

ASSESSING RISK AND SETTING TARGETS IN TRANSPORT SAFETY PROGRAMMES

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The European Transport Safety Council

The European Transport Safety Council (ETSC) is an international non-governmental organisation which was formed in 1993 in response to the persistent and unacceptably high European road casualty toll and public concern about individual transport tragedies. Cutting across national and sectoral interests, ETSC provides an impartial source of advice on transport safety matters to the European Commission, the European Parliament and, where appropriate, to national governments and organisations concerned with safety throughout Europe.

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EXECUTIVE SUMMARY

The purpose of this review is to identify best practice in risk assessment and target setting in transport safety and the scope for their wider application and further useful development, and to make recommendations, having regard to experience in Member States, developments at the EU level, and the prospect of enlargement. Road transport is treated at greatest length because about 97% of deaths in transport in the EU occur on roads and target setting is used widely in road safety policy. In rail, air and maritime transport, rather similar needs and opportunities for addressing the issues at the EU level are identified.

In the year 2000, about 40 800 people were killed on roads in the EU and about a further 11 600 in the Accession Countries. Deaths per million person-years ranged from about 60 in some countries to over 200 in others, and were about 110 for the EU as a whole. There is abundant evidence that many of these deaths can be prevented by already available and cost-effective means. Achieving this requires a strategic approach which all stakeholders are actively involved in developing.

Assessment of risk contributes to effective strategies for casualty reduction, by helping to show where scope for applying different safety measures lies. Setting challenging yet achievable numerical targets can strengthen motivation to contribute to casualty reduction, and this can be maintained by regular and transparent monitoring of progress towards the targets.

Complacency about death and injury on the roads can be shaken and sights raised by adopting a vision or philosophy for road safety. A vision or philosophy providing a long-term goal and a succession of shorter-term targets directed towards its realisation can have complementary effects in motivating the initial development and subsequent implementation of road safety strategies.

The sadly large annual numbers of road users killed or injured make it possible to estimate risk to road users reliably and numerically by relating recorded numbers of casualties to measures of exposure to risk. Road safety targets in EU Member States differ widely as to performance indicator, timescale and degree of challenge. Many countries and the EU itself have set targets to reduce the number of deaths and some to reduce the number injured. Target periods are typically about 10 years. It is important to use a sound statistically based methodology to set the targets.

When targets have been set and the strategy for achieving them has been developed, then the targets and strategy need to be formally adopted to declare a public commitment to them by the responsible politicians, preferably of all parties. Monitoring and evaluation should take place throughout the target period in order to benefit from experience and adapt to changing circumstances, as well as to track progress towards the targets.

Quantitative road safety targets have been adopted by the EU, a number of EU Member States and Poland. Most aim to reduce the annual number of deaths by 40 to 50% within typically about 10 years. They represent an ambition to reduce the number of deaths more quickly than continuation of past trends would imply.

Risk assessment in controlled engineering systems such as rail, air, and maritime transport is more highly developed than in road transport. This reflects both the more comprehensively managed nature of these systems and the relative rarity of accidents in them. In relation to safety targets for them, the small numbers of relevant accidents, and of deaths and serious injuries in most of them can make it difficult to know whether a specific target has actually been reached.

Numbers of deaths on railways in the EU in 1996-2000 averaged about 120 per year to passengers, 40 per year to staff and about 700 per year to third parties, excluding suicides. These figures indicate the scale of risk, but they suffer from the weakness that there is no international agreement on what constitutes a railway casualty. Nor are there standard ways of measuring exposure to risk on the railways. There are three general methods for estimating risk, which are often used in combination in rail transport. Only a minority of Member States have quantified targets for rail safety.

The annual number of deaths in the EU on scheduled and charter flights operated by commercial airlines is estimated to average about 140 for flights within the EU and 50 for flights to or from the EU. The rarity of fatal accidents and the international character of air transport make risk assessment and target setting largely a matter to be addressed for the EU as a whole by the European Air Safety Agency. Risk assessment has been applied to air transport widely on an *ad hoc* basis and systematically to two important aspects, but these account for only a small proportion of accidents.

The annual number of deaths in maritime transport in EU waters has previously been estimated by ETSC to average about 140, with about another 40 in inland waterway transport in the EU. Risk assessment is used in maritime transport, partly under the influence of the off-shore industry, and partly in relation to exemptions from provisions of international instruments. The rarity of multi-fatality accidents and the international character of maritime transport make target setting in terms of resulting death or injury largely a matter to be addressed for the EU as a whole by the European Maritime Safety Agency. There are related issues of loss of vessels and environmental damage resulting from maritime accidents. Corresponding attention is needed to inland waterway transport.

The review leads to the following recommendations:

1. The EU should embark urgently and vigorously upon a timetabled and fully funded programme to achieve consistency across Member States in recording road traffic collisions involving personal injury, estimating the level and pattern of underrecording of collisions, and estimating the amount of use of the roads, together with the assembly of resulting data from all Member States in a common database accessible to all at marginal cost of access.
2. The EU and each Member State, and with their help each Accession Country, should continually and robustly challenge society's complacency about the level of risk in using the roads by adopting or further developing road safety strategies which evoke and channel coherent and effective action by all those stakeholders within and outside government who can contribute to reducing death and injury on the roads.
3. The EU and Member States and Accession Countries should focus their road safety strategies by setting numerical targets for casualty reduction over the period covered by the strategy which are challenging enough to motivate the stakeholders to strenuous effort, yet achievable through the policies and measures envisaged in the strategies.
4. Experience of different aspects of the target-setting process, especially the forecasting of casualty rates and of the effectiveness of safety measures, should be shared among the EU, the Member States and the Accession Countries.
5. The EU should identify the route to achievement of its target, the respective roles of the EU and its Member States in doing so, and how the EU can help the Member

States to deliver their respective contributions.

6. Railway safety data for the EU member states should be assembled comprehensively and to common international definitions, as envisaged in the proposed Railway Safety Directive, together with common measures of exposure to risk, and this should be a high priority for the proposed European Railway Agency.
7. It should be an early task for the European Railway Agency to investigate appropriate forms of target for numbers of train accidents and casualties in them across the EU and ways of judging progress towards such targets, having regard to the small numbers of accidents and variability in the numbers of casualties in them.
8. It should also be an early task for the European Railway Agency to progress the further development of common methods of risk assessment and criteria for safety measures that is envisaged in the draft Railway Safety Directive.
9. Railway operators' safety assessment documents, including their risk assessments, should be public.
10. It should be an early task for the proposed European Air Safety Agency to assemble a database for uniformly reported incident and exposure data concerning intra-European and intercontinental scheduled and charter flights in European airspace by both EU registered and other operators, and to investigate appropriate forms of target for the corresponding numbers of air accidents and casualties in them across the EU and ways of judging progress towards such targets.
11. The European Air Safety Agency should then develop counterpart reporting systems, database, targets and monitoring of progress for general aviation in European airspace.
12. It should be an early task for the proposed European Maritime Safety Agency to assemble a database for uniformly reported incident and exposure data concerning both EU registered and other vessels above a certain tonnage in European waters, and to investigate appropriate forms of target for the corresponding numbers of accidents and casualties in them across the EU and ways of judging progress towards such targets.
13. The European Maritime Safety Agency should then develop a counterpart database and counterpart targets and monitoring of progress for loss of vessels and environmental damage from incidents involving vessels in European waters.
14. The EU should establish counterpart databases, targets and monitoring of progress for inland waterway transport throughout the EU.

1. INTRODUCTION

Reduction of risk and consequent death injury and damage is the key objective of policy for transport safety. The systematic assessment of risk, the setting of targets for its reduction in the context of safety strategies, and the monitoring of progress towards such targets are playing an increasing role in the formulation and implementation of transport safety policy across the modes – road, rail, air and maritime.

Risk assessment ranges from the interpretation of data concerning numerous and frequent occurrences to the estimation of the likelihood of very rare events, combined in each case with the quantification of exposure to risk. Target setting requires forecasting of exposure, levels of risk, and the acceptability and effectiveness of policies and measures for risk reduction, in order to identify targets which strike a balance between challenge, achievability, and public and political acceptability. Monitoring requires tracking not only of the targeted outcomes but also of the ways in which developments in exposure, policy, implementation and external factors differ over the target period from what was anticipated when the targets were set. The context of the processes of risk assessment, target setting and monitoring in relation to safety differs between road, rail, air and maritime transport, and so do the extent to which and the manner in which these processes have been developed.

The purpose of this review is to identify best practice in risk assessment and target setting and the scope for their wider application and further useful development, having regard to relevant experience in Member States of the EU, related developments at the EU level, and the challenges and opportunities presented by enlargement.

Road transport is treated at greatest length both because about 97% of deaths in transport in the EU occur on the roads and because of the already extensive use of target setting in road safety policy. In the other three modes, rather similar needs and forthcoming opportunities for addressing the issues at the EU level are identified. The review concludes with a range of recommendations for action by the EU and its agencies supported by counterpart effort in the existing Member States and in due course in the Accession Countries.

2. RISK ASSESSMENT AND TARGET SETTING IN ROAD TRANSPORT

2.1 INTRODUCTION

In the year 2000, about 40 800 people were killed in road traffic collisions in the EU and about a further 11 600 in the Accession Countries. Deaths per million person-years ranged from about 60 in some countries to over 200 in others, and were about 110 for the EU as a whole. Definitions of serious injury and procedures for recording the numbers of people injured in road traffic collisions differ among countries, but the numbers recorded as seriously injured in the EU in 1995 amounted to 355 000. The monetary value of the socio-economic benefit that would arise in the EU if all road traffic collisions and associated death, injury, material damage and administrative costs could be prevented was last estimated by ETSC (1997) to be about €162 billion, or about 2 per cent of the gross domestic product of the EU, in 1995 on the basis of valuations currently used for this purpose in Member States in the north-west of the EU.

Figure 1 Risk of death to road users in the EU per billion vehicle-km

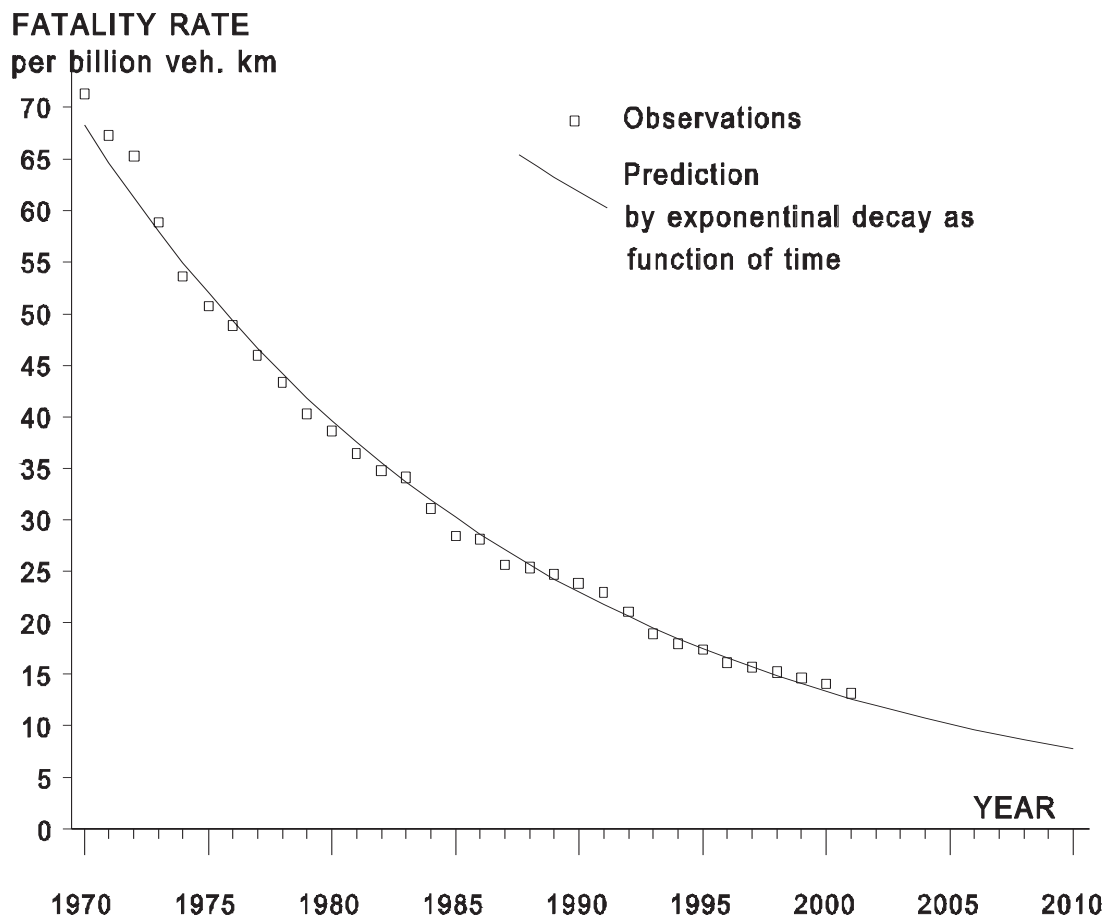


Figure 1 (ETSC 2003) shows how the risk of death to road users per billion vehicle-km has decreased in the EU (including the German Democratic Republic before 1990) since 1970 in comparison with an exponential curve representing a decrease of 5.3% per year.

Whilst the complete prevention of road traffic collisions is for the time being, and is likely to remain, a remote theoretical prospect, there is abundant evidence that a substantial proportion of the deaths and injuries can be prevented by known, already available and cost-effective means, and still more by means on which research is already in progress or is envisaged. The desirability of doing so is widely recognised in principle – for example *improving road safety* is one of the 13 principal areas of action identified in the most recent EU White Paper on transport policy (EC 2001b) – but to do so in practice requires coherent effective action jointly by a number of stakeholders ranging from individuals who use the roads in different ways to government agencies at all levels from local councils to the EU itself.

Achieving such coherent joint action requires a strategic approach, preferably one which all stakeholders have been involved in developing, and towards which they have a feeling of joint ownership and a sense of commitment. Such a road safety strategy is demanding of effort on the part of the stakeholder organisations – initial effort to develop the strategy and then sustained ongoing effort to implement it.

The risks involved in using the roads differ greatly according to the kind of use (walking, cycling or use of motor vehicles of different types) and the circumstances of use (e.g.

age of user, time of day, week and year, kind of road and surroundings of the road). The risks also differ greatly in the scope that exists for reducing them by action of various kinds. Assessment of risk on the basis of sound evidence therefore has the potential to make a powerful contribution to the development of effective strategies for casualty reduction and collision prevention, by helping to identify where the greatest scope for application of different safety measures lies.

However carefully a strategy is formulated, it can be effective only through successful implementation, which requires a corresponding plan of action to be followed by the whole range of stakeholders. This in turn requires government agencies, industry, road user organisations, voluntary bodies and the general public all to be motivated to make their respective contributions, and to keep on doing so consistently over a period of typically a decade or more. Motivation to do so can be strengthened by the setting of challenging yet achievable numerical targets for casualty reduction over the period covered by the strategy, and sometimes also for observable aspects of road user behaviour or quantifiable outputs of road safety work. Motivation can be maintained by regular and transparent monitoring of progress towards the targets.

Complacency about the amount of death and injury on the roads can be shaken, motivation to address the problem strategically can be enhanced, and the sights of those setting targets can be raised, by the adoption of an appropriate vision or philosophy for road safety. The best known such vision is the *Vision Zero* adopted by the Swedish Parliament in 1997 and since espoused by several other Member States. This sets a “long-term goal ... that nobody will be killed or seriously injured as a result of a traffic accident within the road traffic system” (Ministry of Transport and Communications Sweden 1997). A vision or philosophy providing a long-term goal and a succession of shorter-term targets directed towards its realisation can therefore have complementary effects in motivating respectively the initial development and the subsequent implementation of road safety strategies.

In the rest of this chapter, risk assessment and target setting for road safety, and best practice so far in applying them to road transport in various Member States, are discussed as the basis for developing relevant recommendations in Chapter 4.

2.2 RISK ASSESSMENT IN ROAD TRANSPORT

The sadly large annual number of collisions in road transport that give rise to death or injury, several million in the EU, makes it possible in principle to obtain numerically reliable estimates of risk to road users by relating recorded numbers of collisions or casualties to measures of exposure to risk. This can be done at quite high levels of disaggregation by type of road user and type of risk, to the extent that information about collisions is recorded and estimates of appropriate measures of exposure can be made. This is the main form of risk assessment in road transport. Others are the identification of the nature of hazards and mechanisms of injury by in-depth multidisciplinary investigation of small numbers of collisions (OECD 1988), and the safety audit and safety impact assessment of changes to road infrastructure in order not to build avoidable risk into newly constructed or modified roads (ETSC 1997a).

All EU countries collect information about collisions and the number of road users who are killed and injured. However, each country has a different reporting system and different levels of underreporting, including differences in definitions of injury severities and the characteristics and circumstances of collisions. Not even the attribution of deaths to collisions has yet been fully harmonised. Nevertheless, each member state is

able to analyse the occurrence of death and injury on its own roads in useful ways, and cross-national analysis within the EU is increasingly possible through the CARE database (ETSC 2001a).

Concerning exposure to risk, population data enable rates of death or injury per million person-years (i.e. annual numbers of deaths or injuries per million inhabitants) to be estimated for each EU country. With appropriate adjustment to numbers of recorded deaths to allow for differences in attribution to road collisions, numbers of deaths per million person-years can be regarded as comparable between Member States. Because use of the roads is, with limited exceptions, open to all as pedestrians, cyclists or passengers in vehicles, and to all licensed drivers, at any time without use being recorded, however, estimation of exposure to risk in terms of use of the roads requires systematic and statistically representative surveys of traffic on the roads and of people about their travel, as discussed elsewhere by ETSC (1999). Availability of such data differs widely among EU countries, and even in countries where extensive data about motor vehicle use are collected, information about walking and cycling may be less extensive. Attempts to infer estimates of exposure from collision data (ETSC 1999) have yielded methods that are useful for specialised applications, but are unlikely to provide a general substitute for traffic and travel surveys.

An important aspect of the use of a vehicle on the roads is that it gives rise to risk not only to the users of that vehicle, but also to others – the users of other vehicles that may be in collision with it, and pedestrians or bystanders who may be struck by it. This is relevant in particular to estimation of the effects on numbers killed or injured of changing the amounts of use of different kinds of vehicle or the amount of walking.

2.3 TARGET SETTING

2.3.1 Targets in relation to vision, strategy and implementation

The role of targets in achieving safer use of the roads is to act as a tool for motivating and monitoring action to reduce death and injury in road traffic collisions. As such, targets need to be clearly distinguished from any road safety vision or philosophy that may be adopted, and clearly related to a strategy, or plan of action. The latter may either be a free-standing road safety strategy or be part of a wider transport safety strategy or general transport policy.

A prerequisite for effective action radically to reduce death and injury in road traffic collisions is a strongly felt and lasting motivation for change which is sufficient to root out and overcome the deep seated tolerance of disproportionate numbers of people being killed or injured on the roads that characterises highly motorised societies. This motivation for change has to extend to enough opinion-formers and decision-makers eventually to convince all the relevant stakeholders. One way of generating and communicating such a motivation for change is by promoting an inspiring vision of safer road use. Another is for a sufficiently influential person or group of people, or a sufficiently powerful coalition of stakeholders, to develop and promote a practical philosophy of safer road use. To achieve the necessary shift in the mind-set of decision-makers and stakeholders, the vision or philosophy needs to be far-reaching and long term, looking well beyond what is immediately achievable.

In contrast, an effective strategy or plan of action needs to start here and now, and set out achievable risk-reducing measures for the foreseeable future, typically for, say, the next 10 years. Targets that are soundly related to the stated measures and their likely

effectiveness can provide both clear motivation for stakeholders from whom action is expected and meaningful yardsticks against which progress with implementation of the strategy can be measured. Such a sound relationship between targets and measures can be reached by stakeholders either first agreeing on the measures and then deducing matching targets, or first deciding on targets and then finding a set of measures that makes the targets achievable, or, probably most typically, by a subtle mixture of these two approaches.

It matters little just what mixture of the two approaches is used, so long as the process leads to the agreed measures and associated targets being mutually consistent and gaining the ownership and commitment of all the affected stakeholders. In this process it is also important to find a widely acceptable balance between challenge and achievability of the targets. Targets that go beyond what is achievable in terms of the likely effects of the foreseeable measures can demotivate instead of motivating, while targets that could be reached without a high level of implementation of all the envisaged measures can induce widespread complacency, with each stakeholder tempted to feel that only part of what they could contribute is really needed.

It is of course possible simply to choose targets in the form of appealingly low numbers of casualties or levels of risk without prior consideration of just how they might be achieved. However, unless targets chosen in this way can be matched quickly by practical strategies for their achievement, these targets act rather as aspirational substitutes for a vision or philosophy than as a tool for motivating and monitoring the implementation of a particular road safety strategy. Moreover, once such aspirational targets have been set, it can become difficult subsequently to set more modest interim targets in relation to a specific safety strategy without creating apparent contradiction and consequent confusion.

There need, however, be no contradiction between a far-reaching long-term vision or philosophy and a challenging but achievable, and thus necessarily more modest, shorter-term target associated with a strategy for the foreseeable future. If properly communicated and understood, both the ultimate vision or philosophy and targets for the next foreseeable steps towards it can serve their respective purposes side by side.

2.3.2 Characteristics of targets

Road safety targets in EU Member States differ widely as to the performance indicator to which they relate and their timescales, spatial coverage and degree of challenge.

Performance indicators

Targets need to be quantitative and progress towards them needs to be measurable. Many governments have set targets to reduce the number of deaths. This is consistent with the high value attached to prevention of deaths in estimating the social and economic costs of road collisions, and is in line with understandable public concern and with the concentration of media coverage on fatal collisions. It also has the advantage that data on deaths are normally the most completely and reliably recorded information about collisions on the roads. Data on injuries or property damage are in many countries either subject to underreporting or not systematically collected at all.

Although numbers of the severest non-fatally injured are highly correlated with numbers of deaths, trends in the latter do not necessarily fully reflect changes in the amount of injury on the roads. In the last decade, with increasing densities of traffic, downward trends in deaths have been accompanied by increases in lesser injury in many member states. Some have therefore set targets in terms of numbers injured, distinguishing

between serious and slight injury according to their reporting systems. Targets can also be set in terms of severity of collisions, as measured by suitable ratios of numbers of casualties or collisions.

Actual levels of risk would obviously be addressed more directly by setting targets for death or injury rates per unit of distance travelled or time spent travelling, but the scope for this is limited in some countries by the availability of exposure data, and more generally by the perception that it is easier to communicate with stakeholders and the public in terms of numbers than of rates.

Within broad targets for reduction of death or injury, subtargets can be set for particular administrative areas or types of road. Subtargets addressing specific road safety problems can also be helpful, such as specific types of collision or the involvement of specific road user groups. It is, however, important that subtargets be consistent with the main targets, and that they should not so constrain the allocation of resources among safety measures as to reduce the cost-effectiveness of the whole programme of measures unduly.

In addition, targets for behavioural performance indicators, like alcohol levels, seat belt use and choice of speed, can be valuable elements in safety programmes, provided that corresponding monitoring can be undertaken.

Timescales

The timescales for current targets vary between 5 and 20 years, with the runtime of the majority of road safety programmes being about 10 years. Only Austria, with targets for 2004 and 2010, and Greece, with targets for 2005 and 2015, have so far incorporated interim milestones into their current programmes, but other countries are committed to periodic reviews of progress within their target periods.

Spatial Coverage

Most current targets are set at the national level, where responsibilities for legislation and standards lie. Other issues such as responsibility for road infrastructure and police enforcement are partly dealt with by regional or local authorities, which may make additional target setting at this level helpful. Regional or local targets have been set, amongst others, by Denmark, some German Länder, Norway and The Netherlands. Safety problems on urban roads often fall into the jurisdiction of municipalities, where the direct influence of central government programmes can be limited. The EU project DUMAS (Developing Urban Management and Safety) produced a clear view on how integrated local safety schemes and target setting can be established at the local level (EC 2000).

Degree of challenge

Since only some of the current targets for reduction in deaths or numbers injured are explicitly related to estimates of what is likely to be achievable by foreseeable means, the balance between challenge and achievability in current targets in the EU is hard to assess. There seems, however, to be a tendency for aspirational targets that are set in advance of development of programmes for their achievement to be on the challenging side – sometimes to the point of being unrealistic.

2.3.3 Process leading to target setting

The first step towards setting road safety targets is the recognition by decision-makers of the importance of reducing death and injury on the roads. They may come to this point for a mixture of reasons: the unacceptability of the current number of victims, both

in itself and compared to the other means of transport; the socio-economic cost of accidents; the health consequences and related impacts; the psychological harm to victims and their families; or the impact on the most vulnerable groups such as young and elderly people.

The way is then open to the further recognition that "... strategic planning for road safety with numerical targets is essential to increase political attention and to provide a focus for effective activity by all those who can take action" (European Parliament 2001).

Adoption of a strategic approach implies the need to bring together all stakeholders in different branches of national, regional and local government, in industry and commerce, and among the various road user groups so that different interests are shared and common goals of different policies can be achieved by the combined efforts of a coalition of interested parties committed to the strategy. Target setting can both arise from and contribute to the bringing together of the stakeholders.

On the one hand, stakeholders will soon ask where the envisaged strategy is intended to lead in terms of casualty reduction, and on the other, the need to answer this question will help to focus the attention of each stakeholder on just how much they can contribute in the context of corresponding effort by all the others. Various advantages of having set and committed themselves to targets will become clear:

- target setting means that the responsible authorities commit themselves to striving to achieve specified road safety goals within a certain period of time
- commitment to targets will help to keep the safety strategy on the political agenda, so that once made, the resolution remains effective;
- target setting will help to clarify the roles and responsibilities of all stakeholders;
- the targets will be useful to stakeholders in maintaining the commitment of their members;
- the targets will help in promoting the strategy by education and campaigning and in communicating priorities;
- the targets will be a basis for financial support for the implementation of safety programmes and packages of measures at different administrative levels; and
- the commitment to targets will imply the establishment of effective monitoring procedures.

For target setting to deliver these advantages, it has to be based upon adequate information about the current road safety situation and how it has evolved, upon reasonable assumptions about the future, and upon the sharing of coherent information among all stakeholders.

In this process, it is important for commitment at the national level to be matched at the regional and local levels. Experience has shown that getting the support of local politicians for a safety programme is one of the most important requirements for success. Implementing measures will not always be popular, so it is vital that safety remains a high priority with the decision makers, even in the face of periods of public criticism or the possibility of losing votes. It is unlikely that local political support can be achieved without first getting public interest in and support for casualty reductions. Participation in target setting can help to correct people's underestimation and other misperceptions of risk in using the roads, for example in comparison of the risk of criminal assault.

Target setting at the local level will also help to develop a concern to contribute to the road safety effort in a range of departments of local government, including road building

and maintenance, traffic management, public transport, land-use planning and development, environmental health, education and social services, as well as in the police force, business and community groups. This should contribute to the integration of road safety with the range of other aspects of urban and rural policy and development, as discussed in the urban context by Fleury (1998).

Both nationally and locally, management teams formed to be responsible for formulating the agreed strategy and setting casualty reduction targets can also provide the starting point for leading the subsequent implementation of the resulting policies and measures. A strong alliance between the political leadership and professional management team is crucial.

2.3.4 Technique for setting targets

It is important to use a sound statistically based methodology to set the casualty reduction targets. If the methodology is not sound then the targets will lack credibility and the strategy for improving safety will be jeopardised. Moreover if key people involved in improving road safety subsequently come to realise that a poor method has produced targets that are too demanding and cannot be achieved, they will lose motivation and it will be difficult to maintain progress towards the targets. On the other hand, if the targets are too easy then opportunities for saving lives will have been lost.

Fortunately, a suitable body of knowledge has been built up in recent years which can be applied to forecast the numbers of casualties in the target year under various assumptions. Naturally, the results do not take account of future developments that cannot be foreseen, but the methodology does provide a powerful means of organising available knowledge and thinking systematically about future influences upon casualty numbers. It can deploy reasonably sophisticated national sources of data about road use and the occurrence of death and injury on the roads, but is capable in simplified form of achieving worthwhile results in countries with less sophisticated data sources.

A forecast is not the same as a target, but there are good reasons to build any target on casualty forecasts that are strongly based upon knowledge of what has occurred in the recent past. The changes in casualties over recent years show what has been achieved by national and local efforts to improve road safety, applying the level of resources that has been judged politically to be appropriate. Consequently, a forecast representing the continuation of recent trends shows what may be expected if these efforts continue at broadly the same level in the coming years. This is the starting point for assessing what may realistically be achieved in future with additional efforts.

The methodology is essentially strategic, studying the broad evolution of road safety rather than attempting to explain all of the details. Nonetheless, the effects of specific safety measures should be taken into account where possible, so that the forecasting process is not simply an extrapolation of the past but does take account of the main elements of road safety policy.

The necessary knowledge about recent casualty trends comes from analyses of:

- a) national casualty statistics, principally comprising the annual casualty numbers for the main groups of road users;
- b) measures of the changing exposure to risk of these groups, including the amount of motor traffic and the average distances walked and cycled per person per year; and
- c) available information about the effectiveness at the national level of measures that have influenced casualty numbers substantially.

The first stage of the forecasting process consists of developing statistical models that explain past changes in the casualty numbers (data of type a) in terms of explanatory variables (data of types b and c). These models need to fit the data sufficiently well to provide reasonable confidence in their ability to predict the future. A body of technical literature exists that can guide this work, but the need to present the techniques and results in public once the work is complete argues against an unduly theoretical approach. Broughton et al (2000) describe a British attempt to balance the needs of technical rigour and public accessibility.

The result from this first stage is a series of equations that reproduce the recent casualty trends. The second stage consists of applying these equations to forecast casualty numbers; this is technically simple, but the forecasts rely on the assumption that these recent trends will continue throughout the forecasting period. Confidence in the forecasts depends in part on the length of the period that has been analysed, and ideally a period of at least ten years would be used.

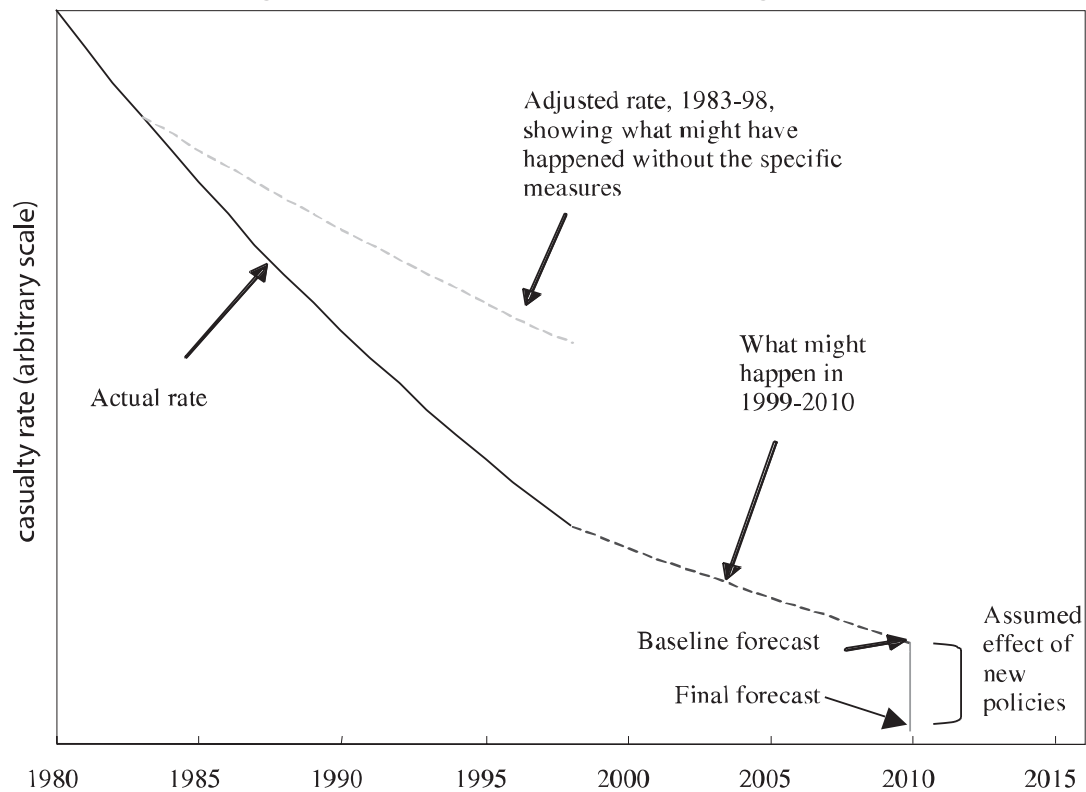
In order to apply these equations and produce casualty forecasts for the target year, values must be assigned to the explanatory variables for that year. The variables mainly represent assumptions about the development of road use over the forecasting period, in particular the amounts of motor traffic and of walking and cycling. Experts may already have prepared forecasts of some of these variables for other purposes.

Since the casualty trends already represent the effects of continuing with existing road safety measures, these forecasts show the number of casualties that would be expected if no further road safety measures were to be introduced over the forecasting period. In this context, further measures are either innovatory or are substantial expansions of existing measures.

In the final stage, these forecasts are adjusted to take account of the likely effects in the target year of road safety measures that are expected to be implemented by then. This involves listing likely further measures in consultation with appropriate advisors, and using whatever information is available to assess their potential for reducing casualties. The assessment should be done separately for each road user group, since measures designed to protect one group may well provide little or no benefit to others.

The method for forecasting casualty rates is illustrated by Figure 2, based on the British example. The effectiveness of certain specific measures could be measured with some confidence, but casualty rates fell faster between 1983 and 1998 than could be explained purely by these measures. The main solid line shows, in an idealised form, how the rate actually fell, while the upper broken line shows how the rate would have fallen without these specific measures. The lower broken line predicts how the rate might fall between 1999 and 2010 if there were no further measures (including no more of the specific measures) and the forecast for 2010 may be termed the baseline forecast. The vertical solid line shows how the likely effects of expected further measures lead from this to the final forecast for 2010.

Figure 2: Illustration of the forecasting method



It will already be possible to describe certain further measures in some detail, and to assess their likely effectiveness. In order to produce a target that is challenging as well as achievable, however, other measures that are less well defined at present should also be included for implementation nearer to the target year. Their effects will be more speculative, but including such measures will set a challenge for the future.

Assessments of likely effectiveness should ideally be evidence-based, the evidence coming either from practical trials or from experience in other countries that have already implemented these measures. Countries that have taken a lead in introducing new road safety measures will generally have fewer opportunities to benefit from foreign experience, and expert judgement will tend to play a greater role in these cases.

Neither the future levels of road use nor the effectiveness and timing of further safety measures can be predicted with certainty, so the outcome of these analyses is a range of forecasts rather than a single forecast. This range represents the sensitivity of the forecast number of casualties to assumptions about future developments. One way of minimising sensitivity to future changes in road use is to express the target in terms of the rate of casualties per unit of exposure, but a target expressed as a rate may well be more difficult to explain to the public than a simple number of casualties.

The outcome of the forecasting process is a series of forecasts that represent alternative views about the future development of road use and of road safety measures. Attention should be focussed on forecasts for the more plausible alternatives, and the target should be based on these values. Several judgements are required at this stage, such as:

- might it prove difficult to maintain the past rate of progress because some key existing measures may start to lose effectiveness in the coming years? – this would

suggest that the target should be less ambitious than indicated by these forecasts;

- may the assumptions made about the rate of introduction of new measures be over-optimistic? – this would also suggest a less ambitious target; or
- may there instead be grounds for greater confidence about the effectiveness of new measures? - this would suggest a target that was more ambitious than indicated by these forecasts.

Once the target has been adopted, it is important to monitor progress towards the target regularly in order to judge whether further measures may be needed to reach (or indeed surpass) the target. The forecasting methodology provides a valuable framework for this monitoring: as each year passes, the casualty forecasts for that year can be checked against the actual data. In the early years, this is mainly useful for checking the validity of the forecasting equations. Later, as new road safety measures start to be implemented, this comparison can be extended to check for their effects, and to assess whether collectively they are proving sufficiently effective for the target to be reached.

2.3.5 Adoption and presentation of targets and the path to achievement

When a target or a set of targets has been set and the accompanying strategy for achieving them has been at least far enough developed to make it clear that the targets, however challenging, are realistically achievable, then the targets and strategy need to be formally adopted in a way that makes a public commitment to them by the responsible politicians, preferably of all parties.

This process should include all the stakeholders who have been involved in setting the targets and formulating the strategy, and who will share responsibility for implementing the strategy and achieving the targets. But it is important for the lead to be taken by the highest relevant level of government: for an EU target and strategy, the appropriate Council of Ministers and Directorate with the endorsement of the European Parliament; for a national target and strategy, the national government, and so on for more local targets. In this way, stakeholders at every level are assured of backing of higher authority.

Public commitment by all stakeholders need not imply and should not have to await complete unanimity on every aspect of the strategy: to require this when there are genuine conflicts of interest between participants would delay the process indefinitely. What it should imply is wholehearted acceptance of the broad lines of the strategy, and in particular of the numerical targets, notwithstanding understandable differences in emphasis across the wide range of policies and measures whose detailed implementation will be worked out over the target period.

Adoption of the targets and strategy provide an opportunity for government to present these to the citizens clearly, concisely and in no uncertain terms, calling for their positive response as individuals to the public commitment of government and the range of stakeholders. Correspondingly, it is an opportunity for stakeholder organisations to accept their respective responsibilities to contribute to implementation of the strategy and achievement of the targets, and to remind their members of the response that will be needed from them. All this should enable the process of implementation to begin in a climate of widespread awareness, even enthusiasm, and clarity about the allocation of responsibility.

The range of policies and measures for achieving the targets is well-known: legislation and its enforcement; education, training and public information; road infrastructure engineering including traffic management; and vehicle engineering and maintenance –

both kinds of engineering to influence road user behaviour as well as making technical improvements. This range is exemplified in the road safety strategies for Austria (Bundesministerium für Verkehr, Innovation und Technologie 2002), Finland (Ministry of Transport and Telecommunications Finland 2001), Great Britain (DETR 2000) and The Netherlands (Wegman and Elsenaar 1997).

Policies and measures to be implemented at the outset will need to be decided by the various responsible organisations when the target is adopted, but it would be counterproductive to attempt to do this for those to be implemented later in the target period because this is usually long enough, typically 10 years, for it to be important to retain flexibility to decide the exact policies and measures and their timing, within the broad thrust of the strategy, in the light of progress and changing circumstances over the period.

For this purpose, monitoring and evaluation should be an ongoing process throughout the target period in order to benefit from the experience gained and adapt to changing circumstances, as well as to keep track of progress towards the targets.

2.3.6 Monitoring and updating

Systematic and transparent quantified monitoring of the implementation of the road safety strategy and of progress towards the targets at the level of government at which the targets are set and more locally is crucial both for maintaining the motivation of the stakeholders and hence the effectiveness of implementation, and for the updating of the strategy and targets in the light of experience and circumstances. Monitoring and updating are integral parts of implementation, and require appropriate systems for the collection, processing and publication of reliable data to allow:

- continuous monitoring of the target performance indices;
- monitoring of implementation, identifying delays requiring corrective action;
- review and updating of policies and measures, with redistribution of resources towards more cost-effective measures; and
- maintenance of confidence in progressing effective policies and measures.

Monitoring to achieve this has three distinct components concerned with the target performance indices, the implementation of measures and the cost-effectiveness of measures.

Monitoring the target performance indices

Systematic recording and analysis of time series data from which the performance indices can be calculated allows the most recent values of the indices and trends in them to be compared with the target levels. This should be done for the whole area to which each target relates, and as far as data allow also for relevant types of area, road, vehicle or road user.

Indicators in terms of numbers of casualties or collisions or their severity require only data about collisions and their consequences. Indicators in terms of rates per unit of exposure require also the corresponding exposure data, such as population or amounts of traffic or travel.

Monitoring of targets for behavioural performance indicators, like alcohol levels, seat belt use and choice of speed, or indicators of the condition of the vehicle fleet or the performance of emergency services in treating the injured require specially designed periodic surveys of these aspects.

Monitoring the implementation of measures

Once firm plans have been made for the scale and timing of implementation of particular measures, effective management requires regular comparison between actual and planned implementation. This allows credit to be given for achievement ahead of schedule, delays to be investigated, and the implementation schedule to be adjusted accordingly. Appropriate procedures can be applied to all common types of road safety measures, and should monitor quality as well as quantity of progress.

Monitoring the cost-effectiveness of measures

Estimating the cost-effectiveness of particular road safety measures and their contribution to achieving the targets is clearly desirable in principle, but is at best a complicated task and cannot by any means always be achieved. Where it can be done, usually by means of carefully designed statistical analysis of numbers of casualties affected or not affected by the measure concerned, the findings can be of great value in guiding the allocation of resources among measures of different kinds and associated updating of the strategy.

Monitoring the performance of policies

The various policies which make up a road safety strategy will usually each consist of a range of related measures, and assessment of the success of each policy in terms of the delivery of these measures in combination and their combined contribution to achieving the targets can contribute to the refinement of policies in the light of experience.

Keys to effective monitoring and updating of targets

Realisation of the full potential of monitoring and updating of targets to contribute to successful implementation of road safety strategies depends on several key factors:

- appropriate management structure and procedures,
- availability of requisite data, especially about collisions and road use,
- active involvement of independent scientific expertise, and
- transparency through making public the results of monitoring.

In particular, the statistical techniques used must be able to make best estimates of the required indicators and effects in the face of random fluctuations in the numbers of collisions and casualties, and of unexpected outside influences such as sudden changes in the price of fuel.

The monitoring of progress and updating of targets and strategy is usually the responsibility of the various levels of government involved, under the leadership of the highest level of government. This should enable adequate resources to be allocated to the process, and facilitate the prompt dissemination of results of monitoring and any consequent adjustments to the targets or strategy to all stakeholders and to the public. This in turn should help to maintain awareness and sustain motivation for continued effort by all concerned.

2.4 CURRENT USE OF RISK ASSESSMENT AND TARGET SETTING FOR ROAD SAFETY IN EUROPE

2.4.1 Road safety targets adopted in Europe

The quantitative road safety targets that have been adopted by the EU, a number of EU Member States and Poland are shown in Table 1. These targets refer to the numbers

killed in road collisions except in Denmark and Great Britain, where the targets refer to numbers killed or seriously injured (KSI).

Most of the targets are quite ambitious, and aim for a reduction in the annual number of deaths of some 40 to 50% within a period varying from 5 years in France to 14 years in Denmark. These targets represent an ambition to reduce the number of deaths more quickly than continuation of past trends would imply.

In addition to the targets shown in Table 1, some countries have set targets to reduce the number of injured road users, for example in Austria to reduce the number of collisions involving injury by 10% by 2004 and 20% by 2010 and in Great Britain to reduce the number slightly injured per billion vehicle-km by 10% by 2010. A further sub-target has been set in Great Britain to reducing the number of children KSI by 50% by 2010.

Most EU countries have set quantitative road safety targets, one Accession Country has done so, and at least one more is preparing to. In both Germany and Norway, however, reports prepared by executive agencies or technical experts on behalf of the relevant ministry have proposed quantitative targets, but the national governments, whilst being committed to road casualty reduction, have refrained from setting targets. In the meantime local authorities in Norway have set targets, and so has one of the Länder in Germany. In Denmark, the national target was set by the local authorities.

The target set for the European Union as a whole – to reduce road accident fatalities by 50% over 10 years – is more ambitious than the targets set by several member states.

Table 1: Quantitative road safety targets in Europe

| Country | Base-year for target | Year in which target is to be realised | Target for reduction of the number of deaths in road collisions (KSI in Denmark and Great Britain) |
|-----------------|----------------------|--|--|
| Austria | 1998-2000 | 2004 | -25% |
| Austria | 1998-2000 | 2010 | -50% |
| Denmark | 1998 | 2012 | -40% |
| Finland | 2000 | 2010 | -37% |
| Finland | 2000 | 2025 | -75% |
| France | 1997 | 2002 | -50% |
| Great Britain* | 1994-98 | 2010 | -40% |
| Greece | 2000 | 2005 | -20% |
| Greece | 2000 | 2015 | -40% |
| Ireland | 1997 | 2002 | -20% |
| Italy | 1998-2000 | 2010 | -40% |
| Poland | 1997-1999 | 2010 | -43% |
| The Netherlands | 1998 | 2010 | -30% |
| Sweden | 1996 | 2007 | -50% |
| European Union | 2000 | 2010 | -50% |

*In the United Kingdom, road safety is dealt with so differently in Great Britain and Northern Ireland that the principal target is set for Great Britain only.

In Section 2.3.1 it was noted that targets soundly related to measures for casualty reduction can be set either by starting from envisaged measures and deducing matching targets or starting from desired targets and finding measures that make them achievable, or by a mixture of the two approaches. The examples of Austria and Sweden, where the Vision Zero is adopted, compared with that of The Netherlands might be seen as indicating that the latter approach tends to lead to more ambitious targets. On the other hand Denmark and Finland, which adopt the Vision Zero in principle, have rather similar targets to Great Britain, which does not.

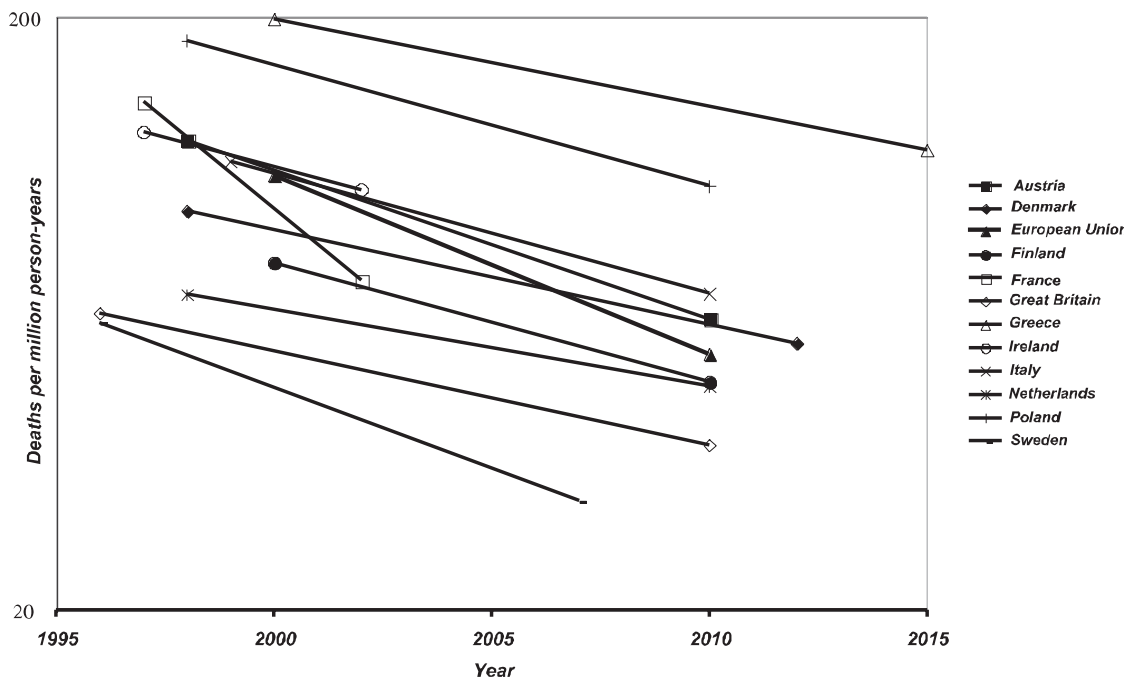
What matters more than just what mixture of the two approaches is used is a serious attempt to match target and envisaged measures. The experience of France with its ambitious but underachieved target of 50% reduction for 1997-2002 illustrates this.

One problem that has been encountered in several countries is that local authorities do not readily carry out as much road safety engineering on local roads as is required to make the envisaged contribution to achieving the targets. Several countries have used financial incentives from the national government to local authorities to overcome this problem.

A good deal of earlier and more recent European experience of formulation and implementation of targeted road safety strategies has been documented by the OECD (1994, 2002).

Figure 3 illustrates the targets set by each country and by the EU. It shows time on horizontal axis and deaths on the roads per million person-years (i.e. annual numbers of deaths per million inhabitants) on the vertical axis. A logarithmic scale has been used for the vertical axis to make directly comparable the slopes of the lines indicating achievement of the targeted reduction in deaths by means of an equal percentage reduction in each year of the target period. These slopes are seen to be rather similar except for France and the EU, for which the steep slopes indicate the ambitious nature of the targets that has already been remarked upon.

Figure 3 Targets for reductions of numbers killed or KSI on the roads



Only one statistical study (Elvik 2001) has so far attempted the complex task of estimating the effect of the setting of quantitative road safety targets by national or local governments upon numbers of deaths on the roads per year in the countries or areas concerned. Data relating to a total of 22 national targets (15 after omitting each target whose period overlapped that of another target for the same country) and 13 local targets (10 after similar omission of targets) were analysed. The author of that study is rightly concerned to point out a number of limitations on the interpretation of the results of the range of before-and-after comparisons and multivariate analyses made in the study, and that where statistically significant associations were found, these did not imply cause and effect.

Nevertheless, the findings did indicate a statistically significant association between setting national targets and an improvement in the year-on-year percentage reduction in the number of deaths on the roads of the countries concerned. The central estimate of this improvement was about 0.5% (or about 5% fewer deaths per year by the end of a 10-year target period), and this was not sensitive to the omission of targets with overlapping periods. The findings also indicated that greater than average improvements were associated with more ambitious targets and with longer term targets.

3. RISK ASSESSMENT AND TARGET SETTING IN RAIL, AIR AND MARITIME TRANSPORT

3.1 INTRODUCTION

Risk assessment in controlled engineering systems such as rail and air, and to a somewhat lesser extent maritime, transport is more highly developed than in road transport. This reflects both the more comprehensively managed and controlled nature of these three systems than that of road transport and the relative rarity of accidents in them, which prevents the levels of many important risks from being reliably estimated simply from ratios of numbers of accidents occurring to measures of exposure to risk. In these three systems it consists of:

1. Identifying the hazards in the system that could lead to accidents, typically those potentially causing death or injury to people;
2. Estimating the frequency of each type of accident, given the current safety measures;
3. Estimating accident consequences, often measured by the mean and the distribution of the number of deaths or injuries per accident;
4. Calculating various measures of risk, such as (a) deaths or injuries in the system per year, (b) *individual risk* – that is the risk of death or injury per year to representative individuals in groups such as railway track workers or regular airline passengers, or (c) the frequency of accidents of particular kinds;

The results of such assessment of risk can be used in deciding upon and implementing further safety measures, which can lead on to monitoring of changes in risk and repeating the cycle. They can also be used, in combination with information about likely future changes in circumstances affecting hazards or the occurrence or consequences of accidents, to help in setting targets.

Two kinds of criteria may be invoked in considering whether further safety measures are needed in the light of risk assessment. These are:

- absolute risk criteria: if, say, the estimated frequency of accidents or the risk to representative or specific individuals exceeds some threshold, then safety measures may be required without regard to costs; or
- criteria set in relation to safety measures: these deem that if safety measures are available that could reasonably reduce risk, then they should be implemented. The level of safety achieved is then not predetermined, but depends on what safety measures are regarded as reasonable. In this context, the benefits of safety measures are sometimes explicitly valued and compared with the costs.

In relation to safety targets for rail, air and maritime transport, it should be remembered that the numbers of relevant accidents can be small, and so can the number of deaths and serious injuries in most of them. This is especially true of the smaller EU countries. Furthermore, the data for a particular country, or even for the EU as a whole, in a particular year can be strongly influenced by a single serious accident. The data are therefore subject to wide statistical variation and a low number of casualties in a particular year or a few successive years is not always a reliable indicator that the system concerned is safe. This makes it difficult to know whether a specific target has actually been met. Indeed, it raises the question of what meeting a target means: does it require the actual data for the designated year to meet the target, or does it require some estimate of the underlying mean of the target indicator to do so? The latter makes more sense than the former, but in turn it raises the question of how the underlying mean is to be estimated.

3.2 RAIL TRANSPORT

Railway casualties are classically divided into passengers, staff and third parties. The UIC (Union Internationale des Chemins de Fer) gives numbers of deaths on the 15 main line railway systems of the EU countries subdivided in this form. According to the UIC data, numbers of deaths on railways in the EU in 1996-2000 averaged about 120 per year to passengers (including those in the two very serious accidents at Eschede in Germany in 1998 and Ladbroke Grove in the UK in 1999), 40 per year to staff, and about 700 per year to third parties, excluding suicides.

These figures are useful in indicating the scale of risk on the railways, but they suffer from the weakness that there is no international agreement as to what constitutes a railway casualty, because railways are organised at the level of member states, and each has developed its own safety management and regulatory system. All countries agree that casualties to passengers and staff in train accidents are railway casualties. However, there is less agreement about casualties caused by misguided actions by passengers such as attempting to board a moving train, and still less about abuse of level crossings by non-rail users, or deaths to trespassers. Different countries almost certainly have different definitions. It is also sometimes difficult to distinguish accidental deaths to trespassers from suicides, and different countries do so in different ways. This makes international comparisons difficult, especially because there are more deaths to third parties than in train accidents. If the proposed Railway Safety Directive and the establishment of the European Railway Agency (ERA) are implemented, comparability of data will improve.

There are also no standard international conventions for measuring exposure to risk on the railways. In the UIC data, the only exposure measure provided is the number of passenger-kilometres, which is a suitable measure of risk to passengers, but only to

them, and they represent a minority of railway casualties. Figure 4 (ETSC 2003) shows the risk of death to passengers per passenger-km across the EU for each year from 1970 to 2000. The data show variation for year to year, particularly due to the occurrence of major accidents, but the general trend is downward, represented by the exponential curve corresponding to a decrease of just over 5.5% per year.

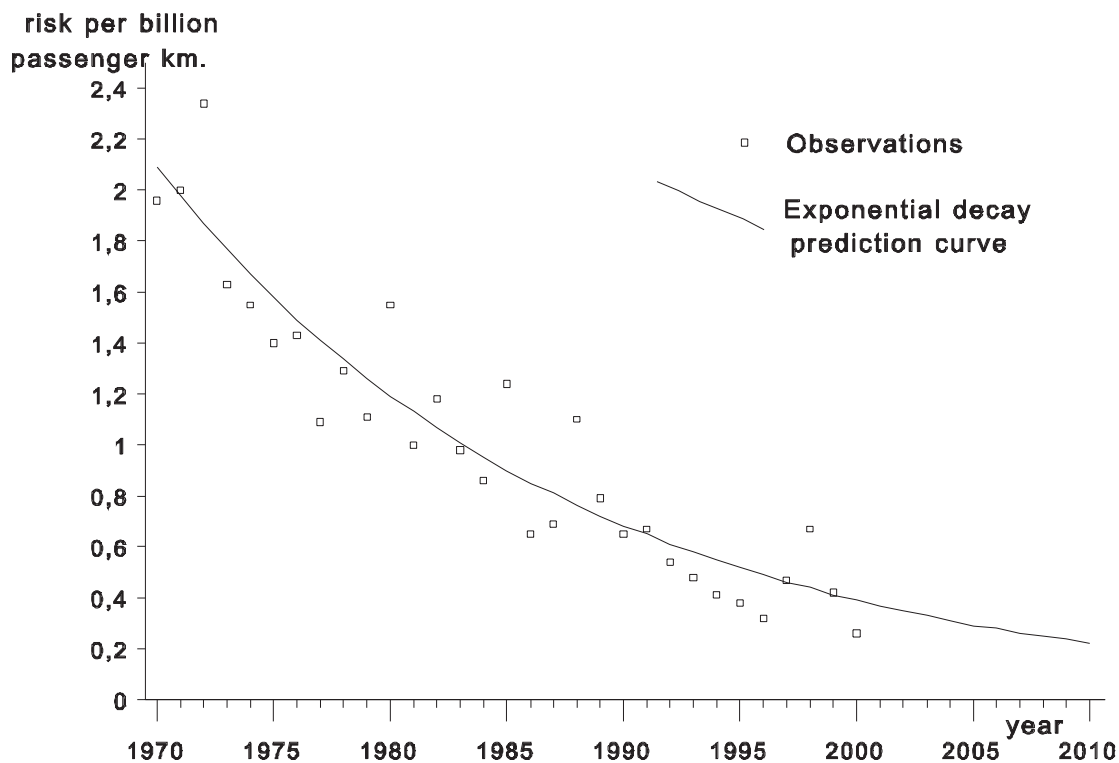


Figure 4 Risk of death to train passengers in the EU per billion passenger-km

A useful general exposure measure for railway risks would be train-kilometres. Many countries collect this information, and assembling reliable information on train-kilometres per year will be another function of the proposed ERA.

3.2.1 Rail risk assessment

Methods of assessment

Most types of railway accident are familiar from past history, and these are a good indicator of railway hazards. Sometimes systematic 'brain-storming' reviews are carried out, especially for new systems, such as new high-speed lines, bridges or tunnels.

There are three general methods for estimating risk. The first is to estimate risk directly from empirical data on past accidents; the second to develop and use a probability model to estimate the accident frequencies and consequences; the third is engineering judgement based sometimes on knowledge of the results of the first two. Most practical methods involve a mixture of these three. Given that railway accidents are relatively rare events, it may be difficult to estimate the likely risk reductions from specific safety measures, especially if these are local (such as an improvement to a depot) rather than system-wide (such as new control systems). The scope for use of safety performance indicators other than accidents has been reviewed previously by ETSC (2001b).

Probabilistic risk models are being used increasingly in railway risk assessment. Some railways have developed comprehensive risk models of the whole system (for example, Railway Safety 2003). More usually, models are developed for engineering components such as proposed new signalling systems or rolling stock, or for new high-speed lines.

Criteria for safety measures

There is no generally accepted criterion for deciding what railway safety measures are needed. There is a widespread view that current safety performance is reasonably good, and this provides a benchmark against which system changes are judged. The explicit valuation of the benefits and costs of safety measures is uncommon in railways.

Three general principles for the adoption of safety measures are current. These are:

- that any change to a system must leave it at least as safe as it was beforehand. This is labelled GAME after the French ‘Globalement Au Moins Equivalente’. It is a formal adoption of the present level of safety as a benchmark, and is an absolute criterion. At least three EU countries explicitly adopt this principle (see Section 3.2.2).
- the ‘Minimum Endogenous Mortality’ (MEM) principle that the risk of death to individuals shall be less than a specified limit. This is also an absolute criterion. Germany and the UK adopt it, though the UK limit does not bind in practice, because it is higher than the risks that are actually encountered.
- the principle that risks shall be ‘As Low As Reasonably Practicable’ (ALARP). This is a legal requirement in the UK. It involves some trade-off between the costs and benefits of safety measures, though the terms of that trade-off remain subject to debate. As noted in Section 3.1, the achieved level of safety depends on what safety measures are judged to be reasonably practicable.

Risk assessment and railway reorganisation

Until fairly recently main line railways were single nationalised industries, but in recent years the trend has been towards a more open market with many participating organisations. There may now be many separate organisations for infrastructure management, train operation, train and track maintenance, and manufacturing. There is wider access for new train operators. All this has profound implications for safety. This is partly because interfaces such as between the track and the trains are no longer within a single organisation but cross organisational boundaries. It is also because the possibility of new operators and suppliers requires more transparent regulatory machinery, both to test their competence and to approve their operation if they are shown to be competent. As the explanatory memorandum to the EU’s draft Railway Safety Directive says, “the opening of the market may not be carried out at the expense of safety, but safety should not be used as an excuse of maintaining status quo”.

One facet of greater transparency is a requirement on existing and would-be railway organisations to assess their risks and to produce public reports on the results of their risk assessments. These are typically included in *safety reports* or *safety cases* which describe how the organisations will manage and control the risks of their activities generally. Commitments made in such reports are usually legally binding.

3.2.2 Rail safety targets

For the purpose of understanding current rail safety targets in Europe, ETSC’s representatives sent a short e-mail questionnaire about targets to people in each of the 15 member states, and in Norway. In addition, targets are mentioned in the *Strategic*

Rail Research Agenda (2002) of the European Rail Research Advisory Council (ERRAC), on which ETSC is represented.

ETSC received responses or has information for 9 of the 15 EU member states, namely Belgium, Finland, France, Germany, Ireland, Italy, Portugal, Sweden and the UK, plus Norway and ERRAC. Appendix 1 gives details of the questionnaire, the people to whom it was sent, those who replied, and what they said.

Finland, Ireland, Sweden, UK and ERRAC have non-zero quantified targets for at least one aspect of railway operation. Belgium, France, Germany, Italy, Norway, and Portugal do not.

Of the countries who do not have quantified targets, France, Germany and Norway explicitly adopt the GAME principle that any technical or operational change in the railway must leave the system as least as safe as it was before the change. This assessment is usually based on technical considerations rather than accident data. Norway and Sweden have also adopted the long term *Vision Zero* for railways.

In relation to rail safety targets in general, the warning at the end of Section 3.1 about the implications for target setting and monitoring of small numbers of accidents, often with small numbers of casualties in each but with occasional serious accidents having much larger numbers of casualties, should always be borne in mind.

It is also useful to repeat the warning that railway casualty data, and therefore targets, may not be comparable between countries, especially for third party casualties and trespassers. However, this does not prevent individual countries having targets that are meaningful for their own definitions. Setting targets for the EU as a whole may well be a role for the ERA.

In addition to accidental casualties, there are many suicides on the railways. One reporting problem is that it is not always simple to know whether some deaths to people on the tracks are accidents or suicides. Different countries may have different methods for making this distinction, which again may lead to non-comparable data both on suicides and accidents. Identified suicides are often not regarded as the railways' responsibility, though some have targets to reduce suicides in collaboration with other agencies.

3.3 AIR TRANSPORT

The number of deaths in the EU on scheduled and charter flights operated by commercial airlines fluctuates widely from year to year because of the occurrence of multi-fatality accidents. The annual number is currently estimated (ETSC 1999, 2003) to average about 140 for flights within the EU plus a further 50 for flights to or from the EU. As for road and rail transport, the rate per billion passenger-km is decreasing exponentially, but for air transport this has only recently led to a downward trend in number of deaths per year, because, until the mid-1990s at least, the decrease in the rate was roughly balanced by the increase in passenger-km per year. In addition, there is a larger number of deaths in general aviation, including private flying.

Air transport is, and has long been global. For any one state, much of the traffic in its airspace comprises aircraft designed and built elsewhere, operated by aircrew trained and licensed elsewhere, on behalf of airlines based and licensed elsewhere. Accordingly, the rules governing air transport have been developed largely

internationally, mainly through the International Civil Aviation Organisation (ICAO), and then implemented in national legislation. In the EU, excluding general aviation, probabilities of a fatal accident are less than one in one million flights in most member states. Since many states do not generate more than one million flights per year, fatal accidents happen rarely in any one state, with none in many years and sometimes one or two accidents occurring in a year.

The rarity of fatal accidents and the international character of air transport make risk assessment and target setting in terms of such accidents largely a matter to be addressed for the EU as a whole by the European Air Safety Agency (EASA). The potential value of monitoring other safety performance indicators such as serious incidents at the national level has been identified, but difficulties with the reliable collection of such data still hamper widespread progress.

3.3.1 Risk assessment in two aspects of air transport

Risk assessment has been applied to air transport widely on an ad hoc basis but systematically to only two aspects:

- airworthiness of aircraft and reliability of their technical systems, and
- air traffic management,

and these account for only a small proportion of accidents.

In the 1970s, as more safety-critical functions were performed by increasingly complex aircraft systems, it was realised that, in assessing the acceptability of system designs, rational failure probability requirements should be established. In particular, single faults with catastrophic consequences should be extremely improbable. Historical evidence suggested that the probability of a serious accident due to all causes was about one per million flying hours, and about 10% of the accidents were attributed to aircraft system failure. Hence the probability of an accident induced by system failure was one in 10 million flying hours. It was arbitrarily assumed that about 100 failure conditions in the systems of a typical aircraft could be catastrophic. Hence the allowable probability for each such condition should not exceed one per billion flying hours. This absolute criterion is used as the upper limit for the average probability per flying hour for catastrophic failure conditions such as loss of the automatic landing system below a critical height or the inadvertent opening of an external aircraft door. This requirement is not for reliability of system components (which must generally be many times higher), but concerns the probability of catastrophic events.

This criterion means only that the existing risk of accident from system failure per flying hour is maintained. It does not cater for the steady increase in the volume of air transport or for newer aircraft carrying more passengers so that accidents may involve more victims. Nor does it allow for change over time in the acceptability of fatal accidents.

Risk assessment in air traffic management (ATM) is often similarly based except that it usually takes into account the growth of traffic volumes over time. Examples are the maxima for risk of collisions between aircraft on laterally separated North Atlantic Tracks and of fatal accidents to aircraft taxiing on the ground. The procedure is then roughly as follows.

1. Calculate the accident rate due to all causes using available historical data.
2. Assign a proportion of this accident rate to collisions (taking into account that in the recording of aviation accidents one collision equates to two accidents).

3. Apply an improvement factor to cater for future growth in traffic volumes.

The resulting accident rate is then used as a maximum allowable accident probability. Since traffic growth is accounted for, this absolute criterion is such that the number of accidents due to ATM does not increase. This matches the European ATM strategy (Eurocontrol 2001), which stipulates that “the number of ATM induced accidents shall not increase, and where possible decrease as traffic grows”. The second half of this stipulation implies that the same criterion may also serve as the upper limit of an ALARP scheme – *i.e.* a level of risk below which only reasonably practicable measures need be taken to reduce risk, but above which risk is required to be reduced other than in exceptional circumstances.

3.3.2 Air safety targets

The absolute criteria just discussed for risk of aircraft system failure and risk of accidents due to ATM are themselves targets for these two aspects of air safety, and the latter is being adopted in the European context by Eurocontrol, but it is important to note that the vast majority of accidents are not covered by these two kinds of target or any counterpart specific target.

The public, the media and many decision-makers are, however, interested less in the safety of specific technology or procedures (notwithstanding the spotlight that may be cast upon these in the aftermath of serious accidents) than in the overall safety of air transport. Also, there is an increasing tendency in the aviation safety community to consider air transport as a complex system whose safety performance should be approached holistically, considering in particular the interrelationships between the airlines, airports, regulators, air traffic service providers and other actors. In this context, several overall safety targets have been set in recent years.

In 1997, targets were set for the safety of air transport by US carriers by a commission headed by the then Vice-President of the USA (White House Commission on Aviation Safety and Security 1997) and by the National Aeronautical and Space Administration. These targets are to reduce risk relative to its level in 1998 by 80% by 2007 and by 90% by 2018. There is no recorded analysis of feasibility of achieving these targets or plan for doing so, but it was recognised that safety research should be undertaken to support the targets. They have accordingly formed the basis for a major research programme at NASA and the formation of the US Commercial Aviation Safety Team (CAST), in which all actors in air transport including government are participating voluntarily in an important international air safety improvement programme. This cooperates on a modest but significant scale with its European counterpart Joint Safety Strategy Initiative (JSSI).

The JSSI was formed in 1998, as an initiative of the Joint Airworthiness Authorities (JAA) (JAA website). In JSSI, representatives of all actors in the air transport system in Europe, including the research community and trade unions, are participating voluntarily. The objective of JSSI, which could be considered a safety target, is that, notwithstanding traffic growth, the annual number of fatal accidents and the annual number of fatalities, based on a moving average, shall not increase. This objective is based on the notion that an increase in the absolute number of accidents is socially unacceptable and may eventually curtail the demand for air travel and place a mobility constraint on the development of the EU. There was a general consensus that this objective was feasible, but this was not based on explicit analysis.

In 2000, a group of leading people called the Group of Personalities (GoP) was invited

by the EU Commissioner for Research to propose a goal for Europe in 2020 in respect of aeronautics, and set (EC 2001a) a safety target for air transport, namely a reduction in the average accident rate of global operators by a factor of five by 2020.

An overall safety target of this kind makes sense for the USA as a single country only because its air transport and aircraft manufacturing activities are so large. In Europe, such targets make sense only for the EU as a whole. The US and two European examples are all aspirational, rather than being based on estimation of what seems likely to be achievable. Of the two European targets, the JSSI objective, set by a combined government and industrial group, is the less challenging, and aims for no more than is considered politically necessary, whereas the GoP target aims to open the way to substantial future improvement by presenting a challenge to the regulators, the industry and the research community alike.

There is clearly scope for the EASA to establish appropriate databases and develop air safety targets for commercial air transport in the EU based on analysis of what is likely to be achievable. In assembling data on exposure to risk, it will need to distinguish between the take-off, cruise and landing phases of flights (ETSC 1999). Corresponding attention is also needed to the larger and more intricate problem of death and injury in general aviation.

3.4 MARITIME TRANSPORT

The number of deaths in maritime transport in EU waters fluctuates widely from year to year because of the occasional occurrence of multi-fatality accidents, especially to ferries. The annual number has previously been estimated by ETSC (1997b) to average about 140. Whether this underlying average is increasing or decreasing depends mainly on the balance between the rate of growth in ferry traffic and the rate of decrease in the risk of travel by ferry, and the latter is hard to infer from accident data because of the rarity of very serious accidents. The corresponding ETSC estimate for the annual average number of deaths in inland waterway transport in the EU is about 40. Deaths in the fishing industry or in boating are not considered here because these are industrial and leisure activities respectively, rather than transport.

Risk assessment is finding a number of applications in maritime transport, partly under the influence of its use in the off-shore industry, and partly because exemptions from some provisions of international instruments depend on showing that risk is no higher under a preferred alternative than under a provision from which exemption is being sought.

The rarity of multi-fatality accidents and the international character of maritime transport make risk assessment and target setting in terms of resulting death or injury largely a matter to be addressed for the EU as a whole by the European Maritime Safety Agency (EMSA). There are related issues of loss of vessels and environmental damage resulting from maritime accidents.

3.4.1 Examples of risk assessment

The main safety instrument from the International Maritime Organisation (IMO) is the Convention on Safety of Life at Sea (SOLAS). This allows exemption from any of its rules provided that a proposed alternative can be shown to give the same or better protection compared with what is prescribed in the rules.

The Code on High Speed Craft (HSC-code) consists formally only of recommendations to countries belonging to the IMO, but once again, alternatives to the recommendations in the code may be allowed if it can be shown that the alternative is at least as good as what is recommended.

In both these examples, no risk assessment is necessary as long as what is recommended in the instrument is done. Anyone who wishes to do differently, however, has to show by some sort of risk assessment that the result will be as good or better.

The safe management of passenger ships and other ships with a gross tonnage of more than 500 is covered by the ISM-code, which deals with many different areas of operation. This code requires every shipowner to have an incident reporting system covering accidents, near-accidents and other identified risks. The shipowner is also required to have a formalised plan for dealing with these reports in a constructive way. This means in effect that the reports must be analysed using some sort of risk assessment method.

In addition to the general rules prescribed by IMO, national administrations often require risk assessments when a ship is to be used in special operations such as the transport of hazardous material within certain areas. Another example is the assessment whether a cruising ship should have a helipad or not, which involves a comparison of the risk created by having a helicopter near the ship with the probability that people on board need transport ashore for medical treatment.

An example of a national administration building upon IMO requirements is provided by the development in recent years by the Swedish Maritime Administration in close co-operation with the Swedish Shipowners' Association of an information system on critical incidents in the shipping industry (INSJÖ). The basic information is the incident reports that the shipowners are required to make under the ISM-code. These reports are combined in a database which is the heart of the INSJÖ system. Additional information obtained about the incidents from other reliable sources can be added to the database. This database makes possible broader analyses of occurrence of incidents in the Swedish shipping industry than would be possible for an individual shipowner, with correspondingly greater potential to identify and reduce risks.

Quantification of risk in relation to routinely collected exposure data is less widespread in maritime transport than for road, rail and air, but two European multinational studies have illustrated possible approaches. The COST 301 project (1987) used ship-miles and frequency of encounters closer than one mile as measures of exposure in an analysis of collision rates in different European waters. Meeting, crossing and overtaking encounters were distinguished. The investigation following the *Estonia* disaster of 1994 (Joint Accident Investigation Commission of Estonia, Finland and Sweden 1997) used vehicle- and passenger-time and vehicle- and passenger-distance as measures of exposure in comparing the risk of ferry transport with those of other modes.

Estimation of the risk of ferry transport from accident data provides a particularly clear example of the difficulty identified at the end of Section 3.1, namely the wide statistical fluctuations resulting from the occasional occurrence of multi-fatality accidents when there are few accidents in total and most of them result in few deaths. There were several such very serious accidents to ferries in European waters in the decade 1985-1994 and none since 1994 – a time-series which is hard to interpret in terms of reduction in risk in recent years.

3.4.2 Maritime safety targets

ETSC is not aware of any significant European examples of maritime safety targets. It should therefore be an early task for the European Maritime Safety Agency (EMSA) to assemble consistent Europe-wide data on the incidence in maritime transport of death and injury, distinguishing between passengers, crew and third parties, of losses of and substantial damage to vessels, and of significant environmental damage. Such a database, together with the various experience of risk assessment in the maritime transport industry should enable the EMSA to set meaningful maritime safety targets for the EU.

An important complementary transport system to maritime transport is transport by inland waterway, for which Europe-wide data is also lacking and for which a corresponding programme of work is required.

4. RECOMMENDATIONS

For all four means of transport, recommendations follow from the foregoing review concerning more systematic and consistent EU-wide data collection and analysis to support the development and implementation of targeted strategies for improved safety. For road transport, experience in the EU of such strategies is already extensive, and recommendations are made for building upon this in the further development of such strategies in existing EU Member States, in their development in the Accession Countries and in the matching of the EU target for reduction in deaths per year by 50% between 2000 and 2010 by a commensurate strategy. For rail, air and maritime transport, recommendations are made for the new European agencies to address the challenges of risk assessment and target setting.

4.1 ROAD TRANSPORT

Recommendation 1 The EU should embark urgently and vigorously upon a timetabled and fully funded programme to achieve consistency across Member States in recording road traffic collisions involving personal injury, estimating the level and pattern of underrecording of collisions, and estimating the amount of use of the roads, together with the assembly of resulting data from all Member States in a common database accessible to all at marginal cost of access.

Work on this should benefit from, but not await, the findings of research on accident and injury analysis under Objective 4 of the Sustainable Surface Transport work programme of the 6th Framework. It should extend to non-fatal injury as well as death, and to road use on foot, in wheelchairs and on bicycles both for whole journeys and as part of motorised journeys as well as to the use of motor vehicles of all kinds.

Availability of the resulting data both nationally and across the EU is the key to the assessment of risk in use of the roads on the basis of sound evidence. This in turn can make a powerful contribution to the development of effective strategies for casualty reduction and collision prevention, by helping to identify where the greatest scope for application of different safety measures lies. In doing so, it is important to distinguish between risk to road users themselves and risk that their use of the roads creates for others.

Recommendation 2 The EU and each Member State, and with their help each Accession Country, should continually and robustly challenge society's complacency about

the level of risk in using the roads by adopting or further developing road safety strategies which evoke and channel coherent and effective action by all those stakeholders within and outside government who can contribute to reducing death and injury on the roads

Recommendation 3 The EU and Member States and Accession Countries should focus their road safety strategies by setting numerical targets for casualty reduction over the period covered by the strategy which are challenging enough to motivate the stakeholders to strenuous effort, yet achievable through the policies and measures envisaged in the strategies.

The sights of those formulating strategies and setting targets can be raised by the adoption of an appropriate vision or philosophy for road safety. There need be no contradiction between a far-reaching long-term vision or philosophy and a challenging but achievable, and thus necessarily more modest, shorter-term target associated with a strategy for the foreseeable future. Strategies and targets for road safety need to be related to policies concerning the environmental impacts of road traffic and to wider economic and social policies.

To achieve subsequently the coherent joint action needed to implement a strategy and meet its targets requires the involvement of all stakeholders in developing the strategy and setting the targets so that they have a feeling of joint ownership of them and of commitment to them. Setting of challenging yet achievable targets requires the forecasting of future values of the target indicators under various assumptions about road use and about implementation of safety measures, but the process of target-setting should be transparent and not too complex to be accessible to interested members of the public. Effective implementation of a strategy requires clear allocation of responsibilities to the various stakeholders. Motivation can be reinforced throughout the target period by regular and transparent monitoring of progress towards the targets.

Casualty reduction targets should be for numbers injured as well as for numbers killed. Subtargets for particular groups or for observable aspects of road user behaviour or quantifiable outputs of road safety work can be helpful provided that they are consistent with the principal targets and do not unduly constrain the allocation of resources to casualty reduction. A typical target period is about 10 years.

Recommendation 4 Experience of different aspects of the target-setting process, especially the forecasting of casualty rates and of the effectiveness of safety measures, should be shared among the EU, the Member States and the Accession Countries.

Recommendation 5 The EU should identify the route to achievement of its target, the respective roles of the EU and its Member States in doing so, and how the EU can help the Member States to deliver their respective contributions.

4.2 RAIL TRANSPORT

Recommendation 6 Railway safety data for the EU member states should be assembled comprehensively and to common international definitions, as envisaged in the proposed Railway Safety Directive, together with common measures of exposure to risk, and this should be a high priority for the proposed European Railway Agency.

Given the small numbers of some types of railway accident, it will be some years after common data gathering begins before enough data are available for substantial analysis. The measures of exposure to risk should include train-km run.

Recommendation 7 It should be an early task for the European Railway Agency to investigate appropriate forms of target for numbers of train accidents and casualties in them across the EU and ways of judging progress towards such targets, having regard to the small numbers of accidents and variability in the numbers of casualties in them.

In this context, the use of safety performance indicators other than numbers of accidents and casualties should also be considered.

Recommendation 8 It should also be an early task for the European Railway Agency to progress the further development of common methods of risk assessment and criteria for safety measures that is envisaged in the draft Railway Safety Directive.

Recommendation 9 Railway operators' safety assessment documents, including their risk assessments, should be public.

4.3 AIR TRANSPORT

Recommendation 10 It should be an early task for the proposed European Air Safety Agency to assemble a database for uniformly reported incident and exposure data concerning intra-European and intercontinental scheduled and charter flights in European airspace by both EU registered and other operators, and to investigate appropriate forms of target for the corresponding numbers of air accidents and casualties in them across the EU and ways of judging progress towards such targets.

In assembling data on exposure to risk, the Agency should distinguish between the take-off, cruise and landing phases of flights.

Recommendation 11 The European Air Safety Agency should then develop counterpart reporting systems, database, targets and monitoring of progress for general aviation in European airspace.

4.4 MARITIME TRANSPORT

Recommendation 12 It should be an early task for the proposed European Maritime Safety Agency to assemble a database for uniformly reported incident and exposure data concerning both EU registered and other vessels above a certain tonnage in European waters, and to investigate appropriate forms of target for the corresponding numbers of accidents and casualties in them across the EU and ways of judging progress towards such targets.

Recommendation 13 The European Maritime Safety Agency should then develop a counterpart database and counterpart targets and monitoring of progress for loss of vessels and environmental damage from incidents involving vessels in European waters.

In acting on these recommendations the Agency would do well to consider building upon and appropriately augmenting ISM requirements for incident recording and follow-up systems and the COST 301 approach to measures of exposure based on routes and various kinds of encounter.

Recommendation 14 The EU should establish counterpart databases, targets and monitoring of progress for inland waterway transport throughout the EU.

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APPENDIX 1: QUESTIONNAIRE ON RAILWAY SAFETY TARGETS

A1.1 QUESTIONNAIRE

As mentioned in section 3.2.2, during 2002 ETSC explored the use of targets on the European railways by means of a brief questionnaire, sent to people in all fifteen member states of the EU, plus Norway. In addition, account was taken of the targets mentioned in the *Strategic Rail Research Agenda* (2002) of the European Rail Research Advisory Council (ERRAC) on which ETSC is represented.

The questions asked are in the following box.

Please state the scope of this reply (for example, what specific railway operator or what country)

Do you have quantified targets for reductions in railway accidents and casualties?

If so, do you have targets for?

All fatalities or injuries?

Passenger fatalities or injuries?

Workforce fatalities or injuries?

Public fatalities or injuries?

Train accidents or other "catastrophic" risks?

Anything else?

What is/was the reasoning behind the choice of targets?

The people to whom the questionnaire was sent are:

- members of ETCS' Rail Safety Working Party, who together cover Finland, Germany, Italy, The Netherlands, Sweden, and the UK;
- contacts in Belgium, Denmark, Finland, France, Ireland, and Norway; and
- national representatives on ERRAC for Austria, Greece, Luxembourg, Portugal and Spain.

ETSC received responses for Belgium, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Sweden and the UK.

A1.2 RESPONSES

The following table summarises the responses. All of them cover the main line railways in each country. Some may also cover urban railways and metros.

Summary of responses to the questionnaire

| Country | Targets | Reasoning behind chosen targets and other comments |
|--|--|--|
| Belgium (SNCB) | No quantified targets (yet). Evolution of accident counts is monitored. Intervention if a negative trend is detected (follow up for given type of accident/incident). | No targets. But SNCB expect targets to be required by EU Safety Directive. |
| Finland (MinTC) | The target is to raise rail safety in Finland from an average European level to a top international level. Specifically, there should not be any passenger fatalities. Annual number of reported level crossing accidents should be reduced from present 50–60 to below 40. | Not documented “If it is possible elsewhere, it is possible in Finland.” |
| France (SNCF) | Fundamental principle is ‘Globalement Au Moins Equivalente’. That is, any change to the system shall lead to a level of safety that is at least as good as previously. Within that, there are no quantified targets, but safety measures are considered on their merits, taking account of safety effects outside the rail system as well as within it. | No specific targets. |
| Germany (All railways under legislation) | A new technical or operational system shall be at least as safe as the previous one. Germany also has the ‘Minimum Endogenous Mortality’ (MEM) principle, which limits individual risk. (to 10^{-6} per year?) (See Section 3.2.1) | MEM limit on the argument that railways should not materially add to the background risks of life. |
| Ireland (Irish Rail) | All fatalities or injuries: - Attain a 10% reduction in accidents/incidents. Passenger fatalities or injuries - Regain 1998 record of no fatalities Workforce fatalities or injuries- Regain 1999 record of no fatalities. Work towards a 10% reduction in lost time accidents. Public fatalities or injuries - work towards reduction of passenger injury accidents by 5%. | These targets are realistic, achievable and sustainable |
| Italy (Italian Railways RFI) | Generic, looking only for an unquantified reduction of the mean number (on a ten years basis) of all UIC typical accidents. No specific targets for subcategories of accidents | Statistical validity of the indicators is low due to the rarity of the events and it decreases if the events are subdivided into categories. |
| Norway (National Rail Administration) | Zero mindset vision: <i>“Rail transport shall not lead to loss of human life or serious damage to humans, the environment or material.”</i> Based on the zero-mindset vision, a Main Safety Target has been developed: <i>“The established safety level for Railway activity in Norway shall be maintained. All changes shall improve the existing safety level.”</i> The Main Safety Target applies to persons (passengers, employees/contractors/hired help and third party), environment and material. Reduction of risk has not been transformed into a percentage reduction target. | The process of developing the safety vision/philosophy, methods and acceptance criteria had started late autumn 1999, based on Railway Inspectorate regulations, but not widely accepted to be required within the railway culture of Norway. Following the Åsta accident January 2000, it became clear that things had to change, but the process was still slow moving and the railway culture was not ready to accept criteria expressed in the form of percentage reduction in risk level. This as the total risk picture had not been explored until early autumn 2001. |

| | | |
|---|---|---|
| Portugal (CP) | No quantified targets so far. A reduction of passenger fatalities or injuries by 10-20% could be considered, as it is a target that depends mainly on the actions and measures developed by CP. CP had zero passenger deaths in 2001 and would wish to maintain that. | The tool for measure and registration of data is still under development. Target probably depends on possible actions and measures developed by CP (Operations Safety Authority) |
| Sweden (National Rail Administration) | Zero vision: <i>"Nobody should be killed or seriously injured as a consequence of railway accidents"</i> This is broken down into the following effect goals: <ul style="list-style-type: none"> • The railway system should always be safe; • High-voltage electrical installations should be safe; • Accidents in railway traffic and electrical installations should be prevented; • Consequences of severe accidents should be mitigated. As for more short-term safety targets, the following have been specified: <ul style="list-style-type: none"> • The number of deaths and injuries in the railway system shall decrease; • The number of level crossing accidents shall be reduced by 50% in the period 1996 to 2007; • The number of derailments during train operations shall be reduced by 50% in the period 1999 to 2009; • The number of derailments during shunting operations shall be reduced by 50% in the period 2001 to 2009. | Not specified |
| UK (Railway Group) | Some 10 separate quantified targets for 2009, including: <ul style="list-style-type: none"> a) overall equivalent fatalities* ≤ 0.3 per million train-miles b) catastrophic risks: SPADs reduced by 80%; c) passenger safety and security: passenger fatalities ≤ 1 in 133 million passenger journeys; d) public safety: fatalities ≤ 0.7 per year per million population e) workforce safety: accidental major injury ≤ 1 in 750 employees per year. * Equivalent fatalities are a weighted combination of fatalities, major injuries and minor injuries, in which 10 major injuries or 200 minor injuries are regarded as equivalent to 1 fatality. | What appears to be achievable within the industry. |
| ERRAC | Safety objectives for 2020 relative to 2000 include: <ul style="list-style-type: none"> 1) A 50% reduction in the number of rail fatalities. 2) A 75% reduction in the number of external fatalities. | Most (80%) of the safety improvements to the first group, and all those to the second require better 'safety management' in the broadest sense. The rest of the improvements to the first group will be achieved by improved railway interoperability, half by the new train control systems, and the other half by improved operational rules. |

