European Commission

Thematic Report

Traffic law enforcement

Mobility and Transport

This document is part of a series of 20 thematic reports on road safety. The purpose is to give road safety practitioners and the general public an overview of the most important research questions and results on the topic in question. The level of detail is intermediate, with more detailed papers or reports suggested for further reading. Each report has a 1-page summary.

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Summary

Traffic law enforcement (TLE) can be defined as the entire penal procedure designed to persuade road users to abide by traffic laws and regulations through threat of detection of violation and the imposition of a penalty or other sanction. TLE influences driving behaviour through two processes: general and specific deterrence. Penalties for detected violations should be certain, swift and legitimate. In addition, understanding the role of internal sanctions (guilt, shame), and perceived legitimacy of laws and regulations may help to reduce offending behaviour.

In a safe road system, both general and targeted TLE are required to limit the occurrence of the safety-critical violations. Within the safe system approach TLE is best combined with other measures to reduce violations.

The main types of TLE can be distinguished along three main dimensions: automatic versus manned controls, stationary versus mobile controls, and visible/conspicuous versus less visible/hidden controls. There is ample evidence that increased police enforcement can be effective in improving road safety. For example:

- Regular random alcohol checks in traffic are effective in reducing the number of alcohol-related crashes.
- Automatic camera enforcement on speeding and red light running reduces crashes, but several factors, e.g., choice or disclosure of locations, may influence effectiveness.
- Manned controls of not wearing seat belts and mobile phone use have been shown to reduce these behaviours.

Although enforcement can improve road safety, it remains a challenge to maintain and optimise the effects of TLE. The effectiveness of TLE can be improved by:

- Legislation that is clear and fair, and provides police with adequate legal competences and effective procedures.
- Use of crash and violation data to better predict safety relevant TLE locations and make informed decisions about deployment of police officers and/or safety cameras.
- Accompanying public communication about risks in traffic, feasible alternatives, and purpose of police actions.
- Evidence-based sanctions, such as license suspension combined with rehabilitation courses or the combination of alcohol interlock with medical/psychological counselling that also addresses underlying problems of violation behaviour.
- Points systems that include a rehabilitation programme for offender groups with specific behavioural problems.

1. What is traffic law enforcement?

1.1 Definitions

Traffic law enforcement (TLE) is one of the instruments to secure or improve compliance with road safety regulations. It can be defined as the entire penal procedure designed to persuade road-users to abide by traffic laws and regulations through threat of detection of violation and the imposition of a penalty or other sanction (Wegman, 2000; Mäkinen et al., 2003). Enforcement of traffic laws is intended to influence the behaviour of road users in such a way that their risk of becoming involved in a crash or causing a crash decreases (Goldenbeld, 1995).

In the literature, the concepts of 'traffic law enforcement' and 'police enforcement' are often used interchangeably. However, these concepts differ in scope. Traffic law enforcement is broader and covers the entire enforcement chain, from detection of a violation through to the penalty imposed (Goldenbeld et al., 1999; Mäkinen et al., 2003). Police enforcement refers to the actual work of detecting a traffic law violation, apprehending the offender, and securing the evidence needed for successful prosecution. Police enforcement can only be effective if it operates in a supportive environment of laws, regulations, and a sensitive penal system (Hakkert, 2004). In the same way that the functioning of police enforcement depends on a supportive penal system, the penal system itself needs to be grounded in the moral convictions of the larger society (e.g. Andenaes, 1977). The failure of prohibition in the 1920s in the USA is a well-known historical example when law and public values do not align.

1.2 Enforcement and the safe system approach

The safe system approach seeks to identify and rectify the major sources of error or design weakness in the road traffic system with the aim to prevent fatal and severe injury crashes, as well as to mitigate injury severity (ITF, 2016). This means that the required behaviour of road users should be facilitated by credible rules and regulations and elicited by self-explaining infrastructure. This way most unintentional violations will be prevented and TLE can focus on intentional violations. Hence, in a safe systems approach, other measures must be considered before deciding where and, to what extent, TLE is implemented.

TLE also needs to be credible (ITF, 2016). For example, speed enforcement on a road with a posted limit of 50 km/h which has the look of an 80 km/h road may undermine the credibility of the enforcement. It may give the undesirable impression that TLE is aimed

at generating money for the national treasury, rather than for improving road safety.

2. The working mechanisms of TLE

2.1 General versus specific deterrence

It is generally accepted that traffic law enforcement influences driving behaviour through two processes: general deterrence and specific deterrence (Homel, 1988; Zaal, 1994; Goldenbeld, 1995; Mäkinen et al. 2003). General deterrence can be described as the impact of the threat of a penalty on the public at large, while specific deterrence can be seen as the impact of an actual penalty on those who have been apprehended (Mäkinen et al. 2003). General and specific deterrence are based on the same underlying mechanisms, but the populations which they refer to are different: general deterrence is relevant for all drivers; specific deterrence is relevant for those who committed the respective violation.

2.2 Objective versus subjective probability of detection

The objective probability of detection is the actual risk of a violation being detected by TLE activities. The subjective probability of detection is the drivers' own judgement of the chance of getting caught for a violation. The subjective probability is, to a large extent, determined by the objective probability, i.e. the actual level of TLE, but can be enlarged through frequent communication about TLE activities as well as highly visible rather than hidden TLE. The preventive effect of TLE is generally greater if the subjective chance of apprehension is increased, (Homel, 1988; Zaal, 1994; Goldenbeld, 1995; Mäkinen et al. 2003; ETSC, 2011; Castillo-Manzano et al., 2019).

2.3 Certain, swift and legitimate penalties

Based on theories of deterrence, penalties for detected violations should be certain, swift and legitimate (Zaal, 1994; Goldenbeld et al., 1999). In other words, when caught for a violation, it must be certain that it is followed by some sort of formal punishment. This punishment should follow the violation as soon as possible. In practice, administrative procedures often take much longer than desirable. Finally, penalties must be considered appropriate and legitimate: "… individuals voluntarily comply with rules when they perceive them, as well as the authorities and institutions that enforce them, as just, moral, fair, effective and consistent with their representations of reality

and their system of values and beliefs" (Varet et al., 2021, p.2). Perceived legitimacy of laws and police can positively influence road users' compliance with traffic laws (Hertogh, 2015; Huang et al., 2023).

2.4 Light versus severe penalties

Penalty severity only affects the preventive effect of enforcement to a limited extent. For example, a meta-analysis indicated that fine increases between 50 and 100% were associated with a 15% decrease in violations, that fine increases of up to 50% did not influence violations, and that fine increases over 100% were associated with a 4% increase in violations and thus tend to be counterproductive (Elvik, 2016).

The effect of penalty severity has been found to depend on the type of violation (Goldenbeld et al., 2013; SWOV, 2019). In the area of drink-driving, making penalties more severe seems to have little or no effect on (re-)offending behaviour (SWOV, 2019; Raftery & Edwards, 2021; Eun, 2021). On the other hand, for violations like not wearing seatbelts, speeding and red light running, higher fines may lead to fewer (re)offences (Goldenbeld et al., 2013; Goldenbeld, 2017; SWOV, 2019). The fact that drink-driving seems not to be affected by the severity of penalties is possibly due to the fact that, in most countries, existing penalties for this offense are already fairly severe. Another possible reason is that drivers who commit drink-driving offences experience difficulty in changing their behaviour as they may be alcohol-dependent.

2.5 Main types of TLE

Traffic law enforcement can be distinguished along three main dimensions: automatic versus manned enforcement, stationary versus mobile enforcement, and visible versus hidden enforcement (Mäkinen et al., 2003; Erke et al., 2009; EC, 2018).

2.5.1 Automatic versus manned enforcement

Automatic enforcement with the use of cameras for violations such as speeding and red-light running has the main advantage that high levels of enforcement can be realised with relatively little effort. Reliable and efficient back-office conditions are required to deal with the possibly many detected violations (Wijers, 2017). However, automatic enforcement is not possible for violations like drink-driving and drug-driving, and in many countries for mobile phone use and other kinds of distracted driving. For these and other types of violations, manned enforcement (also called "physical policing") is needed. Manned enforcement has the advantage that a violator is stopped and gets

immediate feedback, enabling the police officer to interact with and influence the violator (EC, 2018). Moreover, other road users may observe the enforcement action, increasing their perception that enforcement is active and, hence, the subjective probability of detection (EC, 2018). The disadvantage is that manned controls are very labour-intensive which makes it virtually impossible to reach the same enforcement levels as with automatic cameras.

2.5.2 Stationary versus mobile enforcement

Especially in the area of speed enforcement, the dimension of stationary versus mobile has been studied. Whereas cameras at fixed locations tend to have a larger safety effect per location, mobile cameras that are flexibly used over several locations tend to generate effects over a larger area. Mobile cameras, especially when they are hidden, have an advantage over fixed cameras that their location is less predictable, thus increasing the subjective chance of detection (EC, 2018).

2.5.3 Visible versus hidden enforcement

The decision to use visible or hidden enforcement depends upon the specific aim of enforcement (EC, 2018). For example, when it is very important that road users lower their speed on a specific section of the road, e.g., near an intersection or school, it is more effective to have a visible speed camera, preferably accompanied by a warning sign. A disadvantage of visible camera enforcement is that it may lead to unexpected behaviour of road users, e.g., sudden braking when detecting a speed or red-light camera (Kangaroo-effect). Høye (2014) did find such an effect, even though it did not seem to affect crash risk. Hidden cameras prevent this type of reaction, but have a less preventive character.

3. TLE in Europe

3.1 Developments in TLE

The TLE activities in Europe are followed in the ETSC PIN programme that covers the 27 EU Member States, together with Israel, Norway, Serbia, Switzerland and the United Kingdom. Carson et al. (2022) reported the following developments in TLE deployment in the period 2010-2019:

- In 21 of the PIN countries the number of tickets for speeding went up, in 7 countries the number decreased, and 4 countries did not have information.

- In 6 PIN countries the number of alcohol roadside breath checks went up, in 8 countries the number decreased and 18 countries did not have this information.
- In 11 PIN countries the number of tickets for mobile phone use went up, in 14 countries the number decreased, in 7 countries the information was lacking.
- In 5 PIN countries the number of tickets for not wearing seat belt went up, in 24 countries the number decreased and 3 countries could not provide information.

The amount and type of enforcement activities vary widely among European countries (Carson et al., 2022).

One of the experimental road safety performance indicators[1] within the EU-wide Trendline project is addressing the collection of data on enforcement of traffic regulations. In future, the Commission intends to collect such data, where feasible, on a regular basis.

3.2 Cross-border enforcement

In 2015, the European Union adopted the Directive (EU) 2015/413 - also known as the Cross-Border Enforcement (CBE) Directive. The CBE Directive aims to facilitate the enforcement of violations by foreign-registered vehicles, i.e., for violations committed in a different EU Member State to the one where the vehicle concerned is registered. The Directive has two main goals: to improve road safety and to ensure equal treatment for resident and non-resident drivers. The EU has recently (December 2024) adopted a new Directive (EU) 2024/3237[2] to strengthen cross-border enforcement of road traffic rules. While previous EU rules improved compliance with road safety regulations by non-resident drivers, a significant gap remains, with approximately 40% of cross-border offences going unpunished due to challenges in identifying offenders or enforcing fines. The newly adopted rules tackle these shortcomings by enhancing cooperation among Member States, streamlining offender identification and facilitating fine enforcement. Cooperation between national authorities will not only focus on the most common and serious offenses like speeding, drunk and drugged driving, but also on several other hazardous behaviours.

[1] https://trendlineproject.eu/

[2] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024L3237&qid=1741856717997

3.3 Experiences with and perceptions of TLE

The third iteration of the international ESRA survey (E-survey on Road Safety Attitudes) asked drivers about their experience with the enforcement of impaired driving (Figure 1), and the estimated likelihood of being checked for several violations (Stelling, Schmidt & van der Kint, 2024).

As shown in Figure 1, in Europe, drivers in Czech Republic (38.4%), Latvia (34.9%) and Poland (34.8%) most frequently reported to have been checked for drink-driving in the past 12 months. This is much more frequent than the European average of 18.8%. Being checked for the use of illegal drugs while driving is much less frequent with a European average of 5.5%. Drivers in Spain (9.9%) and Czech Republic (8.6%) most frequently reported that they were checked for drug-driving.

Figure 1. *Self-reports of being checked by the police for alcohol or drugs in traffic at least once in the past 12 months in Europe. (Source: ESRA2 - Goldenbeld et al., 2022).*

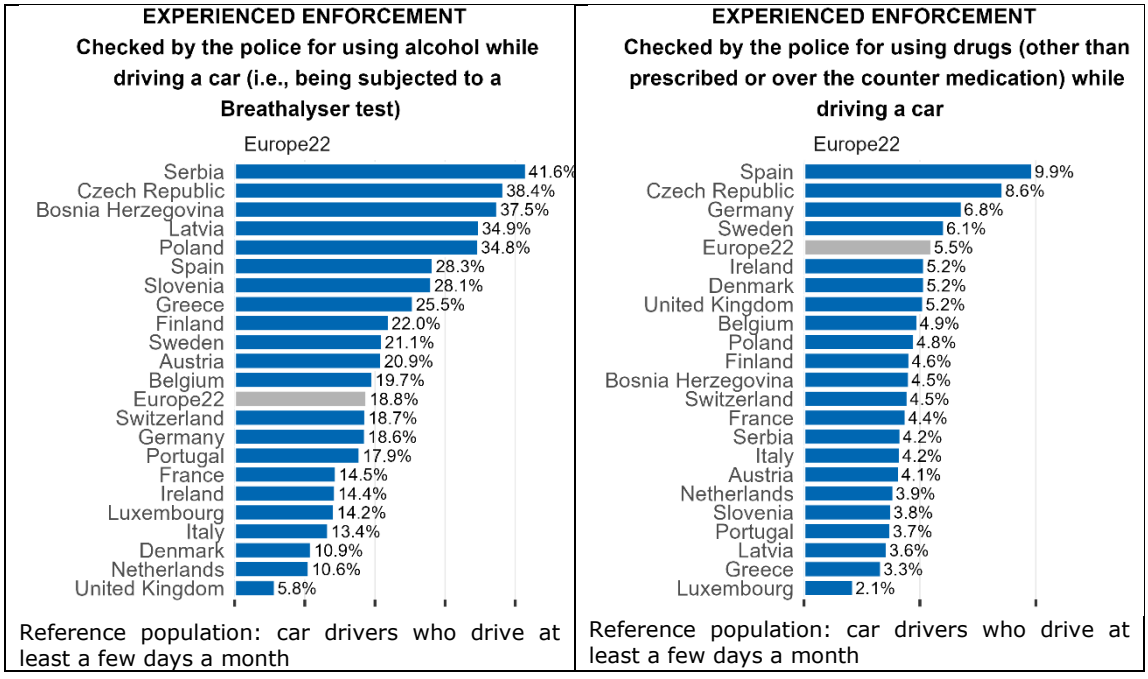
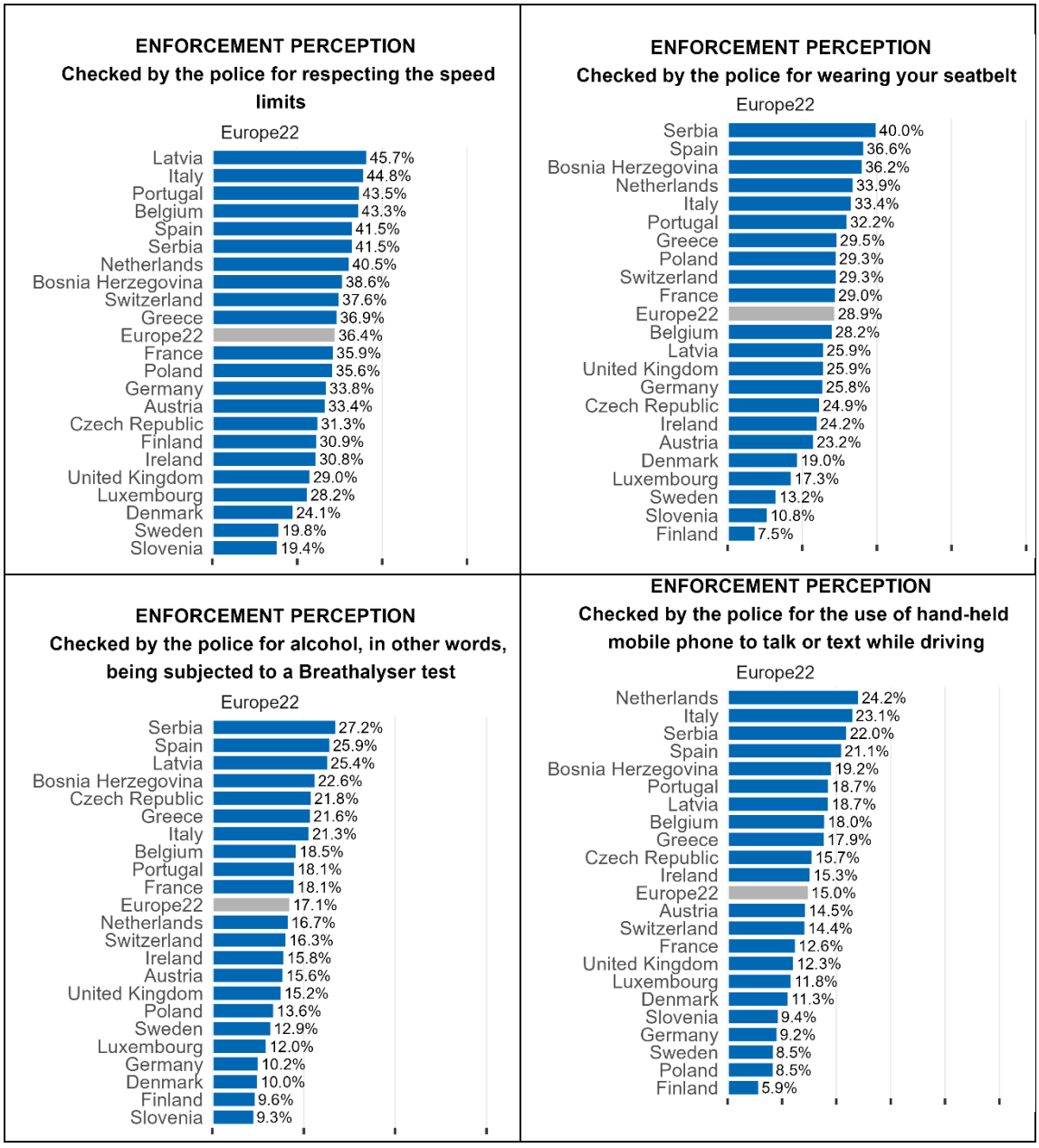
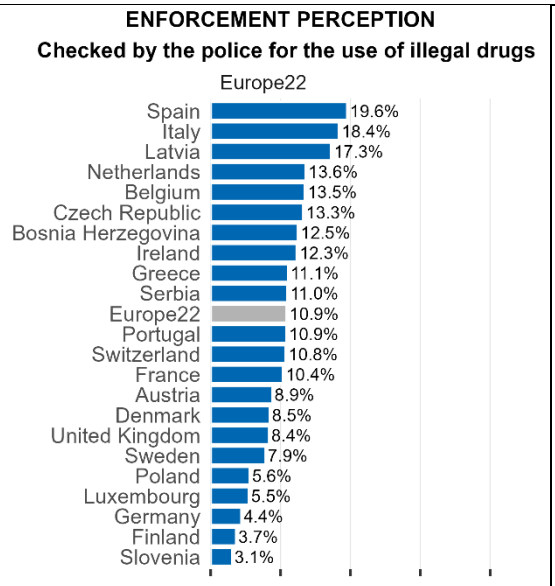


Figure 2 presents the ESRA results for European countries on the perceived likelihood of being checked for traffic violations. On average, European drivers consider a speed check most likely (36.4% considers that likely), followed by a seat belt check (28.9%), a check on drink-driving (17.1%), a check on hand-held phone use (15%) and a check on drug-driving (10.9%).

Figure 2. *The perceived likelihood of being checked for traffic violations by European car drivers. Percentages of respondents who assess it 'likely' to be checked.*
(Source: ESRA2 - Goldenbeld et al., 2022).





Reference population for all tables:
car drivers who drive at least a few days a month

4. How effective is TLE for road safety?

There is ample evidence that increased police enforcement can be effective in improving road safety. The subsequent paragraphs describe some of the evidence for enforcement of speeding, red light running, drink-driving, drug-driving, mobile phone use and not using seat belts.

4.1 Enforcement of speeding

Enforcement of speeding can be done by manned controls (either stationary or while driving/patrolling) or by automatic cameras (either at fixed locations or mobile).

In a meta-analysis, Erke et al. (2009) found positive, but not significant, effects on crashes of manned stationary controls (11% reduction) and manned controls while driving (6% reduction). In another meta-analysis, Steinbach et al. (2016) found that speed camera programmes reduced total crashes by 19%, injury crashes by 18% and severe/fatal crashes by 21%.

The effectiveness of speed camera programmes to a large extent depends upon a good choice of camera locations (Job, 2022; Shaaban et al., 2023; Tilahoun, 2023). Monitoring and evaluation may improve the set-up of speed camera programmes.

A common finding in the literature is that automatic speed enforcement effects are limited in terms of both time and space (Vaa, 1997; EC, 2018; Job, 2022; Fu & Liu, 2023). In terms of time, the effect of mobile

speed cameras may last for several days (Gouda & El-Basyouny, 2017) to several weeks (Vaa, 1997). In terms of space, Li et al. (2013) found that the fixed speed cameras were most effective for up to 200 metres form camera site and were also effective for up to 500 metres from camera site.

Several EU countries (see Carson et al., 2022) also apply section controls or time-over-distance cameras, i.e. controls based on the average speed over a longer stretch of road. An advantage is that it reduces speed differences at the controlled section and that road users consider it fairer as very short, temporary speed violations will not be fined (Soole et al., 2013). Based on meta-analysis, Høye (2014) found that section controls reduced total crashes by 30% and serious and fatal crashes by 56%. In addition to safety benefits, positive effects of average speed enforcement have been found for traffic capacity, vehicle emissions, and fuel consumption (Soole et al., 2013).

4.2 Enforcement of red light running

Enforcement of red light running can be performed by manual police controls, but is mostly done by automatic cameras. Red light cameras have a strong and immediate effect on red light running: the installation of red light cameras reduces red light running (Chin & Hague, 2012; McCartt & Hu, 2014; Chai et al., 2015; Polders et al., 2015a, b), whereas the removal of red light cameras increases red light running (Porter et al., 2013). In terms of crash reduction, a meta-analysis by Cohn et al. (2020) indicates mixed safety effects including a significant 24% reduction of right-angle crashes and a significant 19% increase of rear-end crashes. Since right angle crashes generally result in more severe injury than rear-end crashes (Peterman, 2020) the overall safety effect is positive. To reach the highest safety effects, red light cameras are best implemented at intersections with a high risk of right-angle crashes. Possible adverse effects, i.e. an increase of rear-end crashes, can be mitigated by additional measures, e.g., by reducing approach speed.

Cameras can also combine red light running and speeding detection. Goldenbeld et al. (2019) found somewhat larger safety benefits of the combined speed/red light cameras than for just red-light cameras: a reduction of the total number of crashes by 17%, of injury crashes by 25%, of right angle crashes by 37%, and of rear-end crashes by 2%. Presumably, the safety effects of the combined red light/speed camera are larger because speeding itself is a key factor in the red-light running problem.

4.3 Enforcement of drink-driving

Intensive roadside testing operations, combined with publicity, reduce alcohol-related crashes (Homel, 1988; Zaal, 1996; Fell et al., 2004; Erke et al., 2009; Cameron, 2013; Allsop, 2020; ETSC, 2022).

A meta-analysis on results from 40 studies indicated that crashes decrease by 17% when regular alcohol checks are carried out (Erke et al., 2009). In the meta-analysis, the effects were considerably larger in Australia (22% reduction) than in the United States (12% reduction). The greater effectiveness in Australia probably has to do with the fact that random breath testing is allowed in Australia enabling large numbers of drivers to be tested. With random testing, drivers can be stopped without prior suspicion of drink-driving and every stopped driver is tested for alcohol use. In the United States, however, random breath testing is not allowed, and far fewer drivers are tested for alcohol. Nevertheless, even in the US, highly publicized, highly visible, and frequent sobriety checkpoints, even though not random, were also quite effective in reducing drinking and driving (Fell et al., 2004; Fell, 2019).

Nearly all European countries allow enforcement of drink-driving by random breath testing (Modijefsky et al., 2022). The exceptions are Luxembourg, Malta, and United Kingdom (Modijefsky et al., 2022). In Lithuania, Latvia, Slovenia and the United Kingdom a sobriety test can only be carried out if the police officer suspects that the driver has consumed alcohol before driving or is drunk.

4.4 Enforcement of drug-impaired driving

It is far from certain whether the success of drink-driving enforcement (see Section 4.3) can be simply copied to the area of drug-impaired driving. There are some practical factors that complicate roadside drug-driving enforcement. The screening test for illegal drug use takes longer than the screening test for alcohol and is also more costly (Mills et al., 2021; Modijefsky et al., 2022). There are also technical problems related to drug-driving enforcement. First, not all illegal drugs can be screened by current oral fluid testers. Second, for some drugs, the drug concentration in oral fluid does not accurately reflect the drug concentration in the blood. Third, the oral fluid testing is unable to distinguish between active drugs and inactive metabolites that may be present in oral fluid (Houwing and Hagenzieker, 2013; Gjerde et al., 2018; Robertson et al., 2022). Fourth, in some countries blood is taken after oral fluid testing for evidentiary testing. This may take several hours requiring a lot of police resources, and the time spent waiting could result in drug concentrations falling below the legal threshold;

both diminishing police willingness to perform random roadside checks (Goldenbeld, Stelling, van der Kint, 2024).

Most research into enforcement of drug-impaired driving has taken place in Australia (e.g. Davey et al., 2017; Anderson et al., 2021; Cameron et al., 2022; Mills et al., 2022, 2023). The evidence from Australia regarding the impact of random drugs testing on the reported likelihood of drug-driving is mixed with some studies showing no effect and other studies showing some effect (Hassan et al., 2022). In Australia discussions are ongoing about random versus targeted drug-driving enforcement (Anderson et al., 2021). Whereas a targeted approach would detect more drug offenders than a random approach, it would have less impact on the general driving population which may include future drug drivers. Nevertheless, Anderson and colleagues argue for the application of a random approach at night times when detection rates are much higher than during daytime.

4.5 Enforcement of bans on mobile phone use

Olsson et al. (2020) analysed 32 studies on the effects of enforcing bans on hand-held mobile phone use while driving and concluded that the evidence was weak and inconsistent but pointed to a positive effect on the prevalence of mobile phone use and on safety.

Ironically, some aspects of TLE may stimulate drivers to use mobile phones in traffic in order to avoid enforcement (Truelove et al., 2023). There are a wide range of phone applications that notify drivers of enforcement locations. On the other hand, this type of warning might make drivers more aware of the various enforcement practices that are in place, and as such increase the subjective probability of detection (see Section 2.2).

In Europe, the Netherlands is one of the countries in the lead of automatic enforcement of mobile phone use. In 2020, the Netherlands began issuing fines following detection of mobile phone use by a new generation of cameras (Stelling-Kończak et al., 2020; Carson et al., 2022). With these cameras, a picture is taken of the windshield showing the car drivers and possibly front passenger. If the system determines that the driver is likely to be holding a phone, the photo is automatically forwarded to the relevant agency where an investigating officer will determine whether there is indeed a violation (Stelling-Kończak et al., 2020; Carson et al., 2022).

4.6 Enforcement of seat belt use

The effects of enforcing seat belt use largely depend on current levels of seat belt use. When seat belt use is low, an increase in enforcement can lead to a 30 to 45% increase in seat belt use. However, when seat belt use is already above 90%, an increase in police controls does not appear to have a measurable effect (EC, 2022). Current seat belt use varies widely in the EU, between countries, between vehicle type and between position in the vehicle. Baseline data show that for passenger cars average (all positions, 15 countries) wearing rates range between 70% in Greece and almost 100% in Germany; for goods vehicles (all positions, 7 countries) between 34% in Greece and 93% in Germany (Van den Broek et al., 2022).

5. Enforcement support measures

Three main categories of support measures for police enforcement can be distinguished (Goldenbeld et al., 2000):

- Measures that improve effectiveness or efficiency of enforcement, e.g., by more refined legislation, procedures and sanctions (Sections 5.1, and 5.2).
- Measures that improve the effects of actual policing operations, e.g., by better information about risk locations and risk times (Section 5.3).
- Measures that improve the way policing operations are perceived and valued by the public, e.g. by public communication (Section 5.4).

5.1 Legislation

Legislation establishes the legal framework for traffic laws and regulations (Mäkinen et al., 2003). It defines violations, sets penalties for violations, and outlines the rights and responsibilities of law enforcement and drivers. In most countries in and outside Europe, legislative traffic rules and penalties are either laid down in a criminal law or administrative law framework. Most traffic violations, such as minor speeding violations and seat belt use, are handled under administrative law. Drink-driving violations, extreme speeding violations, or extreme dangerous/careless driving are often handled in criminal law.

In the past decades, the process of handling traffic offences has in many countries undergone a shift towards administrative procedures in order to unburden the workload on the judicial process. Under an administrative framework, legal procedures for fining traffic offenders

are streamlined so that the government is capable of fining large numbers of traffic offenders against low costs.

Automatic enforcement operates under a driver or an owner liability legal framework or applies a hybrid approach (see Table 1; Carson et al., 2022). In countries with a driver liability provision, it is legally required that the automatic camera identifies the driver in order to enable prosecution of a violation. This often requires a photograph of both the vehicle number plate and the driver. In countries with an owner liability provision, the vehicle owner is held responsible for an offence and a photograph of the license plate from the rear of the vehicle is sufficient for purposes of legal evidence. In countries with a hybrid approach it can be both driver or owner liability, depending on the situation.

Table 1. *European countries applying driver, owner or hybrid liability as legal basis for automatic TLE. (Source: Carson et al., 2022).*

	Does your country have driver or owner liability?
Driver	AT, DE, EE, EL, ES, IL, NO, PL, RO, RS, SE
Owner	BE, CH, CY, CZ, HR, HU, IT, LV, NL
Hybrid	DK, FI, FR, IE, LU, PT, SK

In 2024 the EU amended the Cross-Border Enforcement Directive (2024/3237; EU, 2024) to strengthen cross-border enforcement of road traffic rules.. See section 3.2 (EU, 2024).

5.2 Sanction types

The most common sanction for general road user population is a financial fine, either alone or in combination with demerit points. For large, serious offences and repeat traffic offenders, licence suspension or revocation, alcohol interlock, and rehabilitation courses or intensive surveillance are the most frequent sanctions, often used in combination.

5.2.1 Fines and demerit points

Most countries have fixed fines for specific violations. The amount of the fine varies substantially among EU countries. Many European countries also apply a demerit or penalty point system in addition to a financial fine (Van Schagen & Machata, 2012). If a certain points limit is exceeded, revocation of the licence follows. Usually, the licence will simply be declared valid after a period of time; sometimes the offender has to pass the driving test again.

Demerit point systems contribute to road safety through three mechanisms: 1. prevention of unsafe behaviour through the risk of receiving penalty points, 2. selection and suspension of the most frequent offenders and 3. correction of risk behaviour through an educative element in the demerit points system (Van Schagen & Machata, 2012). Demerit points systems can lead to a reduction of crashes (21%), fatalities (10%), and injuries in the range of 9-20% immediately after introduction, but these positive effects generally exist for just a limited period of time (Castillo-Manzano & Castro-Nuño, 2012; Castillo-Manzano et al., 2019; Alonso, Faus, Esteban & Martí, 2025).

5.2.2 Licence revocation or suspension

Licence revocation means that a driving licence will remain invalid forever, sometimes with a possibility to earn a new one. Licence suspension means a temporary withdrawal of the driving licence which will be restored after a fixed period of time and/or fulfilling certain conditions, e.g., having participated in a rehabilitation programme. Licence suspension is much more common. There are two basic ways in which licence suspension may improve road safety. First, the threat of licence suspension may motivate drivers to comply with traffic rules and to abstain from risky driving. Second, licence suspension temporarily removes risky drivers from traffic (except for those who continue driving without a valid license). Studies indicate that licence suspension and revocation are effective in reducing crashes and violations of repeat offenders (recidivists), despite the fact that a considerable group of drivers continue driving without a valid driving licence (Masten & Peck, 2004; Goldenbeld, 2017; Hoekstra, 2020).

5.2.3 Alcohol interlock

Some countries have the legal option of imposing an alcohol interlock on convicted drink-driving offenders. In 2020, twelve EU countries had such an alcohol interlock programme (Modijefsky et al., 2022). An alcohol interlock requires drivers to undertake a breath test before starting the car and will disable starting when alcohol is detected. Often an alcohol interlock is embedded in a wider drink-driving rehabilitation or counselling programme. International studies showed that the recidivism rate of users of an alcohol interlock is 65-90% lower than that of drivers whose licences were suspended or revoked (Elder et al., 2011; Nieuwkamp et al., 2017; Nochaski et al., 2020). Some studies found that the effects disappear when the alcohol interlock is removed (Elder et al., 2011; Nieuwkamp et al., 2017), but when embedded within a supporting coaching programme effects were found to be more sustainable (Bjerre and Thorsson, 2008; Gustafsson and Forsman,

2016; Voas et al., 2016). Houwing (2016) developed best practices and guidelines for alcohol interlock programmes in EU countries. ETSC (2020) identified two key elements of a successful alcohol interlock programme: accompanying rehabilitation measures and affordable costs for implementation and maintenance.

Since 2022 (new vehicle types) and since 7 July 2024 on (all new registered vehicles), an alcohol interlock installation facilitation is mandatory for cars, vans, trucks, and buses, as required by the EU (Official Journal of the European Union, 2019).

5.2.4 Rehabilitation courses

Rehabilitation or driver improvement courses are common measures for traffic law violators, in addition to or replacing, for example, licence suspension. Most rehabilitation courses target drink-driving violators. In 2020, eight EU Member States had an active operating rehabilitation programme in place for drink-driving offenders (Modijefsky et al., 2022). Several countries also have courses for speed offenders, drug-driving offenders and for more general dangerous driving. The effects of rehabilitation courses on recidivism depend on a large variety of factors. They have more effect if they have both informative and therapeutic components (Miller et al., 2015; Slootmans et al., 2017; Hoekstra, 2020). Furthermore, it is important to align the programmes to specific subgroups, related to, for example, language, culture, gender and age (Wyatt & Novotna, 2021).

5.3 Data-driven enforcement operations

Most police enforcement agencies operate under a strict budget and with limited resources, and, therefore, there is considerable interest in new approaches to maximize the efficiency and effectiveness of their deployment (Ibrahim & Sayed, 2019). Data-driven or intelligence-led TLE has become increasingly prevalent allowing for the limited resources available to be used to target specific road safety issues (Norbury, 2020).

"Predictive policing" may be considered as a special case of data-driven enforcement. For predictive policing advanced statistical models and algorithms are applied to predict or foresee future crime or crashes (Meijer & Wessels, 2019). Sieveneck and Sutter (2021) explain the importance of predictive policing for road safety: "Predictive policing in road traffic safety will be the use of data about past crashes and traffic incidents, and about crash perpetrators, victims, and environmental and geographical aspects to foresee where the probability for future crashes and traffic incidents is high and to prevent these from

happening through measures taken by the police, like identifying and patrolling high risk areas" (page 1).

5.4 Public communication

The effect of traffic enforcement is substantially increased if it is supported by public communication targeted at the road user (Williams, 1994; Delhomme et al., 2009; Erke et al., 2009; Hoekstra & Wegman, 2011). Communication with road users should (Williams, 1994; Delhomme et al., 2009; Erke et al., 2009):

- emphasize that safety is the goal of the enforcement activities,
- explain how and why traffic violations lead to more and more severe accidents,
- explain the enforcement method and procedures,
- preferably illustrate that the revenues from fines are used for the benefit of local road safety, and
- provide feedback on the interim and final results of the enforcement activity, either in terms of traffic behaviour or safety.

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