Safety on Roads

WHAT'S THE VISION?

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

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- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

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QUELLE VISION POUR DEMAIN ?

FOREWORD

The Road Transport and Intermodal Linkages Research Programme (RTR) is a co-operative approach to transport issues among Member countries of the OECD.

The mission of the RTR Programme is to promote economic development in OECD Member countries by enhancing transport safety, efficiency and sustainability through a co-operative research programme on road and intermodal transport. The Programme recommends options for the development and implementation of effective transport policies for Members and encourages outreach for non-member countries.

This report identifies and assesses “best practices” among road safety programmes in OECD countries. An emphasis is placed on those programmes that have been evaluated. In addition, the underlying criteria that influence the success or failure of these “best practices” are identified to facilitate the development of effective road safety policies in Member countries.

ABSTRACT

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Approximately 125 000 people die every year on the roads of OECD countries. A wide variety of solutions have been put in place in OECD countries and further measures are being developed for implementation. However, no country has implemented all proven measures to their full extent.

Fatalities across OECD countries could be halved if all governments were fully committed to improving road safety by implementing and enforcing best practice measures.

This report identifies and assesses “best practices” among road safety programmes in OECD countries. An emphasis is placed on those programmes that have been evaluated. In addition, the underlying criteria that influence the success or failure of these “best practices” are identified to facilitate the development of effective road safety policies in Member countries.

Fields	Economics and administration; accident statistics; accidents and the human factor; road safety devices.
Field numbers	10; 81; 83; 85.
Keywords	Accident, accident prevention, accident rate, addiction, attitude (psychol), behaviour, cost-benefit analysis, data acquisition, decision process, driver, drugs, drunkenness, economics, education, enforcement (law), evaluation (assessment), fatality, fatigue (human), financing, highway, legislation, mobility (pers), OECD, planning, policy, safety, social cost.

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Approximately 125 000 people die every year on the roads of OECD countries. In other words, one road crash victim dies every four minutes. The real tragedy is that, to a large degree, these crashes, and the resultant deaths and injuries, are preventable. Indeed, research shows that, when we consider the main causal factors of traffic crashes (the road user, the vehicle and the roadway infrastructure), all crashes can be attributed to at least one of these factors. Thus, adequate and increased investment in producing better drivers (and other road users), improved vehicle manufacturing and maintenance standards, and improved road design and maintenance standards can, and will, prevent road crashes.

Moreover, it is increasingly apparent that effective safety management processes are a fundamental step towards addressing road safety problems. Only with good management systems in place will those responsible for road safety be able to compete successfully for resources and make sound decisions with respect to the development and implementation of effective measures.

The argument for road safety investment is not simply an emotional one: road crashes represent a serious economic burden, and are estimated to represent up to 4% of GDP in some countries. Even among countries which have shown significant overall improvement over the last 30 years, there is considerable disparity among death rates, which range from less than seven deaths per 100 000 population (United Kingdom, Sweden, Norway, Netherlands) to more than 18 (Korea, Portugal, Greece).

This report identifies and assesses "best practices" among road safety programmes in OECD countries. An emphasis is placed on those programmes that have been evaluated. In addition, the underlying criteria that influence the success or failure of these "best practices" are identified to facilitate the development of effective road safety policies in Member countries.

Road safety visions, targets and plans

A vision for road safety should be developed and incorporated into political and societal philosophy. The message needs to be clear, simple and easy to communicate. Ownership of the vision by all stakeholders is key to ensuring success in achieving road safety objectives. It should be designed to raise awareness of the social unacceptability of road fatalities and injuries, and hence, be incorporated into transport policy. In the same way that drink-driving has now become socially unacceptable in many countries, other deviant road-user behaviour (*e.g.* speeding) should be viewed likewise by society.

Targets should represent a corollary to the development of a vision. Targets may vary in their specification, depending on the national situation. However, in order to secure public ownership, targets should be achievable within a realistic timeframe. Absolute targets (*e.g.* ten fatalities per 100 000 population) may not be as effective as relative targets (*e.g.* no more than ten fatalities per

100 000 population), in that the former implies a degree of acceptability or inevitability in road crashes.

Targets can be set by a top-down process (based on idealism) or through a bottom-up process (based on realism). In the first case, the target is set without too much prior consideration as to how it can be reached in terms of safety measures and at what costs. In the second case, targets are based on the estimated effects of the available set of road safety measures; thus, the required budget can be estimated at the same time. Normal practice is usually a combination of the top-down and bottom-up approaches.

The setting of targets has proven its value in many countries. Target setting leads to more realistic and effective programmes, results in more integration of institutional efforts and, by securing political commitment, often produces a more focused allocation of resources.

Communication of the vision, targets and strategies to raise awareness within society should pave the way for ownership and acceptability of the measures introduced to attack the social problem of road safety.

Road safety plans and programmes

Action plans need to be comprehensive and focused on outcomes. Their development should involve all relevant stakeholders in order to achieve effective implementation, particularly in those areas where society needs to make important trade-offs (*e.g.* lower levels of alcohol in the blood, speed, seatbelt wearing or compulsory wearing of helmets for cyclists). Plans may be general (*e.g.* national) or specific (*e.g.* rural road safety), may involve differing time horizons, and may target high-risk groups (*e.g.* children's safety). Plans incorporating a clear vision and target(s) for road safety represent key elements for galvanising funds to support key strategies/measures to improve road safety.

The overall political and technical responsibility for traffic safety policy should, in principle, be at the national level. Multi-annual programming of the actions is usually necessary, supported by systematic public information and communication. It is also important to obtain participation at the regional and local levels, *e.g.* by allocating specific responsibilities at each level. In addition, it is recommended that safety plans be developed at regional and local levels.

The planning of measures can be based on existing knowledge regarding their effectiveness and efficiency. Their contribution to the target (fatality and injury reduction) should be optimised through reduction of risk and/or exposure. Where the effects of new measures on the key indicators are unknown, other indicators of effectiveness could be used (behaviour, knowledge, organisational performance). Experiments with innovative solutions can prove useful; however, these projects have to be accompanied by actions of communications and thorough evaluation.

The composition of the safety programme demands a ranking of possible safety measures. Besides economic efficiency (in relation to the intended effects), side-effects (on transport and environment), social equity, funding mechanisms and political feasibility should be taken into account. Road safety budgets should be allocated to realise a maximum return to society. Three socio-economic tools are available to support resource allocation decisions: cost-effectiveness analysis, multi-criteria analysis and cost-benefit analysis.

Theoretically, social cost-benefit analysis is the best tool to achieve optimal use of scarce resources. However, cost-benefit analysis requires extensive information that is not readily available

and hence, it is not often possible to use it as the main criterion. Research into increasing the applicability of cost-benefit analysis is therefore strongly recommended. Currently, the allocation of budgets to road safety is based on political priority ranking of problems in society. Funds are therefore often insufficient to finance all efficient projects. The lack of alternative decision support tools means that targets continue to be set along the lines of a political top-down process. This can lead to targets that are not feasible or that are too expensive.

Once the target is set, cost-effectiveness analysis or multi-criteria analysis can be used to select the "best" set of measures to realise this objective. If available data (on costs and safety effects of alternative projects) allow, cost-effectiveness analysis helps to determine the most efficient path to achieving these goals. Multi-criteria analysis can be used for ranking measures, even without quantitative data, although it does not guarantee economic efficiency. Despite their limitations, analytical procedures (cost-benefit analysis, cost-effectiveness analysis, multi-criteria analysis) are important tools for guiding the decision-making process in identifying appropriate measures and setting priorities.

Road safety measures

In view of the set targets, an inventory should be made of possible safety measures, directed at human behaviour, vehicles, roads and environment. A broad traffic safety programme should include measures for roads as part of the transport system, land-use planning, road infrastructure, traffic education, public information, legislation and enforcement, telematics and vehicle technology. National and regional differences in regulations (*e.g.* driving hours, vehicle standards, licensing provisions) should be taken into account.

There is general agreement among countries regarding the main road safety problems. A wide variety of solutions have been put in place in OECD countries and further measures are being developed for implementation. However, no country has implemented all proven measures to their full extent. Further, the realisation of expected benefits from the implementation of any measure will depend on the level of enforcement that goes with it.

Significant gains in road safety could be achieved if all proven measures were implemented and enforced in all countries. The more successful countries have now managed to reduce risk levels to six fatalities per 100 000 population even in countries with relatively high car ownership and mobility rates. It is therefore not unreasonable to assume that all countries could achieve similar rates by fully implementing and enforcing known safety measures. This could more than halve the number of road fatalities in OECD countries.

Organisational roles

Political commitment is essential to ensure that road safety is given high priority. Top officials therefore play a key role in championing road safety and ensuring that it is placed high on the political agenda.

Co-ordination across all stakeholders at all stages of road safety planning and implementation is fundamental to realising road safety outcomes. The responsibility for co-ordination among the numerous actors should be laid down at the national level. This task can be achieved by various means such as legislation (*e.g.* guidelines), financial incentives and dissemination of knowledge and information. The execution of this task should be monitored continuously. A balance between a

completely integrated programme and innovative actions often initiated by the local level should be sought.

Safety integration across all levels of government and agencies (including enforcement) in road safety target setting, planning, programme development and implementation is recommended. All organisations with responsibility for aspects of road safety should therefore inform others and co-ordinate their activities. This practice can maximise the benefits of public investments for road safety. It ensures that the secondary road safety benefits from investments in public education and health, for example, are realised. Further, the dialogue and co-ordination among all primary and secondary entities that are stakeholders in road safety ensures that public policy is less likely to work against road safety. Removal of institutional barriers through the use of an integrated road safety management approach should be considered. The safety conditions of road infrastructure and road vehicles, as well as the education of road users, all combine to affect the level of safety.

A representative group of stakeholders outside of government should also be involved in setting road safety targets. This assists in the setting of more ambitious targets. Furthermore, the organisations and groups that are involved in setting the targets will support the planning and implementation of the road safety programmes and the later task of evaluating their effects.

To achieve harmonisation in road safety programmes, programme development should occur at both national and regional levels. Harmonisation among programmes at these levels is desirable. Regional governments should therefore participate in the planning of national level programmes, while the national government should take part in the planning of regional level programmes.

Data needs and evaluation

Reliable and consistent data are essential ingredients to the development of effective road safety policy and measures. They are also essential to evaluating measures and ensuring maximum return on investments in safety. While sound fatality data exist, there are serious data deficiencies in many other areas, including:

- Non-fatal and non-injury collisions.
- Exposure data.
- Causal factors.
- Mobility requirements.
- Near-collision data.
- Road-user and traffic behaviour.
- Road-user knowledge, skills and opinions.

There is a need for timely, complete and linked safety data systems to support safety management. This is a key element of safety management to ensure that the best possible decisions are made. Data sharing by those involved in decision making is also critical. It is recommended that databases should be compiled to include all relevant data. The database should be easy to use and accessible to all organisations involved in road safety. Feedback mechanisms to the agencies in charge

of implementing measures should be in place and should be activated through the outcomes of the monitoring and evaluation process.

It is advisable that an independent agency with good research capabilities be put in charge of this monitoring and evaluation. *Ex post* evaluation of measures should be part of any road safety strategy.

Methods for forecasting and evaluating the results of road safety measures need to be developed in order to improve existing programmes or plan new programmes. They should be based on past traffic crash and incident data and analysis of information about near-crash events.

It is often difficult to find quantified evidence of the cost-effectiveness of road safety measures. This does not necessarily mean that countries are not evaluating the effects of measures, although good examples of consistent cost-benefit analyses are hard to find.

For this reason, consideration should be given to a review of the cost-effectiveness of road safety measures with a view to producing clear guidance on the state of the art in methods of evaluation, and on the measures likely to have the best benefit–cost ratios. All countries have financial constraints in their road safety budgets. It is therefore imperative that attention be paid to obtaining best value for money through targeting activity where it will be most cost-effective.

Recommendations

- The development of a *vision* and the *setting of targets* have proven their value in many countries. Target setting leads to more realistic and effective programmes, results in better integration of institutional efforts and, by securing political commitment, often produces a more focused allocation of resources.

- In the same way that drink-driving has become socially unacceptable in many countries, other deviant road-user behaviour (*e.g.* speeding) should be frowned upon by society. Raising *public awareness* and participation is crucial to the success of safety measures and is key to gaining support for the measures being implemented.

- *National co-ordination* of road safety strategies should involve all stakeholders (*e.g.* infrastructure providers, vehicle, road-user groups, police, emergency response). Together with regional and local governments, they should participate in the development of the national road safety action plan. Responsibility should include both policy and technical assistance.

- *Regional and local road safety action plans* should be drawn up based on the national plan.

- The benefits to be gained from the implementation of *road safety measures should be quantified and ranked* so that maximum returns are realised. Analytical procedures (cost-benefit analysis, cost-effectiveness analysis and multi-criteria analysis) should be encouraged as part of the decision-making process, while bearing in mind that there may be other issues and political pressures which could lead to a different decision or prioritisation.

- There is general agreement among countries regarding the main road safety problems. A wide variety of solutions have been put in place in OECD countries and further measures are being developed for implementation. However, no country has implemented all proven measures to their full extent, and *countries may benefit from adopting "best practice" measures developed by others*. Further, the realisation of the expected benefits arising from

the implementation of any measure is dependent on the levels of public awareness and enforcement that go with it.

- Data collection and management could be improved by integrating sources into an *easy-to-use and accessible database of all road traffic, exposure and crash data*. The collection of relevant performance indicators (*e.g.* behaviour data, near-collision data) should be improved to facilitate the evaluation of safety measures.

- Methods for *monitoring and evaluating the results of road safety measures* need to be developed in order to improve existing programmes or plan new programmes. They should be based on past traffic crash and incident data and analysis of information about driver behaviour and near-crash events.

Chapter 1

INTRODUCTION

The road safety problem in OECD countries

Despite dramatic improvements in road safety since the 1970s, road crashes still kill an unacceptably high number of people in OECD countries. Approximately 125 000 people die every year on the roads of OECD countries. This means that a road crash victim dies every four minutes.

In 1990, road crashes were ranked as the ninth largest disease or injury burden in the world. According to a study co-sponsored by the World Bank, Harvard University, and the World Health Organisation, road crashes will become the third largest burden by the year 2020, exceeded only by heart disease and depression. By comparison, HIV will be the tenth, and war the eighth, highest causes of death (Burden of Disease Unit, 1996).

These tragic numbers are magnified when we consider the correspondingly larger numbers of serious injuries, and the personal and emotional costs that accompany road crash trauma. The real tragedy is that, to a large degree, these crashes, and the resultant deaths and injuries, are preventable.

Indeed, research shows that, when the main causal factors of traffic crashes are considered (the road user, the vehicle and the roadway infrastructure), all crashes can be attributed to at least one of these factors. Thus, adequate and increased investment in producing better drivers (and other road users), improved vehicle manufacturing and maintenance standards, and improved road design and maintenance standards can, and will, prevent road crashes. Moreover, it is increasingly apparent that effective safety management processes are a fundamental step towards addressing road safety problems. Only with good management systems in place will those responsible for road safety be able to compete successfully for resources, and make sound decisions with respect to the development and implementation of effective measures.

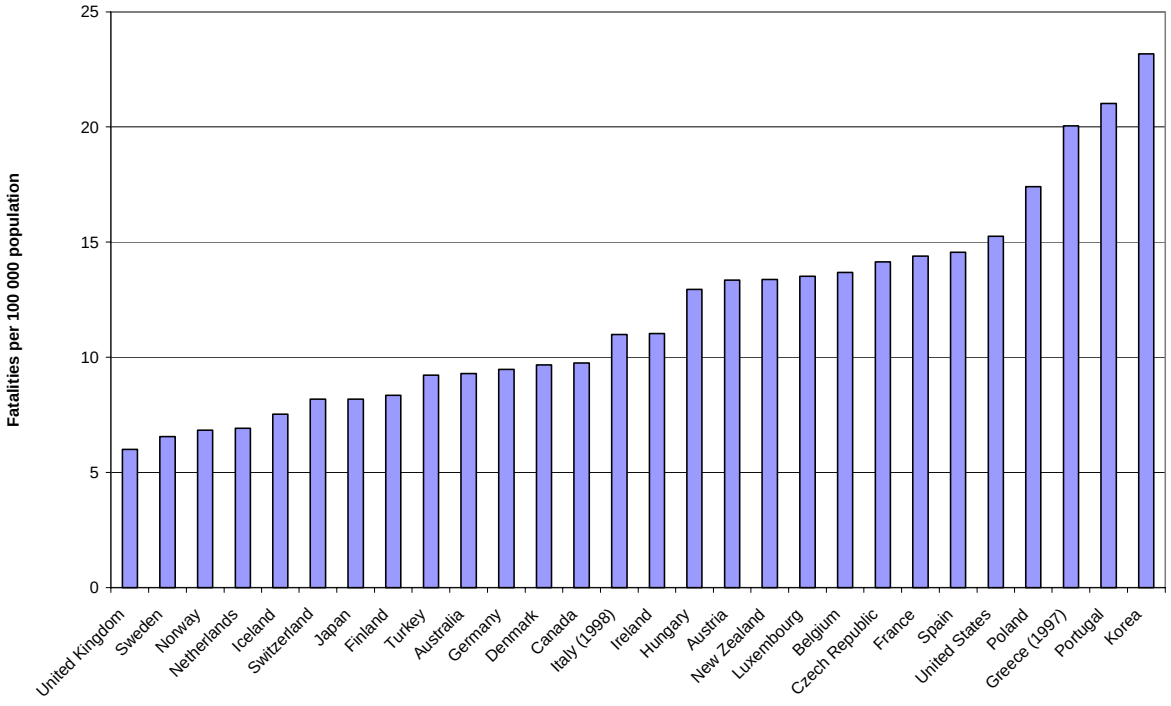
The argument for road safety investment is not simply an emotional one: road crashes represent a serious economic burden. Calculations of cost vary widely due to differing methods, objectives (*e.g.* estimation of socio-economic burden for use in cost-benefit analysis, internalisation of external costs, fixing compensation payments), definitions and statistical methods (European Commission, 1994).

The European Commission (1997) estimates that each fatality costs at least EUR 1 million. In Australia, the total economic loss resulting from deaths and injuries in 1996 amounted to 3.6% of GDP (Bureau of Transport Economics, 2000). Fatal crashes represented almost 20% of that cost, while injury crashes amounted to nearly two-thirds of the total cost of road crashes. In the United States, 1994 estimates for the economic cost of motor vehicle crashes were 2.2% of GDP (NHTSA, 1994).

Figure 1.1 shows the comparative risk in 28 OECD countries, using the annual number of road deaths per 100 000 population as a performance measure. Population is used as the denominator of

this performance measure ratio as a surrogate measure for traffic exposure. Care has to be taken in interpreting the results as these depend on the exposure measure used. Distance driven (in vehicle-kilometres) would provide a better exposure measure; however, consistent and reliable "distance driven" data are generally lacking. Registered vehicles could also be used as an exposure measure; however, vehicle usage rates vary considerably across countries. For example, vehicle ownership in the United States now exceeds the number of licensed drivers. A recent study comparing car usage showed that Denmark has lower car ownership than most countries (at a given GDP/capita), but has about average distances driven for the European countries studied. That is, the Danes have fewer cars but drive them significantly more than drivers in the other European countries (IEA, 2000). Population data (which is quite accurate in OECD countries) is a reasonable measure in developed countries where the rough relationship between population and vehicles/distance driven is more direct than it would be in developing countries. However, even within OECD countries, there are large differences in levels of motorisation and this should be taken into account.

Figure 1.1. **Recent fatality rates in 28 OECD countries**



Source: OECD International Road Traffic and Accident Database (IRTAD).

Even among countries that have shown significant overall improvement over the last 30 years, there is considerable disparity among death rates, ranging from less than seven deaths per 100 000 population (United Kingdom, Sweden, Norway, the Netherlands) to more than 18 (Korea, Portugal, Greece).

An historical perspective reveals several characteristics regarding the nature of the road safety problem in OECD countries. Figure 1.2 shows data from three countries with differing performance over the period 1970-99.

The United Kingdom has achieved a significant reduction in fatalities (from a high in 1972 of 14.5 to just under six fatalities per 100 000 population in 1999). This is despite a doubling in vehicle registrations. Similarly, vehicle registrations in the United States doubled over the same period, and this trend was accompanied by a significant reduction in fatalities, from a high of 26 fatalities per 100 000 population also in 1972. However, 1998 performance in the United States (over 15 fatalities per 100 000 population) was worse than the United Kingdom's worst year in the early 1970s. Greece has seen a disturbing upward trend in fatalities; from a fatality rate of 12.5 per 100 000 population in 1970 (below that of the United Kingdom), the death rate has risen to more than 20 per 100 000 over the same time period. However, there has been a ten-fold increase in the number of registered vehicles in Greece during that period.

Figure 1.2. **Fatalities per 100 000 population, 1970-97**

Source: OECD International Road Traffic and Accident Database (IRTAD).

The majority of OECD countries have shown a steady general downward trend in road deaths from the early 1970s to 1998, despite the significant increase in traffic volume. Among those countries showing significant improvement, several have levelled off in the 1990s. Several countries have shown level, erratic or worsening road safety performance over the period (Hungary, Korea, Poland, Spain and Greece).

Goal of the report

Road crashes are preventable: significant numbers of road deaths and injuries are not a fundamental law of nature or an inevitable result of motorisation. The above analysis shows that countries can significantly improve their road safety performance. Nevertheless, the rates of improvement in OECD countries are significantly different, as are the current road death rates. Some

countries have shown no improvement or have even regressed. This suggests that actions taken by countries with respect to road safety can considerably affect the number of road crashes, deaths and injuries. This is not to say that other factors, such as volume of traffic or economic change, do not influence crash rates. However, this report provides ample evidence that road safety activities have a strong influence on crash rates.

The goal of this report is to identify and assess "best practices" in road safety programmes in OECD countries. Emphasis is placed on those programmes that have been evaluated. In addition, the underlying criteria that influence the success or failure of these "best practices" are identified in order to facilitate the development of effective road safety policies in Member countries.

The objective is to encourage countries to adopt the "best practices" which most fit their current or expected road safety needs. The information in the report should provide the basis for overcoming public apathy and political inertia regarding road safety. In this way, the report will allow road safety to take its proper priority in the fight for competing resources by focusing greater attention on the social cost of crashes.

The report is directed at decision makers responsible for road safety and those in a position to influence such decision makers (politicians, policy makers, researchers, strategic planners, road transport authorities, traffic safety institutions, public interest groups, and private sector organisations).

Study approach

The study was undertaken by an international group of road safety experts, representing 21 OECD countries, as well as the European Commission (members are listed in Annex D). For this project, a combination of international expertise from Europe, North America and the Asia/Pacific region was essential. This combination allowed open dialogue regarding common themes and similar road safety challenges, at the same time recognising dissimilar socio-economic-political environments in all regions. This report attempts to reflect those perspectives.

The expert group undertook a global examination and discussion of planning approaches to road safety, various solutions to specific road safety problems, and management and organisational models for road safety. More specifically, the group analysed recent statistical trends in Member countries, major successful safety interventions, inter-sectoral relationships between road safety agencies and other bodies, cost-effectiveness of programmes, road safety indicators and target setting, the role of various organisational structures and the role of technology.

This analysis was based on information collected in several ways: *i)* plenary discussions by the expert group; *ii)* discussions within four task forces, each with specific assigned responsibilities; *iii)* presentations from each participant, regarding the progress and state of road safety in his/her country; and *iv)* detailed written responses by each participating country to a lengthy set of questions posed by the four task forces.

Structure of the report

The expert group's discussions on "best practices" for road safety were wide-ranging, varying from very specific topics, such as how to persuade an individual driver to use a seatbelt, to more global and complex topics, such as how to persuade governments to invest in road safety.

Following the overview of the road safety situation provided in this chapter, the report is structured around the following components. Chapter 2 addresses road safety planning processes and attempts to identify "best practices" which can help jurisdictions to decide on how road safety resources should be distributed to address current or anticipated problems. Chapter 3 discusses socio-economic evaluation and monitoring of road safety programmes, highlighting two important issues that need to be more comprehensively developed in many countries. Chapter 4 lists chronic road safety problems in OECD countries, and outlines "best practices" for solving them. In addition, some emerging problems are identified and suggestions for researching solutions included. Chapter 5 deals with the various management/political/administrative models by which countries (or states or provinces) assign organisational responsibility for road safety. Essentially, this chapter attempts to identify "best practices" for organising a country's resources and responsibilities for road safety, including policy, legislation, enforcement, marketing, courts, health care, etc.

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Chapter 2

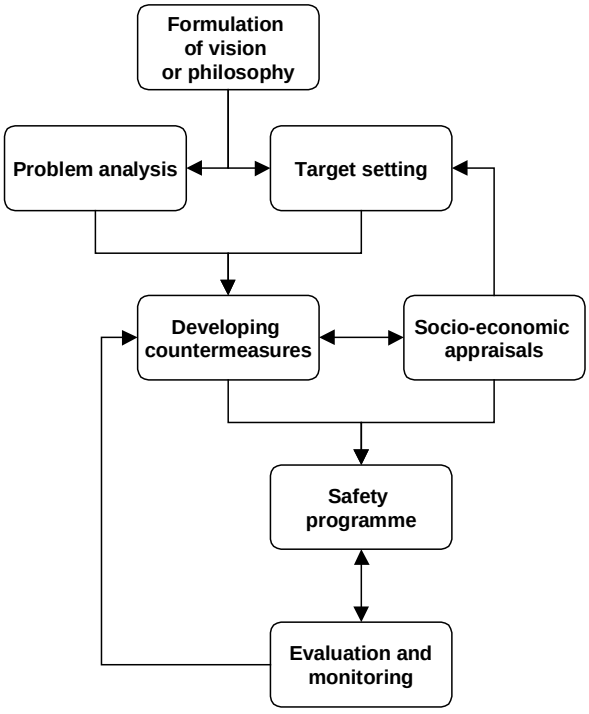
TARGETS, PLANS AND STRATEGIES

Introduction

Governments and road safety organisations act at many levels to diminish the risk of road crashes. This complexity demands the adoption of some method of planning. The advantages of planning such a complex process are quite evident: the goals become apparent to all parties involved; it stimulates effective and efficient countermeasures to identified problem areas; it enables all relevant parties to deliver their contributions in a timely and co-operative manner; and feedback to the plan allows easy modifications.

OECD countries use a great variety of road safety planning practices (OECD, 1997). Figure 2.1 identifies the main steps of planning procedures that are common in experienced and successful countries. These elements are discussed in detail in this chapter and the next.

Figure 2.1. **Planning procedure for developing and implementing road safety programmes**



This chapter discusses an approach to developing a road safety plan. A *vision* gives a strategic view on the nature of the road safety problem and ways to deal with it. *Targets* are quantified and measurable goals to be reached within a certain period of time. Increasingly, this is linked with a road safety programme and an estimation of its effects. The setting of targets goes hand in hand with *problem analysis*: a description of the number and types of collisions, historical trends, possible explanations and forecasts. *Developing countermeasures* involves the selection of effective interventions which will address identified problems and help meet the target. Given the varied circumstances of each national situation, no ideal planning procedure is presented. Instead, "best practice" examples are discussed along with the relevant circumstances for their use.

Two essential elements in developing and implementing a road safety programme are socio-economic appraisals and evaluation of the programme. These two subjects are discussed in Chapter 3.

Visions and philosophy

Traditional philosophies of road safety work

All countries have road safety programmes in the sense that authorities carry out a set of organised activities with the aim of improving road safety. Some countries include these programmes in broader policies (*e.g.* transport, urban planning, etc.). Many countries, as well as the World Health Organisation and the World Bank even consider road crashes as a major health problem.

Different methods have been used to indicate the seriousness of the road safety problem. These include:

- Comparing the risks on the roads to those of other social activities and other modes of transport.
- Emphasising their economic consequences.
- Positioning road safety as a public health problem (lost years of life, causes of death).
- Calculating the number of people killed every year, worldwide.
- Calculating the chance of being injured in a collision during a lifetime.

However, these efforts have failed to achieve high social and political priority for road safety universally. In those countries where road safety has been singled out and recognised as a problem, it is apparent that the priority has been born in the same period that the number of serious collisions has increased (Mulder and Wegman, 1999).

New philosophies and visions

In recent years, new philosophies for improving road safety have been introduced in some countries. *Visions* have been developed in a number of countries. A vision is interpreted as an innovative description of the future traffic system or a desired direction of safety development. For example, the vision in Canada is to have the "safest roads in the world". The purpose of a vision is to ensure that road safety gains a prominent place in transport policy and decision-making processes. A vision can also raise public interest and create support in the population and among public and private

organisations for road safety improvements. A road safety vision should be formulated so that it is simple, easy to communicate and realistic (Rumar, 1999).

In Sweden and the Netherlands, the vision includes some ethical viewpoints that guide a broader set of social activities which go beyond road transport. Nevertheless, short-term quantitative targets are still needed and used in both countries.

Examples

Sustainable safety (the Netherlands)

In the 1980s, the Dutch Government set the following road safety targets: 50% fewer fatalities and 40% fewer hospital admissions resulting from road crashes by the year 2010 compared to 1986. It was concluded in 1991 that the road safety targets set for 2010 would not be reached if traditional policies continued, even if the related activities were intensified. New, innovative policy was required. The SWOV Institute for Road Safety Research was requested by the Dutch Government to develop, in co-operation with other experts, a scientifically supported, long-term concept for road safety work. The "sustainable road safety" project was inspired by the general concept of sustainable development: "No longer do we want to hand over a traffic system to the next generation in which we have to accept that road transport inevitably causes thousands of deaths and tens of thousands of injuries year after year in the Netherlands" (Directorate General of Public Works and Water Management, the Netherlands, 1996).

The target is to drastically reduce the probability of road crashes. This can best be achieved by tackling the root causes underlying collisions, and by removing areas of conflict or making these controllable for road users. Where collisions still occur, the risk of serious injury should be virtually eliminated.

Basically, a sustainable and safe traffic system has:

- *Infrastructure* that is adapted to the limitations of human ability through proper design (the function of the road should be easily recognisable, large variations in speed should be prevented, the course of the road and the behaviour of other road users should be predictable).

- *Vehicles* fitted with facilities designed to simplify the tasks imposed on the driver and constructed to protect the human body as effectively as possible against the violent impact of crashes.

- *A road user* who is adequately trained, informed and, where necessary, controlled.

The first stage of the sustainable safe traffic system is now being implemented as a "Start-up programme 1997–2000" (including the construction of roundabouts, 30 km zones within built-up areas, 60 km zones outside built-up areas).

Vision Zero (Sweden)

Road safety work has historically been fairly successful in Sweden, positioning it as one of the safest countries in the world. Still, fatalities and serious injuries in road traffic are seen as unacceptable, especially when these consequences could be prevented. Vision Zero was born out of this perception.

The current quantitative target is to halve the number of 1996 fatalities by the year 2007, which would mean 270 fewer fatalities. In 1997, the Swedish Parliament reached a decision regarding the long-term goals of traffic safety. This decision defines the goals as: "nobody should be killed or seriously injured within the road transport system (Vision Zero), and the road transport systems' structure and function must be brought into line with the demands this goal entails" (Vägverket, 1998).

In Sweden, road deaths and serious injuries are treated as a public health problem. The transport system is being built to take account of human characteristics and behaviour over a long period of time. According to Vision Zero, serious personal injuries must be eliminated. The vision does not expect all collisions to be avoided. The ethical basis for the vision is that mistakes that are made on the roads both now and in future should not lead to loss of life or serious injury. The road transport system must be designed so that human error does not have disastrous consequences.

The main change instigated by Vision Zero is the new way of dividing the responsibility for road safety. The road authorities must always be ultimately responsible for the design, operations and use of the system and, therefore, for the level of safety within the system. The road users are responsible for following the rules laid down for using the system. Following the rules should ensure that they will not be killed or seriously injured. In practice, these principles have led to the introduction of some quite radical measures in Sweden.

Discussion

Vision Zero has drawn much attention and led to a great deal of discussion, especially among the safer countries. Some countries have already adopted the concept, with or without modifications.

The adoption of a vision affects target setting. Targets may be more ambitious if there is political support for a strong vision. However, Vision Zero might be less successful in a country in which the fatality rate is high or where road safety is considered less urgent relative to other social problems.

One of the drawbacks of Vision Zero is its "absolute" nature. The objective of complete traffic safety seems to be stated without taking into account other interests and factors. However, it is by no means self-evident that all fatalities or serious injuries can ultimately be prevented within the road transport system. This will also depend on the development of traffic volumes, speeds, control systems, etc. (Katajisto, 1998). Comparisons across risk levels in traffic and time spent at work or at home suggest that an hour spent in road traffic should be no less risky than an hour spent at work or at home (Rajalin, 1999).

Lastly, to determine the optimal level of safety, it is necessary to compare the costs and benefits of safety measures. From the perspective of cost-benefit analysis, the prevention of the last fatalities can be very difficult and expensive (Elvik, 1999).

Visions and philosophies in practice

Politically accepted national long-term visions (and targets for the short term) reflect a societal desire to make a serious commitment to substantially improving road safety. Such visions are practical and easy to use at regional and local levels, too. In both the Netherlands and Sweden, the new vision has led to the creation of new design principles. In both countries, regional pilot projects have been launched to implement the new strategies. The projects are supported at the national level. Nation-wide implementation is usually precluded due to a lack of financial resources.

Conclusions

A good safety vision should motivate road users, politicians, road safety experts and those responsible for road provision, vehicle standards and transport policy. An optimal vision is in line with a country's common safety philosophy, since road safety needs to be considered in the same perspective as other problems confronting society. The vision should also be seen as an integral part of a broader policy framework. In a broad sense, it should be compatible with economic efficiency principles (as implied in social cost-benefit analysis). Successful marketing of a safety vision is dependent on several factors. A good vision should be:

- *Understandable*: provide a clear, easy-to-explain description of the future.
- *Desirable*: appealing to different road-user groups in the long term.
- *Feasible*: realistic, achievable in the long term.
- *Guiding*: useful in political decision making.
- *Motivating*: all responsible agencies are ready to work for it.
- *Flexible*: it should both stimulate initiatives and be adaptable to changing conditions.

A credible vision for the future which has the support of society is the most efficient way to lead people in the right direction and induce creativity, energy and participation. However, at least as important as visions are *quantitative targets* (these are discussed in the following section).

Target setting

It is, of course, possible to improve road safety without setting quantified objectives. However, the lack of clear objectives or targets may hamper creativity, and in the long run lead to more conservative thinking and acting.

In 1994, the OECD report *Targeted Road Safety Programmes* compared road safety programmes based on quantitative targets with programmes that were not based on such targets. A number of targeted programmes were analysed, containing a great variety of target formulations, and it is useful to highlight some of the findings.

Types of targets

The target in the Netherlands is a 50% reduction in fatalities by the year 2010 compared to 1986. Denmark aimed at a 40% reduction in the numbers killed and injured by the year 2000, while Norway sought to avoid an increase in fatalities. In the United Kingdom, a target was set to reduce road casualties by one-third by 2000 compared with the average for 1981-85. By avoiding an absolute number, some countries specify targets in terms of "*less than* n fatalities per 100 000 population" in an attempt to convey the message that any road death is unacceptable.

There are two different approaches to setting targets. A target can be based on an idealistic objective, through a top-down process, with little prior consideration being given to how to it could be reached. Conversely, the target can be based on a more realistic objective, through a bottom-up process, where the basis for the target is the estimated effect of the available road safety measures. In fact, many countries use a combination of the two approaches, combining idealism and realism. On the

one hand, the targets must have a certain degree of public support while, on the other, they must have a certain degree of ambition in order to initiate efficient actions.

Vision statements (for example, the Swedish Vision Zero) promote an element of top-down target setting and pose the question: "*What do we have to do* to reach our goals?" rather than "What can we obtain with our traditional road safety measures?".

A recent example of a bottom-up process comes from Australia with the preparation of targets for the national road safety strategy up to the year 2010. Proposals have been put forward to derive such targets from the estimated effectiveness of a complete programme. To this end, the potential savings have been estimated for each measure that is part of the programme.

A mainly bottom-up approach was adopted in the United Kingdom in devising a new target for 2010. Thorough reviews of road safety measures and their effects were carried out. Casualty forecasts were produced based on a range of traffic growth and policy implementation scenarios, and the results of these analyses were used to inform the choice of the new targets. Compared with the average for 1994-98, the number of people killed and seriously injured is to be reduced by 40%, and the slight casualty rate per km travelled is to be reduced by 10%. A separate target aims to reduce child deaths and serious injuries by 50%.

The value of targets

Specific and ambitious targets help to raise society's interest in road safety. The targets create a need for a comprehensive programme outlining how to reach the targets; such a programme will, in turn, pave the way for the allocation of funds and subsequent actions. If the targets have a reasonable degree of ambition, they will create a need for new knowledge on how to improve safety. This will result in research and creative thinking on new ways to reduce road crashes. A road safety programme will normally involve a variety of actors and hence will encourage co-operation between such actors. Progress will have to be closely monitored in order to see if the collision trend is moving in the right direction, and the actions can be intensified or modified at an early stage. In this respect, it should be stressed that targets must be operational; therefore, they must be formulated in such a way that it is easy to determine whether they have been reached or not.

The conclusions of the 1994 OECD report are still applicable:

- The existence of targets and targeted road safety programmes increases the likelihood that safety policies will be implemented.

- Institutions in those countries with targeted road safety programmes change their behaviour once such a programme is introduced. Targeted road safety programmes can result in better integration of existing institutional efforts, generally require greater co-ordination and often produce a more focused allocation of resources.

- Road safety programmes with quantified targets have a wider scope than those without such targets, and target setting leads to better and more realistic programmes.

Norwegian experiences

A recent research project in Norway studied the effect of quantified road safety targets on crash reduction in different Norwegian counties (Elvik, 1993). The project was a non-experimental "before-and-after" study with a comparison group. Because of its design, the study is quite unique and is able to yield convincing results. The details of the study are presented in Box 2.1, while the main conclusions are summarised below.

Box 2.1. **Study on target setting in Norwegian counties**

The project studied the development of the road safety situation in 19 counties over two time periods (1982-85 and 1986-89). During these planning periods, the road safety targets expressed in the road plans in the different counties varied considerably. The project was a non-experimental before-and-after study with a comparison group. The test group consisted of Norwegian counties which had adopted quantified road safety targets either for the years 1982-85 or for the years 1986-89, or for both periods. The comparison group consisted of counties that did not adopt quantitative targets in at least one of these periods. Eleven counties adopted quantified road safety targets during the first period, eight did not; and 16 counties adopted quantified road safety targets during the second period, three did not. The counties which adopted quantified road safety targets were divided into two groups, those with highly ambitious targets (a reduction of more than 30% in collisions for the first period and more than 15% for the second period), and those with less ambitious targets.

The advantage of looking at all of the counties in the same country is that they are subject to the same legislation, they use identical collision reporting systems, they have identical political systems and they have roughly the same level of road safety and motorisation. A disadvantage is that the counties do not have full policy-making authority in all areas; in particular, they do not have legislative power.

At first glance, the data show that few of the targets were reached and, as such, the target setting could be considered a failure. However, this first comparison does not take into account what might have happened in the absence of the targets.

In order to assess the value of quantified targets, the results in the counties which had implemented targets were compared with the results in the counties without targets. A fairly clear picture emerges from such a comparison for the first time period: The collision rate per kilometre travelled dropped by 39% in counties with highly ambitious targets, by 16% in counties with less ambitious targets and by only 5% in counties without quantified targets. All of the changes were statistically significant at the 5% level, and the differences in decline in collision rate were also statistically significant.

Differences in public spending on collision prevention programmes were also measured on the basis of spending per collision in the "before" situation. The comparison showed that spending increased by 20% in counties with highly ambitious targets while in counties with less ambitious targets, it decreased by 13%. Curiously, spending increased by 12% in counties without quantified targets. A slightly different comparison showed that the share of the budget allocated to road safety programmes increased by 19% in counties with highly ambitious targets, by 15% in counties with less ambitious targets and by only 8% in counties without quantified targets.

For the 1986-89 planning period, the improvement in collision rates was clear. In counties with highly ambitious targets, the rate declined by 25%. In counties with less ambitious targets, it declined by 17%, while declining by only 13% in those counties without quantified targets. All the differences are statistically significant at the 5% level. In terms of the spending criteria, the results are less clear for the second planning period.

The results indicate that quantified road safety targets were an effective tool for policy making during both the planning periods evaluated (1982-85 and 1986-89). Counties that set quantified targets were more successful in improving safety than counties that did not. The more ambitious the quantified targets, the better the policy outcome. These results were valid for both time periods and were statistically significant.

Public spending on collision prevention programmes was also used as an indicator of effectiveness. In the first time period, spending (measured as a percentage of the budget allocated to

road safety programmes) increased more in those counties with quantified targets. However, the spending results were less clear for the second time period.

The project concludes that, when both planning periods are considered, there appears to be a relationship between the ambition of targets and safety performance. During both planning periods, counties with highly ambitious quantified targets had the best safety performances.

Current national targets

There are significant disparities among countries in terms of road safety targets. Although a number of countries have not adopted such targets, Table 2.1 provides some examples of current road safety targets:

Table 2.1. **Targets in OECD countries**

Country	Target (killed)	Annualised % reduction[1]	Target year	Base year and number (approx.)	Killed per 10^9.veh.km. (1997)[2]
Australia	5.6 per 100 000 population (or a 40% reduction)	1.4	2010	1999 (1 759) or 9.3/100 000 population	10.0
Canada	30%		Average 2008-2010	Average 1996-2001	
Denmark[3]	- 40% (8 050 killed and injured)	4.2	2000	1986/87 (13 417 killed and injured)	11.3
	- 40% (8 050 killed and injured)	4	2010	1998 (5 214 killed and seriously injured)	
Finland	- 50% (367) - 65% (less than 250)	6.1 6.4	2000 2005	1989 (734)	10.1
France	- 50%	12.9	2002	1997 (8 000)	16.4
Hungary	-25~30%	-3.5~4%	2000	1992 (2 101)	38.0
Iceland	- 20%	5.4	2000	1991-96 (250)	7.8
Korea	-62%	10.3	2006	2000 (10 236)	
Netherlands	- 25% - 50%	1.9 2.9	2000 2010	1985 (1 438) 1986 (1 529)	10.2
Poland	- 20%	3.5	2001	1997 (7 311)	45.0 (estimation)
Sweden	- 25% (max. 400) - 50%	6.9 6.1	2000 2007	1996 (537)	8.1
United Kingdom[4]	- 33% - 40%	2.6 4.0	2000 2010	1981-85 (5 800) 1994-98 (3 577)	8.1
United States	- 20% - 50% (large trucks)	1.8 4.5	2008 2010	1996 1998	10.2 17.5
European Union (EUR 1 million rule)	- 15% (7 000) - 40% (18 000)	3.2 3.4	2000 2010	1995 (45 000)	13.9 (in 1996)

1. Necessary percentage reduction in each preceding year to meet target.
2. *Source:* IRTAD (except EU and Sweden: estimation by ETSC; Poland: approximate estimate by Gdansk University of Technology; Australia for 1998: Australian Transport Safety Bureau; Hungary estimate by Dr. Peter Holló, Institute for Transport Sciences).
3. The target for 2000 was for killed and injured, while the 2010 target is for killed and seriously injured, with no increase in slight injuries.
4. The target for 2000 was for all casualties, while the 2010 target is for killed and seriously injured.

As can be seen from Table 2.1, a number of countries have introduced targets for fatality reduction. Most of these are quantified and easy to monitor. As such, they are easy to use as a steering mechanism for the development of strategic road safety programmes. For ease of comparison, the targets have been expressed as annual percentage decreases. This highlights the significant differences in targets. The Korean and French targets are the most ambitious; however, these targets should be seen in the context of their road safety performance.

Conclusions

It appears that targets have proven to be a valuable tool in the development of effective road safety programmes. Whether developed through a "top-down" or "bottom-up" process, a measurable, clear and ambitious target can motivate all the actors involved in road safety, and greatly increases the likelihood of effective programme development and improved road safety at national, regional and local levels.

Problem analysis

Information requirements

In several countries, collision and traffic analyses define the set of problems at which traffic safety measures should be directed. However, the final content of action programmes are also affected by:

- Constraints set by the goals and vision.
- Planned scope of the programme.
- Problems in traffic behaviour.
- Threats and prospects of the future.
- Image of traffic safety in the country in question.

Collision analysis is done on the basis of a few years' statistics. Fatal crash statistics are used extensively for the analysis of road safety problems and cross-country comparisons. However, it is important to analyse trends in fatality crashes over a longer time span, as well as trends for less serious crashes (number of victims hospitalised) where available. Information is generally available on the times and places of collisions, involvement of various road-user groups, types of collisions, road and light conditions, role of alcohol, etc. Additionally, a separate review of urban and rural areas, and of problem areas in the road network, is useful.

It is also important to analyse exposure data (time travelled, passenger kilometres, vehicle kilometres, or surrogate measures such as number of inhabitants or vehicles) and risk data (collisions divided by exposure). Several countries gather information on traffic behaviour, road-user knowledge, skills and opinions. However, data on these variables are lacking in many countries (in terms of both availability and reliability).

Analysing the future

When planning traffic safety measures, an analysis of the present situation is not always sufficient; safety experts should attempt to prepare for the future. For example, in several countries, the ageing of the population, the growing economy and the rising volume of traffic pose new challenges for traffic safety analysis. On the other hand, new technology offers opportunities for speed restriction, traffic management and mitigation of collision consequences. Traffic safety work should also be considered in general transport policy and thus influence traffic volumes and patterns.

Considering today's problems as well as future prospects requires the prioritisation of road safety measures. For example, in several countries, the problems faced by the elderly have been given higher priority as the population structure changes. In addition, certain groups, such as vulnerable road users, are becoming more of a road safety priority.

Other considerations

In analysing road safety problems and developing measures to solve those problems it is necessary to consider broader, less direct factors that may influence road safety solutions. These include such things as:

- A country's safety ranking compared to those of other countries.
- State of the economy.
- Rising or falling traffic volumes.
- Research and data deficiencies.
- Dissemination of existing knowledge and data.
- Organisation of traffic safety work.
- Evaluation of traffic safety work.

Conclusions

Collision analysis is an important tool for determining the main safety problems towards which measures should be directed. For a better understanding of these problems, it is useful to analyse data on traffic behaviour, road-user knowledge, skills and opinions, and on background variables (*e.g.* trends in traffic volume, population and economy).

A comprehensive programme requires solutions in all sectors of safety work, proposes measures that are feasible at the regional and local levels, and deals with indirect, yet significant issues such as data and research needs.

Problem analysis can also be used to prioritise the areas for possible countermeasures when, inevitably, limited resources are involved.

Developing safety measures

The range of possible measures

Traffic safety measures are aimed at people, vehicles, the road and its environment. In the planning process, all three elements should be considered. The areas where measures are planned and implemented are: land-use planning, transport systems and environment, traffic education, information, traffic control, telematics and vehicle technology. Problem solving calls for, co-operation among different sectors. Existing international agreements or supranational (EU) decisions might limit the range of possible measures.

The following categorisation may be applied in the planning of measures:

- Decreasing the exposure (vehicle kilometres travelled).
- Decreasing the collision risk.
- Decreasing the risk of death or injury.

The planning of safety measures is based on decreasing exposure and risks. This requires information on the influence of the measures. At the international level, a great deal of research exists on the efficiency of traffic safety measures (resulting from cost-benefit or cost-effectiveness analyses). However, the knowledge of safety effects is often limited to technical improvement measures and does not cover, for example, traffic education and land-use planning. In these cases, the planning and measures can be based on knowledge of behavioural effects, changes in attitudes, or on expert assessment of the feasibility of the measures.

The proposals for measures may involve research data collection, information on collisions, and organising traffic safety work. These are so-called indirect measures that can be categorised separately in the programme. The plan can be based on knowledge of organisational effectiveness (resulting from process evaluations, etc.). During the planning process, the options to implement, organise and finance the programme at the regional and local levels must be considered.

To commit various organisations to the work, officials from different sectors should be involved in the work from the outset. The party or parties responsible for each measure in the programme, the year of implementation and the need for additional resources are marked in the programme. In reality, it is not always possible to develop a broad-based programme, and even less possible to implement all parts of the programme. However, it is important to strive for a broad programme that addresses all the road safety problems identified. Such a programme will provide a benchmark for the evaluation of future programmes.

Selecting measures

Selected measures depend very much on the overall approach to traffic safety. A comprehensive approach requires applying solutions to transport technology and the planning process must be connected with traffic education, information, land-use planning, traffic control and concern for the consequences of collisions. The regional and local dimensions are also important: if the national programme is meant to serve as a guide to traffic safety work for the entire country, the goals and at least some of the measures must be feasible at regional and local levels.

It is difficult, however, to estimate the effects of specific measures due to data limitations and difficulties in carrying out cause-and-effect analyses.

Assessment of measures and their adoption in the programme

Several criteria are used in assessing and adopting the measures. Although some programmes have not been evaluated, the aim is to adopt those measures that have proven their worth. Only a small proportion of countries use, to some extent, cost-benefit principles to prioritise measures. The lack of relevant and reliable data is the biggest obstacle to its use. However, cost-effectiveness analyses are more often used by decision makers. In some countries, the focus lies more on benefits than on costs. A few countries use other impacts, such as political approval of the measures, environmental impacts, etc., as criteria, either exclusively or in addition to other indicators.

The ideal approach is to review, in addition to the economic cost-benefit data, other social impacts of the measures such as environmental views, social equality, political acceptance and compatibility with other areas of transport policy. Thus, the measures are not chosen solely on the basis of their efficiency but also on values and aspects that cannot easily be expressed in monetary terms. Theoretically, these should be integrated into a comprehensive social cost-benefit analysis. Political judgement and decisions ultimately shape the final action programme. An overview of methodologies used to compare safety measures in developing a road safety programme is presented in Chapter 3.

Conclusions

A broad and effective safety programme includes measures for all areas of safety work: transport system and environment, land-use planning, roads, traffic education, information, traffic control, telematics and vehicle technology. All of the organisations responsible for implementing the programme should be involved in the planning process. International constraints should be taken into account.

The most important criteria for choosing measures are their ability to decrease risk and/or exposure. Where appropriate data exist, social cost-benefit analysis is recommended to prioritise measures. In addition to their economic returns, such analyses should include other social impacts such as effects on transport and mobility, environmental effects, social equity and political acceptance.

Process for developing a road safety plan

Concept of a plan and the stages to follow

Several types of road safety plan exist in OECD countries:

- National plans *based on a concept*, expressed in detail with a generally qualitative and ambitious objective, such as “no more serious crashes” (Sweden). This type of concept supposes major modifications of current practices.

- National plans which *focus on safety management* while seeking to optimise current practices and build on national successes or on those of other countries.

- National plans of countries which *recently became aware of safety problems* and are in a phase of listing the problems to be solved; they have not translated their intentions in the form of global plans but are reflecting on the best way to improve the situation.

Since countries are starting from different initial situations, a single planning process common to all countries cannot be described. The phases which a road safety plan should normally follow are presented. Based on the expertise of the most advanced countries in this field, general principles are proposed, illustrated by specific cases. Annex B outlines more specific details of the planning process in individual countries.

A road safety plan proceeds in two principal stages:

- Preparation of the plan, resulting in its confirmation by the stakeholders.

- Implementation, monitoring and evaluation, with adjustment or reorientation.

Fundamental to the successful development and implementation of road safety plans is co-ordination among the various stakeholders at all stages.

The preparation phase

Countries that describe a total safety concept with ambitious objectives seek to enable their institutions to implement this concept. Stating the concept highlights the need to significantly modify current practices or at least to accelerate the implementation of actions that are already underway. This has repercussions in all fields, including transport and town and regional planning (as in the case of Sweden which integrates safety in its urban development plans). The plan must be initiated at the central government level.

It is necessary to obtain a general consensus on the concept in order to ensure its effectiveness. However, it is generally a basic condition that a political authority, typically the Parliament, adopts the concept. The concept then needs to be developed into concrete action plans at *national, regional and/or local levels,* in order to gather support and benefit from the expertise of public sector actors. Communication plays an essential role in this phase. This process requires:

- Analysis of key safety problems and development of proposals by professionals with a high level of expertise. Responsibility varies for this task. For example, it can be the central administration (Japan, the United Kingdom, the United States), a national commission (Canada), a special Committee for road safety (Denmark, Finland). Usually, research organisations are involved.

- Discussion of proposals by key stakeholders.

Definitions of the roles of the public sector actors vary considerably. For some countries, the roles are defined at the federal level and monitoring of the action plan should take place at this level (Japan, the United States). These roles are often specified by law (Japan, the Netherlands, France). However, in other countries, regional or local decision makers need to be persuaded to participate in the process, as they are under no legal obligation to do so (Finland, France for municipalities, Germany).

There are many examples of road safety plans, usually at central government level, and a number of regional and local plans. Ideally, one organisation should be responsible for connecting all levels of

government, thus ensuring consistency in approaches to road safety management and implementation of measures. Responsibility is a key element in achieving effective outcomes (in Canada, the provinces are responsible for safety, which encourages them to develop their own precise objectives, for example seatbelt use rates).

Multi-annual national plans are common practice; for example, five- or ten-year plans (in the United States and the United Kingdom), and sometimes longer (15- and 25-year plans in the Netherlands). This enables performance to be evaluated and adjustments to be made to the plan if progress is not satisfactory (*e.g.* the Dutch plan has two objectives, one for 2000, and the final one for 2010).

Plans are also developed at regional and local levels, although information on this subject is less complete than for the national plans. However, two principal types of plans can be distinguished:

- Plans dealing with road safety only (for example Canada, with objectives for reducing the number of fatalities specified in each province, and France, where each department must have a triennial road safety plan).

- Plans for more general matters, integrating road safety with transport and town planning (examples in Italy, Japan and Sweden).

Implementation, monitoring and evaluation of the plans

The implementation phase involves developing the plans into specific actions and finding the most cost-effective solutions. Cost-benefit and cost-effectiveness analyses are useful for this purpose and are carried out at the national level in some countries, although rarely at the regional or local levels. These methods, which are discussed in the following chapter, are perhaps less appropriate at the local level.

Experimental projects can be helpful and are justified by ambitious objectives which cannot be met by relying on traditional solutions alone. However, innovation involves uncertainty, and novel solutions should be tested before general implementation. Pilot projects have proved very useful in France, the Netherlands and the United Kingdom; such projects often require support (financial or otherwise) at the national level. The costs can appear high, but if the experiment is successful it will have a direct impact on future projects. On the other hand, unsuccessful results can avoid subsequent errors. In general, experimental projects are subjected to a thorough evaluation.

Given the uncertainty regarding the effects of individual actions, it is useful to provide for a periodic review of results in order to allow for adjustments if the initial trend does not meet expectations. This requires that the measures be monitored and their effects assessed, preferably by independent institutions. Practices differ considerably among the various countries. At the national level, monitoring and evaluation are very important in the United States; in the United Kingdom, where a formal review of progress towards the target will take place every three years and reorientation of programmes is possible, if necessary; in Canada, Denmark, Finland and the Netherlands. It is becoming important in other countries (France, Japan). However, it has yet to become general practice. The lack of evaluation methods adapted to the local level has been identified as a problem by a number of countries.

Need for co-ordination

Co-ordination is normally the responsibility of the federal/central government and can be achieved by controls, but also by developing regular exchanges between the various levels (for example, in the United Kingdom, meetings for exchange of experience, development of guidelines, and establishment of a Road Safety Panel). Some countries have specifically built up networks between the federal/central and local levels; for example, regional councils in each province in the Netherlands, safety commissions in each French department (see also Chapter 5, which discusses the organisations involved in road safety and their relationships).

Co-ordination involving all levels and stakeholders is essential in order to avoid duplication of energy or divergent actions. It is not efficient for the central level to have exclusive responsibility for the choice and implementation of the actions. Co-ordination between the plans of various levels varies considerably:

- It can be obligatory (*e.g.* in the United Kingdom as part of Local Transport Plans), ensuring compatibility between local actions and the national plan.

- It can be achieved by incentives, possibly with financial subsidies (*e.g.* Denmark has a budget for cities).

- In some countries, it is still weak or even absent.

Two somewhat contradictory interests are at stake:

- On the one hand, integration and harmonisation of practices at all levels is desirable, although difficult to achieve. Procedures need to be in place to ensure that safety is taken into account in the various fields of action of the state.

- On the other hand, encouraging initiatives at the regional and local levels can help meet the need for innovation and experimentation. Exchanges of experiences with others are essential. One of the principal roles of the central level should therefore be to disseminate safety knowledge among all stakeholders and ensure that information is shared.

The form of government and size of the country are key factors in national practices. In the largest countries with a federal state structure, the national level gives the impulse and the general orientation and leaves the concrete initiatives to the local or regional levels. In the United States, the federal level sets the main objectives, imposes guidelines and recommends standard solutions to the states, which apply them according to their own views. Furthermore, the federal level provides the local government with the instruments for monitoring and evaluation.

Practices vary in countries with other forms of government. Some have detailed national plans, further developed in regional and local plans (Denmark, Japan, Sweden and the United Kingdom). In Japan, the national level ensures co-ordination of action in accordance with the law, in particular by making the budgetary decisions.

Other countries are still at the stage of preparing a national plan while trying to integrate local practices (as is the case in Italy, where the large cities already have urban road safety plans), or on the basis of expert opinions (Turkey).

Conclusions

The development of effective road safety plans requires sound co-ordination among stakeholders in order to avoid difficulties at the implementation stage:

- Divergent interests of the various stakeholders (even within the same government, when ministries have different objectives) need to be taken into account in the development of action plans. The proposed actions should be supported by analysis to determine the best suite of measures. Where difficulties are encountered, the principal organiser of the safety policy should be empowered to take the decision if consensus cannot be reached.

- As far as possible, experts should be grouped and technical responsibilities should be concentrated to avoid wasted energy and time. This prevents fragmentation across various government departments (including many levels of political decision making, highly specialised expertise in technical analysis and research; and multiplicity of associations).

- The development of a road safety plan should take account of cultural sensitivities in order to ensure acceptability and success. For example, the concept of a road safety "plan" may have negative connotations in some Central and Eastern European countries. The contents of the most ambitious plans from other countries should serve as an example.

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Chapter 3

EVALUATION METHODOLOGIES

Socio-economic evaluation of safety measures (to ensure the most cost-effective solutions are chosen) and monitoring of safety programmes are two areas that are somewhat neglected in many countries but which are seen as increasingly important. These issues are therefore discussed in more detail in this chapter.

Socio-economic decision support tools

The development of a road safety plan requires a mixture of political, technical and legal assessment, as well as a socio-economic appraisal. Given the limited resources available for competing policy needs, policy makers should evaluate the expected costs and benefits of alternative projects when designing road safety policies. This enables funds to be directed to profitable safety activities and away from low-yielding ones. Formal cost-benefit analysis of safety projects is not yet common practice in OECD Member countries. However, thinking in terms of saved lives and financial costs of safety measures is certainly part of the decision-making process. The lack of relevant and reliable data continues to be one of the main barriers to the use of socio-economic evaluation techniques.

Methodologies

In general, three complementary formal procedures for the evaluation of safety measures can be distinguished (Brent, 1996; Jones-Lee, 1989): cost-effectiveness analysis (CEA), multi-criteria analysis (MCA) and cost-benefit analysis (CBA).

Cost-effectiveness analysis either starts from a given safety target and seeks the most efficient path to realise it, or starts from a given budget for road safety and specifies the allocation path yielding the highest returns, *e.g.* measured in saved lives. More comprehensive cost-effectiveness analyses also take into account concerns such as social fairness, funding mechanisms and political feasibility issues, in the development of policy scenarios. However, cost-effectiveness analysis only specifies a policy scenario to realise a target and cannot ascertain whether a project should be undertaken or not. In this context, policy measures for realising a road safety project are ranked according to their estimated cost-effectiveness ratios.

Multi-criteria analysis starts from a set of policy criteria that are relevant to the evaluation of a road safety project in terms of general objectives. Value scales and weighting schemes are used to indicate a value trade-off between criteria or objectives. The advantage of this approach is that all relevant factors can be judged, including those to which it is difficult to attribute a monetary value (*e.g.* the value of a saved life). This tool neither judges the desirability of a project or measure nor specifies targets in a formal way. The procedure used to aggregate all of the impacts is complicated and is often unclear to policy makers.

Social cost-benefit analysis is potentially the most powerful evaluation tool for public choice. This tool integrates the supply side of a policy (derived from cost-effectiveness analysis) with the social demand side for public policy intervention (the level of road safety that is socially desirable, derived from "willingness-to-pay" inquiries). The convergence of the two curves indicates the optimal social level of road safety. The lack of a market for road safety is bridged by the creation of a virtual road safety market in a cost-benefit analysis framework. However, this technique requires that all social costs and benefits are measured in monetary terms, including the statistical value of a saved human life. This need for full monetary values of effects is, in practice, the major barrier to performing social cost-benefit analysis.

The argument that it would be impossible to measure the value of all impacts is rather simplistic because the approach is essentially the same as for measuring the expected operational and maintenance costs of investments, although it is true that the measurement of intangible effects requires more uniform and reliable methods. Furthermore, putting statistical values on human life is an ethical and sensitive issue. To some extent, this is due to the focus in the usual terminology on "value of statistical life" (VOSL). In fact, what is being measured in willingness-to-pay studies is the amount people would be willing to pay for a small reduction in their risk of being killed in a road crash. The aggregate value for one fatality is thus more accurately termed the value for prevention of a fatality (VPF), which reflects the use of such *ex ante* values in cost-benefit analysis. Moreover, every decision maker in road safety should recognise that this trade-off is implicitly performed when designing road safety policies. It is difficult, if not impossible, to avoid making value judgements when making social decisions.

A comprehensive cost-benefit analysis fed by solid information that captures as many relevant considerations affecting decision making as possible, leads to powerful decision-making principles. The funding of road safety projects will be beneficial as long as any additional money spent results in a safety return which is at least as high as the investment cost. When investment leads to a marginal benefit-cost ratio lower than 1, policy makers should stop spending more money on that project. Although cost-benefit analysis is a sophisticated decision tool that leads to useful guidelines, its value depends largely on the data used and the issues captured. The advantage of the cost-benefit analysis framework is its almost unlimited potential to cover decision criteria and objectives in an integrated way, since everything is expressed in the same monetary unit. This framework proposes a comprehensive structure which enables decision makers to streamline policy debates about whether or not to spend money on a given road safety project.

The complementarity of these formal methods (cost-effectiveness analysis, multi-criteria analysis or cost-benefit analysis) means that they can also be used in combination. As an example, under the European Union Road Safety Action Programme 1997-2001 (European Commission, 1997) a multi-criteria analysis of the various safety actions was followed by a cost-effectiveness analysis leading to the definition and ranking of short- and medium-term road safety priorities in the European Union (European Commission, 2000).

Whatever the method used, the quality of the economic appraisal will always depend upon the quality of the quantified data. It must also be remembered that there are likely to be issues that cannot be expressed in monetary terms in a traditional cost-benefit analysis. Such analysis cannot be the final arbiter in decision making, and non-monetary effects and political issues also need to be taken into account. Cost-benefit analysis and other evaluation methods are therefore a valuable input to the decision-making process but cannot substitute for the use of judgement by policy makers in taking decisions which may have to take account of broader political and ethical concerns. In practice, a combination of cost-benefit analysis for monetarised effects within an appraisal framework that takes explicit account of non-monetarised effects, based on political judgement, is likely to be needed.

Current best practices

Currently, comprehensive cost-benefit analysis as a decision support tool for road safety is almost exclusively performed as an academic practice in OECD Member countries. There is no widespread use of analytical cost-benefit analysis by decision makers for formulating policies. Certainly, the cost-benefit framework for target setting is rarely recognised in policy environments. However, the benefit-cost ratios from partial cost-benefit analyses are increasingly being used to rank projects and policy measures. The same comments can be made for cost-effectiveness ratios from cost-effectiveness analysis, and for the use of multi-criteria analysis.

There are essentially four interrelated steps in designing policies: *i)* prioritising the problems for which government intervention is recommended; *ii)* determining the budgets available to solve the problems; *iii)* specifying possible policy targets; and *iv)* developing policy scenarios to address the problems. These four steps will be used in discussing the road safety decision processes in OECD countries.

Prioritising problems

In most OECD countries, road safety strategies are integrated in a wider transport and mobility policy framework (OECD, 1997). This means that road safety is considered a quality aspect (similar to environmental quality) of transport policies, rather than a separate policy issue. This is a healthy approach for policy efficiency and illustrates the complexity of designing policy for road safety (European Commission, 1995). At this stage of the strategic planning process, ranking and prioritising is essentially based on the perception of policy makers with regard to the scale of the problem, the perception of society, ease of implementation and political considerations. These priorities are, in principle, reflected in the policy programmes of the political parties and legitimise the actions of the elected government. Most OECD countries put transport and related issues high on the policy agenda and mobilise considerable resources to guarantee the quality of life, even at the cost of pure economic considerations. However, this prioritising is not based on a formal evaluation in which the ranking and social weights of the problems are derived from empirical analyses.

Funding mechanisms

At the national level, the allocation of public resources to road safety is most often undertaken according to its political and societal priority ranking. Often, road safety is covered by several ministries managing their own budgets, leading to a virtual single public fund for road safety. Thus, funding mechanisms at a national level do not result from formal decision analysis but rather from democratic rules of play. A cost-benefit framework could contribute to a more efficient budgeting by confronting the "willingness-to-pay" for safety by society. Theoretically, the point at which the additional amount of money society is willing to pay for road safety equals the cost of an additional policy effort determines the target. The EUR 1 million rule of the European Commission is supposed to reflect this equilibrium. The budget needed to finance all the efficient measures up to the target point corresponds to the desired fund. Although theoretically correct, this application of social cost-benefit analysis faces enormous practical problems, *e.g.* lack of well-performed impact assessments of measures, and lack of monetary data. It also presumes a level of precision in both monetary values for reduction in risk and the benefits of road safety policies that are not in accordance with the current state of knowledge.

On the other hand, road safety funding for lower level governments is, in several countries, subject to formal analysis of costs and beneficial returns. This is particularly true when national

governments use subsidies to finance lower level safety projects. In the United Kingdom, for example, local authorities until recently bid for funds for local safety schemes by presenting results from cost-benefit analysis. While the United Kingdom's new system of Local Transport Plans places less emphasis on individual schemes and focuses on output (casualties saved), value for money continues to be an important consideration. This approach guarantees that scarce resources are invested in a way that ensures the highest safety return. Countries like Belgium, Canada, France, Japan and the Netherlands evaluate safety impacts of local government actions to some extent before transferring payments. However, the use of fixed criteria in terms of benefit-cost criteria for obtaining funding is not common in OECD countries. The funding mechanisms are, of course, closely related to the horizontal and vertical co-ordination between ministries and levels of government, respectively. In Finland, for example, there is no co-ordination between local and national plans. Since budgets are revised each year, the financing of longer-term safety actions is not evident.

Target setting

Up until now, national targets have had a high political and symbolic content, at the cost of formal underpinnings (top-down process). Several OECD countries have idealistic goals, the best examples are "the safest roads in the world" (Canada) and "the Vision Zero" (Sweden). Neither of these goals, nor the quantitative targets in other countries (*e.g.* a 50% reduction in the number of fatalities in France over five years), result from cost-benefit analyses or from any detailed assessment of their feasibility. The lack of formal underpinnings and of comprehensive action plans supporting these visions may undermine the credibility of ambitious policies.

Recently, however, some countries (*e.g.* Australia, the United Kingdom) have attempted to develop targets through a bottom-up process that offers opportunities to apply cost-benefit analysis and provides greater guarantees of the feasibility of the plans. As indicated above, the theoretical target is determined by the point where the additional amount of money society is willing to pay for road safety equals the cost of an additional policy effort.

Implementation scenarios

Once the target has been determined, the government seeks the most desirable path to reach it. An impact assessment of possible measures is developed, together with social cost estimations. Hence, the costs are compared to the physical benefits (cost-effectiveness ratios) which may also be aggregated and valued in monetary terms (cost-benefit ratios). The use of cost-effectiveness analysis to rank measures is widespread in OECD countries (*e.g.* Finland, the Netherlands, the United States) (see *e.g.* Dutch Ministry of Transport, 1996; Finnish Ministry of Transport and Communications, 1997). Although data problems persist they are less significant with cost-effectiveness analysis: side-effects and monetary values of consequences form no part of the analysis.

Multi-criteria analysis is less formal and brings the impacts together in order to reach an overall conclusion on the acceptability and priority of the measures. Broader strategies (*e.g.* environmental issues) or indirect impacts (*e.g.* effects on employment) can be considered in this framework but the method remains highly qualitative, with a large degree of subjective assessment and planner judgement. The internal logic of multi-criteria analysis is a very valid policy support framework and is commonly used by decision makers in OECD countries.

The combined use of cost-effectiveness analysis and cost-benefit analysis to specify marginal road safety improvements due to a mix of policy measures is not a general practice but a number of

case studies have been developed in co-operation with research centres (*e.g.* in Finland, France, Iceland, Italy, the Netherlands).

Conclusions

Ideally, OECD countries make rationalised policy decisions in the field of road safety. The incentive is that only socially worthwhile road safety projects should be selected and that the budgets devoted to these projects should be allocated to realise the maximum return in road safety terms. Three socio-economic tools are available to support these decisions: cost-effectiveness analysis (CEA), multi-criteria analysis (MCA) and cost-benefit analysis (CBA).

CBA can promote the allocation of national revenues to road safety. Likewise, target setting plays an important role in this regard. The ranking of safety measures in order to reach a given target can be supported by each of these tools.

Theoretically, if the goal is optimal accomplishment of the social need for road safety and optimal use of scarce resources, social CBA is the preferred tool to support all these decisions. However, CBA requires extensive information that is not readily available: evaluations of safety effects are scarce and often methodologically flawed; impact studies have been directed at intermediate variables instead of collisions; there is a lack of monetary valuation of benefits.

Given the limited availability of robust data, CBA cannot yet be used to the full extent of its potential. Consequently, the allocation of budgets to road safety will continue to rely on political and public priority ranking, as will target setting. Alternative decision support tools for evaluating the social value of projects are not available. The problem that available funds are usually insufficient for financing all socially desirable projects will continue to exist.

Once the target is set, cost-effectiveness analysis and multi-criteria analysis can be used to select the "best" set of measures to realise this objective. If available data (on costs and safety effects of alternative measures) allow, cost-effectiveness analysis helps to point to the most efficient implementation path towards these targets. Multi-criteria analysis can be used to rank measures, even without quantitative data, although it cannot guarantee an efficient choice and allocation of the budget to the different measures.

The evaluation and monitoring of safety management and implementation strategies

Background

The current monitoring and evaluation activities for each country, which form the basis for the discussion in this chapter, are summarised in Annex A. Comparing current practices to 1992 (when a similar OECD analysis was carried out), it appears that more countries have implemented or are currently preparing national safety plans (which include the setting of numerical targets). However, a number of countries, including some that have an extensive safety programme (such as Norway), do not believe in or have not set numerical targets. Others have targets expressed as fatality and collision rates (per million vehicle-kilometres travelled). In terms of monitoring and evaluation, the countries with the most extensive programmes are the Nordic countries (Finland, Sweden, Norway, Denmark and Iceland), the Netherlands, the United Kingdom and, to a more limited extent, Australia, Canada, France and the United States.

Monitoring of a safety plan or programme consists of the systematic recording of the many actions and activities that make up the programme. Monitoring is an essential first step in systematic evaluation. While the various activities may be carried out by many different agencies, it is essential that the monitoring be conducted, or at least co-ordinated, by a lead agency.

Evaluation consists of the systematic study of the effects of the various programme elements on road safety. As will be explained below (see section on performance indicators), not all activities can be directly related to safety outputs, *i.e.* reductions in the number of crashes, casualties and fatalities. For such activities, a number of surrogate indicators can be developed to measure the scope, quality and success of the activity.

Safety programmes should interact positively with other types of programmes (environmental programmes or infrastructure programmes) and should form part of the decision-making process. This is discussed further in the report *Integrated Strategies for Safety and the Environment* (OECD, 1997). Similarly, it is clear that to be fully successful, road safety should be considered at the highest and earliest level of decision making on urban and regional planning, on infrastructure projects and other major transportation decisions.

Responsibility for monitoring and evaluation

The national level

In most countries, evaluation is carried out at the national level by the agencies responsible for road safety. There are major differences between large countries, where much responsibility lies with the states (Australia, Germany, United States), the provinces (Canada), and the departments (France). However, even in smaller countries like the Netherlands, a process of decentralisation is evident. Nevertheless, overall responsibility for target setting, policy and evaluation generally remains a national task. In almost all countries, safety work is divided among a multitude of agencies, governmental departments and many non-governmental organisations. Those countries that have set up co-ordinating agencies, in most cases under the auspices of the Ministry of Transport, seem to have a more clearly defined and detailed safety plan.

From the input received from the countries participating in the current OECD study and from knowledge gleaned from similar studies by the OECD (1994) and PIARC (Mulder and Wegman, 1999), it appears that many countries focus their road safety programme on a limited number of topics.

Among the safety topics appearing in many countries are: speed management (both urban and rural), driving while over the alcohol limit, the use of safety restraints (seatbelts, child restraints and airbags), the use of motorcycle and cycle helmets, programmes targeted at young drivers, programmes dealing with pedestrians, and treatment of hazardous locations. In many countries, these topics are supplemented by topics of particular relevance to that country. These include: driver fatigue, heavy goods vehicle safety, emergency medical services, etc.

It is important to ensure that the data available for programme monitoring are at a level that enables evaluation of the separate programme elements and their possible interactions. Ideally, crash forecasts and a detailed evaluation programme should form part of the evaluation/monitoring process. Some countries, including Sweden, the Netherlands and the United Kingdom, have developed prediction curves and are starting to use them in their safety programmes.

The regional and local levels

In almost all countries, it is now accepted that a major part of safety work should be delegated to and executed at the regional and local levels. However, little information is available as to how administrations at these levels cope with the monitoring and evaluation of their efforts. In some cases, regional and local levels use criteria similar to those used at the national level. This is important if a meaningful aggregate national total is required. In any event, it is important that regional and local agencies take responsibility for monitoring and evaluation of the road safety measures they have implemented.

Performance indicators

Given the number of countries now involved in monitoring and evaluation, it seems possible to prepare a framework for successful monitoring and evaluation of a safety plan. The data requirements and the level and type of disaggregation needed for evaluation are closely linked to the details of the safety programmes.

It is generally accepted that road safety is expressed in the number of collisions, casualties and fatalities that occur in the transport system – the "tip of the safety iceberg". Accepting these measures is an admission of the inability to collect more complete information that can reveal the root causes of and precursors to collisions, casualties and fatalities. This more detailed information should cover near-miss events and incidents that do not result in collisions, casualties and fatalities. It should be realised that many safety actions and programme elements cannot be directly related to these safety indicators. Programmes that deal with safety awareness campaigns, advertising and traffic education, for example, cannot generally be assessed on their direct effect on the numbers of collisions and casualties. For such programmes, other types of performance indicators are developed which can be monitored and evaluated. Behavioural measures have behaviour indicators and other activities have process indicators that can be assessed.

Usable performance indicators should be SMART: **S**pecific, **M**easurable, **A**mbitious (but also **A**cceptable), **R**ealistic, and **T**ime-dependent. The various types of indicators and the associated data needs are described below:

Product indicators

These are associated with the outcome of safety activities and can be of two types:

- *Collision/casualty indicators*, which describe the expected number of collisions/casualties relevant to the activity and the change in collisions/casualties to be expected.

- *Behaviour indicators*, which describe the changes in the relevant type of behaviour to be expected from the programme activity. For a highway safety programme, this could be a change in speed; for a seatbelt campaign, it could be the increase in the number of car occupants that wear seatbelts.

Process indicators

These describe the safety measures in terms of the efforts. These could be the number of hours of police enforcement, the number of hours spent on safety teaching at schools, the number of persons trained in advanced driver programmes, etc. Process indicators are useful in the assessment of a safety programme because they indicate the adherence of the activity to the programme. They are sometimes the only possible indicator but, even for those subjects for which product indicators exist, both types of indicators should be established.

Indicators of organisational effectiveness

A final type of indicator that fits neither category is the system/organisational indicator. This can give an indication as to how the safety organisation is effective and is contributing towards achieving the safety goals.

Data needs

Collision data have to be supported by data on exposure, road elements, vehicles, drivers, driver behaviour and violations. To obtain the best results, such files should be integrated into an accessible database. In addition to the above, it is essential to collect data on a number of road-user behaviours that are closely related to elements of the safety programme. Only by correlating data on such behaviours, assuming they are available, is it possible to make accurate deductions about changing trends.

Disaggregation of crash and casualty data

In most OECD countries, by law, the police at the local or regional levels collect at-scene data on motor vehicle collisions. Collision data represent the primary data used to establish safety targets and programmes, and the police are required to establish responsibility for crashes. The national or federal government generates national official statistics and national databases using non-personal data collected from local and/or regional police agencies. Local and regional agencies may also compile statistics from their collected data. In some countries, coverage is limited to major public roads. Often, the road infrastructure agency responsible for construction and maintenance maintains a separate database using the national system and adding linked road infrastructure data elements.

Under-reporting of crashes is a well-recognised problem; the more serious the crash, the more likely it is to be recorded. While fatalities are usually fully recorded in official statistics, injury crashes and material-damage-only crashes are far greater in number and go mostly unrecorded.

Given the limitations of official crash statistics, other data sources are also used for research purposes, for example hospital and insurance company records. The motor vehicle manufacturing industry also collects vehicle defect and crash data for vehicle design decision making. As the police are not medical professionals or engineers, crash information in official statistics may not be fully consistent with other crash records. However, information from other sources is collected for other purposes and therefore not optimal for road safety analysis. For example, policies vary between different insurance companies and hence no single company can provide a representative sample of a region’s road safety problems.

Public surveys can also provide useful information for road safety plans. Sweden carries out an extensive annual survey of road traffic safety through questionnaires to selected members of the public. The surveys include safety behaviour topics. Observational studies of human behaviour add to this pool of information and are used to set future targets.

For a successful strategic plan, access to detailed collision and casualty data is needed. Most countries have a database using collision data reported by the police. The general type of disaggregation includes details of type and location, level of severity, type of crash, time of day, and many other details. Such information over a long period of time (normally at least ten to 15 years, preferably more) is essential for evaluating the various elements of the national strategy. The collision data need to be supplemented with data retrieved from additional files.

Monitoring behaviour

Many countries have introduced safety programmes that target a number of topics for priority treatment. Speeding, drink-driving, use of safety belts, use of crash helmets are some examples of the issues appearing in many safety programmes. For evaluation purposes, it is essential to monitor behaviour associated with the safety programme, in order to evaluate programme effects and successes. The Nordic countries, the Netherlands, the United Kingdom and, to a lesser extent, Australia, Canada, France and the United States, have programmes that monitor some of the essential behaviour. Few countries, if any, have a programme of monitoring behaviour that can be regarded as nationally representative. The behaviour monitored generally includes: the distribution of speeds and of speeding vehicles (*i.e.* exceeding the speed limit), number of drivers with a certain level of alcohol, number of drivers and passengers wearing seatbelts (in front seats and in rear seats), number of children using child restraints, number of motorcyclists wearing crash helmets. As stated above, the Nordic countries (Sweden, Finland and Norway) monitor a more complete set of behaviour that includes: the proportion of drivers who break regulations other than speed limits, red-light offences, distances between vehicles, respect of stop signs, etc. However, even in these countries, data on most of such behaviour are not collected in a statistically representative manner, which would be essential for the determination of changes in behaviour, collisions, and casualties aggregated to the national level.

Process and system indicators

Another type of data that needs to be monitored is concerned with process evaluation. The safety programme generally consists of a package of measures and activities that are assumed to have a positive effect on safety. Measurement and monitoring of the scope of activity in each programme element can provide valuable information as to its success. With regard to the infrastructure, the number of hazardous locations treated, the number of road kilometres upgraded with respect to safety, number of intersections improved, roadside kilometres treated, all fall into this category. With regard to vehicle safety, the number of vehicles inspected for defects and the number of weight inspections are examples that are used. As to road users, the number of driving tests and failure rate, the number of drivers stopped by the police, the number of convictions and types of convictions are all intermediate variables describing parts of the process.

Many countries (including Australia, Austria, Belgium, Canada, the Czech Republic, the Netherlands, Scandinavia, the United Kingdom and the United States) emphasise the importance of the opinions and knowledge of the public in relation to road safety in general, and towards various parts of the safety programme (in particular, police enforcement, speeding, drink-driving, etc). Such

information can also be described as an intervening product indicator or as a process indicator, since it describes the scope and success of publicity and educational campaigns and other government actions.

A final type of indicator is the system/organisational indicator. This can give an indication as to how the safety organisation is effective and is contributing to achieving the safety goals. No simple indicator exists to assess this issue, but an organisational analysis could assist in developing such indicators.

An example of this type of data which is collected on a regular basis comes from the Netherlands. An annual questionnaire-survey has been conducted for several years among all municipalities, to register the amount and nature of their road safety activities.

Other information

Other types of data can provide valuable background input to the monitoring process. This includes the collection of data on underlying socio-economic trends and changes in the amount of traffic and its composition, which could also be associated with changes in safety. These trends have to be understood and quantified so that they can be separated from actual safety programme effects. Such data include the amount of traffic, vehicle types, population characteristics, national income, unemployment data, land use, urban development, housing, etc.

Research associated with monitoring and evaluation

Although monitoring and evaluation help to build a clear picture of the underlying trends and contributions of various elements of the safety programme, it should be borne in mind that we are dealing with a complex and intricate system of related variables. In many cases, it will not be possible to determine the effect of a programme element without conducting a specific research study. In fact, as part of the monitoring and evaluation process, each country should have an associated research programme which can assess the effectiveness of the major parts of the programme. Such a research programme will generally require additional types of data for the specific projects. Most countries surveyed have a safety research programme, but the research programme is not specifically related to the programme evaluation process in all countries. Reliance on previous results obtained in the same and other countries is an integral part of such programmes. Also, based on the available literature, the adoption of what is termed “best practice” could form part of the research programme.

Cost-benefit and cost-effectiveness evaluations are gaining importance in the field of safety evaluation. With ever-increasing knowledge and understanding of safety-related outcomes and interactions between activities, it is becoming customary to conduct cost-benefit evaluations of safety activities. Three components are required to carry out such studies: *i)* the cost associated with the programme; *ii)* the expected effect of the programme activity in terms of crashes, casualties or fatalities prevented; and *iii)* these impacts have to be valued in monetary terms. Although a fair amount of controversy still exists on this subject and various estimates of collision costs are used in different countries, this topic has reached a level of knowledge where it can be applied to a large number of safety activities.

Information systems and data dissemination

Dissemination of information (databases)

So far, the types of data required for the monitoring and evaluation process have been described. It should be realised that various evaluation efforts can occur simultaneously at the local, regional and the national level. For data to be useful, they should form part of an easily accessible data management system for decision makers and advisors. This system should ideally link data files for collisions, vehicles and drivers and other data. Most countries still experience great difficulties with the linking of such data files, even where the files belong to the same jurisdiction (*e.g.* the police or the Ministry of Transport). Recognising the difficulty of linking data files that were created for different purposes, the system adopted in the United States for collisions involving a fatality aims at collecting, collating and coding all the relevant information from the very beginning. Analysts in each state gather information from the police, medical examiner, motor vehicle departments and emergency medical people to compile accurate information on each crash. It is also important for some types of evaluation that the data can be aggregated at various levels – local, regional or national.

It is essential that such databases are easy to understand and use since the analyses can become quite complex. Current data is essential, so the databases must be updated frequently (at least once a year). An example of such a system is the Dutch road safety information system (RIS).

Programme feedback and updating

Although, in most countries, programmes are evaluated once a year, it is useful to have intermediate assessments to examine certain aspects of the programme. At such points it is possible to verify that different, previously set crash projections are adhered to. If not, adjustments to the safety programme can be introduced, relating to both the quantity and scope of various programme parts.

It will not always be possible to conduct such intermediate evaluations at the local and regional levels because there will not be sufficient statistical volume at these levels. However, in general, they could be conducted nationally and on a half-yearly basis.

Conclusions

A first requirement is the clear organisation of safety activities, co-ordination and division of responsibilities. Too many countries still rely on each agency to conduct and evaluate its own safety activities. However, many countries have now established co-ordinating agencies and national task forces or safety committees. These agencies generally have a clear mission to evaluate or to oversee the evaluation process.

As part of the trend towards a disaggregation of safety targets, it should follow that the monitoring and evaluation processes should involve similar levels of disaggregation. This means that collision, behaviour and performance data should all be available in a disaggregated manner.

In addition to the disaggregation by subject, it is increasingly common nowadays to evaluate by region and by local authority. This fits with the idea of decentralisation which is taking place at many levels of government and in many countries.

In most countries, the public agency in charge of the safety programme is also responsible for the evaluation. Although this has the advantage of first-hand knowledge of the subject areas and a deep

involvement in the process, it seems advisable to have an independent agency, with good research capabilities, in charge of evaluation and monitoring. This will generally lead to a more objective and sound evaluation.

Data should be kept in an accessible database in order to be useful and used. They should be available to and used by all relevant agencies, at the national but also at the regional and local levels.

With the creation of a national safety programme, a detailed monitoring and evaluation scheme should be prepared. Such a scheme should include the data to be collected, the behaviours to be monitored and the processes to be evaluated.

An evaluation research plan, which follows the safety programme and assesses its results, should form part of the process. Feedback between the monitoring, the evaluation and the agencies in charge of implementation is an essential part of an efficient process.

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Chapter 4

ROAD SAFETY PROBLEMS AND SOLUTIONS

Introduction

This chapter focuses on solutions to major road safety problems in OECD countries. The key problems were identified from replies to a questionnaire which was sent to all members of the Expert Group. Common themes, as well as problems that were cited by a minority, emerged from the questionnaire responses. Thus, this chapter is not a comprehensive coverage of all aspects of road safety. Rather, it identifies eight areas where there is common ground across a range of countries and presents the strategies implemented to address those problems.

In discussing each problem area, the focus is on the nature of the problem in various countries, successful approaches and solutions, and barriers to success. Previous OECD reports have dealt with specific problem areas and solutions; see, in particular, *Safety Strategies for Rural Roads, Safety of Vulnerable Road Users, Targeted Road Safety Programmes (OECD 1999, 1998, 1994)*.

Rather than looking ahead to new or innovative solutions, this chapter is based mainly on tried-and-tested remedies. However, emerging problem areas for road safety and areas that merit further research are briefly discussed. Information on bibliographical databases and other relevant source material is also provided.

Key road safety problem areas

From the analysis of responses to the questionnaire, the following list of problems was drawn up:

- Young and novice drivers.
- Speed.
- Impairment (alcohol, illicit drugs, illness and prescribed drugs, and fatigue).
- Enforcement.
- Urban areas (pedestrians and cyclists).
- Rural roads.
- Commercial and heavy vehicles.
- Safety equipment use (seatbelts, airbags, child restraints, helmets).

Although all these problems may not be priority areas in every country, they represent a broad consensus, and many of them are of concern to all. They are not listed in order of priority since such an ordering will vary across countries, but the problems towards the top of the list are those most likely to concern most countries.

Young and novice drivers

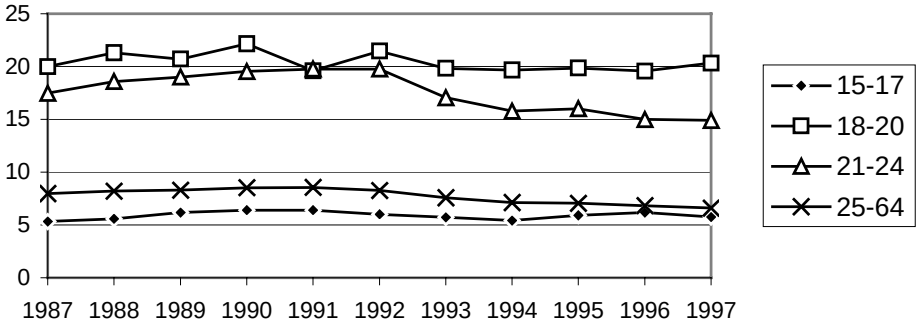
The nature of the problem

Both age and driving experience are important in determining a driver's crash liability, with mature drivers having significantly lower crash liabilities than their younger counterparts. Novice drivers are predominately young drivers: in the United Kingdom, for example, in 1998, 30% of males and 36% of females were under 21 years of age when they passed the driving test, and 39% of males and 49% of females were under 25. Studies have also shown that males have a much higher crash rate than females.

This combination of youth and inexperience is often a lethal mix. While drivers under 25 represent about 10% of the driver population in the United Kingdom, they account for 21% of all road crash fatalities and nearly 30% of car occupant deaths. In the United States, young drivers are twice as likely as adult drivers to be involved in a fatal crash. Crash rates for 16-year-old drivers are three times higher than for 17-year-olds, five times higher than for 18-year-olds, and twice as high as those for 85-year-olds. Similarly, in Poland, drivers aged between 18 and 24 accounted for 10% of the population but were responsible for 20% of crashes between 1991 and 1996. Surveys showed that the typical causes are alcohol and speed.

Comparison of data on car occupant fatalities in Germany, France, the Netherlands, Sweden, the United Kingdom and the United States (1990-94, from the IRTAD database) shows that, with the exception of Germany, fatalities involving car occupants in the 18-24-year-old age group account for 20-26% of all car occupant fatalities. Compared with the proportion of drivers in that age group, fatalities are over represented by a factor of 2.1 to 2.6. Conversely, for the 25-64-year-old age group, the proportion of fatalities is the same as the proportion of drivers in the age group. Germany had a higher relative risk of three times the proportion of drivers aged 18-24, due to a considerable increase in fatalities following reunification.

Figure 4.1. **Car occupants killed in the European Union**
Per 100 000 inhabitants of that age group



Source: IRTAD.

Figure 4.1 shows the mortality rate of car occupants in the European Union for different age groups. Since 1992, the mortality rate has decreased sharply for the 21-24 age group, with a slightly lesser decrease for the 25-64 age group.

International studies of novice driver crash risk all show that it is highest in the three years following the driving test, falling rapidly as experience is gained. This experience effect is not unique to the youngest drivers. A study in the United Kingdom (Maycock *et al.*, 1991) considered age and experience factors separately and showed that when annual mileage is taken into account, the experience effect contributes considerably more to crash liability reduction in the first three years following the driving test than does the age effect. Experience alone produces a reduction of 30% in crash liability in the first year, 17% in year 2, and 11% in year 3. By contrast, the age effect between 17 and 21 delivers only a 5-6% reduction in crash liability per year. In the first eight years of driving, experience accounts for a reduction in crash liability of 59%, and between 17 and 25, age alone accounts for a reduction of 31%.

In several studies of novice driver crashes time of day has been shown to be a significant factor. For example, a United States NHTSA report to Congress in 1993 showed that in the case of drivers aged 15-24, one in three crashes occurred during night driving; this proportion declines with age. Studies in Canada and the United Kingdom also demonstrate that young drivers have a higher proportion of their crashes at night, with the relative risk increasing by a factor of around 2.0. However, such data as exist on crash risk by time of day suggest that the younger age group drive considerably more often at night than do older drivers, which would account for much of the apparent increased risk.

Younger drivers have a much higher proportion of single vehicle crashes than older drivers, especially in the evenings and early mornings. The US NHTSA report shows that 20% of crashes involving drivers in the 15-24 age band are single vehicle crashes. UK data show a similar picture, with 22% of crashes involving young males being single vehicle collisions. In both countries, the proportions decline with age.

UK data show that young drivers are more likely than other drivers to crash while negotiating a bend, overtaking or turning right, but are no more likely overall to have crashes at junctions. A study of crash circumstances in the United Kingdom (West, 1997, 1998) showed that young drivers have more loss-of-control crashes and reversing crashes. Studies in the United States (Treat *et al*., 1979; Lestina and Miller, 1994) showed that younger drivers were involved in crashes related to excessive speed and losing control on bends, and were weaker than older drivers in terms of search skills, *i.e*. keeping a proper lookout and anticipating the actions of others.

Confirming earlier studies, recent pilot studies of contributory factors in accidents in the United Kingdom involving three police force areas show that speed features more strongly for younger drivers, as does loss of control on bends. However, other contributory factors did not seem to be over-represented in accidents involving younger drivers. Alcohol is not a significant factor for younger drivers' crashes once allowance is made for exposure and underlying crash risk. Alcohol-related crashes are a problem for all age groups up to 39, although the 20-24 age group appears to be at somewhat higher risk. After the age of 39, the involvement of alcohol declines.

Several studies in Germany, the United Kingdom, Belgium and Canada have attempted to assign fault to drivers involved in crashes. There is a consistent finding that younger drivers tend to be at fault in a higher proportion of crashes than middle-aged drivers. The percentage of young drivers judged at fault ranged from 48% to 70% (Carsten *et al*., 1989; Praxenthaler, 1995; Verhagen, 1995; Schlag, 1993; Carper, 1993).

A UK study of novice drivers (Forsyth, 1992b) asked about willingness to commit driving violations. Younger drivers were more prepared to violate traffic regulations, particularly with regard to speeding, traffic light infringement, cutting corners and overtaking slow drivers on the inside. This study also reported on crash liability of novice drivers (Maycock and Forsyth, 1997) and showed that a high violation score is strongly correlated with crash liability. Other work in the United Kingdom (Reason *et al.*, 1989, 1991) has also shown that violations are related to crashes.

Approaches to solving the problem

Measures to reduce novice driver crashes fall into four main categories:

- Pre-driver education.
- Driver training and testing.
- Post-test restriction/graduated licensing.
- Penalties.

Pre-driver education

In 1996, the United Kingdom introduced an education package for use in schools and colleges for the 16+ age group. It included video and workbook materials and a questionnaire for self-assessment of attitudes to motoring. The questionnaire has now been evaluated, and shows that, compared to a control group, participants demonstrated higher scores on driving safety, awareness of risk, and responsible attitudes to driving. The package was welcomed by teachers and students alike.

In France, a "Lifelong Training Programme" includes traffic education in schools. In Poland, "Traffic Education" was introduced into the primary school curriculum in 1996. A free monthly publication bearing the same title is distributed to all primary schools. Open competitions on road safety regulations have been organised for primary schools for the last 20 years and for secondary schools since 1997. Two types of traffic education facilities for children are currently in use in Poland. Mobile traffic centres (trucks equipped with deployable training appliances) travel around the country teaching and publicising safe behaviour among the youngest road users and preparing the ground for safer driving habits in the future. Traffic education centres established on racetracks help to promote secure use of roads.

Driver training and testing

Finland introduced a new two-stage curriculum for driver training in 1990. However, the results have been rather mixed: over a four-year period, the number of crashes decreased by 21% among males in the 18-20 age group, but by only 3% for females aged 18-20. For novices aged 21+, the number of crashes involving males fell by 48%, while those involving females increased by 28%.

A traffic safety campaign in Finland targeted young male drivers. Actual traffic behaviour and attitudes were recorded and played back to the target group of 18-19-year-old males undertaking military service. Following the campaign, there was a slight increase in the use of seatbelts and a significant decrease in the highest speeds.

Iceland has introduced a new system to improve driver training and testing and to encourage learners to take more lessons and acquire more practice. The driver-training period was six months in 1994, increasing to one year in 1998. Learners can take lessons from the age of 16, after which they can practice if accompanied; at 17, they can hold a full licence. In 1998, 40% of 17-year-olds were involved in a crash; by 1999, this share had been reduced to 25%. The new system of driver training and testing may account for this improvement.

The Swedish driver-training system was changed in 1993 to allow 16 year olds to learn to drive. Before that, learners had to be aged 17½. Evaluation of the scheme shows that, overall, the crash rate of novice drivers declined by 15% in the three years following the test, and that those who had started learning at 16 had a 40% lower crash rate. The younger group practised for 118 hours compared with 41 hours for those starting at 17½.

Improvements were made to the practical driving test in the United Kingdom in 1999. The driving time was lengthened and most test routes now include fast dual-carriageway driving. Another change was the possibility of failure on an accumulation of more than 15 minor faults, as well as on one dangerous or serious fault. The effects will be evaluated. It is also planned to introduce a test of hazard perception into the theory test in 2002. This decision is based on evaluation of hazard perception testing and training which has shown that inexperienced drivers are slower to spot developing hazardous situations than those with more experience, and that their skills can be improved with suitable training. The effect of the new test will be evaluated.

Post-test restrictions/graduated licensing

During the 1990s, several Canadian provinces introduced graduated licensing systems for new drivers. An evaluation of the Ontario system, a two-stage licensing system, has been carried out. During stage 1, the learner driver must be accompanied. After a basic road examination of operating skill, a novice may drive unaccompanied, but must have zero blood alcohol content and only carry passengers in seats with operable seatbelts. The evaluation showed a drop of 31% in collision rates for new drivers one year after the introduction of the new system. In Nova Scotia (Canada), the introduction of graduated licensing resulted in a 24% reduction in crashes involving 16-year-old drivers.

Graduated licensing programmes have been introduced in many states in the United States. These impose restrictions on young drivers in terms of night curfews, passenger carrying and drink-driving. Evaluations clearly show the benefits of adopting graduated licensing laws and components. In Florida, the introduction of graduated licensing resulted in a 9% reduction in crashes for drivers aged 16 and 17. Ongoing research in Kentucky, Michigan and North Carolina show a positive effect on the crash experience of teenaged drivers. California reported a 5% reduction in crashes and a 10% reduction in traffic convictions for drivers aged 16 and 17. Oregon noted a 16% reduction in crashes for 16- and 17-year-old male drivers.

Penalties

Poland introduced a revised points system for traffic offences for novice drivers as part of a new road traffic law that became effective on 1 July 1999.

The system for traffic offenders in Finland, implemented in 1996, has a lower threshold for disqualification for novice drivers than for experienced drivers. The number of offenders in the 18-19 age group fell by 10%, and the proportion of repeat offences also declined.

Higher fines and a points system for all drivers have been introduced in Iceland, largely in order to influence the behaviour of young drivers. In the event of three serious offences within a three-year period, the driver's licence can be suspended for three months.

In the United Kingdom, a New Drivers Act came into force in June 1997. If new drivers obtain six or more penalty points within two years of passing the driving test, their licence is revoked and they must reapply for a provisional licence and re-sit both the theory and practical tests. The effect is being monitored and evaluated, but the results are not yet available.

Barriers to success

As is the case for all road safety measures, the main barrier to success is the extent to which driver behaviour can be improved. Young drivers are generally not lacking in basic driving skills, but they may overestimate their ability. This is particularly true in the first year of unaccompanied driving; crash rates drop sharply as experience is gained. Graduated licensing, which attempts to reduce exposure to crashes by imposing restrictions on new drivers, has met with some success in some countries, mainly in those where entry age is relatively low and driver training and testing is less rigorous. Other countries have taken the path of improving training and making the driving test more difficult so that the novice driver is better prepared before driving alone.

Enforcement may be another barrier. Systems which impose restrictions on new drivers rely on a sufficient degree of enforcement to ensure compliance.

Public acceptability of measures aimed at young drivers is important to increase compliance. In some countries, blanket restrictions are viewed as unpopular and would be seen as reducing mobility and limiting choice of education or employment. Stiffer penalties for new drivers who offend are generally accepted as a fairer measure.

Greater co-ordination is needed in evaluating schemes to ensure that successful measures are identified and more widely implemented.

Speed

The nature of the problem

It has been estimated that, in the United Kingdom, excessive and inappropriate speeds are major contributory factors in around a third of all road crashes (Carsten *et al*., 1989; Sabey, 1993). In 1998, over 1 100 people were killed and a further 100 000 people injured in speed-related crashes (DETR, 1999*a*). Speed moderation has an important part to play in reducing the number and severity of road crashes, and relatively small reductions could reduce casualties by as much as 5-10% of the total national road injury toll.

Most injuries occur in urban areas, although this is not the case for deaths, where higher speed roads are the main cause. In free-flowing traffic, the road safety evidence points to the need for lower speeds on most urban roads, and particularly on main roads. Problems on rural roads primarily concern vehicle speeds which are within the limits but which are inappropriate for the conditions, especially on older single-carriageway roads.

Too many drivers regard speed limits as a guide and do not take them seriously. When asked, the majority of drivers consider that their driving skills are well above average and that crashes happen to

other people or are unavoidable. They believe that most crashes have no obvious cause. That is rarely the case: driver error is found to be a contributory cause in over 90% of crashes, and driving too fast is an error of judgement about what represents a safe driving speed (DETR, 1999*b*).

The relationship between speed and safety is a complex one. However, from the international literature, there is overwhelming evidence that lower speeds result in fewer crashes, and that those crashes that do occur are of lesser severity (for reviews see, for example, Baruya, 1997; Finch *et al*., 1994; Transportation Research Board, 1998).

American studies of the role of speed in crash causation are reviewed in *Managing Speed* (Transportation Research Board, 1998). The report concludes that speeding or excessive speed contributes to a significant percentage of all crashes and to a higher percentage of more serious crashes.

Ashton and Mackay (1979) calculated impact speed distributions from at-the-scene pedestrian crashes for car and car derivatives. They found that 5% of fatalities occurred at impact speeds below 20 mph, 45% occurred at less than 30 mph and 85% occurred at speeds below 40 mph. About 40% of pedestrians who are struck at speeds below 20 mph sustain non-minor injuries; however, this rises to 90% at speeds up to 30 mph. Age effects mean that elderly pedestrians are more likely than younger people to sustain non-minor injuries in the same impact conditions. The use of traffic calming to reduce speeds to an average of 20 mph or less has been demonstrated to reduce the number of casualties by up to 60% (Webster and Mackie, 1996).

Similarly, with vehicle-to-vehicle collisions, lower impact speeds greatly reduce the risk and severity of injury. At 30 mph, the risk of serious injury to a seatbelted car occupant in a front seat is three times greater than at 20 mph, and at 40 mph the risk is five times greater than at 20 mph (Hobbs and Mills, 1984). Once a collision has occurred, the vehicle decelerates rapidly but the occupants continue to move at the pre-collision speed until they are either ejected from the vehicle or are restrained by seatbelts or airbags. The physical explanation for the steep rise in injury severity with increasing speed is kinetic energy, which increases with vehicle mass and the square of speed. As an example, a small rise in speed from 30 to 35 mph increases kinetic energy by more than a third (36%), since absorbing energy during impact is what causes damage and kills people. Kinetic energy is also the reason why vehicle stopping distance increases at a greater rate than speed.

Finch *et al*. (1994) reviewed the literature on the relationship between speed and crashes. Analysis of research results from several countries demonstrated a simple linear relationship: a 1 mph drop in mean speed leads to a reduction in crashes of about 5%. However, other studies have indicated that the relationship is more complex, with different relationships being relevant for roads of different types and with different speed profiles (Baruya, 1997; Baruya *et al*., 1999; and Nilsson, 1981 in Finch *et al*., 1994). These results imply that modest reductions in mean speed have the potential to bring about reductions in the numbers of crashes on all types of road.

In a study investigating traffic speeds and crashes on 200 links on urban roads, Baruya and Finch (1994) concluded from the crash frequency models derived from the data that the higher the mean speed the more crashes occur overall. The models indicate that for a 1 mph reduction in mean speed, a reduction in crashes of up to 4% may be achievable on city centre roads and about 2% on sub-urban roads. The results from traffic-calming studies suggest a 6% reduction in casualties for every 1 mph reduction in mean speeds (Baruya, 1997; Webster and Mackie, 1996). When traffic migration is taken into account, there is still a 5% reduction in traffic-calmed areas for every 1 mph reduction in mean speed.

An indication of the relationship between speed and crashes also exists for British rural single-carriageway roads. Assuming everything else is constant, this suggests that a 1 mph reduction in the mean speed (achieved by a reduction in the proportion of vehicles exceeding the speed limit) could reduce crash frequencies by 5% if the mean speed is in the range of 40 to 50 mph (Baruya, 1998). This finding is in line with earlier before-and-after studies (Allsop, 1998).

A Swedish model has been developed based on experiments with different speed limits in Sweden undertaken during 1968-71 and validated using later data. The model is based on the hypothesis that: the probability of an injury crash reported to the police is proportional to the square of the speed; the probability of a serious crash is proportional to the cube of the speed; and the probability of a fatal crash is related to the fourth power of the speed (Andersson and Nilsson, 1997).

Studies have also been undertaken to derive relationships between change in speed limit and change in vehicle speeds. Finch *et al*. (1994) compiled data from single- and multiple-carriageway roads and reported that the change in mean traffic speed is about a quarter of the change in posted speed limit. Nilsson (1981) in Finch *et al*. (1994) summarised the effect of speed limit trials in Sweden and observed that a lowering of the speed limit by 20 km/h resulted in an average reduction in speeds of 6 to 8 km/h.

In the county of Suffolk, United Kingdom, in 1995 and 1996, new lower speed limits were introduced through 450 villages and before-and-after 85 percentile speeds were measured. For reductions from 40 mph to 30 mph, the average reduction in 85 percentile speeds was 3.5 mph, while for reductions from 60 mph to 30 mph, it was 6.2 mph (Suffolk County Council, 1997). The change in mean speeds was not reported, but it appears that the introduction of 30 mph limits is proportionately more effective in reducing speeds when the old limit was 40 mph than when the old limit was 60 mph. This supports Finch *et al.*'s highly speculative view from sparse data that smaller changes in speed limits may be more effective than substantial ones.

While drivers tend to drive at the speeds they consider appropriate for the road rather than respecting the posted limit, few will drive as fast as their vehicle is capable of going. It is apparent that some drivers choose to drive within the speed limit while others choose to exceed it. It is believed that these drivers make an implicit trade-off between travel time and safety. Rather than make these decisions continuously, drivers may rely on rules of thumb based on experience with particular roads or types of roads to select a driving speed that has been a reasonable trade-off for them in the past (Transportation Research Board, 1998).

An Australian study found that in a 60 km/h speed limit area, the risk of involvement in a casualty crash doubles with each 5 km/h increase in travelling speed above 60 km/h. They calculated relative risks of driving above the speed limit compared with driving with an illegal blood alcohol concentration. Even travelling at 5 km/h above the 60 km/h speed limit increases the risk of crash involvement as much as driving with a blood alcohol concentration of 0.05 g/100 ml (Kloeden *et al*., 1997).

Data from speed surveys carried out in the United Kingdom illustrate the problem of speeding. The surveys provide estimates of the speeds at which drivers choose to travel in free-flowing traffic when their behaviour is not influenced by congestion, enforcement or other road conditions:

- *On motorways*, 55% of cars exceed the 70 mph limit, with 19% exceeding 80 mph. The use of speed limiters means that few buses, coaches or HGVs exceed the limits.

- *On dual carriageways*, 54% of cars exceed the 70 mph limit (14% drive at over 80 mph), and 79-93% of HGVs exceed their 50 mph limit.

- *On rural single carriageway roads*, the average speed of cars and light goods vehicles is around 46 mph and only 10% of cars exceed the speed limit. However, between 60 and 76% of HGVs exceeded their 40 mph limit, with 17-30% exceeding 50 mph.

- *On urban roads*, compliance with the 30 mph limit is lower than with the 40 mph limit.

- *On 40 mph roads*, speeding is far less common than on 30 mph roads: 26% of cars exceed this limit, as do 35% of motorcycles, between 7 and 16% of larger HGVs, and 7% of buses and coaches.

- *On 30 mph roads*, 69% of cars exceed the limit, as do 63% of motorcycles, over half of HGVs and 41% of buses and coaches.

For roads with a 20 mph limit, compliance is good on those roads which employ sufficient traffic calming to reduce speeds to this level. On roads where a 30 mph limit was reduced to 20 mph without the introduction of traffic-calming measures, research suggests that a reduction in the mean speed and in 85 percentile speed is only of the order of 1 mph (Mackie, 1998).

Approaches to solving the problem

The following conditions are necessary for speed enforcement to be effective (Oei, 1998; Kallberg, 1998):

- A strategic alliance between relevant ministries (traffic, justice, interior, finance and road authorities) is essential.

- Specific and quantified goals regarding reduction in speed and crashes or victims within a certain time frame should be formulated.

- Enforcement is not an ad hoc but a sustainable activity.

- Relevant laws and rules are needed, *e.g.* point demerit system, use of automatic detection and processing techniques.

- Combination of enforcement with education of, and communication with, road users is essential.

- Exchange of knowledge and experience of speed enforcement across borders will increase the efficiency and effectiveness of the enforcement.

- The relationship between *enforcement level* and *compliance level* has the form of a hysteresis curve. The enforcement level can be modulated; the moment for change of the enforcement level can be determined by monitoring the speed.

It is important to look at different aspects of speed (related to safety problems) in relation to geography (Oei, 1998):

- *Local problem, e.g.* at a school complex with many children crossing or at a sharp bend or at an intersection.

- *Problem on a road stretch, e.g.* at road works or on dangerous routes.

- *On a road network, e.g.* the main roads in a city or in a province.

In the first two cases, since the aim is prevention at the selected location or road stretch, passing drivers should be warned that frequent speed checks are conducted.

In the third case, the goal is general prevention (*i.e.* at all times on all main roads). Therefore, no pre-warning should be given at the checking site. A sign could be placed a couple of hundred meters past the speed check location reading "Your Speed has been Checked. Police". This will increase the subjective probability of being caught.

Automating the enforcement by using cameras is more efficient than stopping speeders at the roadside. In addition, measuring the mean speed of each passing car between two points on the road (by automatically reading number plates) can increase the efficiency and effectiveness of the enforcement measure.

Urban areas

Speed enforcement on a network of main roads in the cities of Eindhoven and Amsterdam (the Netherlands) resulted in a reduction of the mean speed of a couple of kilometres per hour. Fatal and injury crashes were reduced by 14% in Eindhoven, while the number of injury crashes in Amsterdam fell by 25%. This reduction may be due to a combination of the enforcement campaign and a general downward trend in crashes (Oei, 1998).

A pilot project carried out in 2000 in Warsaw which reduced the speed limit from 60 to 50 km/h led to a 21% reduction in crashes and up to a 53% reduction in the number of fatalities between 19 September and 19 November compared to the 1999 reference period. It is planned to implement this measure in all cities.

Traffic calming on residential roads has been widely adopted and has proven very successful in reducing speeds and crash risk. Common forms of traffic calming include road humps, chicanes, pinch points, traffic islands, road markings and mini-roundabouts. In the Netherlands, a flashing speed sign showing "50" at a school complex reduced the mean speed by 5 km/h.

In the United Kingdom, 20 mph zones with self-enforcing traffic-calming measures were found to reduce casualties by 60%. In the absence of such measures, schemes based on signage reduce speeds by a mere 1 mph on average (Webster and Mackie, 1996).

In the Netherlands, extensive use has been made of "*Woonerven*" areas where road space is shared between motor vehicles and other road users, with the needs of pedestrians and cyclists being given priority. These areas are physically laid out to significantly reduce traffic speeds. The Netherlands also has 30 km/h zones; the entrances to these zones are clearly identified with signs and road markings or by so-called entry constructions. At problem points, ridges and speed humps can be installed as a supplementary measure. A reduction of the urban speed limit to 50 km/h from 60 km/h, introduced in the Czech Republic in October 1997 resulted in a decrease of 20% in fatalities. However, at the same time, the speed limit on motorways and expressways was raised from 110 km/h to 130 km/h. In Hungary, too, the urban speed limit has been reduced from 60 km/h, and traffic-calmed 30 km/h zones have been introduced.

For ten years, the Austrian city of Graz practised a policy of progressively introducing 30 km/h zones with traffic calming. However, the waiting list was increasing faster than the zones could be installed. In 1992, Graz decided to introduce a blanket 30 km/h speed limit on all non-through roads. The remainder kept their 50 km/h limit. This was part of a local integrated transport strategy called "gentle mobility" which aimed to promote walking, cycling and public transport and to limit car use. Intensive public awareness work and police enforcement accompanied the introduction of the lower speed limit. Public approval ratings increased from less than half to over three-quarters after four years. Casualties fell by 12% city-wide; mean speeds between junctions were reduced by 0.5 km/h and at junctions by 2.5 km/h. Eighty-five per cent of drivers implemented speed reductions of about 2 km/h at junctions and 1.6 km/h between junctions. The proportion of those travelling above 50 km/h fell from 7.3% to 3%. Nevertheless, when enforcement was reduced, speeds gradually increased to close to their previous levels (DETR, 1999*c*).

In Sweden, the normal 50 km/h speed limit in urban areas is reduced to 30 km/h in the vicinity of schools or in other densely populated areas as notified by the County Administrative Board. It has been estimated that reducing urban speed limits from 50 km/h to 30 km/h results in a 70% reduction in fatalities and a 60% reduction in serious injuries. The 30 km/h limits are supported by engineering measures such as construction of tapered lanes, road humps, smaller interchanges and measures causing the lateral movement of vehicle traffic. New legislation to implement urban zones with 30 km/h speed limits was introduced in Belgium in 1998.

In Japan, Community Zone Development Projects have set up areas in which priority is given to pedestrians. Vehicle speeds are controlled by the use of zigzag lanes and other measures such as humps and chicanes (not yet evaluated).

Rural roads

Lower speed limits are often advocated to deal with the problems of inappropriate speed and high crash rates on rural roads, although there is no evidence to support a blanket approach to lowering speed limits without increased enforcement. The safety problems on these roads are clear. Many collisions are the result either of overtaking or of driving too fast to negotiate a hazard such as a bend or junction. Better control of speeds at such hazards has been shown to be a more effective way of reducing casualties on rural main roads than blanket speed limit reductions.

In the United Kingdom, trials of vehicle activated signs which remain blank until triggered by a vehicle exceeding a pre-determined speed are currently underway. These systems can be used on approaches to hazards such as bends, and they are flexible enough to detect weather conditions such as ice or rain and change the trigger speed accordingly. When activated, they display a sign warning the driver to slow down. Early indications are that these signs can achieve significant reductions in vehicle speeds.

A similar measure in the Netherlands showed a positive effect. Speed limits have been reduced from 100 to 70 km/h at a provincial intersection, combined with a flashing sign indicating "You are speeding". The average speed was reduced by 20 km/h and there was a reduction of fatalities from six to two.

Other speed management approaches that have been evaluated in the Netherlands include four provincial road stretches with 80 km/h speed limits. The speed was managed using fixed and flashing signs and speed cameras from roadside boxes. The mean speed was reduced by 5 km/h and the number of crashes by 35%. The effectiveness of a speed enforcement measure using a radar car parked alongside the road was difficult to evaluate. Passing cars braked at the sight of the car since a parked

car along side the provincial road is suspect. The experiment was therefore disturbed by this phenomenon (Oei, 1998).

In Finland, an experiment took place in 1987-89 when winter speed limits were reduced from 100 km/h to 80 km/h, and motorway limits were reduced from 120 km/h to 100 km/h. The 80 km/h limit resulted in an average decrease for the whole year of 14% in all crashes and 11% in injury crashes, but the latter was not statistically significant. Motorway crashes decreased by 10%, also not statistically significant. When the speed limits were raised in the summer, crashes increased, particularly head-on collisions. It was estimated (Peltola, 1997) that the lower wintertime speed limit reduced all winter injury crashes by 28%, fatal crashes by 36%, and deaths by 49%.

Other measures

Advertising campaigns have been used to influence drivers' attitudes to speed and speeding behaviour. In the United Kingdom, the DETR "Kill Your Speed" campaign, which has run since 1991, has focused on speeding in urban areas. Research into the effects of the campaign shows high levels of recognition and understanding of the message. Driver training and testing address the problem of speed by educating drivers, and driving too fast for the conditions is a fault on which a candidate will fail the driving test.

Speed cameras have been introduced quite widely in the United Kingdom. They are generally located where there is a known crash risk. A UK research report shows that at camera sites speeds were reduced by an average of 4.2 mph (6.8 km/hr) and crashes by 28% (Hooke *et al*., 1996).

Signing and marking has been tried without a great deal of success. On its own, extra signing such as carriageway roundels, countdown signs, or additional repeater signs has only a small effect on vehicle speeds. Evidence from the Netherlands suggests that a co-ordinated approach to this kind of signing may be more effective and could provide a solution to the problem that on some roads motorists have the impression that it is safe to drive at a higher speed than the limit which is in force. Ideally, road design, markings, etc., should help drivers to choose the appropriate speed for safe use of the road. This concept of "self-explaining roads" has great potential for the future.

Certain cars now feature speed limiters where the driver can pre-set the maximum speed. The driver cannot exceed this speed without applying "kick down" to the accelerator.

Further into the future, external vehicle control would make it possible to control all vehicle speeds to the posted speed limit. Technology to do this is being investigated in the United Kingdom, using satellite information systems. Trials are also taking place in Sweden and in the Netherlands.

Barriers to success

The biggest problem with speed is that the majority of drivers do not consider speeding to be a serious road safety problem. Influencing driver behaviour is a crucial element of speed management policy. Most of the time, the feedback to the driver from speed is positive, and the misperception of crash risk and the generally low likelihood of enforcement of speed limits do not deter drivers from speeding. Equating the consequences of speeding with other risky behaviour (*e.g.* comparing it to blood alcohol content) may help to emphasise the seriousness of this behaviour and increase the acceptability of enforcement measures.

The effectiveness of speed cameras is limited by the cost of their operation. This is being addressed in the United Kingdom through a pilot project to set up a system whereby the camera providers and operators are able to retain a proportion of fine income to cover camera installation and running costs.

For more advanced methods of speed control, such as external vehicle speed control, the constraints are likely to be political ones of public acceptability rather than technical problems.

Impairment (drink, drugs and fatigue)

The nature of the problem

Alcohol impairment

A brief review by Sweedler (1997) provides information on drink-driving programmes and outcomes in Australia, Canada, France, Germany, the Netherlands, the United Kingdom and the United States. Sweedler noted that: "In general, all countries experienced a dramatic and steady decline in drinking and driving in the 1980s. Early in the 1990s, most countries began to show a slowing in progress or even experienced an increase in the problem. In most countries, the decline was accompanied by (or possibly the result of) a decrease in alcohol consumption, an increase in the number of and severity of legal controls, an increase in enforcement and greater public awareness of the problem. The slowing in progress or the reversal seems to be accompanied, in most countries, by a reduction in enforcement, less political attention being paid to the problem and a perception that perhaps the problems have been solved."

In the United Kingdom, drink-drive related road deaths fell rapidly from 1 640 in 1979 to 540 in 1993. The decline appeared to have halted in the mid-1990s, and deaths remained between 540 and 580 until 1998, when they fell again to 460. Provisional data for 1999 show 420 deaths. The proportion of breath-test failures for drivers and riders involved in a crash resulting in death or injury has fallen from 14% in 1988 to 3.5% in 1999. Although the number of drink-drive related road deaths has fallen compared to the levels in the 1980s, the number of people killed in crashes where the driver was above the current legal limit still represents around one in seven of all road deaths.

A similar situation has occurred in Australia. The percentage of drivers and motorcycle riders with a blood alcohol concentration of 0.05 g/100 ml or greater killed in road crashes declined from 44% in 1981 to 28% in 1997. However, the levels have remained virtually unchanged since then (Federal Office of Road Safety, 1999).

This pattern is seen in many countries, with progress in combating the contribution of alcohol to road trauma slowing in recent years. Even in countries with quite intensive programmes to combat drink-driving, alcohol use by drivers and other road user groups (particularly pedestrians) remains a significant problem.

Some nations have set specific targets for reductions in the incidence of drink-driving. For example, Canada has set a specific target of 20% reduction in drink-driving deaths and serious injuries in the Strategy to Reduce Impaired Driving 2001 (STRID, 2001). Sweden reported a target relating to the number of drink-driving offences, rather than casualties.

In the Netherlands, drink-driving during week-end nights dropped from 15% in the early 1970s to 4.3% in 1999 (Mathijssen, 2000a). The target set by the Dutch Government for the year 2000 is 4.0%. However, the decline in drink-driving coincided with a strong increase in drug-driving, especially by

young male drivers (Mathijssen, 2000b). While making up less than 5% of the Dutch population, young males aged 18-25 cause nearly 25% of serious alcohol-related crashes. One reason for this might be that they tend to combine high blood alcohol content with cocktails of several illegal drugs.

All of the survey responses that mentioned alcohol focused on drink-driving. Alcohol use by pedestrians can also be a significant factor in road trauma, particularly among teenage and adult males (Brooks, 1998), although none of the survey responses listed this as a major issue that had been successfully addressed. For example, in Poland, alcohol impairment accounted for 18% of accidents in 1996; in 11% of cases, alcohol was found in the drivers' blood and in 6% of cases, alcohol was detected in the blood of pedestrians.

Drug impairment

In France, illicit substances are thought to be involved in 15% of fatal crashes. Under the "guaranteeing the right to a safe driving environment" framework, France has committed to identifying illicit substances in fatal crashes.

Hunter *et al*. (1998) provided a comprehensive review of international research on drugs and driving. Broadly, this research points to a conclusion that alcohol makes a substantially greater causal contribution to road crashes than any other drug, or indeed all other drugs combined (at least in the countries for which relevant research data are available). This is a function of both the prevalence of alcohol use, and the clear evidence of a rapid increase in crash risk as dosage increases. However, a substantial number of drugs other than alcohol have been shown in laboratory tests, driving simulator, "off-road" and "on-road" studies to impair performance on driving-related tasks. These include both licit and illicit drugs.

It is important to make a distinction between the prevalence of a drug in crash-involved drivers, and its causal contribution to crashes:

- Many crash-involved drivers in whom drugs are detected have also used alcohol. In these cases, drug use may have contributed to elevated crash risk, but it is clearly not the only causal factor.

- It is likely that many of the cases in which low concentrations of drugs or their metabolites are detected may not be behaviourally impaired by drug use at the time of the crash.

- In particular, drivers classified as positive for cannabis in many studies would have included cannabis users with inactive cannabis metabolites, which may persist in blood for days after the behavioural effects of the drug have ended.

"Induced exposure" studies (based on analysis of culpability in crashes) have been used to assess the causal contribution of drugs to crashes. Some drugs (including benzodiazepines, opiates, combinations of psychotropic drugs with alcohol or multiple drug combinations) have been shown to be associated with culpability in crashes, and hence (by inference) increased crash risk. However, apart from drug-alcohol combinations, the incidence of these drugs among crashed drivers was much smaller than alcohol, in the studies reviewed (results reviewed in Hunter *et al.*, 1998).

Evidence on the possible causal contribution of cannabis (*active* metabolites) to road crashes is still controversial, but there is as yet no clear evidence that the risks or incidence of cannabis-impaired driving are the same as those found for alcohol.

Different approaches may be needed to address the risks associated with different types of drug. For example:

- Driver impairment arising from the proper use of medications may be best addressed by good-quality advice from doctors, pharmacists and other health professionals.

- Driver impairment arising from the deliberate improper use of medications and the use of illicit drugs probably requires a different approach, but there may still be scope for education and information programmes.

Enforcement-based measures may be less cost-effective for drugs than for alcohol. Roadside screening for alcohol is sufficiently cheap, accurate and non-invasive to be used on a mass scale. There is also ample research evidence on the relationship between measured alcohol concentrations and crash risk: so that in many countries evidence of alcohol above a prescribed limit is sufficient for prosecution. At present, the same is not true for other drugs that may contribute to crashes. Accurate, reliable and robust roadside screening devices have to be developed for drug testing. An effective training programme is needed for the law enforcement authorities regarding drug recognition, drug impairment and drugs and driving. In addition to these factors, enforcement-based approaches may be less effective in producing behaviour change among some categories of drug user than they have been with alcohol.

Fatigue impairment

The two main problem areas are fatigue impairment of commercial drivers of heavy goods vehicles and buses and passenger/light vehicles. In the United Kingdom, driver fatigue is a contributory factor in around 10% of all road crashes involving car drivers and up to 30% of crashes on high-speed roads at certain times of the day. In Australia, it is estimated that up to 29% of fatal road crashes could have fatigue as a primary causal factor (Department of Transport and Regional Services, 1999).

Vehicle crashes caused by drivers falling asleep at the wheel are not only more common than is generally realised but are more liable to result in death and serious injury owing to the relatively high speed of the vehicles on impact. Often, in these crashes, the driver runs off the road or/and collides with another vehicle or object.

Long, undemanding and monotonous driving is prone to induce sleepiness and, in the United Kingdom, this occurs particularly on motorways where 20% of crashes are attributable to the driver falling asleep at the wheel (Horne and Reyner, 1995).

Few sleep-related crashes occur on urban roads because the driving conditions are relatively stimulating and there is much for the driver to see and do. Research has shown that the same is not true of non-urban roads. Clear time-of-day effects exist in sleep-related crashes, with peaks around 2 a.m. and 6 a.m. and between 3 p.m. and 4 p.m. (Horne and Reyner, 1995). In the United Kingdom, the general peak times for road crashes are around the major commuting times of 8 a.m. and 5 p.m., which are distinct from the daily peaks of sleep-related vehicle crashes.

A review carried out in the United States (NHTSA, 1996) identified three high-risk groups (while noting that no section of the population is immune from fatigue risks):

- Young people (aged 16 to 29), especially males.

- Shift workers whose sleep is disrupted by working at night or by working long or irregular hours.

- People with untreated sleep apnoea syndrome and narcolepsy.

The focus on fatigue among commercial heavy vehicle drivers reflects the demanding schedules worked by many of these drivers (particularly in North America and Australia, where rules are more permissive than in Europe) and public concern about the serious consequences of fatigue crashes involving trucks and buses. In the United States, it is estimated that 15% of all fatal crashes involving large trucks are directly or indirectly attributable to fatigue: 5% are directly attributable to fatigue while a further 10% are attributable to secondary types of lapses associated with fatigue (Federal Motor Carrier Administration, 2000a).

There is some evidence that the proportion of fatigue-related crashes among light vehicle drivers is broadly comparable to that of commercial drivers. In terms of absolute numbers, fatigue crashes among light vehicle drivers predominate simply because these drivers account for the bulk of road traffic.

Reviews have emphasised that driver fatigue is not necessarily the result of sustained long-distance driving. Sleep deprivation or disruption of circadian rhythms have been identified as key factors in driver fatigue or "drowsy driving", and can be associated with non-driving activities, including work and recreation.

Approaches to solving the problem

Alcohol impairment

Comprehensive programmes used to reduce alcohol-related crashes include most or all of the following:

- Roadside and evidential breath testing (either testing of compromised drivers, or "random" testing).

- Imposing strict limits (and/or reductions in limits) on permitted blood (or breath) alcohol concentrations.

- Introducing severe penalties for breaking alcohol limits (and/or penalty increases).

- Public education (which can relate to enforcement and penalties; intrinsic risks of drink-driving; and/or advice on how to stay within prescribed limits).

- Rehabilitation programmes.

- Controls on re-licensing offenders classified as high-risk.

Random breath testing is one solution adopted in Australia. Generally, any motorist passing an arbitrarily selected checkpoint, usually on a main road, could be pulled over for a breath test regardless of age, sex and manner of driving. Random breath testing was first used in Victoria in July 1976 on a small scale. Since then it has been widely adopted, although the level of testing and method of operation varies across states. An associated publicity and media campaign is a vital element to the success of random breath testing. Several evaluations of the effects of the random breath testing package have been undertaken. The results suggested that random breath testing had an immediate, substantial and permanent impact on crashes. The effects were clearest in New South Wales, where random breath testing reduced fatal crashes by 15% on a permanent basis. There is some evidence to suggest that the publicity is as important as the random breath testing itself in reducing drink-driving.

In the Netherlands, the importance of large-scale random breath testing was clearly demonstrated in Amsterdam. After its introduction in 1994, the share of motorists with an illegal blood alcohol content dropped steadily, falling from 7.8% to 4.8% in 1998. This decline was realised in spite of an almost complete lack of accompanying publicity and education campaigns. In 1999, however, the enforcement level was approximately halved, resulting in a significant increase in drink-driving to 7.0% (Mathijssen, 2000b). An explanation for reduced enforcement was given by Sweedler (2000): "When progress has been steady, leaders tend to shift priorities to other public concerns, believing that the problem has been solved. This results in less public attention and less enforcement."

There has been a worldwide trend to reduce the legal limit. Many states in the United States have reduced their limits from 100 mg/100 ml to 80 mg/100 ml. All Australian states now have a legal limit of 50 mg/100 ml. Some European countries (*e.g.* Belgium and France) have recently reduced their limits to 50 mg/100 ml. Sweden reduced its limit from 50 mg/100 g to 20 mg/100 g in 1990. An evaluation of the Australian lower limits has proved difficult as other countermeasures were introduced at the same time (*e.g.* introduction of random breath testing in Queensland, extension of licensing hours in Victoria). The United States cited an increase in the legal drinking age to 21 as an effective countermeasure.

Sweden was the only responding nation to refer specifically to breath alcohol ignition interlock devices fitted into vehicles as a drink-driving countermeasure, although other OECD countries, including the United States and Canada, have active interlock programmes in some of their states. A study of the effectiveness of an interlock programme in Oregon (Jones, 1993) found that the interlock device fitted into the vehicles of convicted drink-drive offenders was effective in reducing re-arrest rates as long as the device was fitted. However, once removed, the rates returned to their previous levels. Similar findings were found by Popkin *et al*. (1992) in North Carolina. Although interlock programmes may have some success in preventing drivers who have been drinking from driving their vehicles, they are not primarily designed to influence an individual's behaviour *per se*.

In Canada, community-based enforcement and education campaigns have been used. These campaigns are led by advocacy and victims' groups and rely on local volunteers, free local media attention and inter-community co-ordination. No information was provided on how well these techniques worked.

In the United Kingdom, under the Road Traffic Act 1991, certain courts offer drink-drive offenders the opportunity to attend rehabilitation courses. If the offender successfully completes the course, the disqualification period is reduced by up to one-quarter. Evaluation of these courses has

shown that those who do not attend a rehabilitation course are three times more likely to re-offend than those who do. The courses are now permanent and offered nation-wide.

Countries describing comprehensive alcohol programmes generally reported evidence of substantial reductions in alcohol-related fatalities and casualties. Australia, Canada, Finland and the United Kingdom specifically articulated a substantial, and long-term, decrease in alcohol-impaired driving.

Although all nations that identified drink-driving as a key issue noted there had been significant reductions in drink-driving, none attempted to identify which particular measures had had the greatest impact. It may be that this question is not answerable in principle; that is, different elements of an overall programme may have synergistic effects, and any attempt to partition the contributions of the different elements may produce spurious results. For example, it may be meaningless to attempt to assess the separate contribution of enforcement, independently of penalties or publicity.

Drug impairment

The ROSITA project, co-funded by the European Commission under the Fourth Framework Programme, has investigated various aspects of roadside drug-testing devices. Various devices, initially not designed for roadside use, were field tested and evaluated in Belgium, Finland, France, Italy, Germany, Norway, Spain and the United Kingdom. The criteria for the evaluation were usability, practicality and validity aspects. Drug-testing equipment is currently under rapid development and it may be expected that roadside drug-testing equipment will be available within two to five years. Based on the increased incidence of drug-impaired driving and technological development of drug-testing equipment, it can be concluded that national legislators will need to consider developing appropriate legal and enforcement frameworks.

The United Kingdom is currently conducting research to understand the problem of drugs and driving. In particular, activities have focused on evaluating roadside screening devices and evaluating training programmes designed for police officers in recognising the signs of drug-driving and impairment due to drugs. Research is also being carried out on the effects of cannabis on driving.

According to French law passed in 1999, illicit drugs are to be identified in the case of fatal crashes. Germany and Belgium introduced zero-tolerance laws for illegal drugs in 1998 and 1999, respectively.

There is ongoing research at the Victorian Institute of Forensic Medicine, Australia, which involves collating and analysing the available toxicology and crash data from fatal accidents. Similar, smaller-scale research investigating the prevalence and role of drugs in non-fatal crashes is also underway in Tasmania and South Australia. All jurisdictions in Australia have some legislation relating to driving while impaired by drugs, although the requirements, police powers and enforcement vary from state to state.

Fatigue impairment

The most practical countermeasures in the combat against fatigue impairment have been public education campaigns. In general, educational campaigns are most successful when the messages are simple, specific and easy to implement.

The following advice has been identified for public education campaigns (NHTSA, 1996):

- Stop driving as soon as fatigue begins to set in.
- Get sufficient sleep.
- Avoid or limit driving between midnight and 6 a.m.
- Do not drink even small amounts of alcohol before long trips, or at other times when fatigue may be a hazard.
- Avoid driving after longer than usual periods of wakefulness.

While most of the priority messages suggested by NHTSA are reasonably specific, many people are likely to find such advice difficult to implement (apart from consumption of alcohol). To date, many public education efforts and community programmes have focused on measures that are not likely to be particularly effective (short rest breaks without sleep, combined with consumption of quite moderate doses of caffeine).

Two remedial actions have been shown to make a short-term difference in driving alertness: taking a short nap (of about 15 to 20 minutes) combined with consuming the caffeine equivalent to two cups of coffee (Loughborough University, United Kingdom). Compared with this, blowing cold air on the face or switching on the radio are at best only temporary expedients in reducing driver sleepiness; that is, they may provide enough time for the driver to find a suitable place to park and rest. Sleepy drivers are often recommended to go for a walk or take some exercise during a break from driving but there is no substantive evidence in support of this.

Fatigue has been highlighted in Australian road safety strategies and public education campaigns for some years, and opinion surveys indicate rapidly increasing public awareness of fatigue as a safety issue. To date, however, there is no solid evidence that this awareness has translated into behaviour change and crash reductions.

Common solutions specifically relevant to commercial heavy vehicle drivers include improvements to regulation of driving hours; and technology to monitor and control driving hours (such as the use of tachographs under EC regulations) or to detect/monitor driver fatigue.

Research findings in Australia have clear implications for the design of improved fatigue management strategies for the long-distance road transport industry. Working hour regulations for long-distance drivers are primarily based on limitations to periods of driving and rest during a trip, largely in isolation from overall scheduling patterns. In contrast, the research findings suggest that effective management of fatigue involves consideration of the whole pattern and timing of work and rest. This includes recent patterns of work/rest activities, activities before driving begins, as well as the way trips are structured in terms of timing and periods of work and rest. It seems that where fatigue had accumulated before the start of a trip, it clearly added to the build-up of fatigue due to driving once the trip had started. The research showed that the use of overnight rest at mid-trip in combination with two-up driving (where a pair of drivers operated the truck continuously, alternating between driving and resting) appeared to be the most successful strategy for managing fatigue. To date, neither regulations nor typical operational practice in Australia reflect these important influences on driver fatigue (Williamson *et al.*, 1997). However, Alternative Compliance Model Legislation (which provides the basis for State and Territory legislation) for the establishment and operation of alternative compliance schemes, such as fatigue management, has been approved by Australian transport ministers (NRTC, 2000).

Apart from measures aimed at discouraging or preventing drowsy driving, there are a number of "harm reduction" options that may be effective in reducing the consequences of driver fatigue (no details of evaluation):

- Audible edge lining to alert drivers who drift off-path.
- Clearance of roadside hazards.
- Use of energy-absorbing barriers.
- Possible future technological measures, such as fatigue-warning devices.
- Other measures that reduce fatigue risks indirectly, such as seatbelt use and improved vehicle crashworthiness.

Barriers to success

Alcohol impairment

Many countries have had a comprehensive programme in place to reduce drink-driving for many years, thus new initiatives sufficient to capture public interest and raise awareness are harder to find. The first major initiatives are always likely to have the greatest impact and any subsequent initiatives will have less effect. Enforcement is also a major barrier. Changing legal limits and introducing higher penalties rely on sufficient enforcement and resources to ensure compliance.

Public acceptance is important to increase compliance. Some potential methods of reducing the number of drink-drivers intrude upon innocent drivers and cause delays and inconvenience (for example random breath testing). Breath alcohol ignition interlock devices require drivers to perform an additional task every time they start their vehicle, but only target drivers who have been convicted of drink-driving. The majority of countermeasures include placing additional restrictions or expense on almost all drivers; therefore, the essential question is the extent to which drivers will accept such restrictions in order to benefit from a reduction in deaths and injuries caused by drink-drivers. However, much of the success in reducing drink-driving is due to increased public awareness of the risk and acceptance of the need for alcohol limits and enforcement.

Drug impairment

The main barrier to success is the difficulty of accurately measuring the presence of drugs in an individual. Accurate, reliable and robust methods are needed for drug testing. Problems in recognising drug impairment also need to be overcome.

Further research evidence on the relationship between measured drug concentrations and crash risk are needed so that evidence that a driver has certain drugs in his or her bloodstream above a prescribed limit is sufficient for prosecution.

Fatigue impairment

Effective public education about fatigue for non-commercial drivers faces significant challenges. Unlike other forms of high-risk behaviour (such as speeding and drink-driving), educational messages about fatigue are not backed by a plausible means of enforcement for this form of risky behaviour.

In addition, the most effective action to stop a driver falling asleep at the wheel is for that driver to stop driving as soon as possible. Many people are likely to find such advice difficult to implement and may resort to the less effective methods of opening a car window, turning on the radio, taking exercise or consuming coffee.

Enforcement

The nature of the problem

The enforcement of road safety initiatives was cited by most countries as being crucial to the overall success of such initiatives. Therefore, a weak enforcement strategy is a key problem for road safety. The Czech Republic identified the problem of declining enforcement following the changes in the political situation since 1990. Turkey also mentioned that the lack of effective deterrents encouraged undesirable behaviour and habits.

Canada and Hungary indicated that decreasing resources were negatively affecting the effectiveness of enforcement. Enforcement agency apathy was also noted by the Czech Republic as an impediment to effective enforcement.

Specific areas listed in the questionnaire where enforcement activity was targeted follow. Clearly, it is not a comprehensive list of the range of behaviour subject to enforcement, but rather an indication of the range of issues raised in the survey.

Table 4.1. **Targeted behaviour for enforcement**

Country	Targeted behaviour for enforcement
Australia	Speeding Alcohol Seatbelt use
Canada	Seatbelt use
Czech Republic	Speeding, Red light running
France	Speeding
Iceland	Speeding Alcohol Red light running Seatbelt use
Netherlands	“Full range” of behaviours targeted as a component of a broader strategic programme
Sweden	Speeding Alcohol Close following Red lights and stop signs
Turkey	Technical inspections and safety management
United Kingdom	Recidivist drink-drivers Excessive speed
United States	General road rules

Approaches to solving the problem

A successful solution to effective enforcement has been adopted in Victoria, Australia (the "Victoria solution"). In 1990, the government changed its strategy since all professional agencies were in agreement that traditional approaches were not working. Through the joint development of common goals, the Victoria Road Safety Partnership (the Victoria police force, the Transport Accident Commission, and VicRoads, the state roads authority) produced an integrated road safety and infringement enforcement system designed to significantly reduce road deaths and injuries by changing driver behaviour.

The solution focuses on education, enforcement, engineering and evaluation. High-impact television advertising forms the backbone of the publicity that supports the enforcement activity. Enforcement addresses casualty causes, with the equivalent of two-thirds of all registered vehicles being checked for speed each month and over 1 million breath tests carried out annually at highly visible roadside checkpoints. There is community involvement in enforcement practices. Evaluation is critically and independently carried out to influence operational decisions, provide clarity on cause and effect and give credibility to the findings. The Victorians have halved their road deaths and serious injuries and reduced all classes of injury crash by over a third. In addition, they have gone a long way to making speeding socially unacceptable – the number of drivers exceeding the speed limit threshold has fallen from 23% to just 1.8%.

Other enforcement solutions noted by various countries included automated enforcement, such as speed cameras.

The EC MASTER project has published a comprehensive review of speed management in Europe (Kallberg *et al.,* 1998) which includes a number of enforcement-related recommendations:

- Further development and wider application of automated speed enforcement.
- Legislative changes so that the owner of a vehicle can be held responsible for speeding offences (such legislation already applies in a number of jurisdictions, including most states of Australia).
- Education campaigns to complement enforcement and other speed-management initiatives.
- Commence preparation for the introduction of compulsory adaptive speed limiters (devices that would prevent speeding by adjusting speed to the prevailing speed limit).

Zaal (1994) provided a comprehensive review of enforcement practices and issues.

Barriers to success

Inadequate resources and lack of commitment to enforcement programmes are clearly a barrier to success. However, it is impossible to provide a simple formula to overcome this, as approaches that work in a particular jurisdiction at a particular time may not be universally applicable.

One approach that may be effective is collection and publication of outcome-oriented performance indicators for enforcement such as measurement of alcohol involvement in crashes, and vehicle speed distributions. Such indicators can provide important feedback on whether targeted behaviours are decreasing, increasing or remaining constant. A clear signal that things are getting worse (or have ceased to improve) can be important in underlining the case for more resources (or

better deployment of existing resources). Infringement-based indicators (the number of people subject to enforcement action) are clearly less appropriate, because it can be difficult to distinguish between improved on-road behaviour and a reduced rate of detection. Up-to-date, outcome-based indicators can be supplemented by (longer-term) time series research to establish links between enforcement measures and crash outcomes: this can also strengthen the case for increased enforcement.

Urban areas

The nature of the problem

The proportion of fatal road crashes in urban areas varies from 17% in Spain to almost 50% in the United Kingdom (OECD, 1994).

In Sweden, 50% of the fatalities in urban areas were occupants of motor vehicles, 30% were pedestrians and 20% were cyclists. A very high proportion of the pedestrian and cyclist fatalities are persons aged 65 years or more (one-half and two-thirds, respectively). Single-vehicle crashes accounted for about two-thirds of motor vehicle occupant fatalities. Nearly all pedestrians and the majority of cyclists killed were hit by a motor vehicle. Most of the fatal crashes occurred in areas where the speed limit was 50 km/h.

A European Research Project, DUMAS (Developing Urban Management and Safety), examined national state-of-the-art reports of nine countries: Austria, the Czech Republic, Denmark, France, Germany, Greece, Italy, the Netherlands and the United Kingdom (SWOV, 1997). The extent of the safety problem differs considerably among the nine countries, as does its development over the last decades. These days, traffic results in a yearly toll of 35 000 fatalities in these nine countries. The number of fatalities per 100 000 inhabitants varies among these countries by a factor of three. In the last 20 years, the number of fatalities decreased in most countries by some 30-45%; it increased, however, by 50-80% in the Czech Republic and Greece.

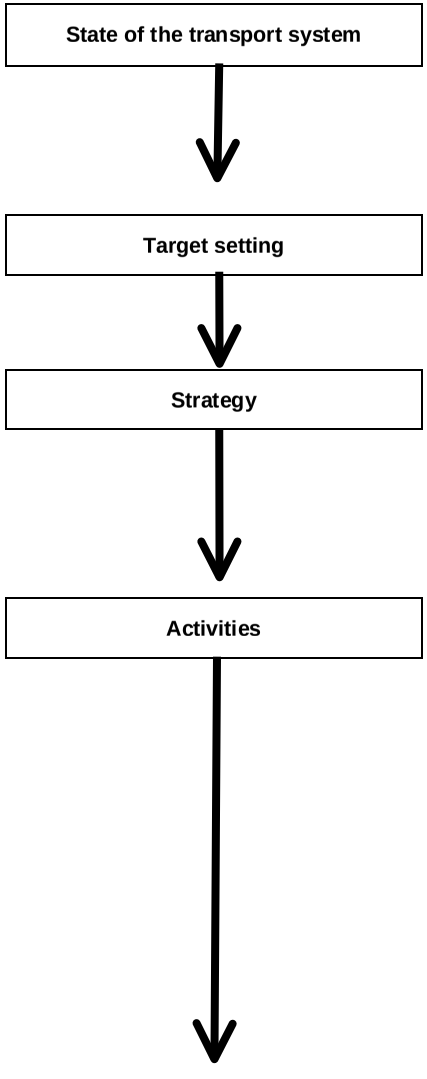
These differences between the European Union countries are, in part, due to the different education and mentality of users or to the quality of the road network and the systematic effort carried out to improve the above two factors. However, modal split is also a very important factor. High use of public transport reduces crash rates in developed countries. The opposite is true for the extensive use of motor cycles and mopeds (*e.g.* one per six inhabitants in Greece) for which the crash rates are up to 20 times higher than those of private cars.

In each of the countries, between half and three-quarters of all injury crashes occur in built-up areas. However, for understanding and thus effectively treating the urban traffic safety problem, quite an effort still has to be made in creating, organising and applying databases which offer reliable information on the local situation. In that respect, administrative improvements are a major requirement.

Approaches to solving the problem

As part of the DUMAS project, a general framework for speed management in urban areas has been investigated. This is summarised in Table 4.2. A more detailed comparison has been made in the DUMAS project on national practice and experiences in Denmark, the Netherlands and the United Kingdom.

Table 4.2. **General framework for speed management in urban areas**



Collect and map data on

- Accidents
- Speed
- Road network
- Traffic flows

Consider public participation in order to map perceived risk, security

Set targets for the speed management programme
Should be set on the basis of national/local targets and the current status. Can be formulated in more detail during the process

Involve local politicians

Describe the speed management strategy

- How can the targets be achieved
- What kind of methods could be used
- Where should the effort be aimed at?
- Does any specific road user group need special attention
- Set up a rough estimate on economy and time plan

Road and speed classification
Classify the road network for:

- Road type, road function (road hierarchy).
- Speed class.

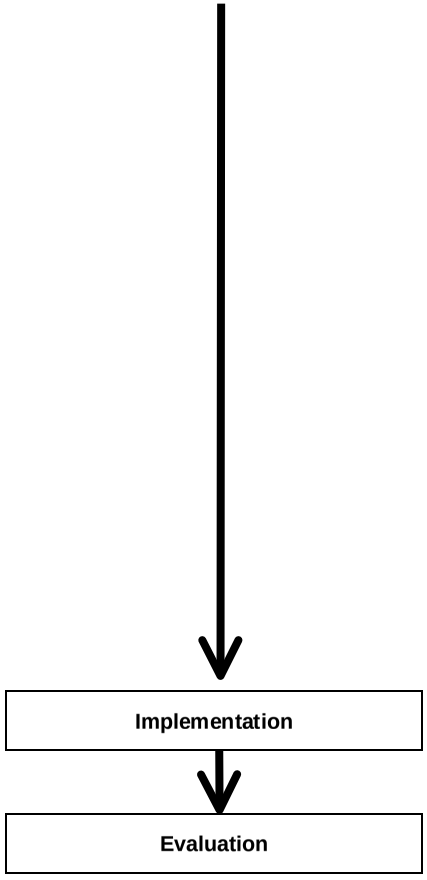
Speed management techniques
Consider the main types:

- Road layout measures (humps, staggering, narrowing, etc.).
- Network design
- Campaigns, information, education.
- Police enforcement

Overall decision on where to use measures and what kind of measures to use. Take into account: economy, time plan, road safety audit

Consider participation from:

- *Public / affected residents*
- *Politicians*
- *Police*



Draft design
Produce a first draft of the speed management scheme: draft drawings, rough estimates on costs, safety benefits, road safety audit.
Consider participation from:
- *Public / affected residents*
- *Politicians*
- *Police*

Involving the public
Can be arranged via:
- Information
- Hearings
- Meetings
- Working groups

Involve: household owners' associations, local chambers of commerce, the local road safety council, school boards, groups of handicapped people, environmental action groups, local cyclists' association, etc.

Priority
Put the measures in order of priority on basis of:
- Cost/benefit
- Economy
- Time plan
- Other issues

Make sure that the priority is accepted by local politicians

Detailed design
Produce a detailed design of the speed management scheme. Consider road safety audit.
Make sure that all the needed "before" data is available for the evaluation.

Implementation

Carry out the scheme
Make visual inspection before opening/start (road safety audit). Collect "after" data for the evaluation, inform the public and press about the project

Evaluation

Make an evaluation
As a minimum on:
- Accidents
- Speed
- Traffic flows

Compare results with the set targets, success criteria. Evaluate the process, what went wrong, what went well. Communicate results to all actors involved, other road authorities, professionals, technical staff, etc.
Consider participation from:
- *Public / affected residents*
- *Police*

Source: DUMAS.

Some urban traffic safety concepts have been developed over time and have become generally accepted. In this context, the “area-wide safety approach” is of particular interest. The approach, being an integrated traffic safety management philosophy, embeds past beneficial experiences in the field of traffic safety, taking into account other local interests and related policies as well.

Urban traffic safety concepts have been elaborated into a wide range of measures and schemes, and adapted to and implemented in practice. The main and generally accepted concept of relevance here is the “hierarchical network structure”, in which the design of the road and its place in the hierarchy corresponds to its functions of, respectively:

- Rapid processing of through traffic.
- Distributing traffic for rapid access to districts of built-up areas.
- Providing for local access.

The leading safety principle is that road users are able to recognise the function of the road – and thus the kind of traffic conditions they will have to deal with – enabling them to adjust their behaviour accordingly.

With regard to residential areas, the function of making destinations along a street accessible is combined with making a street as safe as a meeting place. In residential areas, the “habitat” function of the public space has to be of major importance.

Traffic-calming measures proved to be most valuable in residential areas, mainly due to their impact on speed reduction and diminished exposure of motorised vehicles. Among these, the “30 km/h speed limit zone” type of measure has been elaborated extensively over time. Positive experiences in practice were also gained. This most cost-effective traffic-calming measure can be considered as “mature” and, thus, suitable for further application.

New developments include the so-called “sustainable traffic safety concept” and the “Vision Zero approach”.

The starting point of the “sustainable traffic safety concept” is the principle that man is taken as the reference standard. The probability of crashes should be reduced in advance by means of the infrastructure design. Where crashes might still occur, the process which determines the severity of these crashes should be influenced such that death or serious injury are virtually excluded.

In the “Vision Zero approach”, the traffic system has to be dimensioned in such a way that possible conflicts or incidents which might cause fatal or serious injury never exceed a pre-defined level of unacceptable loss of health.

The main problem with urban areas is that vulnerable road users, such as pedestrians and cyclists, share road space with motor vehicles. A safe traffic environment must allow road users to make mistakes without being killed or severely injured. The challenge is to find solutions such that the crash severity level does not exceed the human threshold for withstanding serious physical injury. In traffic, this is normally accomplished by decreasing speed or improving overall road infrastructure or by a combination of the two.

In Sweden, a strategy has been designed to create a safe traffic environment for unprotected road users based on the “Vision Zero” concept together with a living space model. According to this model (Gunnarsson, 1990), the urban area is divided into three spaces:

- Safe transport space.

- Free space.

- Soft traffic space.

In the “safe transport space”, priority is given to motor traffic. The intention is that no pedestrians or cyclists should use such areas. This means that the passages needed by pedestrians and cyclists to cross streets must be grade-separated. The “free space” belongs to pedestrians and cyclists. Here, no vehicles are permitted, although a certain amount of excepted traffic may be allowed. The “soft traffic space” comprises streets with motor traffic as well as pedestrians and cyclists. It has not been possible, or even meaningful, to separate pedestrians and cyclists from motor traffic in this space. Speed-reduction measures are used to ensure that traffic safety is achieved.

Although separation measures have been used on a large scale for a considerable time (creating “transport” and “free” space areas), speed-reduction measures have been used only to a comparatively limited extent. If the level of violence that the human body can withstand is to be the basic design parameter, the speed should not exceed 30 km/h in any situation where pedestrians and cyclists share the road space with motor vehicles. A number of studies have been conducted on the relationship between the speed at which a collision occurs and the resulting injury. In Zurich, the speed limit was reduced from 60 to 50 km/h at the beginning of the 1980s. This reduction resulted in 20% fewer injuries and 25% fewer deaths among pedestrians. Moreover, the injuries that were incurred were less severe. In connection with the analysis on the speed reduction in Zurich, a group of experts analysed the relationship between the likelihood of being killed and the speed of the collision. Basic material was also gathered from other studies. The results corroborate those from similar studies in the United States, according to which a pedestrian runs about an 80% risk of being killed at a collision speed of 50 km/h and about a 10% risk at a speed of 30 km/h.

In the United Kingdom, the following safety measures have been shown to contribute to casualty reductions in urban areas:

- Traffic calming (road humps/tables/cushions) produce good speed reductions and good casualty reductions for all crashes (especially among pedestrians and cyclists). These measures are relatively low cost and the benefits are certain. However, they sometimes prove unpopular with residents.

- Remedial measures for crash prevention at “black spots”, including low-cost engineering measures.

- Zones with a 20 mph speed limit are effective in reducing casualties among children and pedestrians and in aiding cyclists.

- Speed enforcement using speed cameras (effective over short distances).

- Pedestrian facilities such as refuges and central islands, guard-rails and fences, have been found to be effective in reducing pedestrian casualties but pedestrian/pelican/zebra crossings may not always give the overall benefits expected. Some pedestrian facilities may cause problems for cyclists.

- Urban safety management can be beneficial for vulnerable road users – with reductions of up to 25% in casualties, according to estimates based on the “Safer City” project in Gloucester.

- Cycle schemes can produce good reductions in cyclist casualties.

- Road construction/improvements such as junction layouts or modifications, right-turn lanes, mini-roundabouts, roundabouts (although costs can be high).

- Surfacing such as anti-skid can provide benefits for motorists and good casualty reductions in car occupant crashes.

- Signs/lines and road markings.

Reducing casualties by making the road network safer has been a major objective for the local highway authorities in the United Kingdom for decades. Most authorities have an ongoing programme for treating accident "black-spots". Many authorities, however, are at the point where the bulk of the treatable "black spots" have been dealt with and casualty reductions are becoming harder and more expensive to achieve. As the clustered crashes associated with "black spots" are dealt with, a higher proportion of casualties fall into the category of scattered crashes. These scattered crashes are not associated with specific road features but occur more or less randomly over the network.

The United Kingdom has found that these scattered crashes can be effectively treated using urban safety management which involves using safety and traffic management measures to ensure that appropriate traffic uses the road according to a hierarchy of roads in the network. Safety in the network is improved by considering conflicts, speeds, etc. Another aspect of urban safety management relates to raising the profile of safety, both in the local authority and with the public. Training, publicity and consultation are major features of the strategy.

Barriers to success

Research undertaken in the 1970s and 1980s indicated that the road environment in the United Kingdom was the major factor in around 20% of crashes and a minor factor in most of the remaining 80%. Over the last 17 years a great deal has been done to improve the safety of the road environment; this would indicate that the number of crashes where the road is the major factor is now lower than 20% and falling. This suggests that there will be diminishing returns from road safety engineering measures in urban areas, which is partly borne out by recent findings that show that treating crash "black spots" in the United Kingdom is giving smaller returns than in the past. However, these schemes are still very cost-effective and there is still scope for significant crash reduction in urban areas. Also, installing road engineering measures is a very visible activity which raises the profile of road safety and supports other activities such as changing public opinion and driving behaviour.

The Netherlands has had a successful history in traffic calming. The Dutch invented both the *"Woonerven"* and the 30 km/h zones. However, these methods have their disadvantages: it is expensive to rebuild the infrastructure and there comes a point where road users will not put up with any more infrastructure inventions such as road humps and mini-roundabouts. These barriers have meant that the Netherlands is now exploring alternative countermeasures such as Intelligent Speed Adaptation systems which automatically control vehicle speeds.

Rural roads

This section is based on the OECD report *Safety Strategies for Rural Roads* (1999).

The nature of the problem

Rural road safety accounts for a considerable share of the total road safety problem. Each year, nearly 75 000 people are killed on rural roads in OECD countries. This equals more than 60% of all road fatalities in the OECD area.

The risk of being killed (per kilometre driven) is generally higher on rural roads than on urban roads, and is four to six times higher than on motorways. Rural road crashes are generally more severe than crashes on urban roads due to differences in operating speeds (higher on rural roads), road geometry (rural roads have evolved rather than having been designed), functionality (rural roads are multi-functional), enforcement levels (rural roads receive a lower priority) and other factors. This accounts for the increasing relative importance of rural road fatalities in relation to total road crash fatalities which has climbed from 50% in 1980 to more than 60% in 1996 in the OECD Member countries. Because OECD countries have generally experienced a reduction in the total number of road crash fatalities in the same period, it is clear that motorway and urban road safety improvements have been more successful than those on rural roads.

As much as 75% of all crashes on rural roads fall into three categories: single-vehicle crashes (especially running off the road), head-on collisions and collisions at intersections. Single-vehicle crashes constitute 35% or more of all fatal rural road crashes. This type of crash is most prevalent because all three elements of the family of hazard factors – *i.e.* the driver behaviour, the vehicle, and the road (infrastructure) environment – play a role in causing these crashes and increasing their severity. Head-on collisions make up nearly 25% of all fatal crashes on rural roads. Although driver behaviour (speed) and the road environment (conflict caused by the non-separation of opposing lanes) are the principal factors in these crashes, vehicle technology has the potential to lessen the severity of the crash. Collisions at intersections account for about 20% of all fatal rural road crashes. Again, driver behaviour and road infrastructure are the key contributing factors to these types of crashes.

Rural road crashes are scattered over the entire rural road network, excluding some specific unsafe locations. Under these circumstances, a pressing challenge for safety professionals is to understand the causes of these rural road crashes and the contributing factors. A main conclusion from this analysis is that the rural road system has inherent characteristics that significantly contribute to the high number of crashes and the high risks.

Inappropriate and excessive speeds are a key factor in rural road crashes as speeds on rural roads tend to be relatively high (80-120 km/h) under circumstances where such speeds cannot be driven safely all the time and everywhere. For example, rural roads generally do not have consistent design characteristics over their total length. This is especially the case for roads that were not planned, but have evolved over time. This requires constant speed adaptation to account for regularly changing situations and circumstances that increase the opportunities for human error and lead to a higher crash risk. Loss of control is a major factor, accounting for 35% of crashes on major rural roads and up to 60% of crashes on minor rural roads. These crashes are all the more serious when vehicles collide with an obstacle, which is the case for some 40% of fatalities in rural road crashes.

Heavy goods vehicles and buses constitute a special problem due to the fact that these types of vehicles have a speed behaviour that is quite different from that of automobiles. This speed variation generates more instances of overtaking, which in turn is a dangerous manoeuvre, as evidenced by the fact that head-on collisions are one of the major crash types on rural roads. In addition, it is common

to find slow-moving vehicles, such as agricultural vehicles, mopeds and cyclists, on rural roads. When traffic such as this is using the same physical space as fast-moving automobiles, the risk of crashes is amplified.

Approaches to solving the problem

The most important factors in improving rural road safety are reducing inappropriate and excessive speeds and implementing safe roadside design.

Infrastructure

Safety measures that address infrastructure offer the most plentiful opportunities for safety enhancement on rural roads and those that are low-cost and have high benefit-cost ratios have the greatest potential for widespread use. However, even though safety is understood to be an important criterion in road design, it is still too often of secondary importance. Safety should receive explicit attention at every level of the process, from the decision to build or rebuild a road to the planning and design stages, through construction and during operation and maintenance. The basis of safe road design is a consistent, hierarchical road network in which each road category has a particular function to fulfil. The design characteristics of a road need to be in line with its function and provide "positive guidance" for road users. From this standpoint, rural roads should be assigned a specific function rather than trying to cater to a varying mix of functions. In addition, the design of the road should be consistent with the function and in accordance with the lowest functional use of the road.

It should always be remembered that the ultimate level of safety on a road depends on the consistency of the design in all its aspects. For instance, a series of relatively wide curves should not be followed by a very narrow one without extensive warning and/or physical speed-reducing measures. Furthermore, it must be possible to negotiate an isolated curve or the first in a series of curves at a speed which is not excessively below the speed maintained on the straight section preceding it. Whereas there is a general trend that crash rates increase as a curve becomes narrower, from a safety point of view the consistency between curves along the road is at least as important. Using the planning process to minimise direct access to major rural roads and/or not allowing access at bends, hill crests and at or near intersections should be a minimum requirement for ensuring safe road infrastructure.

The main type of rural road crash (single-vehicle run-off crashes) occurs most often on horizontal curves rather than on adjacent tangent sections. This is also the case for many head-on crashes. Flattening horizontal curves is an effective crash-reduction measure. However, reconstruction of existing curves is expensive and probably only cost-effective on higher-volume roads. Less expensive measures are therefore recommended, such as removing (or protecting road users from) roadside hazards, flattening side slopes, improving pavement skid resistance, increasing the super-elevation, paving the shoulders and eliminating pavement edge drops. Typical low-cost measures in this regard include upgrading the pavement edge line and centre line in some situations, adding raised reflective pavement markers or upgrading the advance warning. Rumble devices along longitudinal sections can also be effective in reducing run-off crashes. The installation of roadside markings to guide drivers through a curve or a bridge are also beneficial for safety.

Forgiving roadside concepts and roadside improvements in general can significantly reduce the severity of crashes. There is very high potential for improving overall safety by treating or removing roadside obstacles such as trees, ditches, rocks, utility poles and steep slopes. In addition, obstacle-free zones of between 4 and 10 meters are desirable if the road geometry and right-of-way allow it. Finally,

knowledge transfer and training in the area of roadside safety are key actions that can contribute to better and more timely treatment of roadside hazards.

In relation to head-on collisions, prevention can be accomplished by (physically) separating opposing traffic. A rather drastic approach that is accomplishable on rural roads is narrow physical separation by means of a steel or concrete barrier. In order to reduce head-on collisions caused by overtaking manoeuvres, the provision of conflict-free overtaking opportunities – *i.e.* regular overtaking lanes or climbing lane installations with good forewarning – can have many advantages. In addition, a combination of increasing lane width and shoulder width is the most effective approach for preventing a variety of crash types, including head-on collisions.

In considering intersection collisions, roundabouts have a very good safety record in comparison to three- and four-way intersections. However, because roundabouts are a relatively expensive alternative, the decision to install roundabout intersections must be based on a thorough analysis of the cost-effectiveness of this solution in comparison to others. Channelisation as a remedial measure at existing ordinary intersections can be profitable, even if the annual average daily traffic (AADT) is less than 7 500 vehicles. In addition, road lighting at intersections will reduce the number of night-time collisions in some conditions; however, it is important that the lighting poles or masts in the roadside or median do not contribute to increasing the number of injury crashes through poor design or location.

In addressing the issue of speed variance on rural roads, separating slow and fast traffic will contribute to the overall safety of rural roads. There are a number of ways to accomplish separation: *i)* a parallel road or secondary traffic area for slow-moving vehicles; *ii)* a parallel, physically separated bicycle/pedestrian lane; *iii)* a lane at the outer side of the normal running lane for bicycle/pedestrian use only; and *iv)* a multi-purpose lane on the outer side of the road which in principle is assigned for bicyclists/pedestrians but which may be used by slow-moving motor vehicles to allow faster traffic to pass.

Police enforcement

Police enforcement is an effective symbol to show that road safety is deemed to be as important as other types of crimes and misdemeanours. This is especially important given the role played by inappropriate speed and excessive speed in rural road crashes. Effective enforcement can serve as a general deterrent factor that, combined with other actions including appropriate penalties and sufficient driver training, can bring about long-term behaviour changes in drivers. However, due to the great length of the network, enforcement by conventional means is very limited and one cannot rely only on strategies based on “improving behaviour on the spot” by spending police manpower alongside the road. Publicity campaigns associated with targeted enforcement can increase the enforcement effects and contribute to a change in driving behaviour. In a similar vein, repeated enforcement creates longer halo effects, in terms of either time or distance, in contrast to “blitz” campaigns. By introducing a random element, enforcement effectiveness can be increased and longer halo effects will be produced. Automated enforcement technologies that target the causes of the principal rural road crashes should be considered. Finally, funds generated by traffic enforcement could be earmarked for rural road safety to ensure that these important safety problems are addressed to the fullest extent possible.

Trauma management

Identifying a crash location is one of the key problems in responding to rural road crashes. Solutions include: improving road and kilometre/mile identification schemes; expanding the use of GPS; and exploring possibilities for automated crash detection. Communications technologies can contribute to improving rural road safety; for example, cellular telephones can shorten arrival time at the scene of an accident and improve the overall information available about a crash situation. Publicity campaigns, in conjunction with more widespread first-aid training, play a role in improving trauma treatment at the scene of a rural road crash. Common guidelines and standard procedures could be adopted by local hospitals to improve trauma treatment.

Barriers to success

It is quite evident that the current knowledge and expertise about how to improve rural road safety is not sufficient. For instance, there is insufficient understanding about why road users make errors that sometimes lead to crashes or why, on a massive scale, they do not obey speed limits. Knowledge is also rather limited regarding how to influence human behaviour effectively and efficiently.

Currently, insufficient information is available on rural road safety problems to adequately support appropriate policy and investment decisions. This is important because improving rural road safety will require unified methods for collecting and reporting crash data, identifying exposure measures, monitoring and evaluating countermeasures and estimating the cost-effectiveness and benefit-cost ratios of these countermeasures. With these co-ordinated methods in place, it would be possible to build a sound basis for rational rural road safety policies.

Commercial vehicles

Nature of the problem

Of the countries surveyed, Canada, Finland, Italy, Sweden, Turkey and the United States cited commercial vehicles as posing a particular road safety problem. The problem concerns not only heavy goods vehicles (HGVs) that carry goods but also buses and vehicles that transport people.

In Italy, goods are mainly transported by road rather than by rail. Nevertheless, commercial vehicles still only account for a fairly small proportion of vehicles on the road. A recent Italian Road Agency study of crashes showed that 90% of vehicles on the road in 1997 were in fact non-commercial. Of the crashes which occurred in 1997, 69% involved (private) cars, 7% commercial vehicles, 21% motorcycles and 3% other vehicles. Evidence shows that, despite the low proportion of crashes involving commercial vehicles, the severity of such crashes is very high.

For all fatalities resulting from crashes on Australian roads, one in five involves a truck. Trucks are also involved in 10% of serious injury crashes. However, for most of these fatalities and serious injuries, the truck driver is not at fault. In fact, car drivers were primarily responsible for five out of six crashes involving an articulated truck, and for two out of three crashes involving a rigid truck. There has been a general decline of 17% in the number of fatalities and serious injuries resulting from all crashes involving trucks since 1990. The decline in truck-related road trauma exceeds the general decline in fatalities and serious injuries for all types of vehicles. In 1995, there was a 14% decline in all fatalities and a 9% decline in all serious injuries since 1990 (Federal Office of Road Safety, 1997).

Truck drivers have a greater level of exposure, *i.e.* they drive many more kilometres than the average driver, and this needs to be taken into account when comparing trends. The number of people killed or seriously injured per 100 million kilometres travelled provides a measure of risk that takes into account the level of exposure. In Sweden, research on public transport showed that in 1997 approximately 300/400 people were injured on buses and about 700/1 000 lorry drivers were injured in crashes.

In Finland, the likelihood of commercial vehicle crashes is greatest during the winter and spring periods. Other countries highlighted problems involving narrow bridges, crossings, urban areas and HGVs with mechanical defects.

Approaches to solving the problem

Key issues in commercial vehicle safety are training (OECD, 1996), fatigue (see earlier section on fatigue) and industry pressures. Governments have long attempted to combat fatigue by regulating drivers' hours. Problems with such regulations have included the falsifying of logbooks and the difficulties in enforcing the regulations. In addition, regulations in some countries led to accumulated fatigue as regulated driving hours were not synchronised to the human body clock (for example, work/rest shift patterns in the United States could lead to 18-hour cycles). The Australian Government has tackled this problem in conjunction with the road transport industry as part of its overall road transport reform agenda.

Reforms in Australia with safety as a central target include dangerous goods legislation, bus and truck driving hours, roadworthiness and alternative compliance including fatigue management (see earlier section on fatigue) and vehicle maintenance (National Road Transport Commission, 1997).

In addition, safety campaigns were introduced with a focus on truck safety. These included a joint industry/government initiative to target speeding trucks, as well as public awareness campaigns aimed at helping other drivers understand the space requirements of heavy vehicles, such as "Cut Out Cutting In". Road transport industry organisations, such as the Australian Trucking Association, focused on "cleaning up the industry" to improve its safety record through initiatives such as TruckSafe, an industry-based voluntary accreditation scheme under which truck operators must meet certain specified standards and associated criteria. These standards have been developed by the industry and cover four main areas: maintenance management; workplace and driver health; training; and management.

The United States has a target to reduce truck and bus fatalities by 50% between 1999 and 2009. Strategies to meet these targets include new hours of service regulations, improved enforcement, training, licensing, data collection, border monitoring of foreign carriers and performance incentive grants (Federal Motor Carrier Safety Administration, 2000a, 2000b).

In Italy, resources have been allocated exclusively to road safety, using guard rails conforming to the road national plan, adopting the low water retention road surface, increasing safety in tunnels by means of new road signs and structural interventions, and promoting an advertising campaign for seatbelt use.

Turkey has carried out educational driving courses and increased controls on lorries. Driver training has been introduced in Finland, together with speed limits during the winter period.

In many countries, fines have been increased. In others, such as Canada, temporary mechanical controls have been introduced on vehicles. In European countries, the number of consecutive driving

hours for commercial drivers has been limited, and heavy vehicles have speed limiters as well as being subject to lower speed limits than light vehicles.

The United States has increased safety through roadside inspection, compliance reviews of motor carriers' safety management practices, and driver education schemes. Research is continuing into the use of anti-lock braking systems, electronically controlled braking and emergency response systems.

Barriers to success

In Italy, the use of low water retention road surfaces has contributed significantly to improving road safety during the rainy seasons. However, wide-scale implementation is slow and expensive.

Safety equipment

The nature of the problem

The use of safety equipment in vehicles is key to preventing fatal injuries during road crashes. Steps to lessen the severity of crashes, *e.g.* through the installation of safety equipment in vehicles, are often called "passive safety", while attempts to prevent crashes *per se* are termed "active safety". The most important equipment can be considered to be seatbelts, child restraints, helmets and air bags. The use of seatbelts for drivers, child restraints and motorcycle helmets is usually obligatory. Less frequently, the same applies to seatbelts for passengers (especially in rear seats), bicycle helmets and air bags.

The main problems regarding safety equipment were found to be:

- Low use of seatbelts for drivers and front-seat passengers.
- Extremely low use of seatbelts for rear-seat passengers.
- Non-mandatory use of seatbelts in buses.
- Low use of child restraints in some countries.
- Incorrect use of child restraints.
- Low use of motorcycle helmets in some countries.
- Low use of bicycle helmets for children in most countries.
- Extremely low use of bicycle helmets for adults.
- Low proportion of vehicles fitted with air bags.

Seatbelt use

The evidence of the benefits of wearing a seatbelt seems to be clear-cut and indisputable. Most countries have made the use of seatbelts mandatory. Table 4.3 shows how seatbelt use varies across countries (most of the information gathered refers to cars). For drivers, wearing rates exceed 80% in around half the countries in the table, including most northern European countries, Australia, Canada, New Zealand and Japan. Seatbelt usage is much lower in the United States, Denmark, Austria, France (except on rural roads), and Eastern Europe. There is a tendency for driver wearing rates to be higher on rural than on urban roads, an exception being Spain where urban rates are twice those on rural roads. Front-seat passenger rates are similar to those for drivers, but in most countries rear-seat passengers are less likely to wear seatbelts. Seatbelt usage seems to have been improving continuously, but notions of freedom have sometimes been an obstacle, *e.g.* in the United States.

Table 4.3. **Seatbelt use by drivers and passengers**

Percentages

Country	Year	Urban			Rural		
		Driver	Front pass.	Rear pass.	Driver	Front pass.	Rear pass.
Austria	1995	66			78		
Canada	1995	92		51			
Czech Republic	1996	32	25	12	62	62	13
Denmark	1993	60		31	78		33
Finland	1997	82	82	66	92	92	66
France	1995	70			92		
Germany	1995	96			93		
Hungary	1995	48	48	9	59		
Iceland	1999	80	80	80	90	92	92
Japan	1998	87	80		87	80	
Netherlands	1998	67	72	46	80	82	48
New Zealand	1998	87	87	62	91	91	62
Norway	1999	82	92	82	91	93	82
Poland	1997	73		9	82		9
Spain	1996	81	85	23	42	51	17
Sweden	1999	77	81		90	92	74
United Kingdom	1999	88	92	71	94	95	80
United States	1995	61	56	38	60		

Poland: Differences across areas for rear seats is not known.
Canada: Number for rear seatbelts comes from Quebec.
Italy: Seatbelt use in general is estimated to be 10-20%.
Australia: 95% for all car occupants, up to 98% in some cities, rear seat 80-86%.

Some countries provided information on how many lives could have been saved by using seatbelts. Finland states that according to international studies (including Finnish studies) nearly 50% of lives could have been saved. Norway states that a car driver's risk of being killed is reduced by 50% if he/she wears a seatbelt. Denmark highlights a 20-30% reduction in the number of hospitalised front-seat drivers and passengers after the use of seatbelts became compulsory. In the United Kingdom, it is estimated that since seatbelt wearing was made compulsory, there have been at least 370 fewer deaths and 7 000 fewer serious injuries per year to front-seat occupants. Savings to rear-seat passengers are estimated at 70 deaths and 1 000 serious injuries per year. The United States estimates that in 1997 safety belt usage saved an estimated 10 750 lives among passenger vehicle occupants over the age of four. An estimated 19 million more Americans began using seatbelts in 1998. If this rate of increase is sustained, an estimated 1 500 lives may be saved every year.

Laws and regulations in the majority of countries have been changing to make the use of seatbelts mandatory everywhere in the car (both front- and back-seat passengers) and in all areas (both urban and rural). However, in some countries, *e.g.* the Czech Republic and Poland, urban areas and/or rear seats are not included in the legislation. Some countries apply special rules to buses, taxis or heavy vehicles. There is a common tendency not to make exceptions to this general rule, except for some passengers in buses. Countries with exceptions include Norway, Iceland, Finland, Poland and the Czech Republic. It is usually not obligatory to use seatbelts for bus passengers with open space before them, *i.e.* those travelling next to drivers, toilets, entrances and exits. In many countries, such a regulation is now being planned.

Child restraints

The evidence of the benefits of using child restraints seems to be clear-cut. Most countries have made the use of child restraints mandatory. Table 4.4 shows that most countries have a very high rate of use for child restraints, although problems persist in certain countries, *e.g.* Poland, the Czech Republic, Spain, Canada and New Zealand. Wearing rates tend to be higher for the youngest children. There is much more variability among countries in the wearing rates for older children; these vary from 96% in Iceland to as low as 6% in the United States. It has been stated that such equipment is expensive and duties should be reduced.

Table 4.4. **Use of child restraints**

Percentages

Country	Year	Young children 0-4 years	Older children 5-12 years
Australia		>90	>90
Canada	1992	71	---
Czech Republic	1996	49	17
Denmark	1993	87/77	61/56
Finland		95-100/75-80	---
Iceland	1998	98	96
Netherlands		94	---
New Zealand	1998	76	---
Norway	1999	93/88/85	88/86/79
Poland	2000	67	36
Spain	1996	64	16
Sweden	1998	98	95
United Kingdom	1999	93	84
United States	1998	93/87	6

Finland: Nearly all children under the age of one and 70-80% of those 1-4 years old.
Norway: 0-3 years and 4-14 years, average from built-up and rural areas and motorways.
Iceland: Only one figure for children of 0-14 years.
United States: 93% of children aged 0-1, 87% of children aged 1-4; for older children, booster seat only.
Denmark: 0-9 months, 9 months-3 years, 4-7 years, 8-14 years.
Czech Republic: Average from urban, rural and motorways.

There is some indication that the problem is not with the use of the equipment (often more than 90% of children are restrained), but rather with using it correctly. Documents from Canada indicate that about half of those using child restraints use them incorrectly. The restraints, for example, can be wrong for the child's age or weight, improperly fastened, put in the wrong place or facing in the wrong direction, and so forth. Incorrect fitting can also be a problem.

Motorcycle helmets

The benefits of using motorcycle helmets are clear. Everybody on a motorcycle should use a motorcycle helmet and, in fact, the use of motorcycle helmets is mandatory nearly everywhere. In those countries for which information is available (Spain, New Zealand, the United Kingdom, Norway, Iceland, Sweden, Japan, the Czech Republic and the United States), helmet wearing is almost universal, except in the United States. In the United States, helmets are worn by about 64% of motorcycle riders, and only 26 states have mandatory laws today (although helmets used to be mandatory in 47). The reason for this is opposition from local motorcycle organisations. As a consequence, the death rate for users of motorcycles in the United States is on the increase. In some other countries, *e.g.* Norway and Iceland, the motorcycle organisations support mandatory laws.

Cycle helmets

The use of bicycle helmets is considered to be crucial, especially for children, and wearing rates are increasing world-wide (Table 4.5).

Table 4.5. **Percentage of cyclists using bicycle helmets**

Country	Year	Children 0-4	Teenagers 11-16	Adults >16
Australia		60-80	60-80	
Czech Republic		20-30	20-30	Very low
Denmark		34	5	3
Finland		80	21	21
Iceland		72	16	18
Japan		Very low	Very low	Very low
Netherlands		Low	Low	Low
New Zealand	1999	98	94	92
Norway	1999	58/52	14/14	19/29
Sweden	1999	50	33	13
United Kingdom	1999		10-15	7-22
United States		<20	<20	<20

Finland: Under school age, over school age.
Czech Republic: Greater use by leisure cyclists than by commuters.
Norway: 0-11 years, 12-17 years, > 17 years.
Iceland: 0-13 years, 14-19 years, > 19 years.
Denmark: 0-9 years, 10-25 years, > 25 years.
New Zealand: 5-12 years, 13-17 years, > 17 years.
United Kingdom: 11-16 column shows all children 16 years of age and below; figures given are for urban main roads/minor roads separately.

Wearing rates tend to be higher for younger children than for teenagers and adults. They vary widely across countries, reflecting different rules on compulsion. In many countries, the use of bicycle helmets is not compulsory, *e.g.* in France, the United States, the United Kingdom, the Czech Republic, Poland, Norway and Finland. In Iceland, children have to use a bicycle helmet, and in Australia, helmet wearing is compulsory for all cyclists. In Iceland, the bicycle helmet-wearing rate for small children is higher in rural areas, but for teenagers, and especially for adults, it is higher in urban areas, although not high enough. In the United Kingdom, wearing rates for both adults and children are higher on main roads than on minor roads.

Research suggests that all cyclists should use this safety equipment. A literature review of research on cycle helmets (Royle, 1994) found that several studies indicate that wearing a cycle helmet reduces the severity of head injuries. For example, a study by Dorsch *et al.* (1987) in Australia estimated that the risk of death from head injury is 3-10 times higher for unhelmeted cyclists relative to those wearing helmets.

Royles also reviewed attitudes to cycle helmets. The main reasons cited by children for not wearing helmets were that they look silly, that they are uncomfortable to wear, and that children fear being teased by their peers. Adults stated that they did not wear helmets because of their cost, their poor appearance, their inconvenience, and also because of the low perceived risk. Although the studies in the review date back to the late 1980s and early 1990s, the findings are supported by a UK study of attitudes to cycle helmets (Halliday *et al.*, 1996). Young people in particular thought that helmets were unattractive and unfashionable, and they felt self-conscious about wearing them. Other deterrents to helmet wearing were discomfort, the inconvenience of carrying a helmet around, price, and the low level of perceived risk.

Several countries have attempted to raise cycle helmet wearing rates, by making wearing compulsory, through education and publicity, and through discounted purchase schemes. Results of a survey of cycle helmet wearing in the United Kingdom in 1999 showed that wearing rates for adults on a sample of urban main roads which had been previously surveyed in 1994 had increased from 16% to 22%. However, child wearing rates fell from 18% in 1994 to 15% in 1999. In Finland, a helmet damaged in a crash can be returned and replaced at no cost to the user.

Air bags

The use of air bags can lessen the impact of certain crashes, *e.g.* frontal crashes. Some danger can be involved, for child seats and infants (or if the person sitting in the seat is small and lightweight).

Airbags are mandatory in the United States because it is the only way to ensure that occupants who do not wear seatbelts have some form of protection in crashes (the seatbelt-wearing rate in the United States approaches 70%). To protect the unbelted, US airbags fire earlier and with greater force compared to other countries such as Australia. This means that small occupants and the elderly are disadvantaged and low-speed crash cases are now emerging where the so-called “aggressive” US airbags have caused fatal or serious injuries in cases where these occupants have been sitting close to the airbag when it has deployed.

In Australia, airbags are designed as a supplement to the lap shoulder seatbelt. As a result, the airbags fire later and inflate with less force. The Design Rule requires the seatbelts to be fastened; seatbelt wearing in Australia is over 95% (Federal Office of Road Safety, 1996).

Improvements are being developed (United States) by varying the force depending on the size of the occupant and the dynamics of the crash. New vehicle features, such as air bags, can take a long

time to achieve widespread usage, because they are installed only in new vehicles. However, air bags are becoming increasingly common. According to EU Directives No. 96/79 and No. 96/27, cars are very unlikely to pass a collision test unless they have air bags installed. Stricter mandatory laws are unlikely to emerge unless technical improvements are made to air bags and they are put into use and common practice. Current usage of air bags is summarised in Table 4.6.

Table 4.6. **Use of air bags**

Percentages

Country	Year	Use of air bags
Australia	1998	10-20%
Czech Republic	1998	<5%
Denmark	From 1.10.1998 From 1.1.2003	All new car models All new cars
Finland	1998	30%
Poland	2000	16%
Spain	1996	14%
Sweden	1999	44%
United States	From 1.9.1989	All new private cars

Head restraints (and rear-end safety)

A safety area for which facts are hard to find, but which nevertheless must be considered to represent a growing traffic safety problem, involves rear-end crashes. Due to increasing traffic density in most European and American countries, the risk of being hit from behind is growing rapidly.

In the Netherlands, the share of police-registered rear-end crashes has increased from about 4% in 1985 to 12% in 1999. The real annual number of casualties suffering whiplash injury is estimated at about 25 000 (of a real total of some 250 000 traffic casualties needing professional medical treatment).

These injuries, although not considered serious, may result in about 10% of cases in long-lasting incapacity (pain, immobility of the neck, lack of sleep, lack of concentration, etc.)

The standard remedy, currently available in most cars, are head restraints. However, head restraints are often not used properly (with regard to vertical height adjustment) or are improperly designed. In particular, the level of protection given by head restraints conforming to current legislation in Europe is not sufficient for tall people.

Approaches to solving the problem

Most countries stated that their approach to this problem was to make the use of safety equipment mandatory. To be successful, this needs to be combined with increasing public awareness and enforcement. Some form of demerit point system was found to be a good way of making enforcement effective. A strong relationship between mandatory law and high usage rates was evident from an observation of various countries' data.

Many countries have goals for the future, in general targeted to improving the usage rate to a certain percentage in a defined period of time. In the United States, the goal is to increase national

seatbelt usage to 90% by the year 2005. The Norwegian goals are: 95% seatbelt use for adults, 97% use of child restraints for children under four and 60% use of bicycle helmets for all ages.

EuroNCAP is a test programme of new cars, originally designed by European consumer associations, but currently sponsored by the European Union, several European governments, research institutes and the car industry. Some of the test requirements (especially those regarding frontal collisions) are set at a higher level than the current European Commission Directives on the same subject. It appears that the results of the tests, which are internationally published and discussed on a regular basis, influence car manufacturers' decisions in terms of improving the safety aspects of their cars, especially in the event of unsatisfactory results.

The system is also used to incorporate tests concerning safety areas that until now have not been covered by legislation, or where it appears very difficult to finalise this process (*e.g.* protection of pedestrians involved in collisions with the front end of cars). The system may well be used to incorporate new areas of car safety, such as rear-end protection. EuroNCAP therefore acts as a direct (and faster) procedure for improving car safety than would be possible through the normal process of legislation.

Barriers to success

Eastern European countries stated that the lack of police control of traffic in their countries was a barrier to enforcing the use of safety equipment. In addition, a major obstacle for these countries is cost; safety equipment is considered too expensive and seen as dispensable. This especially applies to air bags and cycle helmets.

Some countries consider the current usage rates of safety equipment to be too low. The most commonly mentioned barriers are cost and a lack of understanding by both governments and the general public. As with other measures, increased enforcement, stricter laws and regulations and better traffic education are central to improving the situation.

A very useful method to encourage the use of safety equipment is to reduce duties, thereby lowering the price of the equipment.

Emerging problems and solutions

Elderly road users

The ageing of populations in OECD Member countries suggests that the over-60s will emerge as the highest risk road safety group within the next ten years, overtaking the 17-25 year old age group.

- Two-thirds of all people over 65 who ever lived are alive today, while the fastest growing age group is in the 85+ range.

- Thirty years from now (2030), one in four people in the developed world will be aged 65 or over.

- In designing occupant protection systems, vehicle manufacturers need to give higher priority to minimising serious injuries for the elderly, particularly the incidence of chest and rib injuries, which can prove fatal to older persons.

Pedestrian safety and the ability of the elderly to adapt to new vehicle, traffic and road technologies, such as Intelligent Transport Systems, could represent significant challenges for future road safety policy. The OECD report *Ageing and Transport: Mobility Needs and Safety Issues* (2001) tackles this issue.

Tunnel safety

Crashes and other incidents (such as fires) in tunnels can have serious consequences, as has been demonstrated by a number of recent high-profile incidents. Improvements in tunnel engineering technologies and competition for space has meant that tunnels are increasingly built as part of urban road networks. Fortunately, risk reduction measures have also improved, whether through engineering design or improved emergency response processes. A study on *Safety in Tunnels: Transport of Dangerous Goods through Road Tunnels*, carried out by the OECD and the World Road Association (PIARC), was published in 2001. While the focus of the study is on dangerous goods, many of its findings and recommendations are valid for tunnel safety in general.

Research and documentation

Information and documentation resources are indispensable for data reference and research. This section presents a list of sources of information and documentation linked to aspects of road safety. This is not a definitive list, since the dissemination of information is evolving; however, it should assist researchers interested in obtaining information from other countries.

Bibliographical databases

The International Transport Research Documentation (ITRD) database (formerly International Road Research Documentation), managed through the OECD, is a unique co-operative system providing systematic worldwide exchange of information on scientific and technical literature and current research programmes. Its goal is to collect and disseminate information related to transport research. Currently, the database contains more than 300 000 scientific references from the world's published literature (reports, books, journal articles, conference proceedings), each with an informative abstract. Some 10 000 references are added each year. Summaries of ongoing research are also featured through TRIP (Transport Research in Progress). Four official languages are represented in the database: English, French, German and Spanish.

The Transportation Research Information Services (TRIS) database contains a comprehensive bibliographic resource on transportation information. It is in English only, however, and abstracts are not always available. TRIS is produced and maintained by the US Transportation Research Board at the National Academies of Sciences, and will be available through the Internet (http://ntl.bts.gov/tris).

The ITRD and TRIS databases are also available on CD-ROM.

Expert networks

The World Interchange Network (http://www.piarc.org/rme/index.html) was established as a global road transport knowledge exchange network. Its aim is to put professionals in contact with experts in the field through a worldwide network of contact nodes.

Finally, there are many research and other organisations involved in road safety. The United Nations Economic Commission for Europe hosts a set of Road Safety Links to the Web sites of relevant institutes. These links can be found at http://www.unece.org/trans/roadsafe/rslin.htm.

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Chapter 5

EFFECTIVE MANAGEMENT FOR IMPROVED ROAD SAFETY

What is safety management?

Safety management is a systematic process aimed at reducing the number and severity of road-related crashes. An effective safety management process provides information for selecting and implementing successful road safety strategies and projects; it leads to improved decision making. The national institutions that affect or are involved in road safety – and the relationships between these organisations – are key to the success of the safety management process.

This chapter describes the various organisations involved in the management of road safety. Institutional set-ups have evolved differently, based on historical developments, constitution, social and economic conditions, political organisation, road safety vision and road safety planning and implementation process. Likewise, funding issues and tax regimes differ, as do the responsibilities of national, regional and local governments. Hence, no ideal institutional arrangement can be recommended. This chapter highlights some of the difficulties experienced in the countries studied. It recommends good practice to achieve good safety management systems for and between road system components. The components of the road system are:

- The *road infrastructure* component includes the regulations and standards that govern the planning, design, construction, maintenance and operation of the roadway and roadside. Included in this component are directional and traffic control signs, signals and pavement markings, and roadside barriers.

- The *vehicle* component includes the legislation, regulations and standards that govern the manufacture, operation and maintenance of automobiles, motorcycles, trucks and buses, and associated equipment. Regulations govern the manufacture of these vehicles as well as their safe maintenance and operating conditions.

- The *road user* component includes the regulations and public education that govern and provide information on the behaviour of drivers, occupants, bicyclists and pedestrians, respectively. The public education content may involve non-transportation experts.

It is clear that many different actors are involved in road safety. It is therefore vital that their activities are well co-ordinated to address a common problem in an integrated way. Successful safety management builds upon a systematic relationship between organisations. These arrangements and relationships are institutional and personal. Often, the personal side is essential to overcome long-standing institutional barriers to integrating road safety in non-traditional areas.

Safety management relies first and foremost on the creation of a team of individuals representing organisations with an interest in road safety (vehicle and highway engineers, educators, motor vehicle fleet operators, police, emergency medical technicians, advocates, distributors of goods, and hospital

administrators). This team may be actual or virtual. When these diverse safety interests work together, an integrated approach to safety planning and programmes is born. This ensures more efficient use of limited resources and enables various road safety disciplines and interests to work together to achieve sustainable road safety goals.

Effective safety management processes are dependent upon complete, high-quality data that are transformed into information by expert analysts. They are strengthened when there is a high level of data and information sharing. Linkages between data systems can accomplish increased value in the data used for problem identification and evaluation of results.

In summary, an effective safety management system or process should include the following elements:

- *Political commitment:* to achieve effective outcomes, road safety has to be placed high on the political agenda.

- *Co-ordination:* integration of road safety issues and solutions through communication, co-ordination, and co-operation among the organisations (both public and private) involved with road safety [to include the communities where people live, roadway, roadside, human behaviour, vehicle design and operation considerations, shippers, the motor carrier industry (trucks and buses), emergency response services, roadway users, and pedestrian and other special users].

- *Leadership:* a focal point for co-ordination of the development, establishment and implementation of safety goals (targets), programme development and implementation, and data and information sharing among the above organisations.

- *Safety planning:* short- and long-term road safety goals and plans with specific funding to address identified safety problems. Taxation and user fees represent the primary sources of funding for safety. The extent to which funds are available on a reliable basis has a direct impact on safety conditions.

- *Data sharing and data quality:* collection, analysis, linkage and use of all aspects of road safety data including enforcement and judicial data for drivers.

- *Evaluation:* in addition to the evaluation of specific programmes, there is periodic and intentional assessment of safety management.

- *Accountability:* evaluation of the effectiveness of the organisational structures, requirements and practices where there are identified safety responsibilities.

- *Marketing, outreach and public education:* public information and education activities.

- *Equipped staff:* to identify the skills, resources and training needed to implement road safety programmes and to act as expert technical advisors to the executives who make road safety decisions.

Road safety management in different countries

Most countries have a national government organisation responsible for road safety, generally the Transport Ministry or agency. Typically, there is a tendency to keep the three aspects of road safety (*i.e.* road infrastructure, road vehicles and road users) organisationally separate within the national

transport agency or separated as different transport agencies. In some cases, the relationship between these organisations is stated in the law. Examples of these organisational arrangements include:

- In Canada, Japan, Finland and the Netherlands, co-ordination is carried out through groups that represent different agencies or private sector interests.
- Road safety is part of all activities in Norway.
- In Iceland, road safety plans are required by Parliamentary resolution.
- Health and road safety policies in Canada and the United Kingdom provide a link between road safety initiatives and health.
- Belgium treats road safety as a component of broader mobility policies.
- Participation by the private sector and/or citizen groups takes place in most countries (at least in target setting).
- Some countries do not have co-ordinated road safety programmes at the national level.

A more detailed, cross-country summary is given in Annex B.

Many safety programmes are developed independently of each other, rather than systematically, in the countries surveyed. This is because organisational arrangements can represent a barrier to integrated planning and execution for road safety. Significantly, co-ordination within the agencies responsible for road building and road safety may not be assumed or integrated. Also, co-ordination between road safety programme on infrastructure and other programmes (for example, on regulations, vehicles) which are set by other authorities may not be assumed either.

In countries where a number of organisations take part in the planning and implementation of road safety programmes, the activities of the organisations are integrated and co-ordinated through regular meetings and/or joint committees. Such meetings may occur at state/provincial/regional level as well as at the national level.

The following sections provide a general summary of the organisations that perform management functions for each component of road safety (infrastructure safety, vehicle safety and road user safety) and describe the organisations involved in the safety management tasks (setting targets, developing and implementing programmes), co-ordination, evaluation and budget.

Management of road infrastructure safety

The road infrastructure component covers the regulations and standards that govern the planning, design, construction, maintenance and operation of the roadway and roadside. Included in this component are directional and traffic control signs, signals and pavement markings, and roadside barriers. Road infrastructure may also be referred to as road facility.

Organisations

Road safety for infrastructure is generally determined by the engineering agency responsible for planning, designing and building the roads. It is usually part of the Transport Ministry (agency) or its consultative body. The national legislature or relevant minister often sets the direction for overall road

safety. In many cases, planning and directing is carried out by a road management body with the involvement of other government organisations with jurisdiction in areas outside transportation, such as environment, health, welfare and education.

Co-ordination

In many countries, other organisations are indirectly involved as partners. Public ministries or agencies in this category include justice (police), welfare, education, environment and research institutes. The private sector is represented by driving schools, insurance companies, associations of local or regional transport agencies, motor vehicle manufacturers, trucking associations, universities and citizen groups. In the United States, there is a mandatory process for planning roads that involves the community and by law includes environmental factors and, since 1999, safety factors.

Evaluation

The implementation and evaluation of road safety infrastructure programmes at both the national and regional levels is primarily the responsibility of the organisation that planned the programmes. For road infrastructure safety, no nation has established an evaluation body which is different from the programme development and implementation organisations.

Evaluation of road infrastructure safety improvements is usually based on the measures used for evaluating vehicle and road user safety (*i.e.* traffic crash rate and the decline in the damage caused by road crashes). The evaluation results are therefore based on the implementation of *all* safety programmes (infrastructure, vehicle and road users).

It is difficult to isolate the results of road safety programme on infrastructure from those for vehicle and road users. Causation studies are not systematically used to identify specific road features that are unsafe or as a basis for measuring improvements. The usual assumption is that the driver made an error, the pedestrian was in error, and/or the vehicle failed. However “black spot” programmes have been effective in some countries (*e.g.* Australia, United Kingdom) in identifying infrastructure in need of safety improvements. The United Kingdom is setting up a system for recording contributory factors in the national crash reporting system.

Road safety planners use evaluation to modify existing programmes and plan subsequent programmes. Countermeasure evaluation of infrastructure is actively carried out in most countries. In such cases, the road management body which implements the countermeasure is responsible for the evaluation. The evaluation results are used by the responsible agency to systematically modify standards for future construction and operations, and to correct discrete locations.

For example, in Australia and the United Kingdom, there is a practice of performing road infrastructure safety audits (or *road safety audits*). The United States has also expanded a pilot test of a similar initiative. Interdisciplinary teams made up of road engineers, law enforcement and human behaviour teams conduct these audits. Canada is also currently establishing national guidelines for road safety audits.

Funding

In general, road management bodies use funds from their road construction budgets to construct road facilities with safety functions. The sources of these budgets are primarily taxes (national or regional).

The exception is for countries with "black spot" programmes (for example, Australia) which have dedicated funds to address sites on the road network with a bad crash history. In the United Kingdom, road safety schemes are funded through Local Highway Authorities' Local Transport Plans. The Netherlands, the United States and France are among the countries that set up separate budget frameworks for road safety programmes. In other cases, fines collected from traffic offenders are used to improve road safety.

Management of vehicle safety

The vehicle safety component includes the legislation, regulations and standards that govern the manufacture, operation and maintenance of automobiles, motorcycles, trucks and buses, and associated equipment.

Organisations

The technical aspect of vehicle safety differs from road infrastructure and road users' safety. It is strictly bound by the legislation and standards which set out necessary minimum requirements. In all countries, the national (federal) Ministry of Transport and/or police (or ministry supervising the national police forces) have the authority to set legal regulations, based on the results of independent research. These authorities are also responsible for the implementation and co-ordination of the vehicle safety measures. Where national committees for road safety exist, they are strictly advisory bodies, without decision-making authority. Interested lobbyists include:

- The automotive industry (vehicle manufacturers and dealers), who promote their own interests, although in some cases these are similar to the legal requirements.

- Vehicle users (automobile clubs, associations of transport operators, associations of professional drivers). Their requirements are usually in favour of safety, although in some cases lower costs (and thus lower safety levels) are preferred.

Co-ordination

An important feature of vehicle safety management is the international co-ordination of legal measures (usually within regions). Vehicle safety is generally implemented according to international agreements, making implementation easier since the organisational responsibilities are included. Compliance with those regulations is provided by a process of certification before introduction of the vehicle on the market and by continuous testing during its lifetime. Testing or inspection is carried out at authorised check points (garages or roadside) using special equipment, regularly checked by an official body (usually a governmental agency or an independent organisation approved by the Ministry of Transport).

Specific agencies give each tested vehicle an official document and in many countries also a sticker affixed to the windscreen or registration plate indicating the date at which the next test is due. Police in most countries are authorised to check the actual technical conditions of the vehicle on the road. In many countries, such inspections are conducted on commercial trucks and buses either on the roadside or at weighing facilities. The range of the "on-the-spot" test is limited by the technical equipment available.

Evaluation

Because of the strong legal basis for vehicle safety standards, data are evaluated and used by official bodies at the national, regional and also international public sector levels and by the motor vehicle manufacturing industry.

Funding

Generally, all vehicle safety issues are funded from the national budget, although the majority of costs are borne by road users (who pay fees for roadworthiness checks/tests) or manufacturers (who pay fees for certification). Vehicle tests are a lucrative business in several countries, with the profits being used to fund other road safety activities.

Management of road user safety

The road user component includes the regulations and public education that govern, and provide information which affects, the behaviour of all drivers, occupants, bicyclists and pedestrians. The public education content may involve non-transportation experts.

Organisations

The direction for road user safety is usually set at national level by the Transport Ministry (agency) or its consultative body. In some cases, comprehensive direction is set for overall road safety (although not necessarily separated into these three categories); however, many countries have divisions responsible for road user behaviour programmes. The safety measures for road users are closely related to road infrastructure and vehicles.

Organisations which may be involved in setting direction include advocacy groups and associations, automobile associations, education, medical, health and emergency professionals, the court system, the police, the insurance industry, the driving school industry, and commercial truck and bus associations. Not all countries have citizen's advisory groups participating in setting directions. Where they do, there are advocacy groups with special interests, technical associations, non-technical associations as well as private crash prevention agencies representing interest groups. Among the special interests are anti-drink-driving, motorcyclists, bicyclists, children, novice and young drivers, commercial drivers, public education, driving schools, emergency services.

Co-ordination

The key issue in co-ordination is getting all the stakeholders together (infrastructure providers, vehicle industry, road user groups, police, emergency response services). Good practice is based on dialogue among diverse stakeholders, access to information, integration of safety into other facets of government and non-government activity and development of master plans.

In general, one organisation is responsible for developing, implementing and evaluating road user safety programmes. The level of involvement of other stakeholders (research institutes, universities, police, vehicle and insurance industries, etc.) varies from country to country. While driving regulations and laws are generally set at the national level and enforced by the police, programmes addressing areas of specific interest may be developed at the national, regional or local level.

Co-ordination problems include:

- Absence of specific road user emphasis.
- Lack of mandate.
- Competing priorities.
- Insufficient funding.
- Lack of human resources where they are needed.
- Need for a common language given the diverse interests of stakeholders.
- Barriers to communication when programmes are decentralised.
- Insufficient experience.
- Lack of authority.
- Public reluctance to comply with laws.
- Insufficient data and information.

In a number of countries, due to the structure of the government and the laws governing co-ordination between government agencies, there is no co-ordination. In this case, there is little or no citizen involvement or advocacy.

Plans for overcoming problems and barriers include:

- Customer surveys and analysis of responses.
- Public education and awareness campaigns for safety and traffic operations.
- Reinforcing the importance of road safety with politicians and the courts system.
- Better publication of information.
- Increased voluntary involvement of stakeholders.

The questionnaire responses indicate that the leaders in overcoming these barriers are the agencies that set the targets.

Evaluation

Generally, evaluation is not carried out by independent organisations, but is conducted by the organisation that sets targets and plans and implements the programmes. Occasionally, private sector stakeholders may evaluate and use the information to gain political leverage. The evaluation is mostly limited to collision data.

Data management

The use of high-quality data and information systems is fundamental in managing safety. Effective decision making in target setting, programme development, implementation and evaluation is based on what the road safety data reveal. A wide range of data is collected, not all of which is used solely for road safety purposes: crash statistics (fatal and non-fatal injuries, details of collisions, property damage); road features based on location that can be linked to collisions; enforcement actions for drivers and vehicles; court results for drivers; status of driver licences; condition of drivers; vehicle inspections. However, in many countries data are collected by a diverse set of organisations.

Integration of all aspects of safety data should be targeted to optimise safety management efforts. Data sharing for road infrastructure safety purposes appears to exist in most of the countries surveyed. More importantly, many countries integrate their data in a comprehensive database accessible by all those involved in road safety.

The following problem areas were highlighted concerning the collection and management of safety data:

- *Data access:* for example, some data are limited to use in courts; in certain countries, there are privacy concerns and freedom of information laws to comply with.

- *Data quality and accuracy:* including levels of under-reporting, differences between the police and hospital data systems, lack of uniformity in reporting, lack of definitional consistency between jurisdictions, availability of insurance data only in aggregated form.

- *Data collection problems:* including computer system mismatches, reluctance to share data, lack of computerised databases, delayed data transmission processes, lack of technical abilities and resources in information management, lack of funding to take advantage of technology, lack of linkages between databases, timeliness of data entry.

Evolution of safety management since 1994

The OECD report *Targeted Road Safety Programmes* (1994) included a section on formal organisations, although the scope of the report was limited to describing the organisations responsible only for developing safety plans.

The report states:

> "To cope with road safety problems every OECD Member country carries out a range of organised activities aiming at improving road safety. Many countries have created specific Committees or Councils to oversee the development of a national road safety plan. The most common organisational problem in these plans is still a lack of an integrated process that assigns responsibility for implementation where a wide range of public and private groups are involved."

Organisational models

Based on the results of the questionnaires for this and the 1994 OECD report, three organisational models can be considered according to functional responsibilities and accountability:

- All responsibility for planning is placed with the head of the Ministry of Transport, thus leading to highly centralised co-ordination.

- A ministry or government organisation is designated to take responsibility for co-ordination.

- Independent committees or councils are in charge of identifying the scope of the programmes and preparing plans which will be submitted for government approval.

The second model remains predominant in most countries, as was the case in 1994. The ministry designated to manage road safety policy is usually the Ministry of Transport (the case in Australia, Canada, Denmark, the Czech Republic, France, Germany, Hungary, the Netherlands, Mexico, Poland, the United Kingdom, Sweden and the United States). The Ministry of Justice performs this function in Iceland. It should be pointed out that regional representatives take part in these committees in some countries (Canada, Germany, the Netherlands), as do non-governmental associations (the Czech Republic, Germany, the Netherlands, Sweden). Some countries (Italy, Turkey) do not have road safety co-ordination structures.

Safety integration

Three co-ordination methods are used where programmes involve multiple organisations:

- *Method 1.* Each organisation independently plans its own programmes then distributes proposals to other concerned organisations in order to co-ordinate the programmes with their programmes.

- *Method 2.* Co-ordination meetings are held with the participation of all concerned organisations.

- *Method 3.* A separate road safety programme planning organisation (council, etc.) is formed by road safety representatives from concerned organisations. The programme is both planned and implemented by this organisation.

Where the measures that fall under the responsibility of the various concerned organisations are highly independent, Method 1 may be appropriate since a new organisation is unnecessary. However, if the measures undertaken by the concerned organisations are closely related, Methods 2 or 3 are probably more appropriate. When a separate organisation concerned with road safety is formed, it is

necessary to decide how much decision-making power and how much management authority to give this body that consists of multiple member organisations.

There is a trend towards including road safety in public health and public safety policy or in transport policy. This is reflected in the description of the organisational bodies included in the array of functions under study. The Netherlands provides a good example of a sustainable transport policy that includes a strategy for developing sustainable safety.

The integration of safety into wider policies has consequences for the definition, management and implementation of road safety strategies. Such a measure also influences the active involvement of the network of stakeholders and the choice of local structures for co-ordinating actions.

Lastly, there is a recent trend towards adopting an integration approach which calls for intrinsic safety in road transport systems. Applying this viewpoint to concrete situations requires a clear sharing of responsibilities among the actors involved in the design and application of rules. The Swedish "Zero Vision" approach is based on such principles:

- The designers of the system are ultimately responsible for the design, operation and use of the road transport system and are thus responsible for the level of safety within the entire system.

- Road users are responsible for following the rules set by the system designers.

- If road users fail to obey these rules due to a lack of awareness, acceptance or ability, or if injuries occur, the system designers are required to take the necessary steps to counteract the possibility of people being killed or seriously injured.

This type of vision has a particularly strong influence on the overall design of the road transport system.

Annex A

DETAILS OF NATIONAL MONITORING PROGRAMMES: EVALUATION

Country	Agencies responsible for evaluation	Details of monitoring		Behaviour monitored	Other performances monitored	Remarks
Australia (1992)	National task force	Fatalities and serious casualties related to specific programmes	Once	Not mentioned		Strong emphasis on cost/benefit evaluation
Austria (1992)	No formal responsibility for monitoring. Have monitoring of specific programmes	Crash rates of local communities	Once every three years	Road user behaviour (no details)	Attitudes towards police enforcement: opinion surveys	
Belgium (1999)	Each agency is responsible for own evaluation. Belgium Road Safety Institute (IBSR-BIVV) conducts national evaluation	Mainly in terms of lives saved *vs.* input of resources	Not known	Driving speed	Traffic flows Public support surveys	No cost/ benefit evaluations
Canada (1999)	Road users Federal or provincial governments Vehicles Federal government (Transport Canada) Infrastructure: Provincial/territorial governments	Crash and fatality rates	Once a year	Seat-belt use Impaired driving (alcohol) Graduated licence system	Survey of vehicle/distance travelled	
Czech Republic (1999)	Each ministry has own responsibility. Ministry of Transport and Ministry of Interior are responsible for national evaluation	A general evaluation based on outcome (*i.e.* crashes)	Once a year	Behaviour, no details	Driver attitudes and knowledge, no details	
Denmark (1999)	Danish Commission on Road Safety	No. of crashes No. of fatalities and serious casualties Detailed monitoring of targets	Three times per year Every four years	Speeds	Alcohol/ driving Intersections Bicycles	

Country	Agencies responsible for evaluation	Details of monitoring		Behaviour monitored	Other performances monitored	Remarks
Finland (1999)	Consultative committee on road safety, provincial state offices and Ministry of Transport and communications	No. of crashes, fatalities and casualties	Once a year	Speeds Seatbelts Cycle helmets Pedestrian reflectors	Extent of implementation of measures Traffic growth Economic trends Police activity - hours of enforcement	Crash data from various sources are analysed
France (1999)	The Prime Minister and the Ministry of Transport - Interministerial Road Safety Committee (CISR)	Specific programmes are evaluated: -10% and "safer cities" Crash-free neighbour-hoods Also: no. of crashes, casualties and fatalities	Once a year	Speed survey Drink-driving	No details	
Germany (1999)	Federal Ministry of Transport, Building and Housing	Accident Prevention Report: Accident Statistics, Safety Measures and Actions / Activities.	Once every two years	No details	Investment in federal road construction Technical inspection of vehicles Driving and resting hours of HGV drivers Performance of rescue services	
Hungary (1999)	Ministry of Transport, Communications and Water Management, and Ministry of Domestic Affairs	Transport Research Institute - an evaluation report Number of crashes, fatality and injury trends	Annual road safety report to the government	Seatbelt use, rate of daytime running light usage, speed, alcohol		
Iceland (1999)	The Icelandic Traffic Safety Council and the Public Roads Administration. Also, local authorities	Traffic Safety Plan. Reduction in crashes and fatalities per population Also crash types	Once a year	Speed Use of seatbelts No. of red-light violations No. of drivers under influence of alcohol	No. of fines Points system	Main points: speed, young drivers, seatbelt use, intersections

Country	Agencies responsible for evaluation	Details of monitoring		Behaviour monitored	Other performances monitored	Remarks
Italy (1999)	Each agency for its own activities. Recently the Dept. of Traffic and Road Safety in the Ministry of Public Works	National road safety plan in preparation. Fatalities and casualties	Annual report on road safety submitted to Parliament	Autostrada Co. has a more detailed monitoring and evaluation process for its motorways	Information on "black spots" Traffic growth	
Japan (1999)	Each agency is in charge of own programme evaluation	Fundamental Traffic Safety Plan. Five-year programme. Crashes with fatalities and casualties	Once a year	No details	Black spot programme	
Korea	Each agency is responsible for its own evaluation. Ministry of Construction and Transportation for national evaluation	Fatalities	Once a year	Speeding enforcement by automated speed camera systems	Seatbelt use, motorcycle helmet wearing	
Mexico (1999)	Secretariat of Communications and Transport. Also National Committee for crash prevention on federal roads	No details provided				
Netherlands (1999)	Ministry of Transport, Road Safety Research Institute (SWOV) and also the provinces and municipalities	The Policy Effect report. Crashes, casualties, fatalities and risks	Once a year Every four years (in greater detail)	Drink-driving, seatbelt use, speeds	Traffic counts regional evaluations	Knowledge about policy and opinions. Cost/ benefit studies
New Zealand (1995)	National Road Safety Committee	Fatalities and serious casualties	Monthly	Speeds, alcohol, restraint use, cycle helmets	Public attitudes	Strong emphasis on cost/benefit evaluation
Norway (1999 and 1992)	Public Roads Administration and Provincial and local authorities	Crash reductions	Once a year	Seatbelts, motorcycle helmets. studded tyres, alcohol use	Traffic volumes Road programme information: road data drivers stopped for enforcement number of vehicles inspected	
Poland (1999)	Road Safety Council within the Ministry of Transport	Integrated road safety plan	No details provided			

Country	Agencies responsible for evaluation	Details of monitoring		Behaviour monitored	Other performances monitored	Remarks
Sweden (1999)	The National Road Administration and the National Road Research Institute (VTI)	Detailed programme with many sub-areas, each with targets. Have crash, casualties and fatality prediction curves	Once a year	Drink-driving Excess speed Other violations Use of safety equipment in cars Visibility of pedestrians and cyclists Use of helmets	Crash-worthiness of cars EMS – rescue times Safety opinions Roads built to safe standards – survey	
Turkey (1999)	Each agency is responsible for own evaluation. National Traffic Safety Project prepared by consulting firm	Crashes and casualties	Not known	No details provided	No details provided	
United Kingdom (1999)	Dept. of Environment and Transport (DETR) Have National Safety Plan with targets for 2000 and 2010.	Crashes, casualties by severity and by road user group	Routine monitoring annually In future: formal review every three years	Drink-driving, seatbelts, cycle helmet wearing, speed, attitudes through surveys, other ad hoc surveys.	Traffic volume - by vehicle type, travel pattern, modal split Vehicle registrations, driving test volumes and pass rates.	Use of evaluation research and cost/ benefit studies
United States (1999)	Monitoring and reporting of crashes is done by the National Highway Traffic Safety Administration. National Highway Traffic Safety Administration, Federal Highway Administration, Federal Motor Carrier Safety Administration, develop strategies	Crashes, casualties, fatalities and rates per million vehicle-miles Crash types, vehicle types factors present	Continuous monitoring, annual reporting	Drink-driving; seatbelt use; speeding; helmet use; condition of large trucks and their drivers	Crash worthiness and occupant protection of cars; EMS performance; roadside inspections of large trucks and their drivers	Cost/ benefit is routinely assessed

ANNEX B

PLANNING PROCESS BY COUNTRY

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
Belgium	National Safety plan for the federal police to reduce traffic accidents involving injuries; Federal Safety and Detention Plan with a chapter dealing with traffic accidents involving injuries.	Flanders: safety plan; Brussels: mobility plan; Walloon provinces: mobility plan.	Occasionally in the provinces and the municipalities; In 2002 local police will be obliged to have a security plan with a chapter dealing with traffic accidents involving injuries.	Currently: there are mainly no quantified safety objectives (safety is integrated into quality of life objectives and sustainable development); in the near future: quantified objectives will be defined.	Complex structure comprising of three levels: the federal level, the regional level and finally the local level (provinces and municipalities); modifications in progress. .	Complex organisation leading to a lack of leadership, no general framework and overlap in responsibilities.		National evaluations by Belgian Institute on Road Safety (IBSR) Local evaluations by institutional agencies	Institutional complexity involving many actors with no official co-ordination	Despite absence of official co-ordinator, there is coherence of actions leading to the various levels. The IBSR carries out this function. Various co-ordinating groups were also created. The actors' work is based on charters.
Canada	National plan by CCMTA5 (Canadian Council of Motor Transport Administration) Proposes initiatives without obligation	Provincial plan: objective to reduce number of road deaths	Short-term plan	National objective is to reduce the average number of road users killed and seriously injured during the 2008-10 period by 30% over comparable 1996-2001 figures	National conference to develop the plan. Approval by Federal Government followed by approval by the 12 provinces.	Insufficient funds. Recent demotivation	Division of national plan into provincial plans. Need for uniformity of practices. Insurance plans: have become public corporations in certain provinces	Evaluation of regularly carried-out actions		Fundamental role of the CCMTA to promote and provide impetus for safety. CCMTA brings road safety to attention of politicians, the courts and the public. Provinces: n°1 responsibility is safety. Committed to contributing to the national safety objective

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
Czech Republic	No national plan	Occasionally	Local plan must conform to national transport and environmental objectives (but safety is not addressed separately)	Specific objectives *e.g.* pedestrians in cities, climbing crashes. Some key issues: vehicle checks, children's car seats, road improvement, speed control, and exchanges with Europe, OECD	Roles determined by legislation: principle role given to "Government Road Safety Council" (GRSC)	Lack of funds. Sometimes contradictory objectives of partners. Partition/break up of actions of ministries Increase in traffic congestion and decline in public funds.		Some topics require evaluation at the national level		The principles of action planning and of road safety culture are currently lacking support
Denmark	Strategic plan established by "Danish Commission on Road Safety"	Local plans by counties	Local plans by municipalities	National objective: "every crash is one too many" (ambitious) Local objective: half of the local municipalities have their own targets or quantified objectives (*e.g.* reduce deaths in 2000 by 40% – from 1988)	National plan established by the national commission giving a base for targets in local plans. Each road administration has to provide the budget necessary for implementation on their own road network. Financial support possible from national funds to implement the targets		National plan reviewed triennially Community plans	National plan: evaluated every 4 years Local plans: reviewed every 4 years Evaluations by topic		Links between state and communities are not obligatory. State funds can promote certain initiatives
Finland	Plan established by Consultative Committee on Road Safety Ministry of Transport and Communication	Road safety plan established by the provinces	Not formalised, but cities usually contribute to national objective	National objective for 2005, set by the State Council. Implemented at local level	Principal role given to Ministry of Transport and Communication and the Consultative Committee on Road Safety. The member organisations of the Committee are defined by decree The State Council appoints the Committee for a 3-year period	Variable capacities of municipalities	One national plan for 4-5 years. Co-ordination with other plans ensured; with regional plans and with local plans (depending on activities in municipalities)	Use of cost/benefit methods Evaluation by topic, then by behaviour.	No obstacles in particular (good organisation, based more on expertise and conviction than on regulation)	Well ensured by the central level

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
France	Plan made up of a series of actions determined by the Inter-ministerial Committee on Road Safety (CISR)	No regional plans on safety, except contracts between state and regions for national or regional roads	Departmental plans on safety based on diagnosis of a 3-year period	National objective: "to halve the number of road deaths over a 5-year period" (this ambitious objective is used as a reference)	Established by legislation and regulation Initiative by departmental prefects to develop local actions	Limited funds, in particular for departmental plans, which are primarily oriented towards communication. Variable motivation of the decision makers	.	Evaluations on some topics, but are not performed on thorough basis	Lack of global method. Strong influence of policy makers	DSCR in charge Technical networks of experience sharing between departmental levels, and between certain cities.
Germany	Road safety programme 2001	Road safety programmes in some of the 16 states (*Bundeslander*)	Occasionally	No quantified objectives	National: establishes legislation and national plan Regional: establishes plans and corresponding budget	Little understanding of local actions	Series of action plans	BASt		DVR (German Road Safety Council)
Hungary:	Plan established since 1993 and updated each year in form of action plan		Elimination of black spots	Non-quantified objective: "to decrease the number of crashes"	No existing legislation Several ministries and institutes involved in safety at the national level	Poorly structured organisation Poor collection of crash data		Annual evaluation of crash follow-up and related trends		Badly structured general organisation. Lack of promoters, in particular at the local level
Iceland	Plan 1997-2001 voted in Parliament	Reykjavik	Elimination of black spots, 30km/h zones	Quantified objective: "to reduce the number of killed and seriously injured to less than 200 by the end of the year 2000"	Established by Parliament Objective defined by Traffic Act. Budget: determined by Minister for Transport and Minister of Justice	Lack of co-operation and governmental understanding	National plan, revised yearly	Evaluations at national and local levels, and by topics, every year		Links between state and local authorities are not fixed. The budget is split up in early stages

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
Italy	Triennial plan under development Link with sustainable development, pollution, urban planning	Compulsory interurban safety plan	Safety: compulsory plans for cities of more than 30 000 H (842 cities)	No quantified objectives. Links with actions for sustainable development and with urban improvement plans.	Established by legislation Institutional modifications in progress which will allot more power at the local level	Lack of validated scientific methods. Problems in crash data collection. Lack of evaluation method		Triennial plan should be updated every 3 years, with annual evaluation (problem of defining a suitable method of action)	Limited funds. Technical problems (collection of data, methods). Institutional modifications in progress	Current lack of co-ordination
Korea	Five year (2002-06) national road safety plan established by the National Road Safety Working Group (ad hoc) of Prime Minister	Regional implementation safety programmes developed from the national plan every year	Local plan co-ordinated with civil communities		National road safety working group: yearly review of the 5 year traffic safety plan Regional and local road safety committee: Design and review the detailed implementation plan as scheduled	Lack of co-ordination with governmental agencies and civil communities	National plan: 5-year plan (establishes the framework) Regional plan: 1-year plan (based on national plan) Local plan: 1-year plan (based on national and regional plan)	Evaluation of major topics at national and regional level - half yearly	None	Ministry of Construction and Transportation, National Police Agency, civil communities
Japan	1) National plan (fundamental traffic safety plan) 2) A 5 (7) year improvement programme for specified traffic safety facilities	Plan for urbanisation, environment and education	Plan for local roads, and plan for national and departmental roads	Broad general objectives: environment, traffic, safety Reduction in fatalities from under 10 000 in 1997 to under 9 000 by 2000. No figures.	Established by legislation User participation in local plans.	National level: establishes the framework and approves the budget (very centralised system) Regional level: plan based on national plan. Local level: plan in agreement with national legislation	Plans at each level, with co-ordination	Evaluation by each agency at outset of plan	Little information on the links between regional and local levels	Ensured by the state on the basis of the national plan. The state governs all budgetary decisions.

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
Mexico	No national plan, but project under development by CONAPREA (national committee)		Local projects	No precise objectives except the processing of black spots at all levels	Established by legislation	Recent interest in safety management. Insufficient amount of allotted funds			Methodology Significant problems simultaneously emerging on all fronts: speed, seatbelt use, cross roads, black spots, data collection. Lack of safety culture	CONAPREA is responsible for this project.
Netherlands	Current plan: "Start-up Programme" for the period 1998-2001 Future plan: to integrate Long-term Road Safety Programme (MPV) into the National Traffic and Transport Plan (NVVP)	Regional plans established from national plan	Provincial and local plans, variation of the regional	Quantitative objectives (2000 and 2010). Rather ambitious but realistic: to reduce the number of fatalities by 50% by 2010, and reduce traffic flow by 35%, compared to 1986 average	Legislation within traffic and transport plans: State formulates the plan, stimulates the various levels and must diffuse knowledge. State also verifies consistency of regional plans with national plan.	.	Four-year plans, with a progress report each year	Evaluation, especially at the national level	Necessary at outset to involve all political actors, institutions, experts, technicians, media and road users	Clear desire for horizontal and vertical co-ordination (e.g. a Provincial Safety Board (ROV) office in each region as part of Decentralisation Agreement)
New Zealand	National Road Safety Plan (1995)			To have a level of safety on our roads equivalent to the safest countries in the world, driven by a firmly established safety culture			National Road Safety Plan sets policy framework and priorities.	Regular monitoring of progress with formal review and evaluation annually.		Co-ordination encouraged through regular meetings and guidelines.

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
Norway	4-year “Road and traffic plan”, including road safety	Provincial road safety plans	Community plans, co-ordinated with provinces	Non-quantifiable safety targets	Periodic meetings with partners			Evaluation based on the evolution of crash statistics, and by topic		Through periodic meetings of the various levels
Poland	GAMBIT Programme was approved in 1996 by the National Road Safety Council, chaired by Prime Minister. Links with plan on transport infrastructure until 2015	Provincial Road Safety Council	Several communal safety council pilot projects	National target to reduce the number killed in road crashes over next 5 years to level of 6 000 people (reduction of 20% - about 3.5% yearly since 1997)	Established by legislation		IN project. Pilot projects decided			Co-ordination by the Road Safety Council
Sweden	Long-term national plan for implementation of “Zero Vision” plan (0 serious crashes)	Regional programmes developed from the national plan	Integration of road safety into urban plans	Continuous effort to reduce number of fatalities Risk reduction for all categories of road-users, particularly vulnerable road-users (*i.e.* pedestrians, cyclists, etc.)	Broad discussion at outset of project, with implications for citizens and decision makers, at all levels of responsibility		National long-term plan Local short-term plans	Evaluations by topic, carried out by the VTI		
Turkey	Currently no plan. Project with the World Bank in progress on a limited part of the network (4 500 km)	Decisions based on national choices	Decisions based on national choices.	To raise awareness of the general public	Role established by legislation on topic of highway traffic	Lack of safety culture (need for exchanges with other developed countries) Lack of personnel and funding Lack of related studies and diagnosis		No evaluations performed		Weak co-ordination

Country	National plan	Regional plan	Local plan	Objectives	Roles of each	Organisational problems	Type of plans	Evaluation	Obstacles to planning	Co-ordination
United Kingdom	National targets for 2000 and 2010+ National strategy for 2010		Three-year Local Transport Plans include strategies and targets, compatible with national objective	For 2010, 40% reduction in fatalities and serious injuries and 50% reduction in child fatalities and serious injuries, and 10% reduction in slight casualty rate per km travelled compared with the 1994-98 average	DETR sets objective in consultation with other ministries. Roles established by legislation		National Road Safety Strategy sets policy framework and priorities.	Regular monitoring of progress with formal review and evaluation every three years with programme reorientation if necessary. Similar method at local and national levels		Co-ordination encouraged through regular meetings and guidelines. New Road Safety Panel set up.
United States	Performance Plan: goals and milestones. Strategic plan to effect needed changes	State and local plans encouraged by the Federal Government.	Local plans encouraged by Federal Integration of road safety into urban transportation plans (1 of the 7 criteria	Quantitative goals and milestones for fatalities, injuries, large truck fatalities and injuries, alcohol-related fatalities, seat-belt use, child fatalities, pedestrian fatalities, cyclist fatalities, motorcycle fatalities, speeding related fatalities.	Federal Government launches the programme measures, evaluates, and proposes solutions States ensure implementation.	Variation in practice at local level	Transportation plans that include safety vary by source of funds	Annual evaluations at all levels	Varying interests of user groups Weak mobilisation strategies of elected officials. Limited mobilisation strategies.	Federal, top-down system, yet wide margin of freedom of action at State and local levels

ANNEX C

SUMMARY OF SAFETY MANAGEMENT FOR OECD COUNTRIES

A questionnaire was developed to provide information on new and successful approaches to organisation models, target setting, plans, strategies, evaluation and solutions to road safety problems. The following summary was made of the countries' responses to the questionnaire, focusing on organisational relationships in safety management: decision making, target setting and funding.

Belgium: Decision-making power concerning road safety is redistributed between the federal and regional governments. Road safety is treated as a component in broader mobility policies. Road safety policy is strongly decentralised. There exists no tradition of quantified target setting in terms of "saved lives". The budget is determined annually in the governments' budgets.

Canada: High-level road safety target setting does not differentiate between road users, vehicles and infrastructure targets. Plans developed to achieve these targets include all three areas. The focus of the provincial plans tends to be the road user, although the plans incorporate vehicle and infrastructure issues to varying degrees. Governments share funding of selected initiatives. The private sector provides funding for marketing and educational initiatives related to selected priority issues.

Czech Republic: Each ministry and governmental body funds road safety programmes from its part of the national budget.

Denmark: The government has formulated the vision that road crashes which cause deaths or severe injuries are unacceptable. Road safety programmes are mainly financed through the state budget and through local authority spending. Commercial sponsors finance some of the campaigns. Approximately half of the local municipals have formulated their own targets. The local authorities are free to decide how they arrange their decision making.

Finland: The Consultative Committee on Road Safety, an advisory body to the Ministry of Transport and Communications, is responsible for preparing national strategies. The Consultative Committee comprises representatives from all non-transportation governmental bodies involved in road safety issues (including representatives from road safety research and from the main road-user organisations). The Council of the State, *i.e.* the government, has adopted the national targets recommended by the Committee. The implementation of traffic safety programmes is included in the normal funding.

France: In 1983-84, after the decentralisation laws in France (1981-82), the *REAGIR (Réagir par des enquêtes sur les accidents graves et par des initiatives pour y remédier*) programme was set up to promote mobilisation for road crash prevention. This was through an interdisciplinary team. Through crash investigation ,on the one hand, and local programmes founded by the government, on the other, local stakeholders are involved in road safety. The IDSR (*Inspecteurs Départementaux de Sécurité Routière*) comprises some 3 000 person [civil engineers, police (*gendarmes*), medical doctors in charge of emergency, some automobile engineers, local associations, and elected people]. Many local associations participate. Through this programme, health professionals, for example, are involved in accident prevention. In addition, urgent problems have been highlighted and local improvements carried out.

***Germany**:* The federal level is responsible for a national road safety programme. Earmarking of funds is done at the federal level.

Hungary: Road safety is funded from the state budget. Local authorities' activities and the National Safety Programme are not directly co-ordinated.

Iceland: The Ministry of Justice has overall responsibility for traffic safety. Other actors include Parliament, transportation, education, enforcement and health officials, local authorities, insurance companies, parents' associations and associations of local residents. A citizen's advisory group of specialists participates in setting road safety targets, programme development and implementation. The Icelandic Traffic Council is funded mainly by the state but also partly by institutions, while the Public Roads Administration is funded by the state. Local authorities obtain funds from municipal taxes.

Italy: The Ministry of Transportation sets targets for vehicles. The Ministry of Public Works and the Ministry of the Interior (Road Police) are involved in setting targets for infrastructure. Some private organisations participate in setting road safety targets. Autostrade manages its own budget.

Japan: The Central Council for Traffic Safety Measures prepares the Fundamental Traffic Safety Plan. Decision making can be carried out from a comprehensive perspective. The national government funds the measures it undertakes, while measures undertaken by regional public bodies can be subsidised.

Mexico: Overall responsibility lies with the Secretariat of Communications and Transport. There is participation by private organisations. Agencies responsible for specific safety programmes have their own budgets.

The Netherlands: The Ministry of Transport has the central responsibility for safety policy and allocates funds for specific road safety activities. Dutch road safety policy is designed and executed at different government levels: national/state, regional, and local. Furthermore, various government sectors (road authorities, police, justice, and education bodies, etc.) are involved in policy setting, each with its own tasks and powers. Ensuring coherent road safety policy calls for horizontal co-ordination (between sectors) and vertical co-ordination (between levels). Since 1992, horizontal co-ordination at the national level has been undertaken by the Consultancy Body on Road Safety (OVV), in which all bodies involved at that level are represented. In 1994, important agreements were made about the vertical and horizontal co-ordination in the Decentralisation Agreement under which each province has a Provincial Safety Board (ROV). This measure aims to harmonise regional traffic and transport policy.

Norway: Road safety is part of overall activities. Organisations involved with roadway safety include the Ministry of Transport, the Public Roads Administration, the Ministry of Justice, and citizen's advisory group. Funding is provided through the four-year National Road and Road Traffic Plan and yearly budgets.

Poland: The Polish Government established a National Road Safety Council that provides direction and co-ordinates activities aimed at improving road safety. It is a multidisciplinary co-ordination body with representatives from relevant ministries and central institutions. Actions to improve road safety conditions are financed from the budgets of implementing agencies and ministries.

Spain: Safety co-ordination by the National Traffic and Highway Safety Council involves 50 members and is chaired by the Minister of the Interior. The Traffic General Directorate is responsible for the development of road safety programmes for road users and vehicles, while the Highway General Directorate is responsible for infrastructure. Funding is primarily from the national, regional, and local budgets. Each administration decides the level of funding for the programmes for which it is responsible.

Sweden: The Swedish National Road Administration sets road safety targets. The national government and municipalities fund safety work benefiting road users and road infrastructure. In late 1999, a committee of inquiry was appointed to examine the responsibility of the public and industrial sectors for

safe road traffic. Taking "Vision Zero" as the basis, this committee is to analyse what is missing from current legislation in terms of the responsibility of system designers for a safe road transport system. System designers are those responsible for the design and functioning of the road transport system. The committee report will set out in detail the safety regulations that apply to products and services found within other modes of transport and in the working environment. Based on these findings, the committee will recommend rules suited to the road transport system. In its report, the committee will propose new or revised regulations, sanctions and systems of inspection emanating from the recommendations. The committee will also inquire into the establishment of an independent road traffic inspectorate, including proposals as to how such a body should be organised, its tasks and powers of authority, and how it should be financed.

Turkey: The Ministry of Public Works and Settlement has the main responsibility for road safety. Other agencies involved include the Ministries of Internal Affairs, Industry and Commerce. Each ministry determines its budget, according to the Budget Law.

United Kingdom: National road safety policy is the responsibility of the Department of the Environment, Transport and the Regions (DETR). The Road Safety Strategy sets the national framework for policy up to 2010. Local authorities have a statutory duty to ensure safety on the roads for which they have responsibility. Targets are set at the national level and local authorities set their own targets in their Local Transport Plans, consistent with the national target. Programmes are funded by national and local taxation. For infrastructure programmes on motorways and trunk roads, the Highways Agency, which is part of the DETR, is responsible and has a three-year centrally funded budget. Policy on such issues as drink-driving, speed limits, driver training and testing is set nationally. Local authorities are responsible for local safety engineering schemes and road safety education, in accordance with national regulations and best practice guidance.

United States*:* The US Department of Transportation has responsibility for ensuring a fast, safe, efficient, accessible and convenient transportation system. Three agencies have primary responsibility for and set national goals for different aspects of road safety: Federal Highway (road infrastructure safety including pedestrians), National Highway and Traffic Safety (safety for passenger car drivers and occupants, and the motor vehicle safety design standards), and Federal Motor Carrier Safety (compliance and enforcement of regulations for truck and bus drivers, vehicles and companies). These agencies work together and, where necessary, co-operate with other transportation agencies and related agencies. Each provides dedicated funding to states (grants and apportionments) from the Federal Highway Trust Fund which contains the proceeds of motor fuel and other highway-related excise taxes. States have their own goals and make decisions on how the federal funds are used, adding additional state tax funds, and operate separately using federal funding linkage. In doing so, they adopt federal regulations and requirements on a voluntary basis. The private sector, associations and citizen groups exercise influence through the legislative process and through their involvement in advisory and focus groups that may be convened by government.

ANNEX D

LIST OF PARTICIPANTS

Chair: Mr John Hughes (Canada)

Australia	Mr. Chris Brooks
Belgium	Mr. Chris Cuijpers
Canada	Mr. John Hughes
Czech Republic	Mr. Jan Spousta
Denmark	Mr. Kurt Petersen
Finland	Ms. Anneli Tanttu
France	M. Hubert Trève M. Dominique Fleury
Hungary	Mr. Peter Lanyi
Iceland	Mr. Rognvaldur Jonsson
Italy	Dr. Gabriele Camomilla Mr. Massimo Simonini
Japan	Mr. Katsuhiko Mitsuhashi Mr. Toshiyuki Yokota Mr. Yuri Ikeda
Netherlands	Mr. Paul Wesemann
Norway	Mr. Richard Muskaug
Poland	Mr. Andrzej Grzegorczyk Dr. Ryszard Krystek
Spain	M. Federico Fernandez
Sweden	Mr. Matts-Ake Belin
United Kingdom	Mrs. Kate C. McMahon
United States	Ms. Phyllis E. Young
European Commission	Mr. René Bastiaans
Slovenia (Observer)	Mr. Tomaz Pavcic
OECD	Mr. Ceallach Levins Dr. Anthony Ockwell

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