

Measuring the efficiency and effectiveness of traffic police operations: developing guidelines for a systematic monitoring of police enforcement

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ABSTRACT

Traffic police enforcement is one of the preventative activities to reduce road crashes. A main role of traffic enforcement is seen as deterring road users from committing offences, which can be related to road crashes and injuries.

As with any activity, enforcement activities gain in effectiveness if they are problem-oriented, targeted, have specified objectives and success criteria and are monitored in terms of process and product. At present, the majority of enforcement activities are not assessed in such manner. To apply effective enforcement strategies and tactics, the enforcement activity needs to be systematically monitored. As this concerns, to a great extent, the enforcement effects, monitoring enforcement implies monitoring the actual levels of non-compliance and assessing the impact of enforcement operations on traffic behaviours and road safety.

Referring to published enforcement studies, several current ways for the measurement of enforcement activity can be found: (a) a general overview of available police resources in a country; (b) consideration of citations; (c) specific measures of enforcement intensity. As to specific measures of enforcement activity, in the speeding area, these are, for example, vehicle-hours of patrol per day, number of kilometers enforced per vehicle-hour per day, monthly numbers of site visits, the number of offenses detected per site visit. In the area of alcohol-impaired driving, along with the offence numbers, intermediate indicators are also applied, such as the total number of drivers stopped, the number of negative and positive breath-tests, the total number of hours spent by police officers on random breath testing. In Israeli studies of general enforcement, a wide range of indicators was applied aspiring to provide a comprehensive picture of activity of the National Traffic Police, such as: inputs - the application of police forces and equipment for field enforcement activity; outputs - the level of actual police presence in the field and the citations given; and efficiency indices – the performance versus plan and resource utilization ratios.

According to the common concept of enforcement mechanism, in general, three types of information can be analyzed to evaluate the enforcement effects, i.e. data on changes in drivers' behaviour, drivers' attitudes and accidents. In this paper, a set of guidelines for a systematic monitoring of police performance is suggested that covers: the monitoring of driver behaviour through the regular use of road user surveys; systematically measuring enforcement activity and evaluating enforcement effects through the monitoring of road user behaviour and through following accident trends and accident analysis.

1. Background

Traffic police enforcement is one of the preventative activities to reduce road crashes. A main role of traffic enforcement is seen as deterring road users from committing offences, which can be related to road crashes and injuries (ETSC, 1999). The problem is still urgent due to the high numbers of road crash fatalities and injuries around the world, whereas traffic offences are believed to be a major contributing factor to a large proportion of road crashes. Considering traffic behaviour, it is broadly admitted that most road users violate traffic regulations to some extent, by sometimes exceeding the speed limits, driving in the wrong lane, not slowing down at an intersection, not stopping before a pedestrian crossing, etc. (OECD, 1999). So, it is not the case of removing a small group of violators in order to solve the problem, as happens with other crimes and misdemeanors. As, on the one side, there are police forces, which are generally limited by the available resources and by their established priorities, and, on the other side, the public at large is involved, a special deterrence mechanism needs to be applied to influence behaviour. The cornerstone of this mechanism is the subjective probability of detection when committing an offence (Rothengatter, 1991).

As with any activity, enforcement activities gain in effectiveness if they are problem-oriented, targeted, have specified objectives and success criteria and are monitored in terms of process and product (ETSC, 1999). At present, the majority of enforcement activities are not assessed in such manner. Normally, especially as to routine enforcement, no data analysis precedes the activity, no quantitative targets are set, no specific methods are selected, and no monitoring is carried out. No wonder that the effect of such enforcement is frequently minor. Moreover, in many countries, police enforcement activity is not always considered as an integral part of traffic safety policy, due to little coordination between road safety administrators and police staff. At the same time, some countries (e.g. Finland, the Netherlands, Sweden, Australia) have already developed elements of monitoring mechanisms and a summary of their experience would be of help for other countries.

The need for effective monitoring also stems from the fact that police resources are always limited. The relative ability of the traffic police to influence road traffic also diminishes over time, due to the permanent increase in the number of drivers and vehicles registered and the vehicle-kilometers traveled, compared with the tiny changes in the number of police staff (e.g. Freedman and Paek, 1992; PACTS, 1999). In addition, there are many other pressing problems that the police forces face.

Concerning the availability of enforcement data, several studies (e.g. Bjornskau and Elvik, 1992) reviewed a number of experiments where enforcement was increased considerably. The majority of projects produced reductions in the violation rates and most could also show a decrease in accident frequencies. However, it is frequently unclear what the base levels of enforcement were and how the enforcement project was actually performed. Not rarely "heavy" or "active" police presence is mentioned in a study, but is not being explained numerically. In many countries, a system of indicators for enforcement activity is not developed. Neither Police Headquarters nor road safety authorities are regularly using such indicators. As a result, first, the findings of various studies cannot be compared in a meaningful way; second, the actual reasons for the enforcement success or failure are less well understood; and finally, relevant managerial information, which could form the basis upon which enforcement can be optimized, is generally unavailable.

2. Study's Objective and Method

To apply effective enforcement strategies and tactics, the enforcement activity needs to be systematically monitored. As this concerns, to a great extent, the enforcement effects, monitoring enforcement implies monitoring the actual levels of non-compliance and assessing the impact of enforcement operations on traffic behaviours and road safety.

Therefore, the aim of this study (which was conducted within the framework of the EU project ESCAPE) was to provide a background for the development of guidelines for monitoring routine police enforcement based on practical measures of non-compliance in driver behaviour and other available data, and to sum up the findings in the form of a reasonable set of instructions for application. The main enforcement areas of interest were the areas of alcohol-impaired driving, speeding and the use of seat belts, in which there is extensive experience of assessment work, and also, when available, a relevant summary of methods was provided for other enforcement areas (e.g. red-light running, sign compliance).

Generally, the guidelines were derived from a review of literature and the available experience in European countries. The study (Gitelman & Hakkert, 2000) included:

- (1) An overview of practices accepted for evaluating police enforcement in different European countries (with the help of a questionnaire distributed among police commanders and relevant experts);
- (2) A review of regular surveys for the systematic evaluation of road user behaviour, which are available in European and other countries;
- (3) Drawing out relevant methods and tools for monitoring police enforcement, which were developed in specific enforcement projects, based on a recent literature review;
- (4) Summarizing up-to-date monitoring techniques for the main enforcement areas.

3. Overview of current practice

When traffic police enforcement is considered as part of the safety-promoting activity in the country, there are elements of planning the enforcement activity and of evaluating the effects. As in any working body, main activity data and the outcomes are considered within the Police and are reported to the overseeing agencies (or directly, to the Government). Differences among the European countries exist as to the level of development of this monitoring mechanism, i.e. the data and analyses applied at different monitoring steps, adopted interpretation of the enforcement targets, kinds of dis-aggregation of the components, etc. The monitoring structure and components are generally dictated, first, by the administrative structure and responsibilities of the police forces in the country, and second, by the history of traffic enforcement activity in the country as systematically working (or not) in cooperation with road safety agencies and research bodies. The latter usually depends on how long road safety has been treated as a nationally important problem in the country.

Practices for monitoring police enforcement in European countries, were analyzed for five countries with more than 30-year experience of systematic activity in the road safety field: Finland, France, Germany, the Netherlands and Sweden (the questionnaires were answered by representatives of the Police Commands and experienced researchers in the field). The main

interest was in the identification of the basic stages/ components of the monitoring process, bodies involved, background data used and accepted reporting routines in each country. Four main stages of the monitoring process were discussed:

- Defining enforcement targets.
- Systematic reporting on enforcement activity.
- Evaluating enforcement effects.
- Distributing the evaluation results.

For example, Table 1 illustrates the process of monitoring police enforcement in Finland.

Table 1. Characteristics of practice for monitoring enforcement in Finland

<i>Stage1. Defining enforcement targets</i>			
Starting point	Annual police plan	Targets in terms of	Disaggregation
Traffic safety targets, set by the National Traffic Safety Plan	The Supreme Police Command sets annual targets for traffic enforcement and confirms annual action plans of the police command of each province and the National Traffic Police (NTP)	Road traffic casualties (numbers of fatalities, injuries) and behaviour indicators (share of driving at excessive speeds; drunk drivers per 10,000 drivers; share of persons neglecting seat belt use in front seats of cars outside urban area)	Provincial Police Commands determine the action plans of the local police districts; Chief of the NTP – the action plans of the Provincial NTP divisions; Chief of the division confirms the action plans of the local units
<i>Stage2. Systematic reporting on enforcement activity</i>			
Tools and responsibilities	Data collected	Annual report	Other reports
An on-line information system is in use (over 10 years), where each policeman is responsible to feed the current data into the computer.	Working hours, number of tickets, written warnings, etc.	Annual reports of the police and of the different units include the important summary figures and the comparisons with previous years. The NTP headquarters make comparisons between the four regional divisions.	Cumulative monthly figures can be produced; each unit can take desired reports from the system. It is possible to follow inputs and outputs of a certain police activity.
<i>Stage 3. Evaluating enforcement effects</i>			
Information sources applied		Internal evaluation	Overall evaluation
<p>Accident statistics; Findings of accident investigation teams; Results of systematic monitoring of traffic attitudes; Results of systematic monitoring of traffic behaviours - usually more than one source is applied to correctly evaluate the effects.</p> <p>In 1999 – the NTP implemented a survey of fined drivers on the quality of the traffic enforcement work; more than half of the drivers told that they were positively influenced by the police.</p>		Inputs and outputs of the police units are summarized on the regional level and reported to the chief of the NTP	The National Traffic Safety Council annually evaluates the activities and results attained in the field of traffic safety, but no direct effect of enforcement is assessed. Many research studies have handled the effects of traffic enforcement.
<i>Stage 4. Distributing the evaluation results</i>			
Internal		External	
Action plans with the evaluation of an earlier year are available in electronic form for each police unit.		Annual reports of the police are delivered to all interested bodies. The police have Internet-pages. Police units offer plenty of current information on traffic safety activities and traffic safety situation to mass media. Summaries of accident, behaviour and attitude data as well as the results of their over-time comparisons are systematically published by the relevant governmental bodies.	

It was found that the monitoring practices in the countries reviewed have many common features whereas in Finland and Sweden the monitoring mechanism is more explicit than in other countries.

Concerning the *planning and targets' definition stage*, the following regularities were noted:

- The enforcement targets always ensue from the national safety targets, defined by the national safety program;
- The annual police plans are coordinated with the governmental bodies, responsible for the national safety programs. These plans are developed on national or regional levels;
- The targets are always given in accident/ casualty terms but sometimes also in terms of behaviour changes in the main enforcement areas, i.e. speeding, alcohol-impaired driving, seatbelt use. The latter explicitly characterizes the Finnish practice and is, to some extent, in use in Sweden and the Netherlands. The plans can also include figures on enforcement intensity (working hours) and violations;
- The disaggregation of the annual plans can follow up to the local police units.

In *reporting enforcement activities* the following features were noted:

In most countries (except for Germany) the reporting rules are defined within the police forces. The most regular reporting takes place in Finland and Sweden, where multi-level information systems have been developed for this purpose;

- The enforcement data collected are usually working hours and sanctions produced (tickets, warnings, etc.) but sometimes the numbers of speed and alcohol controls are also reported;
- The periodic activity reports are usually produced by the police, except for France where this is done by the governmental statistical body. On the national/ regional level these are annual/ semi-annual reports; for the local level also quarterly or even monthly figures are provided.
- The reports are generally applied for internal police purposes whereas in Sweden strict control of the figures is performed by the National Road Administration.

As to *evaluating the enforcement effects*, this remains a problematic issue in all countries. Based on all available information sources, i.e. accident statistics, results of behaviour observations, driver attitudes and offence data, the governmental statistical bodies evaluate the overall trends in the road safety situation in the country but these trends, generally, have no direct links to the enforcement efforts applied. To ascertain the enforcement effects, usually, special evaluations are performed by research institutes, as commissioned by the overseeing agencies. While evaluating the effects of routine enforcement seems to be problematic, evaluating the effects of specific enforcement projects is considered as a routine, at least, in the Netherlands where a manual for planning and monitoring enforcement projects was developed in 1995.

Concerning the *distribution of evaluation results*, the governmental or statistical bodies annually publish the summaries of accident, behaviour and offence figures in the country, and these are usually presented to the public, through the mass media. Sometimes, semi-annual figures are available on a regional/ local level. Very close cooperation with publicity, on all levels, is characteristic for the Finnish police, which enables public access to both summary and current enforcement figures. As to relevant *feedback* for the police forces, the police usually have direct access to the accident/ behaviour figures, even prior to their official distribution. Besides, special summary reports on enforcement activity return to the police

units in Finland and France, whereas in Finland these reports can also be produced for any police subdivision and any time period.

4. Monitoring driver behaviour: regular surveys

One of the basic sources for monitoring routine enforcement is a system for monitoring traffic behaviours, which comprises a series of annual surveys, with regards to one or several categories of traffic behaviour. Such surveys take place in Finland, the Netherlands, France, UK, Sweden, USA, Australia, New Zealand and other countries. Annual repetitions of the same measurements enable to observe traffic behaviour trends within the surveyed area and the impact of countermeasures applied. Experience shows that a system for monitoring traffic behaviours functions on a regular basis when it is initiated and supervised by a governmental body (Ministry of Transport, Road Safety Authority) and the data are collected and processed under the supervision of a National Road/ Safety Research Institute or a Governmental Statistical body. There is proof from several EU countries (e.g. Finland, the Netherlands, UK) that a series of behaviour indicators, accompanied by relevant research studies, can serve as a background for the evaluation and development of enforcement measures, especially in the drinking-and-driving field. For example, since the mid seventies, when breath-test equipment became widely available to the police and for random surveys, alcohol-impaired driving has become one of the principal enforcement areas in Finland. During recent years, some 30% of traffic enforcement by the local police and 15% of the National Traffic Police is targeted at drink-driving. The problem always gained extensive mass media coverage as the Central Organization for Traffic Safety chose to ascertain changes in the attitudes of the public. Since the early nineties, the police initiated systematic enforcement campaigns with results reviewed in public. Not surprisingly, today, nine out of ten Finnish drivers support the present level of traffic enforcement (Makinen, 1999). Some 40% of drivers are tested annually. The number of those caught for drunken driving has fallen during the past ten years from 33 out of 1000 to 14 out of 1000.

The methodological rules, learnt from the regular surveys observed, were summed up as follows:

(1) a system of automatic measuring points distributed across the road network is desirable for regular *speed measurements*. When such a system is not available, radar-measurements performed from a non-suspicious car, parked on a roadside, are also possible. Observations take place on at least 20-40 sites, providing a representative sample of different road categories. The duration can change from site to site (according to sample demands, traffic volumes, etc.) or, in the case of automatic measurements, hourly speed distributions for 1-2 working days are considered for each site. Special techniques for averaging results are developed, to provide weighted values for each road and lane type (or speed zone). If possible, the figures are presented separately for day- and night-time and for different seasons. Estimated figures are mean speeds and percentages of vehicles traveling over the speed limits. The presentation of speed distributions by 10 kph intervals for different road categories is proposed as more informative for enforcement purposes.

(2) *Alcohol checks* are performed in cooperation with police teams, which stop the vehicle and ask the driver to take a breath test. Two ways for building a sample are mentioned: one is stopping every vehicle, which is passing a control point (where control points are selected such that the passing traffic is representative), and the other is when the vehicles tested are

randomly chosen from the traffic (a special procedure is needed). The final sample should include, at least, several ten thousands of measurements. The observations take place during the hours of expected higher level of alcohol-impaired driving, i.e. on weekend nights. Estimated figures are percentages of drivers impaired under the legal level, over the legal level and much more than the legal level. If possible, the figures are also provided for different administrative districts.

(3) *Safety belt surveys* are carried out during the warm but working season (excluding summer holidays) and last, on average, two weeks. A wide range of sites is embraced to provide representative figures for urban and rural areas, long- distance and local traffic, high and low traffic volumes, weekday and weekend hours. Two types of sites are mentioned: intersections, where the observation is performed during the red phase of the traffic lights (or when the vehicle stops/slow down before traffic signs), and at entrances to the car parks and shopping centers. Usually, the unobtrusive method is applied whereby the observer only registers the details that can be seen through the window. However, the “obtrusive” method is also possible when the observer asks the driver’s/ passenger’s age or when the vehicle is stopped by the police in connection with, for example, the drink-driving surveillance work. Unobtrusive observation without stopping the vehicle is generally not possible for the observation of rear-seat seatbelt wearing. The number of observation hours per site varies in accordance with sample demands, traffic volume, etc. The total sample of vehicles checked should be of several tens of thousands, at least. A special procedure is developed for weighting values from different sites. Wearing rates are estimated for driver, front- and back-seat passengers, sometimes for child restraints. If possible, separate figures are presented for urban/ rural areas, different traffic and vehicle types. When the data subdivision is performed, the specific sample size estimated is desired to be of several thousand observations (smaller samples are also applied, e.g. when child restraints are considered, but with reservations).

Between the year comparisons of indicators are mainly visual, to indicate overall increasing or decreasing trends of changes. In-depth analysis of long-term trends, involving explaining factors, is performed by research studies. Relevant examples are the studies which examined a decline in drinking and driving which was observed in many European countries over the eighties, following intensive enforcement and legislation changes. For example, Noordzij (1994) discusses this decline in the Netherlands, as seen in the results of roadside surveys and in accident statistics; Clayton and Everest (1994) discussed trends in the UK alcohol related road accidents, and found that the proportion of all car driver fatalities having BACs in the bands between 80 and 200 mg/100ml fell from 25 to 10 percent over the decade and that these trends were consistent with the results of roadside surveys and with the interview statements of male drivers.

5. Measuring enforcement activity

As mentioned before, measuring the efforts invested by the police into traffic enforcement remains a problem in many countries. Published reports of police activity (where they exist) usually relate to the total offence figures, the available police staff and enforcement equipment, and sometimes, the numbers of speed and alcohol controls. As generally agreed, these figures provide merely superficial characteristics of the activity performed and reflect neither strong nor weak features of the force deployment and the enforcement tactics applied.

Referring to published enforcement studies, several ways for measurement of enforcement activity can be found: (a) a general overview of available police resources in a country; (b) consideration of citations; (c) specific measures of enforcement intensity. A *general overview* of police resources was performed, e.g. by Freedman and Paek (1992); Zaidel and Makinen (1997), where the enforcement level was determined by comparing the number of police staff with some objective measures of need for police traffic enforcement services: the number of vehicle miles traveled, the number of licensed drivers or the general length of public roads. Following the same principle, Raub (1988) developed a model for projecting the required number of police officers in the future. Raub's model estimates the future workload (annual number of hours spent on traffic police services), based on the number of vehicle miles traveled – for primary highways, and based on the total rural population and average daily traffic – for rural highways.

Another approach is when the routine work of traffic police is analysed by screening the characteristics of *citations* given and contrasting them to corresponding road types, driver behaviour and accident data breakdowns. This was applied by French researchers (e.g. Alouda and Jayet, 1995), as to speed and alcohol enforcement in built-up areas. When similar time and space parameters were applied for breaking down the available data on speed measurements/alcohol checks, the accident statistics and the offences registered, a general discrepancy was identified between the behaviour and accident characteristics versus the offenses considered. The time and space characteristics of the traffic police strategies appeared to be mostly dependent on the structure of working hours of each agency.

As to *specific measures* of enforcement activity, in the *speeding* area, these are, for example, vehicle-hours of patrol per day, number of kilometers enforced per vehicle-hour per day, monthly numbers of site visits, the number of offenses detected per site visit (Leggett, 1988). Vaa (1997) analyzed the enforcement activity levels in terms of enforcement hours during the project period, distributed according to method (stationary enforcement, mobile or parked car) and week. The enforcement hours during the project were also estimated, e.g. by Bloch (1998), the number of officers per patrol unit – by Jones and Lacey (1997). A different interpretation of enforcement intensity was applied by Waard & Rooijers (1994) who manipulated the level of apprehension for detected speeding drivers.

In the studies of *alcohol-impaired driving*, along with the offence numbers, several intermediate indicators are also applied, such as the total number of drivers stopped, the number of negative and positive breath-tests, the total number of hours spent by police officers on random breath testing (RBT) (e.g. Mercer et al, 1996). To provide a more general indicator of activity, the number of tests are contrasted to the number of license holders, or a rate of area population checked, per month, is estimated.

In two Israeli studies of *general enforcement* (Zaidel et al, 1994 and Hakkert et al, 2000), a wide range of indicators was proposed aspiring to provide a comprehensive picture of activity of the National Traffic Police. Three groups of police activity indices were considered: inputs - the application of police forces and instruments for field enforcement activity; outputs - the level of actual police presence in the field and the citations given; and

efficiency indices – the performance versus plan and resource utilization ratios. The enforcement periods were compared in terms of these indices.

As became obvious, no sound basis is yet available to strictly determine demands as to the indicators of routine police activity. Nevertheless, based on the experience considered, some indices were recommended as both measurable and indicative:

- in the *drinking and driving* enforcement area - the total number of drivers stopped, the number of negative and positive breath-tests performed, the offence numbers and the total number of hours spent by the police officers on RBT (the comparative ratios of these numbers are easily applicable and very informative, e.g. the number of drivers stopped per RBT hour);
- regarding the performance of *automatic cameras* - the number of vehicles processed, the number of locations monitored, the number of cameras in operation, the number of camera- hours worked and the tickets issued;
- as to enforcement of *seatbelt use* - the number of citations, their splits by the car occupants involved and, when possible, the total number of drivers controlled by the police;
- as to *conventional speed enforcement and other fields*, the relevant set of indices is vehicle-hours of patrol with the number of road-kilometers enforced, the numbers of site visits and the number of offenses detected per site visit.

Depending on the purposes of consideration, these can be weekly, monthly or yearly figures, applied to the whole road network or to specific enforcement sites/ area.

6. Evaluating enforcement effects

According to the concept of enforcement mechanism (e.g. OECD, 1999), in general, three types of information can be analyzed to evaluate the enforcement effects, i.e. data on changes in drivers' behaviour, drivers' attitudes and accidents. The relevant choice is mainly dictated by the enforcement terms, i.e. by the scale and duration of the activity assessed (Table 2). Behaviour data are considered as the most suitable in most cases.

Table 2. Choice of type of information for evaluating enforcement effects, depending on enforcement terms

Duration of enforcement activity	Scale of enforcement activity	
	National/ regional	Local
Short-term (up to several months)	Behavioral observations, Drivers' surveys (optional)	Behavioral observations, Drivers' surveys (optional)
Middle-term (several months- one year)	Behavioral observations, Drivers' surveys, Accident analysis	Behavioral observations, Drivers' surveys
Long-term (one year or more)	Behavioral observations (A), Drivers' surveys (A), Accident analysis (*)	Behavioral observations (A), Drivers' surveys (A), Accident analysis

Where: “A” indicates the applicability of the results of regular behaviour and driver opinion surveys;
“*” – an extensive analysis of accident trends, accounting for many contributing factors (legislative changes, economic growth, etc.), can be carried out.

6.1 Special behaviour surveys

When the effects of short-term and local enforcement activities, rather than annual and national-scale, are considered, special surveys of driver behaviour are applied. These are performed by external research bodies, as commissioned by the police or overseeing agencies. A brief summary of methodical rules for the survey performance, in several behaviour fields, which were drawn from more than 40 enforcement studies reviewed is given in Gitelman & Hakkert (2000).

6.2 Drivers’ opinion surveys

In addition to direct observations of driver behaviour, driver opinion surveys can provide an indication to the police and other relevant agencies, concerning the effects of enforcement and other safety activities. Depending on the survey frequency, scope and purposes, three groups of such surveys can be defined:

- (a) Systematic surveys, i.e. nation-wide, usually performed on an annual/biennial basis and comprising a wide range of safety issues;
- (b) Specific surveys, i.e. focused on a specific enforcement area, sometimes nation-wide but not representing part of a regular survey;
- (c) Surveys as components of enforcement studies.

A systematic survey is usually initiated by the national road safety authority with the purpose of monitoring key community attitudes towards road safety issues. As these surveys frequently comprise such issues as self-reported driving habits as to compliance with the traffic laws; perceived level of compliance by other drivers in the same enforcement areas; the perception of current enforcement activity, their findings can be accounted for while determining current enforcement strategies and tactics. Conversely, the survey can provide indications of a high level of drivers’ awareness of the police enforcement efforts in the main enforcement areas. For example, the national Australian survey on road safety issues is conducted since 1986 (Mitchell-Taverner et al, 1995). Recent years’ findings demonstrated that speed and alcohol were steadily recognized by the community as the primary issues in road safety. There are indications of a high level of awareness of police enforcement efforts in both areas: in 1995, three out of five people reported that the amount of speed enforcement had increased over the past two years; nearly two thirds of reporters saw the RBT operations in the past six months and 19% said that they had been tested.

Specific surveys are conducted to evaluate the influence of some changes, which took place in a specific enforcement area (but do not present a component of a monitoring program of an enforcement project). To ascertain the changes (or the lack of changes) in drivers’ attitudes, usually, the results of two similar surveys are compared or, alternatively, the responses of different population categories are contrasted. For example, Aberg (1993) investigated the

effect of the introduction of a change of the legal BAC limit from 0.05% to 0.02% on Swedish drivers' self-reported *drink-driving*. The questions concerned driver's attitudes, social norms, expectations and evaluations with regard drunken driving, knowledge of the law, and personal drinking habits. Almost no changes were identified after the implementation of the new law. Corbett and Simon (1999) examined the effects of various strategies related to the deployment of *speed cameras* (in UK), based on drivers' responses. The main finding was that, according to self-reported measures, camera deployment markedly reduces drivers' speeds.

Drivers' surveys are frequently applied as additional monitoring tools of the enforcement operations in different enforcement areas (e.g. Jones and Lacey, 1997; Retting et al, 1998). Such a survey usually estimates drivers' awareness about the enforcement operation, perceived changes in police activity, perceived changes in the risk of apprehension for a violation, and self-reported changes in driver behaviour.

In all cases, strict methodological rules need to be defined for survey performance. This concerns the sampling method, which is supposed to provide a representative picture of the relevant driving population, sample size and the procedures applied, which should guarantee the desired quality of estimates. A sampling procedure based on characteristics of drivers' behaviour, can provide more detailed indications of existing weaknesses in enforcement practice (Waards & Rooijers, 1994).

6.3 Accident analysis

Due to the complex nature of road accidents, accident changes attributable to enforcement activity are usually not apparent. A reasonable statistical relation can be established when both enforcement activity and road accidents are considered over a long time period. Two principles are essential to properly evaluate the enforcement effect: first, a correct definition of the target accident group and, second, developing a model which accounts for confounding factors.

Based on the experience of enforcement studies (e.g. Leggett, 1988; Elvik, 1997; Mercer et al, 1996), as *target accident groups* can be recommended:

- (1) in the *speed enforcement* area - all injury accidents (or casualty numbers), also subdivided into several severity categories, i.e. fatal, serious, light, damage only accidents (or fatal, serious, slight injuries);
- (2) in the *drinking and driving enforcement* area – the numbers of driver fatalities/ serious injuries with high blood alcohol concentration and their percentages in the total number of driver fatalities/ serious injuries of the same crashes; or, when the accident registration data do not allow for the previous selection, the number of serious crashes (injuries) that occurred in high-alcohol-hours. The latter are the hours of week, when as defined in the country, illegal drink-driving is more likely to occur;
- (3) in the *seat belt enforcement* area – the number of serious injuries of occupants covered by the seat belt law (or enforcement activity) as opposed to occupants not-covered by the law (the enforcement), and to non-occupants. Alternatively, the use of safety restraints by persons injured in the road accidents can be examined when this component of accident statistics is reliable enough.

As to the *accident evaluation model*, different forms of odds ratio and time-series techniques are applicable in all enforcement areas. A time-series model is more complex, needs the implementation of professional statistical packages and, thus, should be developed by a research body. The odds ratio approach enables comparatively simple overall evaluations but demands valid control groups. The odds ratio analysis can be performed by a statistical department inside the police. When a strict accident analysis is not performed, visual consideration of overall accident trends, in combination with corresponding changes in behaviour data and, when available, in driver attitudes, provide some background for defining the enforcement effects (but, generally, as not separated from the accompanied publicity and legislative changes). Results of such consideration should be treated as indicative and not conclusive to the same extent as the results of rigorous statistical analysis.

7. Conclusions

Based on the best practice and the enforcement studies considered, the following management principles can be recommended for monitoring traffic police enforcement:

- The need for monitoring traffic police enforcement should be realized by the Police Commands and the overseeing agencies (National Road Administration, National Road Safety Authority, Ministry of Transport). Both parties should cooperate in planning the enforcement activity, collecting the relevant data, evaluating the effects and distributing the results.
- Long-term enforcement targets should ensue from the national safety targets, defined by the National safety program. Annual targets should be specified, based on the analysis of recent accident and behaviour data. The analysis should relate to three key issues: problematic locations (where most casualties occur) at problematic times; problematic road users (e.g. rogue haulage companies); and problematic behaviours (e.g. speeding). Selection of high priority enforcement sites should be based on a standardized procedure, which has to be accepted by the police and the overseeing agency and which results from preceding research work.
- The annual police plan and annual targets are coordinated with the governmental body, responsible for the National safety program. If, being dictated by the administrative structure of the police, the plan is originally developed on a regional level, corresponding coordination should take place with the regional government. Dis-aggregation of the annual plan should continue up to the local police units.
- The targets accepted by the police are supposed to be ambitious but attainable and definitely given in quantitative figures. Even realizing the problematic character of this point, the long-term targets should be given in accident/ casualty terms. To be more applicable, the enforcement targets should also be given in terms of behaviour changes in the main enforcement areas, e.g. speeding, alcohol-impaired driving, seat-belt use. Figures on enforcement intensity (e.g. working hours, number of controls) can also be included into the plans.

As to circulating the monitoring information, within the police, regular reporting of performed enforcement activities should take place. As the best solution, a multi-level information system should be established for this purpose. Such a system enables both quick data input,

as being performed by each police officer after a shift is completed, and producing periodic data summaries for internal and other evaluating purposes. The periodic activity reports can be produced by the police, or by a governmental statistical body.

Concerning the distribution of evaluation results, the governmental or statistical bodies annually publish the summaries of accident, behaviour and offence figures in the country, and these are usually presented to the public, through the mass media. These summaries should be accompanied by other enforcement figures and by the estimates of enforcement effects (performed by research bodies). Semi-annual and quarterly figures (with regard enforcement activity, driver behaviour and opinion surveys when available) are essential for presentation on a regional/ local level.

As to relevant feedback for the police forces, the police should have direct access to the accident/ behaviour figures, even prior to their official distribution. These data can be applied by the police for internal (intermediate) estimates. Besides, special summary reports on enforcement activity and effects should return to the police regions and local units, to provide a basis for a new cycle of enforcement activity.

Other parts of the summary guidelines (Gitelman & Hakkert, 2000) relate to the indicators of enforcement activity and ways of evaluating enforcement effects, including methodical rules for the performance of regular and specific behaviour surveys, for driver opinion surveys and standards for accident analysis; main findings on these issues were introduced in the previous sections of the paper.

The guidelines suggested, mostly reflect the experience accumulated in different countries and do not provide full-proof answers on all the questions as to monitoring traffic police enforcement. For the enforcement process to be effective it needs to be monitored. This demands relevant data to be supplied and analyzed and a close cooperation between road safety experts and police staff. A general frame for attaining both points is presented in the guidelines. As to decisions accepted by the police based on the results of the data analysis, these remained out of the scope of this document.

It is believed that the proposed set of indicators will provide more purposeful presentation of the police work, than the amorphous mass of citations, which is generally applied today. Being aware of the available difficulties in regular reporting of traffic enforcement activity, we would like to underline that some elements of the proposed set are already reported by the police forces in several European countries (e.g. annual results of screening breath tests in the UK). The other figures, e.g. the number of automatic cameras and their productivity, are frequently available for internal purposes (e.g. in Australia and UK). Major problems can be anticipated in providing the suggested indicators of conventional enforcement. This point usually demands some planning and registration efforts. However, it is believed that both the police management system and other agencies will enjoy the future benefits of the reporting system.

Much systematic research is still needed to establish relations between the different levels of police enforcement, deployment schemes, applied tactics, etc. and the safety effects

observed, especially with regard to routine enforcement activity. Similarly, background studies are required to constitute measurable links between the characteristics of non-compliance in driver behaviour and accident occurrences. In both cases, specific inputs for enforcement strategies and tactics are expected. It is believed that an improved reporting system on traffic police enforcement and a system for regular monitoring of traffic behaviour, coordinated with accident data and driver surveys, and supported by relevant evaluation methods, will provide background for developing solutions of existing problems, will promote more effective current enforcement activity and will contribute to introducing better safety measures in the country.

8. References

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Table 3. Summary of rules for special (short- and middle-term) surveys of selected behaviours

Behaviour type	Equipment applied	Duration of measurements	Number of sites	Control group	Estimates and comparisons
Speed	(1) permanent inductive loops or (2) hand-held speed guns	with (1) – several weeks/ months, with (2)– one-two days; Performed at least twice, before- and during the enforcement operation	Depending on enforcement area, 5-20 locations	Recommended; should be comparable with the enforcement sites in traffic and road characteristics and in weather conditions	<u>Estimates</u> : mean speeds and the percentage of vehicles exceeding the limits (or the limit plus tolerance; or the limit plus 10-20 kph); 85 th percentile speeds and speed variance. Estimates are presented for different road and lane types or speed zones. After-before <u>comparisons</u> of the speed indices are performed, accounting for changes observed on control sites. (Significance of changes is examined, by relatively simple statistical tests, e.g. t-test).
Seatbelt use	Simple “unobtrusive” observations: the observer writes down the relevant details after he has looked into the vehicle, at a constant pace.	2-4 hours or several hundred observations per site, to provide a total sample of several ten thousands, per round; 3 rounds of observations are performed: baseline, towards the end of the enforcement campaign and after the campaign completion	10-20 locations of typical traffic flows, incl. intersections, mall entrances or gates	Recommended, with similar number of sites, but within another community - definitely not influenced by the campaign	The list of details recorded per vehicle depends on the survey purposes: this can be merely driver’s belt use or in combination with driver’s age, sex, vehicle type, belt use by the front passenger, direction and line of travel, hour, etc. <u>Estimates</u> : from simple driver’s use rate to the variations of the indicator in context of other characteristics. Evaluating the enforcement effect, after/before <u>comparisons</u> with a control group are applied.
Red-light running	Camera, automatic or hand-held	Several days, for different time periods, to provide a sample of several ten thousands; Time of day and total number of hours observed should match for before and after rounds	10 or more intersections	Recommended	<u>Estimates</u> : violation rates per 10,000 vehicles or per red-light cycle; if possible, separately for straight and turning vehicle movements, different vehicle types and traffic volumes After/before <u>comparisons</u> of violation rates, as opposed to a control group; for approaches influenced versus not influenced by the enforcement

For drink-driving - the rules of regular survey are applied; for after/before comparisons, two rounds of observations and a control region are recommended.