

**Legislation, regulation and enforcement to improve
road safety in developing countries**

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Contribution to the World Bank Seminar on Road Safety, Washington, 14-15 December, 1992

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LEGISLATION, REGULATION AND ENFORCEMENT TO IMPROVE ROAD SAFETY IN DEVELOPING COUNTRIES

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1. Causes of road accidents

Human error is the underlying cause of almost all accidents. The estimates in this regard lead to the conclusion that with over 90% of accidents, human error in observation, decisionmaking and response was involved (Figure 1). But a small proportion of accidents could (also) be attributable to vehicle defects or faults in road design. Often, and unfairly, the resultant conclusion is that road accidents can only be prevented through education, information and police enforcement. Such a conclusion ignores the true cause of accidents. And these true causes are rooted in the present road traffic system, a system which leaves room for human error. Modern traffic confronts the road user with a series of relatively unpredictable road and traffic situations. The present system makes it difficult for road users to recognise danger and demands a great deal of skill if conflict is to be avoided.

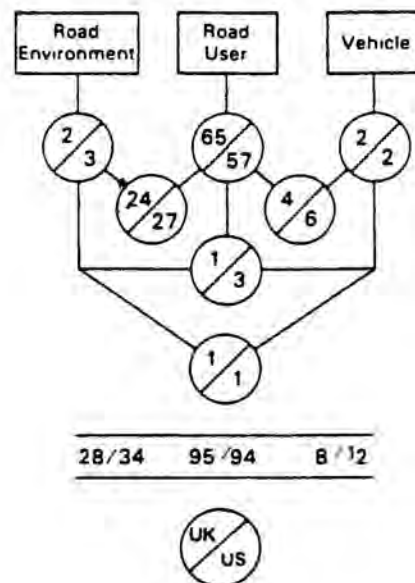


Figure 1. Percent contributions to traffic crashes as obtained in British and US in-depth studies (Rumar, 1985).

Often, accidents are the result of a critical combination of circumstances (OECD, 1984), and cannot be attributed to a single cause. While in the past, the aim was to localise the dangerous driver and make his participation in traffic impossible, or at least unattractive, or else to improve his education, nowadays the 'critical combination of circumstances' argument seems to be widely accepted. The World Bank report 'A systematic

approach to road safety in developing countries' (Carlsson & Hedman, 1990), also follows this line of reasoning.

An example to illustrate the cited report from the World Bank: "A drunken driver drives his car off the road on a sharp horizontal curve, and hits a tree. He is not wearing his seat belt and there is no legal requirement in the country that he should. The driver is killed on the spot".

There are many possible reasons why the accident happened and the driver lost his life:

- the driver was drunk - it is known that intoxicated drivers are exposed to higher accident risks;
- the curve was sharp - sharp curves increase the accident risk, even if they conform to standard design practice and even when negotiated by sober drivers;
- the tree was there - if hard objects near the road are removed, accidents are likely to be less serious; and
- the driver did not use his seat belt - seat belt legislation will increase their use substantially and therefore reduce accident severity".

The police report on this accident is likely to have stated that the driver lost control over the steering wheel and was probably driving too fast. Ergo, human error, thereby resolving the legal question of blame. But the example also illustrates that there are many more factors at play, and that there are many more ways of preventing this type of accident, rather than simply pointing out people's deficiencies and then punishing them for the consequences.

Much of research and policymaking relies on the registration of accidents by the police. Since it is the task of the police to determine who is the guilty party in an accident, it is logical that this is noted as the cause of accident on the registration form. It is not advisable to simply state the 'cause' with accident registrations; rather, it is preferable to base the report on the 'critical combination of circumstances' approach with the setup of a system for the collection and analysis of road accident data.

It would also be advisable to keep in mind the situation as described in the above when we point out human error as the cause of accidents, and try to prevent such accidents via information campaigns and police enforcement; unfortunately, it is not that simple.

2. Prevention of road accidents: a concept

Safe participation in traffic has to be learnt; learning to understand traffic, learning to recognise danger and learning to avoid danger. Attention must focus on inexperienced road users who are not sufficiently skilled in traffic manoeuvres yet, while other categories are better kept off the road (e.g. those driving under the influence of alcohol and drugs). In addition to the efforts made for these specific groups, the key to improving road safety is to adapt traffic such that road users do not need to carry out as many manoeuvres per unit of time: modifying traffic to suit human needs. This is realised by reducing speed differences between road users, by minimising confrontation with traffic coming from other directions, by lowering driving speeds and making traffic situations more predictable, thereby enhancing anticipation opportunities.

Safer road traffic is achieved by better adaptation of measures relating to the infrastructure, vehicles and regulation to suit the characteristics of the user: the fallible and vulnerable human being. Primarily, this demands coordination between the function and design of roads and their potential user conflicts, in order to minimise the likelihood of error by the road user. In a secondary respect, conditions are created in advance, such that the severity of any accidents which still occur is minimised.

To illustrate this point: In comparison with all other types of road, a motorway carries a large volume of vehicles travelling at high speeds. Nevertheless, motorways are relatively safe, as can be seen in Figure 2. Of course, motorways are not safer because only better cars or more responsible road users are found there. On these roads, per kilometre travelled, the death rate is ten times lower than on other roads outside the built up area, because - even at high speeds - the differences in speed are relatively small (no traffic travelling in the opposite direction, no intersecting traffic, no slow traffic). In other words, motorways, designed and constructed in accordance with modern quality standards, satisfy the previously described safety principles to a significant degree. This objective can also be realised for residential areas, as shown in Figure 2.

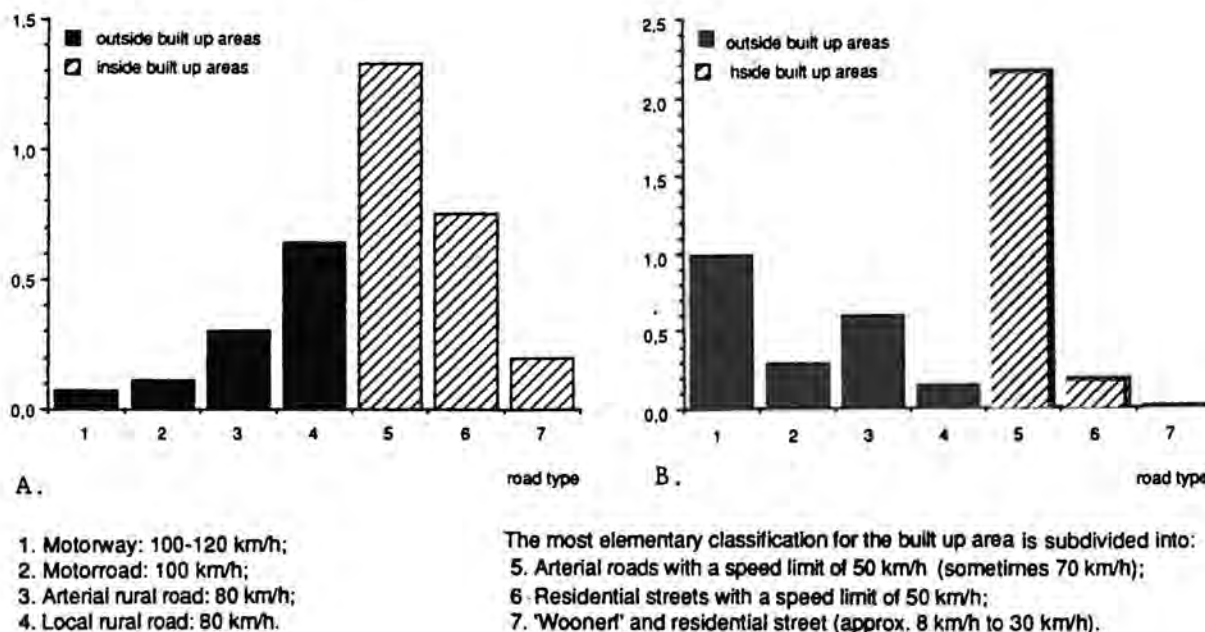


Figure 2. Injury accidents in the Netherlands (1986) A: per million motor vehicle km; B: per km road length.

In a safe traffic system, three different functions can be distinguished for roads: flow function (rapid processing of through traffic), access function (easy accessibility of areas) and local residential function (allowing access to homes and making meeting places, such as the street, safe and livable).

Each type of road demands a design which is optimal for its specific functional requirement, but which also guarantees optimal safety. In order to realise this aim, the various road types must meet three safety principles:

- functional use: prevents unintended use;
- homogenous use: prevents a large variation in speed, direction and mass at high and moderate driving speeds;
- predictable use: prevent uncertainties experienced by road users.

Roads which combine flow, access and residential functions should be excluded wherever possible. Figure 2 shows that where combinations of function are permitted, this leads to increased road hazard. In order to improve predictability of use and behaviour, preference is given to a unique and clearly recognisable design of one type of road per function. This demands a consistent classification of roads. Preferably, marking and signing would be linked uniquely to one category of road. Based on these principles, legislation which fits in with such function and design would represent a logical completion of the whole.

These safety principles for the structure and design of the road infrastructure are not new. However, we have not succeeded in designing and realising such principles for the entire road network, in particular for the relatively hazardous single carriageway roads outside the built up area, and arterial roads inside cities and towns. Today's traffic, in developed and developing countries, is suffering a large number of victims. The know-how is largely available, also with respect to the specific circumstances of developing countries (TRRL, 1991). Nevertheless, the fact that the use of these principles to increase the safety of traffic (considerably) is not yet taken for granted is probably a function of a lack of awareness of current and future road safety problems and the possible solutions, and of not being prepared to accept the consequences of applying these principles (the physical organisation of our society, cost etc.). A social and political base of awareness and support will have to be created to make road traffic considerably safer: knowledge, motivation and ability (SWOV, 1992).

Furthermore, it is surprising that society imposes such high safety standards on rail traffic, air traffic and on the generation and distribution of energy (which is paid for by the users), while such an approach in relation to road traffic seems (as yet?) impossible.

3. Strategy for legislation and enforcement

Even if there were question of an infrastructure adapted to suit human dimensions, then there is still a need for traffic rules, legislation, vehicle requirements, training and education of drivers, regulation and planning. The question in this regard is which requirements legislation must satisfy, in order to achieve the intended effect ('a certain behavioural adaptation'), and in which ways compliance can be stimulated. The question is also which subjects can be subjected to legislation from a perspective of road safety.

Everyday reality shows that a law alone is not enough to change the behaviour of road users. Psychology can teach us much about how behaviour is truly influenced. Although several different theoretical models are available, a number of behavioural determinants still seem to surface repeatedly (see also OECD, 1990). One example of such a model is shown in Figure 3.

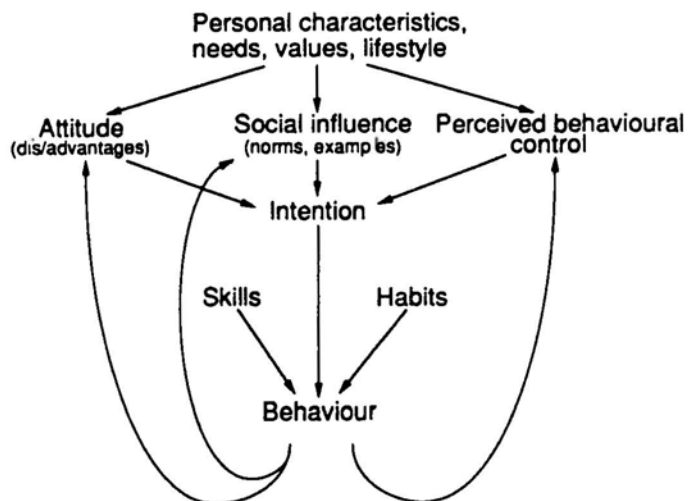


Figure 3. Model of road user behaviour determinants (OECD), in press).

Short of fully describing the model, it is evident that behavioural changes can be brought about by influencing various factors: the personal attitude of road users, social standards with regard to behaviour in traffic and the actual means by which desirable behaviour can be elicited, etc. In addition, the figure makes it clear that actual behaviour on the road is the result of current personal and social characteristics such as needs, values and lifestyles. In short, the cultural component can be of great significance, which is reason to conclude that while a certain approach used to bring about a change in behaviour may be effective for a particular part of the globe, this in itself is not enough to guarantee that a similar approach will work elsewhere.

Legislation in itself such is not a safety measure. A safety effect demands more. It is furthermore advisable, before introducing legislation, to foster a positive attitude amongst the population and amongst social groups via publicity campaigns. Once the new law becomes operational, it is necessary to inform road users about the content and intent of that law. The public should also be informed about the possible consequences of breaking the law. Also, the road user must be aware that the legislator is serious about application of the law. This can be demonstrated by ensuring that police applies sufficient effort to enforce the law and that the judiciary can take care of any criminal procedures.

Legislation, information campaigns and police enforcement must therefore be seen as links in a chain (the weakest link..). In addition, it is necessary to set up a strategy to achieve the intended behavioural changes. Such a strategy should respond to the behavioural changes actually manifested.

4. Example of road safety legislation and enforcement

There are many rules specifying the types of behaviour required or permitted for each type of road or situation in each country. These rules are specifying how to execute certain manoeuvres in certain situations. These rules are necessary for clarity reasons and have to be trained. Some of these rules could have a major impact on road safety, but others do not.

Without entering into too much detail on this subject, a number of subjects are dealt with below which are of great importance from a road safety perspective, and rely on legislation and regulation in order to solve the problems.

Driving speeds and speed limits

It is not easy to represent the relationship between speed and accident risk. Simply stating that more accidents occur at higher speeds is not sufficient. However, research has shown a larger variation in driving speeds will lead to a higher accident probability. Furthermore, high speeds result in more serious accidents. Good speed limits (from a perspective of unrestricted driving speeds and actually maintained limits) lead to less variation in speed (regression towards the limit) and to lower speeds.

Scandinavian studies (Salusjärvi, 1981 and Nilsson, 1982) offer both theoretical and empirical confirmation of this claim. Changes in speed limits in the United States and in France (Figure 4) and also in the Netherlands show a favourable effect on motorways.

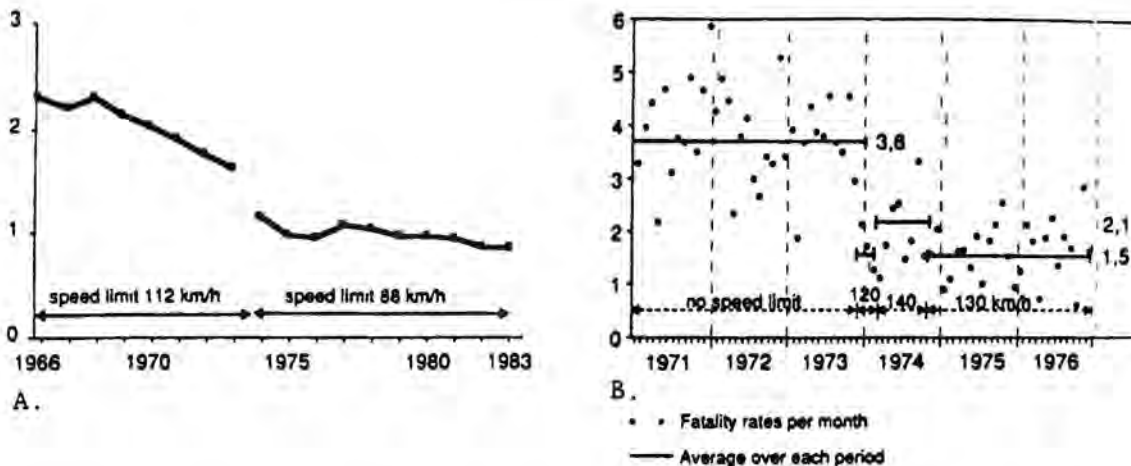


Figure 4. Fatality rates in relation to the speed limit changes (1974)
A: US interstate highways; B: rural motorways in France.

But effects are not only measurable on motorways. The introduction of speed limits inside the built up area can also have a significant influence (in Denmark, the limit was reduced from 60 km/h to 50 km/h and in the Netherlands and other European countries, the lower speeds realised through the 'woonerf concept' or the introduction of 30 km/h zones have resulted in a reduction in road accident victims measured in values of ten percent or more).

Reporting about the effects of speed limit changes often leads to enormous initial safety effects at relatively minor changes in average driving speeds: a reduction in the average speed can have a fourth power effect on fatal accidents. On the other hand, this effect is frequently of a temporary nature.

Imposing a maximum speed can be realised in two ways, in principle: via the road or via the vehicle. Road-related general speed limits offer a rough means of enforcing a maximum speed. Rough, because in this way, specific circumstances cannot be taken into account. Vehicle-bound limits (lorries, mopeds) are associated with their own particular problems. A recent EC report on road safety (Gerondeau, 1991), again points out that there is an increasing number of vehicles on the road with a high capacity and a higher top speed than specified road limits permit. This is comparable to rowing upstream.

Seat belts

Based on theoretical considerations and tests in the laboratory, it has been irrefutably demonstrated that seat belts considerably reduce the probability of fatal injury and other serious injury. In practice also, their effectiveness has now been established. American (Evans, 1986) and British (Harvey, 1986) studies in the field have shown that seat belts have an effectiveness rate of over 40%.

The use of seat belts rose spectacularly after they were made compulsory by law (in: Hagenzieker, 1991). It is striking to note that in some countries, a compliance level of over 90% has been achieved (Figure 5); in addition, this high percentage can be maintained from year to year without needing a high level of enforcement.

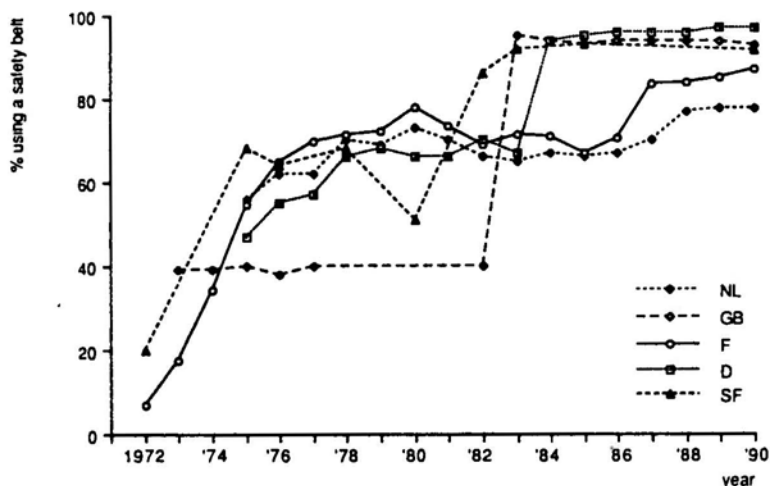


Figure 5. Safety belt use outside urban areas in Germany (D), Great Britain (GB), the Netherlands (NL), Finland (SF), France (F) in 1972-1990 (Mäkinen & Hagenzieker, 1991).

One may expect same effect for other types of protection against injury (crash-helmet).

Driving under the influence

Alcohol consumption increases the likelihood of an accident. After a blood alcohol content of approx 0.5 o/oo is reached, the probability begins to rise, becoming greater as the BAC rises. At a BAC of 1.5, the probability of a fatal accident is already over 10 times greater than if no alcohol were consumed. The introduction of a legal limit for alcohol consumption in many countries led to considerable, albeit often temporary effects (Figure 6).

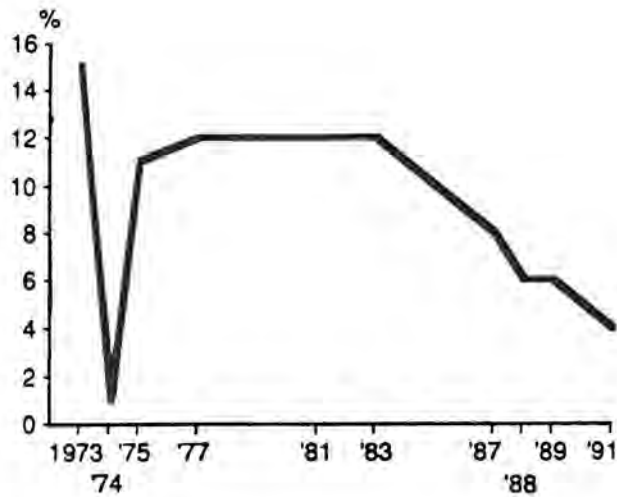


Figure 6. Percentage car drivers > 0,5 prom. (legal limit) during weekend nights in the Netherlands.

Furthermore, in many countries, as published reports have indicated, driving under the influence proved to be a very persistent problem that definitely needed to be 'controlled'. In this context, efforts made by the Australian government and the resultant effects in the state of New South Wales are significant. Intensified random breath testing in New South Wales (police control led to one third of all drivers having to undergo a breath test) led to an overall reduction in road accident victims of 25%, and a 75% reduction during control times.

Vehicle requirements and vehicle inspection

Experience has shown that regulation is an essential instrument for improving vehicle safety. Due to competitive considerations, the car industry tends to be hesitant or even reserved in their attitude. This does not detract from the fact that they supply many new ideas and innovations, particularly if manufacturers believe this will give them a stronger position on the market. Whether it be cause or effect, regulations have led to greater vehicle safety, although it should be noted that the safety effects of vehicle improvements are frequently claimed and also frequently disputed (Blomquist, 1988). One of the regularly recurring issues of debate is the claim that the degree to which drivers respond to technical innovations and the potential gain in safety is dispelled by more dangerous driving behaviour (OECD, 1990).

Vehicle regulation represents an important step towards safer vehicles, but certainly offers no guarantee that vehicles are used as intended and that they will be properly maintained. In a large number of publications, it is noted that this represents an important road safety issue for developing countries. The average age of a vehicle on average is 2 to 3 times greater than in industrialised countries. Spare parts are unobtainable or expensive, and are 'improvised' on a large scale, in an attempt to keep vehicles on the road for as long as possible.

In addition, there is regular question of overloading of all types of vehicles. The inadequate availability of vehicles in relation to the demand is the essential background to this situation. The road hazard that

results from such overloading - quoted by many studies as being one of the most frequent cause of accident - is symptomatic of a fundamental socio-economic problem. Because the enormous economic implications it is not realistic to expect that this symptom represents the only grounds to tackle the causes of overloading.

The literature (from industrialised countries) shows a variation in the proportion of accidents that is thought to be due to vehicle defects, ranging from approx 2% in police registration to 4 to 6% with accident studies. Seen as a contributory factor, the proportion varies between 8 and 21% (Tromp, 1989). An American study carried out some years previously found that vehicles aged 4 to 6 years are involved in accidents resulting from defects about one and a half times as often, while vehicles of 7 years and above are involved about three and a half times as often, when compared to vehicles younger than 4 years. It is also a fact, however, that old vehicles tend to be driven by young persons who are more often involved in accidents for reasons besides driving older cars, e.g. less driving experience.

The most important defects which have a bearing on accidents are shown to be defects of the braking system (50%) and tyre defects (25%). In the Netherlands, as in many other countries, a compulsory periodical car inspection applies. This inspection is intended to serve both road safety and the environment. Cars aged over three years must be inspected every year. SWOV estimates lead to the conclusion that the effect of this inspection has resulted in a safety gain of less than 1%. An important element of this gain was achieved by a small percentage of the vehicles on the road being taken to the wrecker's yard, instead of undergoing inspection.

Although there are great differences in the subjects listed here, they consistently lead to the conclusion that legislation, together with information campaigns and police supervision, has led to significant safety effects, with the reservation that full compliance is only seen as an exception. A large number of legal measures also require constant 'maintenance'.

5. Factors influencing compliance

Based on the literature (from all industrialised and highly motorised countries) it can be concluded that government regulations are applied on a large scale to promote road safety, and not without success. But on the other hand, this form of government intervention has its limitations.

Firstly, people have to realise that control of behaviour relates to the freedom of road users with respect to the use of his mode of transport and his behaviour on the road. Some types of control and freedom restrictions rarely pose a problem: driving on the right hand side and giving way to traffic from the right is hardly regarded as a serious imposition on freedom. This does not apply to speed limits or to the wearing of seat belts, however. If rules are not accepted by the road users themselves and by enforcement personnel, a counter-reaction will follow.

Legislation does not ensure that the desired behaviour is also carried out in practice. From a road safety perspective, it has been clear for some time that traffic legislation should be confined to a limited number of regulations, where the relationship between the behaviour prescribed and

the (safety) objectives of the legislator are clear to the road users. It has also been apparent for a long time that legislation should be the natural outcome of an infrastructure which is understandable and logical to the road user, and should certainly not be seen as an effective means of undoing the consequences of faulty road design.

A large proportion of the rules will have to be complied with voluntarily, and in addition there should be sufficient means by which police and legislature can take action against any offenders. In the remainder of cases, it should be left to the road users themselves to choose which form of behaviour best suits the situation they find themselves in.

The latter does not imply, however, that this 'freedom of choice' should not, or could not be directed: influencing attitudes with respect to relocation, influencing social standards and improving skills are the key concepts here (see Figure 3).

The following factors have been shown to influence the degree of compliance:

- the visibility of the offence to others
- the durability of the offence
- the clarity of the regulation
- the likelihood of police control
- the personal benefit in relation to safety and other factors (cost, driving time, comfort)
- the benefit to others in relation to safety and other factors

A number of measures were evaluated using these factors (see Figure 7 from Wesemann, 1984).

Legislation Factors	Crash helmet	Cycle reflector	Seat belt	Red light	Speed limit	Road signs	Alcohol
Visibility of the offence	++	++	+	+	0	+	--
Durability of the offence	++	++	++	--	-	--	++
Clarity of the regulation	++	++	++	+	+	+/0	+
Likelihood of control	++	++	+/0	+	0/-	+	-
Personal safety benefit	++	++	+	+/0	+/0	+/0	+
Other personal benefit	0/-	0/-	0/-	-	0	-	
Collective safety benefit	0	0	0	+/0	+/0	+/0	+
Other collective benefit	0	0	0	0/-	-	0	0

Figure 7. Appreciation of different rules influencing road user behaviour without police enforcement.

Based on this evaluation, the following conclusions can be made: those regulations for which visibility, durability, clarity and controllability are very great, for which personal benefit is not negative and the public benefit is neutral to positive are virtually fully complied with (crash-helmet). Regulations for which the same applies, but to a

lesser degree, are less fully complied with (seat belts). Regulations that one is expected to comply with from time to time, for which visibility, clarity and controllability are positive, but which have a limited positive effect on personal safety, are only complied with in part (speed limits). If the visibility of the offence is less apparent (alcohol), compliance becomes more problematical.

If rules are not fully complied with voluntarily by the road user, and adaptation of the 'environment' is not possible, while society is nevertheless of the opinion that certain hazardous behaviour should be prevented, then upholding the law via police enforcement and associated punishment is unavoidable. Police enforcement can only be effective if the road user experiences the threat of punishment as a realistic possibility. The detection and handling of road traffic offences represents an enormous burden for police and judiciary. In many countries, i.e. those countries that are subject to reduced government intervention and cutbacks in public expenditure, an expansion in capacity is not feasible. If police enforcement is relied on to solve certain safety problems, then it is important to enhance the effectivity and efficiency of such enforcement. This is a knowledge and training problem, an equipment problem and a management and organisational problem.

Study results (OECD, 1974, Koornstra & Christensen, 1990 and Bjørnskau & Elvik, 1992) in this field have led to the following conclusions:

- Enhanced visibility and specific police enforcement (targeted at specific types of behaviour at specific time periods etc.) leads to a temporary increase in compliance;
- a combination of enforcement and information campaigns enhances the effect of police enforcement;
- constant specific police enforcement at a low level, after a period of intensified enforcement, could result in a lasting effect;
- non-visible forms of enforcement have less effect than visible forms of enforcement;
- the enforcement organisation must exclude avoidance behaviour;
- random forms of enforcement (based on time and location of enforcement) have greater effect than forms which are predictable for the road user;
- random controls (alle drivers are inspected or tested are more effective than selection of 'suspects' by police (all drivers are inspected or tested) personnel;
- police enforcement is more effective if this is in keeping with government road safety policy, which should also be credible.

Although all developing countries have their own legislation and regulations to organise road traffic and enhance safety (a system often based on legislation drafted by former colonisers) current road traffic in many of these countries - as is also true for developed countries - gives the impression that legislation and regulation are not meeting their objective.

Legislation, enforcement and inspection play an important role in the road safety projects of the World Bank. 38% of the projects conducted in Africa included one of these three subjects (Barrett & Lundebye, 1991). The literature does not seem to give much credence to this approach towards road hazard, even though some examples are given of effects of police supervision on behaviour in traffic and on accidents. In the reported examples, there is generally question of a fairly small scale, poorly coordinated and fragmentary approach.

6. Conclusions and recommendations

1. There are a large number of examples from developed countries which demonstrate that legislation and enforcement exert a positive influence on certain aspects of behaviour in traffic, and have thereby offered a contribution towards road safety. Although there are good reasons for not simply transposing these experiences to developing countries, it cannot be ignored that legislation and enforcement can help to exert a favourable influence on road safety. It is desirable in this regard that legislation and enforcement are in keeping with the cultural climate and other (economic) realities of a particular country.

2. Legislation and enforcement of the law in order to improve road safety should never be considered separately, and should relate to safety-conscious design of the infrastructure. Road authorities with well-educated road designers, who are aware of safe and unsafe behaviour and who are also able to encourage safe behaviour and prevent hazardous behaviour through their design and implementation, should take the first step in this regard.

3. Most of all, it is an awareness of the impact of current and anticipated road casualties and of the causes of road accidents, that leads to a willingness and commitment towards improving road safety. This is a precondition for anticipating any effect from legislation and regulation and from enforcement: awareness level 3 (Ross, Lundebye & Barrett, 1991).

4. If these conditions are met, legislation and regulation and the associated enforcement become essential steps in the improvement of road safety. Road safety legislation and enforcement should fit a strategy that considers the entire chain of essential steps: legislation, education, enforcement and judicial procedures.

5. It is recommended that a limited number of important areas are selected for the improvement of road safety by legislation and enforcement. The subject choice should be based on an analysis, where both data from road accidents and behaviour in traffic are used. It is recommended to formulate these subjects as spearheads of policy. For example, relevant subjects include speed limits, use of the seat belt, the technical conditions and overloading of vehicles and in some parts of the world driving under the influence.

6. Motivating and training police personnel is an important step, as is equipping police with suitable equipment. With the organisation of police enforcement, experience with traffic enforcement gained in developed countries could be used as an example. In general, it is recommended that with the aid of research, an attempt is made to determine the effects of enforcement. Such results could be used to further optimise enforcement efforts for the pertinent traffic situation in developing countries.

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