison the influence of the car ownership rate was statistically not significant. (see tables to Figure 11). (It is less meaningful as criticised in /4/ to mix local conditions with rural conditions. To lead back the effects of different speed limits to the car ownership rate is not possible.)

Although the car ownership rate has no significant connection with the accident costs per inhabitant it was accepted as a second independent variable in a multiple non-linear approach. The result of this calculation shows Figure 11.

Austria 1993

International 1995 (without Austria)
Figure 11: Representation of the independent variable (LOGUKEW = Logarithm of accident costs per inhabitant) depending on the influencing variable (LOGSTGEW = Logarithm of fines per inhabitants, LOGMOT = Logarithm of the car ownership rate) as well as tables for the single coefficients seperated for datas „Austria 1993“ and „International 1995 (without Austria)“.

The result of the calculation show that as well the exponents for car ownership rates (exception „Austria 1993“) as for fines is negative. The connection with the car ownership rate is again not significant, but the connection between accident costs and fines. Showing these results in a not linear graphic we can see following figure (Fig.12)
$$UK_E = 11748.9755 \cdot MOT_{0.34}^{0.1}$$

$$UK_E = 83176377 \cdot MOT_{0.63}^{-1.07}$$

$UK_E$ ...... accident cost per inhabitant, $STRG_E$ ...... fines per inhabitant, $MOT$ ...... car ownership rate

**Figure 12:** Nonlinear representation of the connection found out in Figure 11, divided for the groups of data „International 1995 (without Austria) and „Austria 1993“. (Within the group „International 1995“ the cities of Berlin, Bremen and Hamburg are included)

We can derive that increasing higher fines can reduce accident costs effective and visible. This confirms the necessity and effectiveness of executive activities for traffic safety. The approach methodically is in fact not complete till now because there is no accident supporting factor in this approach. To these accident supporting external factors (besides the driver and the vehicle) belongs by sure the supply of the street space. Therefore in a further approach it was tried to include the specific supply of traffic areas (given in meter and length per vehicle) in this approach. As a result following equity is given.

$$UK_E = \alpha \cdot MOT_{0.34}^{0.1} \cdot \left( \frac{roadnetlength}{vehicle} \right)^{0.63}$$

### International 1995 (without Austria)

<table>
<thead>
<tr>
<th>Modellzusammenfassung</th>
<th>Nettoregressionskoeffizienten</th>
<th>Standardisierte Koeffizienten</th>
<th>T</th>
<th>Signifikanz</th>
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<tbody>
<tr>
<td>Modell 1 (Konstante)</td>
<td>4,850</td>
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<td>1,625</td>
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<td>.135</td>
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<td>Abhängige Variable: LOGUKEW</td>
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### Österreich 1993

<table>
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<tr>
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<td>LOGSTGEW</td>
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<tr>
<td>LOGMOT</td>
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<td>-1,183</td>
<td>2,922</td>
<td>.043</td>
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</table>

$a$, $b$, $c$, $d$, $e$, $f$, $g$, $h$, $i$, $j$, $k$, $l$, $m$, $n$, $o$, $p$, $q$, $r$, $s$, $t$, $u$, $v$, $w$, $x$, $y$, $z$
LOGLDKFZ = Logarithm of the road net length per vehicle, further constants see Figure 11

The result of the calculation shows as well for Austria as in an international comparison that this approach may deliver useful results. A positive exponent in both cases is given only for the supply on road space. Fines and also the car ownership rate have in both groups of data negative exponents.

The accident risk is finally a result of powerful vehicles and the resulting desired design speed of the road construction.

The approach confirms the hypothesis, that traffic constructions inducing higher speeds lead to higher accident costs.

Summary

Testing the named hypothesis on an international level was successful. It can be shown on an international level that the height of fines (in connection with the frequency of surveillance) has a substantial contribution decreasing accident costs (as a indicator for accident severity and accident frequency). Furthermore the increasing car ownership rates also seem to reduce accident costs. On the other hand it can be demonstrated that the construction of roads like be done in the last decades, in combination with the development of the car pool, the adaptation of the legal system and as a result the behaviour of the drivers must be seen as a substantial factor for rising of accident costs. We can set up the provocative hypothesis that additional constructions of roads for the motorised individual traffic will lead to a raising of specific accident costs. In fact this hypothesis only seems provoking on surface, but she is a logical conclusion out of the physical effects of the system which receives a raising velocity. This is on the other hand a contradiction to expectancies of the „classic“ road planners.

Literature:


/5/ Knoflacher H., Wister W., Schrammel E., (1979); „Feststellung der Geschwindigkeitsverteilung auf den österreichischen Bundesstraßen“; Bundesministerium für Bauten und Technik; Straßenforschung Heft 117,