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Creating the future of transport

Cross-modal safety: risk and public perceptions – phase 2 report

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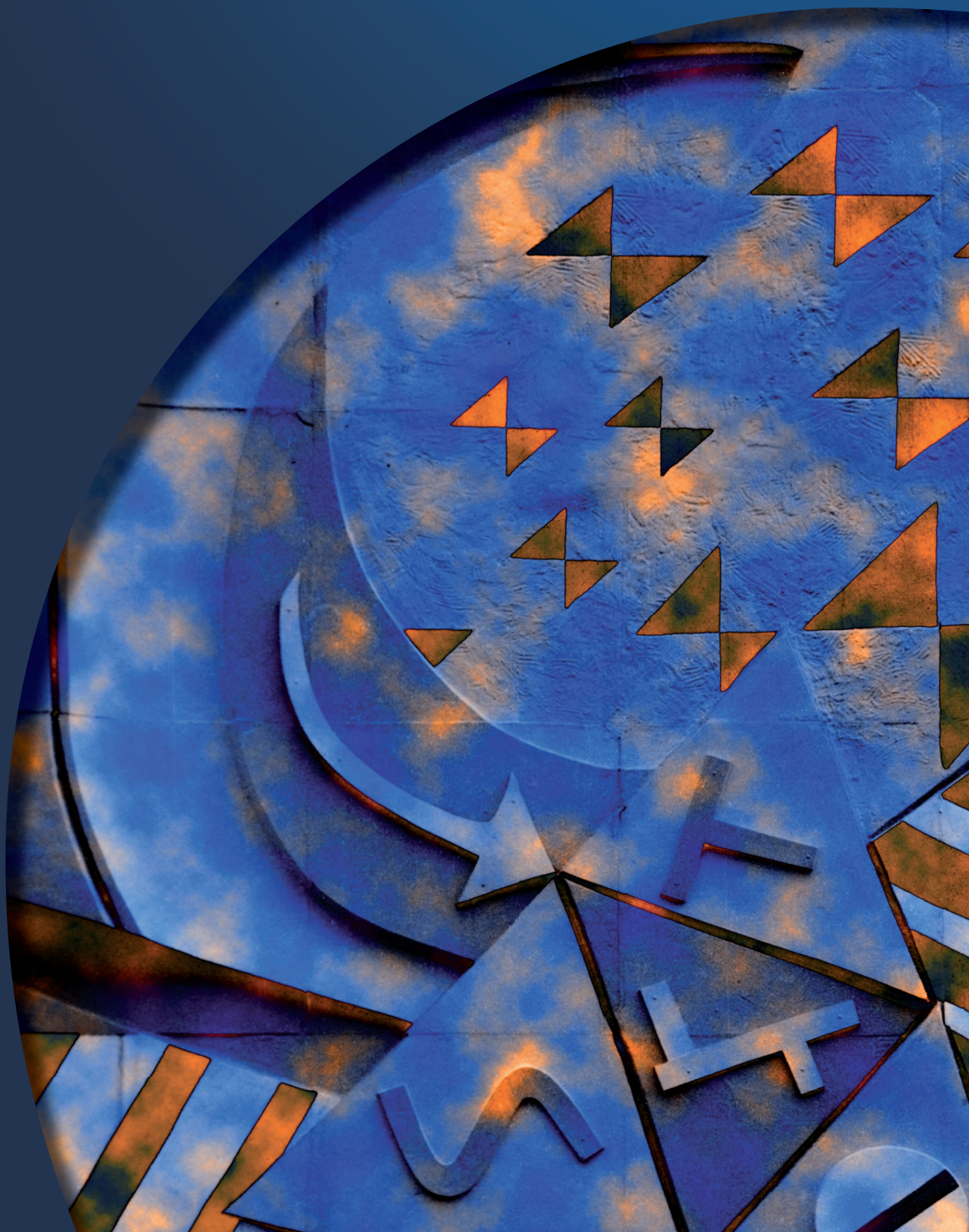

Transport Research Laboratory

PUBLISHED PROJECT REPORT PPR522

Cross-modal safety: risk and public perceptions

Phase 2 report

by David Lynam, Janet Kennedy and Shaun Helman (TRL), Tony Taig (TTAC)

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Cross-modal safety: Risk and public perceptions
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Contents

Executive summary

This report documents the second phase of a project into cross–modal risk assessment and public perceptions of transport risk. The project was commissioned by the Transport Safety Group (TSG) at the Department for Transport (DfT), and was carried out by TRL and TTAC Ltd.

Phase 1 of the project generated a 'snapshot' of current practice in the different transport modes (road, air, maritime, rail) with regards to how risk information is used in decision making surrounding managing transport risk, and also how public perception of risk influences prioritisation of safety spending and mode-choice decisions.

The principal activity of the second phase of the project has been to take the Phase 1 findings to stakeholders across the transport modes, discuss with them the opportunities and practicalities of adopting ideas from other modes, and identify, in the light of this discussion, good ideas that might be capable of adoption in or across the modes. This process generated a 'long list' of potential ideas for the transfer of good practice and for filling gaps in current knowledge. This 'long list' was then pared down to a 'short list' of the best ideas through further engagement with stakeholders across the different modes, and through discussion with DfT. It comprises issues that should be addressed across all modes, issues that primarily require action in relation to a specific mode and issues related to perception.

From a cross-modal perspective, from the perspective of individual modes, and from the perspective of the public perception of risk, these ideas are presented in a format that identifies what each issue is, what the opportunity and benefits are likely to be if the issue is addressed, and what would be involved in taking forward work to address each issue.

Cross-modal recommendations

Our cross-modal recommendations are as follows:

a) Development of an overarching Transport Risk Policy framework laying out the basis for prioritising and taking decisions involving safety, together with context-specific guidance on risk tolerability and the value of risk reduction, capable of application across all the modes

b) Improvement of the information available to support risk assessment and management across the modes, in the short term by enhancing information flow from other government bodies, and in the longer term by using data collected by automatic transport monitoring systems

c) Provision of peer review and challenge of regulatory policy and practices across the modes; a critical success factor (as for our other recommendations) will be the strengthening of DfT's capability to provide a "Guiding Mind" for transport risk.

Roads sector

Our main recommendations for the roads sector are as follows:

a) Enhancement of current casualty and safety performance data to enable better risk analysis, for example by linking to hospital and insurance data, including consideration of how road accident investigation might be made more useful for safety analysis

b) Exploration of the possible use of a system-based approach for roads, similar to those adopted in Sweden and the Netherlands, supported by risk modelling, and performance assessment

c) Assessment of the value of providing more independent input into audit of the process for delivery of road safety improvements

These activities could be linked into a central function involving comprehensive oversight of data collection, risk analysis, programme development, and performance monitoring.

Rail sector

The reporting and use of information on defects found during maintenance varies widely across asset types and failure modes, as was highlighted for points by the investigation into the derailment at Grayrigg in February 2007.

We recommend that research should be commissioned to address the issue of defects found during maintenance and their significance for risk across the whole body of railway assets.

Maritime sector

The Maritime and Coastguard Association (MCA) has recently put considerable effort into enhancing the information sources available to support risk assessment and policy. There would now be high value in enhancing the synthesis and analysis of this information in support of processes such as safety improvement planning.

We recommend a concerted programme of activity by MCA to assembled and analyse the data now available (and to develop the systems and processes to enable this to be done routinely on an ongoing basis) to provide enhanced risk assessment in support of policy and regulatory practice.

Aviation sector

The Civil Aviation Authority (CAA) has a well-developed picture of global commercial aircraft risk which it combines with UK data on incidents and precursors to inform its safety improvement planning process. However, it does not currently combine these data into a risk model to provide quantitative insight into air accident risks, the relative importance of their causes, and their consequences for people.

We recommend that such a model should be developed to enhance the focus on risk of processes such as safety improvement and regulatory resource planning, and to facilitate the comparison of aviation risks with those from other modes in terms of risk to people.

Communication of risk (and other) information to influence mode choice

We recommend that DfT addresses the issue of risk perception and influence in modal choice. Firstly, it is necessary that for the modal decisions that we are trying to influence (e.g. moving people from road to rail, or from driving to cycling, or even from driving on one type of road to driving on another) we understand which of those involve risk perception in the decision process, and which involve decisions based on other factors such as convenience and cost. Secondly, it will be necessary to undertake work to understand the different aspects of risk information (or non-risk information) that need to be communicated, and how they need to be communicated to people in order that we can influence people in these specific mode choice decisions.

1 Introduction

1.1 Background

The Department for Transport (DfT) has set up a Transport Safety Group (TSG) to share information and best practice in safety across all transport modes. TSG has commissioned TRL and TTAC Ltd to undertake research into cross–modal risk assessment and public perceptions of transport risk. This report is on Phase 2 of the project and is intended to assess which elements of good practice might be transferred between the modes and to make suggestions on any common themes that can be applied across the different modes.

The report on the first phase of the project (Kennedy et al, 2008) provided a snapshot of current practice and thinking on risk assessment and perception across the transport modes. It also compared practice across the modes and identified examples of good practice worth highlighting and discussing with other modes, with a view to emulating or adopting ideas if appropriate.

Phase 1 included a series of meetings with relevant contacts in the different modes from DfT, the Highways Agency (HA), the Rail Safety and Standards Board (RSSB), the Civil Aviation Authority (CAA) and the Maritime and Coastguard Association (MCA).

The principal activity of the second phase of the project has been to take the Phase 1 findings to stakeholders across the transport modes, discuss with them the opportunities and practicalities of adopting ideas from other modes, and identify, in the light of this discussion, good ideas that might be capable of adoption in or across the modes. The principal parties consulted were

- Aviation – AAIB and CAA
- Maritime – MAIB and MCA
- Rail – RAIB, ORR and RSSB
- Roads – DfT and Highways Agency, wider TRL staff

The resulting "long list" of ideas, listed in Appendix A, was then filtered and adapted by the project team to produce a "short list" of good ideas/candidate action areas as follows:

- Issues which should be addressed across all modes
- Issues that primarily require action in relation to a specific mode
- Issues related to perception

The cross-modal issues on which we recommend TSG should focus are:

- Risk priorities, tolerability and values
- Enhancing risk information via data sharing with other government bodies
- Enhancing risk information using automatically collected data
- Cross-modal peer review/challenge facilitated via DfT

For the roads sector, the major issues are enhancing data available on road risk, developing a system risk based approach to safety programmes, and considering whether road safety management can benefit from closer audit. For the rail sector, the major issue is enhanced risk information via defects found during maintenance. For the maritime and aviation sectors, it is the synthesis and development of existing/developing data sources into a system risk framework.

The perception issue on which we recommend TSG should focus are:

- Risk and non-risk communication issues in influencing mode choice

For each of these ideas, the following sections provide a short "thought piece" explaining the issue, the opportunity, and what would be involved in taking forward work to address the issue.

Our aim has been to provide TSG with an interesting and value-adding "menu" of possibilities to discuss and take forward. Our mindset throughout, which we have openly explained and discussed with the parties consulted, has been to ask "Given the opportunity to commend issues to TSG that they might promote/champion/enable/ facilitate, what would be the most valuable suggestions we could make?"

We are extremely grateful to all those who have assisted in the consultation and development of ideas during this work. While the ideas presented above and in the following sections owe much to these consultees, we take full responsibility for the ideas, suggestions and their presentation here; they do not necessarily represent the views or policy of any other organisation or individuals.

1.2 Survey of practices overseas

Our research throughout this project has focused primarily on the UK, as both we and DfT considered it more important to collate the picture of current UK practice than to explore that overseas. We are aware of various different practices and approaches overseas, and now that the main issues for the UK have been established, consider that it would be appropriate for TSG to learn more of relevant policy and practice internationally.

Several other countries have considered the scope for better integration and consistency in dealing with risk assessment and safety improvements across modes, while others have different organisational arrangements which more or less span modal boundaries. For example

- Some North European countries have given considerable thought to trans-modal coherence (e.g. Sweden, Norway) or have highly developed risk management frameworks covering all modes (e.g. the Netherlands)
- The English-speaking major nations (e.g. USA, Canada, Australia, New Zealand) generally have more "joined up" accident investigation arrangements, some examples of cross-modal regulation (e.g. Land Transport New Zealand covering both road and rail), and some interesting and significant developments in risk-based regulation, and
- The European Union more generally, and in particular the European Commission, whose policy and approach will prevail in the UK and whom all of the UK-based regulators and investigators interviewed are eager to understand and to influence.

These approaches should be further investigated in order to evaluation any opportunities there might or might not be to incorporate overseas practice or ideas in this country.

2 Cross-modal issues

This section proposes four key areas for consideration by TSG which in our view warrant concerted, cross-modal action:

- Risk policy, priorities, tolerability and values
- Enhancing risk information via data sharing with other Government bodies
- Enhancing risk information using automatically collected data, and
- Establishing a cross-modal peer review/challenge function under the aegis of DfT.

A theme emerging across all of these issues is that, for DfT successfully to take forward actions that add significant value, it needs a high calibre "Directing Mind" for transport risk policy with the credentials to secure respect across the modes. An important general issue for discussion is thus how such a capability should be established – e.g. through appointment of a key individual, or by establishing some form of Board or Committee to bring together people and organisations with strong contributions to make.

2.1 Risk policy, priorities, tolerability and values

2.1.1 The issue

Phase 1 of this project found no major differences in average values of preventing a fatality used in different modes, but revealed a number of important issues in each of the modes with major implications for policy.

1. Prioritising among stakeholders:
    - CAA has a well-developed philosophy for graduating the effort devoted to regulation from large commercial aircraft at one extreme, down to small personal leisure flying at the other, though this is not directly linked to an explicit risk policy agreed with major stakeholders
    - MCA has a constant dilemma as to the effort and focus it should devote to leisure users of non-commercial craft, beaches and the coast generally. The wish of government to save more lives in these areas is in conflict with a desire to avoid unnecessary and potentially controversial regulation of leisure activities
    - The railways have for many years been involved in extensive debate about the relative priority to be afforded to passengers and staff on the one hand, and to trespassers and people committing suicide on the other
    - Current practice in road safety cost-benefit assessment does not differentiate between different victim types
2. Recent research into public perception of risk and willingness to pay to reduce it (in the rail sector in particular) has revealed a strong correlation between public concern and the degree of "blameworthiness" of accident victims. This research suggests that different value and priority should be accorded to victims depending on their position on a scale from "victims of their own deliberate and criminal behaviour" at the one extreme, to "innocent victims of someone else's behaviour or mistakes" at the other. Debate continues on how to factor this into rail safety decisions; current guidance assumes that the weight given to each type of victim should be the same.
3. The concept of individual risk and of its tolerability/intolerability has proved valuable in identifying risk "outliers" for sub-groups of victims and in prioritising safety improvement actions in the rail sector. There are significant concerns about risk tolerability thresholds in other modes (e.g. for the safety of fishermen and road contractors, or for the risk accepted by commercial passengers in balloons or other craft that may not afford the same low level of risk as modern commercial aircraft).

Guidance on risk tolerability/ intolerability would be generally welcomed across the modes.

4. The general advice available on risk tolerability and what is safe enough (e.g. HSE's "Reducing Risks, Protecting People") is difficult to apply in a transport context.

2.1.2 The opportunity

Each mode is active in debating and working on these topics. It would add value to the whole, as well as being more efficient, to develop a single transport risk policy framework, supported by context-specific guidance (capable of application in each mode) on the tolerability of, and value of reducing, safety risk.

We recommend:

a) Development of an overarching Transport Risk Policy framework laying out the basis for prioritising and taking decisions involving safety, and

b) Parallel development of context-specific guidance on risk tolerability and the value of risk reduction, capable of application across all the modes.

Effectively the aim would be to provide an up-to-date and relevant transport version of HSE's guidance documents such as "The Tolerability of Risk from Nuclear Power Stations" and "Reducing Risks, Protecting People".

2.1.3 What would be involved

We anticipate that three (roughly sequential) types of activity would be required to implement this recommendation.

a) Scoping: important initial activities would include:

- Establishing some form of Steering Group with representation from each mode, possibly with an independent external chair
- Collating existing material, which could usefully review overseas policy and practice as well as work across the modes in the UK, and
- Collation across the modes of the set of contexts/issues to be covered – this is critically important to ensure that the work addresses the issues that matter in each mode, and to develop a framework for classification of stakeholders that can be applied across the modes and will enable appropriate opinion research to be designed.

b) Overarching policy framework: having developed the definition of the nature and scope of policy and issues to be addressed, we anticipate that some form of qualitative opinion research would then be needed to inform broad policy issues such as

- Whether/how people conceptualise some risks as "intolerable"
- People's acceptance of, and constraints attached to their acceptance of, balancing risk reduction against affordability and other factors
- Differences in principle between putting others at risk and putting oneself at risk
- What factors determine the values people would give either to thresholds of intolerable risk or to a given quantum of risk reduction.

The aim would be to develop the overall framework and principles to be applied in making decisions about transport safety risks, and to establish the factors to be taken into account in making such decisions. Given the major long-term implications for transport safety and affordability of the principles established here, it might be

appropriate to develop this policy framework with a view to securing ministerial (and hopefully cross-party political) acceptance.

c) Context-specific guidance: with the policy framework and principles established it would then be appropriate to

- Establish how the framework and principles would be applied generically across modes
- Collate existing relevant guidance and research
- Devise and deliver quantitative opinion research in the light of the overall framework and the contexts to be addressed, and
- Assemble, consult on and publish guidance for use in all modes of transport.

While the overall scale and scope of this recommendation is ambitious, several of the component elements are already in place or in progress. The importance of this recommendation lies not just in helping the modes establish safety policy and values more efficiently, but also in providing all the modes with the means whereby they can, with confidence, distinguish more effectively between risks where society expects public policy to be active in control, and those where public intervention is viewed as undesirable or as evidence of a "Nanny State".

2.2 Enhance data sharing with other Government bodies

2.2.1 The issue

Across the transport modes there is a problem in that a significant number of casualty accidents and incidents are not known to the relevant investigatory, regulatory and policy bodies.

- The problem is particularly severe for the MCA in respect of the victims of accidents not involving ships and boats, as their only certain route for learning even of fatal accidents on and around the coast is via calls to the Coastguard. Many accident victims are attended by Police, Fire Brigades, the NHS or others without the Coastguard being called; for some stakeholder groups of interest (e.g. victims of beach accidents, cliff falls, coastal walking) the MCA may historically have missed half or more of all fatal accidents. This is being addressed by MCA via the National Water Safety Forum, but it will take time before MCA can be confident it knows of the majority of fatalities, let alone of less severe casualties and incidents.
- Studies for DfT and others have shown that non-fatal road casualty statistics systematically understate injury accidents particularly to cyclists.
- Reporting of serious accidents involving trains and aircraft is generally very reliable, but there is a large casualty burden of more minor accidents in and around airports, stations etc which are less reliably reported.
- Various initiatives are already in progress (e.g. the Water Accidents and Incidents Database being funded by DfT to bring together data collected via the National Water Safety Forum) to collate incidents known to voluntary and regulatory bodies, but these are not as yet linking up across all of the relevant government bodies.

In the maritime and roads sectors in particular, regulators and safety policy people spend a lot of time and effort liaising with coroners, the NHS and others to try and complete (or estimate the deficiency in) their own casualty information.

2.2.2 The opportunity

There would be considerable added value in setting up a process to tackle the obstacles to sharing data across government bodies and to modify current systems and processes to facilitate such sharing, and the analysis of the resulting extended databases.

A frequently voiced frustration of transport specialists trying to obtain casualty information via hospitals or coroners is that those they are dealing with are bound by confidentiality constraints, and have major difficulties in releasing information. This tends to arise even before the practical difficulties of defining the scope of incidents of interest, the matching of events in different databases, and the information sought by the transport regulator or investigator can be considered.

What we propose here is that a single, cross-modal approach is taken in the first instance to explore the feasibility, practicability, costs and benefits of enhancing accident and casualty information flows from bodies such as the NHS, Coroners and the Fire Service to transport regulators. A particular benefit of adopting a concerted cross-modal approach would be to be able to negotiate once, at a senior level, suitable protocols for protecting information and safeguarding confidentiality with each participating non-transport organisation.

2.2.3 What would be involved

The first stage of any action here would be to undertake a scoping study to consider:

- Establishing points of contact and working relationships with the transport and other government bodies involved
- Identifying existing recording and reporting processes, and the databases they generate, in each organisation
- Identification of legal, ethical, practical and other obstacles to more open sharing of information with transport regulators (and hence evaluation of the COST of enhancing sharing)
- Identification of the enhancements realistically achievable in the information available to support risk management (and hence evaluation of the VALUE of enhancing sharing).

Depending on the outcome of the scoping study, further work might be required to establish:

- Protocols and safeguards to be applied in data sharing
- Means for matching records held in different databases (to ensure the same casualty is not counted multiple times)
- Trial local data transfers and analyses
- Systems and processes to streamline and "routinise" future data sharing, storage and analysis.

The costs and benefits of national implementation could then be evaluated prior to rolling out processes and systems nationally.

A critical success factor for this work is that it should be strongly focused on and motivated by enhancing the evidence available for risk management, and NOT on achieving data sharing for its own sake. To this end we would envisage not only that the team established to progress the work should include strong risk management capability and focus, but also that some form of Steering Group would be valuable to test what emerges from the scoping stage, and ensure that the value of any proposals would outweigh the costs and practical difficulties of their implementation.

2.3 Enhancing risk information via automated recording systems

2.3.1 The issue

All modes of transport are experiencing the introduction of technologies providing an explosion in the volume of data available on the usage of vehicles, for example

- The road infrastructure is increasingly equipped with traffic and speed monitoring devices for both driver information service purposes, and enforcement technologies such as red light and speed cameras. The data capture and recording systems in cars are rapidly increasing in capability and sophistication.
- Aircraft data recorders are routinely used in post-accident investigation and are increasingly being used (with elaborate safeguards over confidentiality and anonymity) in monitoring flight operational performance. Radar and satellite positioning systems provide large volumes of data on the position and flight patterns of aircraft.
- Railway infrastructure is increasingly equipped with telemetry systems monitoring the performance of both infrastructure and trains. Train data recorders are universally fitted and there is considerable variability in the way data is used across train operators; some operators use daily download and analysis of 100% of all journeys as a highly effective part of driver performance management.
- In the maritime sector, radar and satellite positioning systems are transforming what can be learnt about the paths of ships and the navigational decisions made in their operation. Mariners' concerns currently prevent wider sharing and use of such information to learn more about the incidence of risky behaviours and/or near misses.

The general situation across the modes is that technology offers a route to providing a step change in the information available about behaviours and compliance of vehicle operators. This has the potential to transform the evidence available on risk, and in particular on key operational precursors to accidents. This would in turn transform our ability to evaluate the effectiveness of safety initiatives, especially those targeted at behavioural change.

The key obstacles to such transformation are common across the modes. They involve the major public and political concerns surrounding any increase in "Big Brother" tendencies by the state, and the sheer practical issues of dealing with the vast quantities of data already being generated, and discerning from it information of real value for risk management.

2.3.2 The opportunity

This is an issue of strong general interest across the modes. The opportunities vary in detail but are conceptually similar for all modes. The obstacles and difficulties are common across the modes. We therefore propose that TSG could with value explore and develop (or encourage others to do so) across all transport modes the application of automatically recorded data SPECIFICALLY for the purpose of enhancing the information available on the behaviours and patterns of use of transport vehicles, systems and their operators which contribute to accident risk.

2.3.3 What would be involved

Our proposal here is for the development of a common approach to inform all the modes on the opportunities, costs, benefits and practicalities of developing the use of

automatically collected data to enhance information about risks and precursors to incidents. We envisage that this process would involve

- Surveying technologies already in use and emerging across the modes, and the data sources already created
- Identifying behaviours, non-compliance, near-misses etc that can already be identified from existing data sources and the ways such events are identified (automated analysis, manual download/review etc)
- Surveying the uses currently made of such information OTHER than for enforcement and accident investigation, and the lessons learned in negotiating solutions to the generic problems of operator concerns and practicability
- Assessing the value for risk management of the information potentially available via existing and emerging systems, data and analysis methods
- Assessing the implications of introducing routine use of data derived in this way for the systems and processes currently used for accident and incident database management and analysis, and
- Assessing the feasibility, benefits and costs of using existing and/or emerging data to enhance the evidence base available for risk management (focusing on the modes/data sources/risk-relevant events of greatest opportunity). Much of these data may be held by private organisations.

Following this, a decision could then be made as to whether there were further high value issues meriting a cross-modal approach, or whether follow-up should be left to individual modes to progress.

The ultimate aim would be to provide the modes not only with some clearly identified "low hanging fruit" (if any are discovered), but also with practical help in evaluating future opportunities in this area.

A critical success factor for this work is that the approach should be strongly focused on and motivated by enhancing the evidence available for risk management, and NOT on finding ways to utilise new technologies and emerging data sources for their own sake. As for many of the other recommendations in this report, this implies not only that those progressing such work should have significant risk management capability and focus, but also that some form of cross-modal, risk-focused governance via a Steering Group would be appropriate.

2.4 Cross-modal review/challenge function in DfT

2.4.1 The issue

There are various topics of perennial interest within each mode, on which regulators and policy leaders would be interested to have greater awareness of evolving policy and practice among their peers in the other modes, with a view to sharing and learning from best practice. Examples of relevant topics/issues include:

- Safety improvement planning
- Optimising the use of regulatory resources to minimise risk and/or maximise assurance of effective risk control, and
- Influencing European and international policy and practice

The single-mode accident investigators (air, maritime, rail) have established a Board of Transport Accident Investigation providing a forum for exchanging views, comparing practices and peer discussion of topical issues and challenges. There is currently no such forum for regulators (and, for roads, their DfT policy counterparts). Each interacts

with DfT via a mode-specific interface; connections across modes are currently relatively weak.

2.4.2 The opportunity

There is in our view an opportunity to add value to single mode safety policy, and safety regulation in particular, through some form of cross-modal forum or process facilitated by DfT. The precise nature of this forum or process needs to be debated in order to find the best balance between value added on the one hand, and time and effort put into it by the various parties on the other.

2.4.3 What would be involved

This forum or process would involve convening senior staff from regulators, accident investigators and their DfT policy counterparts for purposes that might include:

a) Sharing information on, discussing and comparing approaches and practices

b) Optimising UK influence in international rule-making forums

c) Providing peer test/challenges of key processes and/or decisions

d) Reviewing the allocation of resources across modes and adjusting as appropriate

In practice such a group might most readily start with (a) and perhaps (b), and move on in due course to (c). There would probably be some sensitivities in embarking on a discussion along the lines of (d), but in our view the use of safety analysis and the balance of regulatory resources between modes owes more to history than to any overall policy to align resource with risk management functions (we note that there are significant differences between modes in terms of the proportion of regulatory and policy costs that are funded from industry and from the public purse). If DfT is to be able to test and challenge the allocation of resources across and within the arms length regulatory and accident investigation bodies that report to it, some forum such as this might provide a valuable way both to clarify what the current requirements of safety regulation and policy in each mode actually are, and to engage the most important stakeholders in a debate about the optimal use of resources.

Not only the purpose of this activity, but also the manner in which it is carried out, merit significant discussion. One option would be simply to require the relevant bodies to liaise and establish a group for this purpose. DfT might be more or less involved in chairing and/or facilitating such a group. Alternatively, DfT might establish some more formal review/test/challenge process at a cross-modal level, perhaps built around an annual cycle of safety performance review and improvement planning.

To be effective, this activity would need to involve the most senior safety staff of the relevant organisations (MCA CEO, ORR and CAA Directors of Safety, the investigating bodies AAIB, MAIB and RAIB, and their nearest counterparts in DfT for road safety policy). These are all very busy people, nervous of any significant further "take" on their time without commensurate added value, which helps establish some important success criteria for such an activity:

- It would require high calibre, highly competent and risk-focused chairing and/or facilitating
- It would have to demonstrate added value worth the effort involved, to do which
- It must focus on how to improve safety more effectively, not get bogged down in administrative and managerial difference

Here, as indeed is the case throughout our recommendations, we note that the success in establishing cross-modal initiatives that add value will rely on a strong "Guiding Mind for Transport Risk" within DfT to help devise, initiate, facilitate, monitor, evaluate and

use the results of any relevant work. We recommend that TSG give serious consideration to how this function could be developed/enhanced.

3 Issues mainly relating to roads

The roads sector contributes by far the largest number of deaths and serious injuries of all transport modes, and by far the greatest risk per distance travelled. It is therefore particularly pertinent to consider whether any examples of good practice in the other modes can provide ideas for improving road safety. The approach to Road Safety analysis has historically differed from the approach in other modes due to the large quantity of accident data potentially available. This has two outcomes - first that the accident investigation activity has to cover a very large number of events, and secondly that analysis relies heavily on these data, rather than on building risk models. Models are developed to help understand accident and injury mechanisms, but there is little modelling at the system level. Accident investigation is not treated as a separate function, as it is in the other modes, but as part of regular police investigations. Unlike many of the other modes, there is no single focus for consistent risk assessment across different roads authorities, or for development of a common action plan and improvement programme. The sections below discuss whether such approaches might be useful in the roads sector, and what work might be required to assess this further.

3.1 Enhancement of current data collection to enable better risk analysis

3.1.1 The issues

3.1.1.1 Improving the extent of accident recording and the assessment of injury severity

Trends in fatal accidents, serious injury accidents and slight injury accidents have been diverging in recent years; there is some indication that levels of police accident reporting, at least among slight injury accidents, have changed during this period (Broughton and Buckle, 2008). The Transport Select Committee (House of Commons, 2008) stated that witnesses representing the police have pointed out that police tend to report only those accidents that they attended and that a reduction in the number of roads police officers had led to a reduction in accident reporting. Even though there is strong central encouragement for a uniform policy between forces, action on the ground by officer teams may not always be consistent.

There is known to be considerable under-reporting of injury accidents on roads, particularly of accidents involving a pedal cyclist, and there remains a lack of consistency (Bull and Roberts, 1973 provide an early example) between police and hospital data in the level of severity recorded, despite attempts to improve training. Some countries e.g. Sweden apply a factor to their annual accident statistics to take account of under-reporting. However, a more accurate approach appears to be to link police and medical records.

3.1.1.2 Improving data available from accident investigation

The police carry out accident investigations at most fatal accident scenes and at some other sites where the officers attending consider that there is a serious possibility of a fatality. The focus of this investigation is primarily to establish whether evidence exists that could lead to a prosecution, although the police also aim to help the coroner in determining the cause of the accident. These investigations are carried out by qualified accident investigators; most of these are police officers, although a few forces are now contracting this service to external investigators. At all other accident sites, traffic police complete STATS19 forms giving basic information on accident circumstances.

The Department for Transport has historically supported various independent research projects (e.g. Kemp et al, 1972) to collect more comprehensive in-depth accident investigation data which can be used to understand in more detail the patterns of factors which have led to these accidents. The current On-The-Spot study (Cuerdon et al, 2008) operated jointly by TRL and VRC, Loughborough involves attendance at around 500 accidents per year in locations centred around these two research establishments. The investigators in this study follow a detailed data gathering protocol covering road, vehicle and human factors associated with the accident. These data are compiled into a database which can be interrogated to explore the incidence of various causation factors and their inter-relationship.

For many years, the Department and vehicle manufacturers have also supported a Co-operative Crash Injury Study which involves combining data from inspection of crashed cars with data from hospitals on car occupant casualty injuries. These data are used to understand how car design affects occupant injury and thus to encourage greater occupant protection.

The recent development of a road death investigation manual (National Policing Improvement Agency, 2007)has encouraged a broader approach by the police when fatal accidents occur, with a senior investigating officer being assigned to each case to collate the information gathered and assess what actions might be taken in addition to prosecutions.

For many years TRL has collated files from police fatal accident investigations when these are no longer required by the police. Attempts have been made to extract this information into a database which can be used to identify primary causation factors. However the lack of consistency in the reports means that only the most common factors can be tracked.

3.1.2 The opportunity

Casualty data and vehicle damage data are held by other agencies. The main sources would be hospital records and insurance companies; both of these sources are most likely to have slight casualty data that was not recorded by the police. Other sources give valuable causal data e.g. response times of emergency services. There would appear to be scope to enhance both the estimate of the total number of casualties, and the relative number of casualties of different types, arising from different causes. If work was taken forward at a cross-modal level, building on the previous experience from attempts to enhance police road accident data would be an important initial step. A change in the culture of all these organisations and of the general public may be needed if accurate figures are to be obtained.

Little causal data has been included in Stats19 until very recently, but there are now three full years of contributory factor data from the full gamut of police forces. Although not all road accidents are assigned these factors, it is likely that reporting will improve over time, particularly if there is an improved means of ensuring that accidents are reported to the police.

3.1.2.1 Enhancing with hospital and insurance data

The difficulty of defining injury severity at the accident scene has long been recognised. During the early years for which local authorities were responsible for setting up accident investigation units, police working with the most effective local authority teams often made follow up visits to hospitals after the accident, in order to confirm the injury severity they recorded in STATS19. Matching police and hospital records has been explored since the early 1980s. Stone (1984) achieved a fairly high level of matching with Scottish In-Patient data. More recent matching with Hospital Episodic data in England has resulted in lower levels of matching. Simpson (1996, 1997) used DTI

Household Accident Survey data from a sample of twenty hospitals to demonstrate the differences between the characteristics of hospital and police records. Other studies (Hopkin et al, 1993; Ward et al, 2006; Ward et al, 2007) confirm that there is substantial under-reporting in the police database compared with hospital records; different types of accidents are underestimated by different amounts. Broughton at al (2001) provides an example of linkage using data from the UK Trauma Accident and Research Network.

The major difficulties with all these studies has been matching the hospital records to the police records, gaining access because of confidentiality constraints, and for those traffic accident casualties not in the police database, obtaining information on locational and causal details. In earlier studies the lack of computerised hospital records also made collation of data difficult, and A&E data are still limited.

Similar problems of the absence of centrally held computerised records have also hampered attempts to utilise information held by insurance companies. Commercial confidentiality has also restricted availability of these records. However some companies have provided sample data (e.g. Broughton, 1991) which has illustrated the scope of the additional data that might be available if more regular access was provided. If insurance companies were to be involved in the data supply chain, they could also be required to contribute data on vehicle-damage-only accidents. This would increase the available data by a large factor, potentially leading to better information on accident causality for use in refining risk models.

3.1.2.2 Improving the data available from road accident investigation

Many of the current police accident investigators have the skills to assess accident causes more broadly, but they need to have a remit which requires them to do so, against well defined data collection protocols, and the results need to be collated and used to assess what lessons can be learnt for safety improvement programmes.

Although some police force investigators work closely with local safety engineers to try to ensure their information is used in developing local programmes, this process would be more effective if it was required as part of their remit.

The main improvements that might be achieved would thus be to

- Improve the quality of the flow of information from police accident investigations and its comprehensiveness and consistency to make it more useful for safety analysis
- Develop an independent national investigation capability to enable additional focus on collecting in-depth data on accidents of particular types where more information on accident causation is desirable
- Ensure a central capability exists to collate data from both these sources and to develop follow up analyses to assess how this information can be used to support safety improvements

3.1.2.3 Extending the scope of a national risk database

Current accident data collection could provide more useful information for risk analyses if enhanced in two ways. First there is limited information on pre-accident and post-accident factors. The Haddon risk matrix described below highlights the importance of understanding the factors leading up to an accident and how they differ from normal driving situations, and also the value of speedy appropriate treatment to mitigate injuries. Much effort has been expended on trying to define contributory factor data that police can collect to help understand accident causes, but this remains of limited use for many types of accident.

Second, much can be learnt from the collection and analysis of data on intermediate measures of safety performance. Risk related intermediate performance indicators have been proposed both in the SUNflower study (Wegman et al, 2006) and in the EC SafetyNet project. These are seen not only as tools to help to assess progress in risk reduction, but also as additional measures that can be used in defining and monitoring casualty reduction targets. Such indicators can be used to describe both safety related outcomes and process of achieving these outcomes. A target hierarchy for understanding the linkages between safety actions was originally proposed in the development of the New Zealand 2010 Strategy (LTSA, 2000) and has since been refined (Koornstra et al, 2002; Wegman et al, 2006; Bliss and Breen, 2008). Data collected to quantify the levels of this safety "pyramid" can be used to benchmark progress both within and between countries (Wegman et al, 2006). The development of a target for improving safety beyond 2010 provides an appropriate opportunity to consider such new approaches.

3.1.3 What would be involved

3.1.3.1 For enhancing existing data sources

In order to comply with Data Protection regulations, it would be essential to remove all personal data from the records as is done with STATS19; however, a system for matching records from the agencies involved would be required (and this would probably need to involve personal records). One possibility would be to require the police to issue an identity number before the insurance company could process a claim, ensuring that all claims became known to the police and could be cross-matched. Such an identity number might also be associated with any casualty transported by ambulance services.

The aim would be to create a single national accident and road traffic casualty database for use in monitoring and improving safety performance. This could be an enhancement of STATS19, including new records for non-police reported accidents and casualties, or the creation of a new database. One issue that would need to be resolved would be how to deal with conflicting information provided to different sources about the same accident. In some cases, a priority might easily be established – e.g. hospital data on injury severity taking preference over police on-site injury severity record. A trial covering a small area would clearly be needed in order to establish the practicality of such an approach. There could be substantial practical difficulties to be overcome and the additional cost involved in creating the enhanced data would need to be justified by demonstrating its value in helping to define more effective safety programmes. Any changes in reporting systems will lead to difficulties in analysing trends over time.

The benefits of a new road casualty database should be to improve not only the knowledge of the numbers of accidents occurring, but also information on accident severity and confidence that annual changes in accident numbers were genuine rather than being due to changes in reporting levels (once the system was established). Better data on the types of accident occurring and their frequencies could give insight into the reasons for accident occurrence.

3.1.3.2 For improving data available from accident investigation

The main questions that would need to be answered in enhancing the data from existing police accident investigations would be

- How would the investigation process need to change to enable the data to be used more broadly in risk analysis?
- How much extra effort would this require from the investigators?

The main question that would need to be assessed in developing the concept of an independent investigation process is

- What form should such independent accident investigation take, and to whom should it be responsible?

In both cases, would the additional value of the data be worth the additional cost involved?

The Transport Select Committee proposed that the "government should establish a road accident investigation branch, to parallel those for aviation, marine and rail." But the context for such an organisation is somewhat different from that in RAIB, MAIB and AAIB. It would obtain and collate data from a large number of accidents, even if only fatal and serious injury accidents were considered. Some of the responsibilities of the other accident investigation branches are already covered by existing Roads bodies - for example, VOSA's responsibility for vehicle inspection and roadworthiness. The information collected might still be expected to be available to the Police as part of their routine investigation of blameworthiness.

Some other countries already adopt independent accident investigation procedures e.g. FOLKSAM in Sweden, REAGIR in France. These are financed in different ways. The remit, procedures and outputs from these should be assessed to see what lessons could be adopted for a British system. The French system involves a multidisciplinary team adopting a "case conference" approach; although this can have some benefits, it may also increase tension between the views of different disciplines.

Key issues to resolve would include

- How the interface between the police and the independent investigation is best handled
- How information other than from direct attendance at the accidents (e.g. hospital data) is collected efficiently and comprehensively (this is discussed below)
- How data confidentiality questions are resolved
- How the function of a central risk analysis unit in collating data and developing input to safety programmes interfaced with Departmental divisions currently managing these functions, and fed into their role in developing road safety policy and programmes.

TRL is currently undertaking a research project with five forces piloting an approach in which the police accident investigators are being asked to complete a questionnaire for each fatal accident, at the time of the accident, to provide more consistent and complete data which can be collated into a more useful fatal accident national database. The results of this could provide a useful starting point for defining the most appropriate investigation protocols.

3.1.3.3 For extending the scope of a national risk database

A feasibility study should assess the cost of collating the types of data discussed above, including data from automatic data sources (as proposed in the cross-modal options). In particular, establishing the feasibility of using in-vehicle data recorders (IVDRs) as sources of such data would be useful. The feasibility study could also assess the value to GB safety performance monitoring of benchmarking between different areas within Britain and against other leading European countries on a regular basis, and the potential for this to play a part in future safety strategies and targets.

3.2 Exploring the use of a system-based approach for roads

3.2.1 The issue

Unlike the rail sector, the roads sector has largely traditionally used accident analysis as the basis for assessing risk and for developing programmes to improve safety. The existence of large volumes of fairly detailed accident data has supported this approach. The Highways Agency uses a Value Management approach to select local safety schemes, scoring options against a range of criteria, while local authorities base their assessment on total casualty numbers (in some cases with a weighting for severity), and focus measures on mitigating accident causation factors that appear to be over-represented at a site. Both national and local authorities use cost effectiveness as an important criteria, with larger improvement schemes warranting fuller cost benefit analyses. Within DfT, the focus has likewise largely been on casualty data, with targets defined in terms of casualty reduction.

An exception to this direct analysis of casualty data at specific sites is the development of safety standards for vehicle design and operation and for road infrastructure, which have been informed by accident analysis, but have been applied on a relatively piecemeal basis to individual vehicles and road types. Recently within the Highways Agency, there has been an objective to introduce risk assessment as an integral part of future standards. The first example of this was the revised standard for use of vehicle restraints on roads (Design Manual for Roads and Bridges TD 19/06 and the RRRAP software). In this standard, designers are required to use the software to assess the risks associated with a range of different roadside design options, and to demonstrate that the option recommended falls with acceptable risk criteria.

3.2.2 The opportunity

Increasingly in several European countries and in Australasia (e.g. through Vision Zero and Sustainable Safety), the aim is to progress towards a "Safe Road System" (see for example OECD, 2008). This is defined not in terms of casualty numbers (although numerical targets are still required to monitor progress) but in terms of ensuring the interaction between vehicle and road design and road user behaviour results in acceptable risk outcomes. An estimate of how many sites would require what treatment (at what cost) to achieve this outcome then forms the basis for a future improvement programme.

One example where a Safe System Matrix has been developed and supported by risk modelling in order to plan a future safety strategy and estimate future casualty savings is Western Australia (Western Australia Road Safety Council, 2008). Savings were forecast "using a mathematical model based on evidence-derived estimates of interventions' effectiveness and actual crash data...over recent years". Incremental addition of potential savings from a large number of measures has also been attempted in Sweden (Elvik and Amundsen, 2000). In Britain, the preference has been to use a simpler approach which only attempts to forecast the effect of major measures, using past trends to reflect the effect of continuing general road safety activity.

One attempt to look at a more system-based approach to road improvement can be seen in the European (EuroRAP) and International (iRAP) Road Assessment Programme methodologies. These include both recording accident histories and rating roads against their physical design features. For the latter, a risk based matrix was initially produced reflecting the likelihood of serious injury at a given speed. The "best" ratings were fixed by defining points where fatalities were expected to be very unlikely – i.e. well designed roadside and central restraints or wide safety zones on roads with speed limits of 70mph, and side and frontal impacts at speeds no higher than those used in EuroNCAP vehicle testing. This approach thus tied together the vehicle and road design rather than

treating each in isolation. This methodology was extended within the iRAP model by developing a risk based model to estimate the relative frequency of serious injury accidents on roads with different design features. This model estimates a likelihood factor and protection factor, based on road design and speed. Four separate models are used for car occupants, motorcyclists, pedestrians and pedal cyclists, with sub-models for different accident types (e.g. head-on, run off, crossing) for each mode. The results from a trial in four low to middle income countries have been used to develop large-scale road improvement programmes for these countries (iRAP, 2008).

The basic ratings assume compliance with road traffic law (e.g. seatbelt wearing, posted speed limits, give way at junctions and crossings) but risk can be factored to reflect a known general level of non-compliance within a country.

3.2.3 What would be involved

Work would require:

- An assessment of existing approaches to risk modelling, including particularly the treatment of road user behaviour
- A demonstration of how the output from such modelling could be used, the benefits it would provide in addition to current accident analysis, and the types of improvement programme it might stimulate
- Consultation among safety practitioners to investigate the acceptance of a risk based approach to improvement programmes

A more extensive road risk model could include:

- A range of behavioural factors contributing to accident likelihood (e.g. alcohol impairment, seat belt wearing, speeding, deviance from traffic laws)
- Sub-models for road user groups with different trip purposes or travelling at different times of day (e.g. after dark)
- Sub-models for road user groups with different experience or risk taking habits (e.g. young drivers, teenagers, older road users)
- A component reflecting post-accident care.

An approach of this general form was first proposed by Haddon (1968) in a matrix similar to that in Figure 1 (after OECD, 2008)[1].

[1] Note – an adaptation of the Haddon matrix has recently been incorporated by the MCA into the Coastguard's SAR Incident Information Module (see 4.2.1 below) to enhance information available on the causes of and circumstances surrounding maritime and coastal incidents.

Phase	Factors		
	Human	**Machine**	**Environment**
Pre-crash	Attitudes Information Impairment Enforcement	Handling Speed management Braking Collision avoidance Electronic stability systems	Road design Speed limits ITS Weather Pedestrian facilities
Crash	Use of restraints Impact speed Impairment	Crash protection Restraints Safety features	Passive roadside design
Post-crash	Access to medical care General	Automatic crash notification systems Access to crash site Fire risk	Rescue services Elapsed time to appropriate care

Figure 1: Example of matrix approach

A system based approach enables improvement to focus on situational risk, and develop mass action treatments, rather than simply action at accident sites - to be proactive rather than reactive. This does not bypass a need for economic justification, but requires this to be based on risk rather than accident history. It would also allow targets to focus on achieving specific levels of risk over defined parts of the road network or amongst defined road user groups. An approach based on a good underlying risk model would encourage a consistent approach to risk across different types of measures aimed at different types of road user.

Although there is a substantial knowledge base on aspects of road risk, there are also many areas where risk relationships are only poorly understood. This may suggest, at least initially, the use of risk models with fairly simple structures and only a small number of sub-models. Risk is also much more difficult to predict in the road environment due to the limited control over road user behaviour. It would then be important to evaluate the benefits offered by these models, in terms of safety improvements and cost-effectiveness, in comparison with current procedures. This suggests a risk modelling approach should initially be used alongside current practice. It may also be important to allow local areas substantial freedom in choice of measures and in the emphasis given to the safety of individual road user groups. Justification for improvement schemes would need to be based on the valuation of reduced risk rather than on past accident numbers.

3.3 More effective delivery of road safety improvements

3.3.1 The issues

Delivery in the roads sector differs from the other modes in two ways. Firstly, in the rail and aviation sectors, there are industry-wide safety improvement plans reported against and reviewed annually, which have no clear equivalent in the roads sector. Secondly, in all the other three sectors, there is a body fulfilling a "safety regulator" function, which provides a check on standards and safety activities which is independent of the main executive agencies. Would either of these processes encourage better performance in the roads sector? Are these functions that might be overseen by the Road Safety Delivery Board - with some independent input?

3.3.1.1 Annual improvement programmes

The most recent overall road safety strategy was developed by DfT for a 10 year target period, and reviewed and potentially updated every three years.

Individual highway authorities develop plans, and the Highway Agency has an annual safety action plan. Local authority proposals for safety measures are presented as part of their Local Transport Plans; these were initially produced annually but now cover several years for the better performing authorities. A national plan would need to cover planned national vehicle and behavioural improvements as well as just local actions.

But no clear basis exists on which to link these plans into a national picture, or to link the proposed actions clearly to the targeted casualty changes.

However, funding for road safety schemes, and the political will to carry them through comes through a variety of channels, and it is not clear whether any benefits resulting directly from rail and air sector's use of annual improvement plans, would be replicated in the roads sector.

3.3.1.2 Regulator function

The activities of the rail regulator (ORR) include

- Ensuring legal compliance with health and safety requirements on all GB railways including mainline, light rail, metros [including London Underground], trams and heritage railways through:
    - Inspection of safety management systems and risk controls;
    - Investigation of incidents and complaints to establish the cause(s) and whether any breaches of the law have taken place;
    - Taking enforcement action, where appropriate, to remedy non compliance with statutory duties;
- Obtaining RIDDOR and railway data on reportable accidents and incidents
- Producing an annual report summarising risk trends - this does not include an attempt to translate this information into an overall measure of risk (this is done by RSSB for the main line network and by London Underground for theirs)
- Publishing a corporate strategy: *Promoting safety and value in Britain's railways: our strategy for 2009-14"*

The activities of the aviation regulator (CAA) include

- Producing an annual report on industry performance, publishing data on accidents (and precursor incidents) and promoting a culture of open reporting
- Making rules and standards (unlike rail where standards are made by the industry), including assessing safety benefits and compliance costs for any significant changes in regulations
- Testing and accreditation of pilots and other safety-critical staff
- Inspection and enforcement for air operators and the providers of infrastructure (aerodromes, air traffic control etc)
- Leading and managing a process to develop a 5 year improvement plan

Is there a useful role for the equivalent of a risk regulator in the roads sector? What needs "regulating" and who would do this?

In terms of the activities quoted for the regulators in rail and aviation, the equivalent activities for road can be described as

- Department for Transport collate accident data reported by the police and produce an annual report
- Department for Transport (particularly for changes in vehicle regulations)is required to provide an impact assessment of costs to industry and the public of changes in legislation
- "Safety Plans" are produced by Department for Transport (strategy linked to casualty reduction target - reviewed three yearly), by Highways Agency, and by each Local Authority (as part of Local Transport Plans). The latter two groups are required to meet the national target and thus shape their own plans to contribute to achieving this target
- Standards for vehicles are developed at a European level between governments and industry, while standards for roads are developed by the Highways Agency (mandatory for their own roads, but also followed to some extent by local highway authorities)

The main differences appear to be that

- There is no well defined single action plan
- There is no central body charged with overseeing compliance with standards (although there are active inspectorates in specific sectors)
- There is no independent body either leading the development of a national safety plan, or charged with reviewing it

3.3.2 The opportunity

3.3.2.1 Annual programmes – opportunity

Establishing regular national safety programmes would allow programmes to be defined that were consistent with the level of network upgrading or behaviour modification necessary to achieve defined levels of risk.

Such programmes could also be used to set intermediate targets for risk level, road standards, and behaviours, and to monitor progress towards them.

The benefits of safety expenditure would be seen in terms of changes in network quality, vehicle quality and road user behaviour as well as simply casualty outcome.

If a system based approach was adopted using a formalised risk model, this could provide the basis for defining such a programme.

Basing decisions on a consistent risk model across all roads and all road users should enable more consistent allocation of resources. Large scale programmes could also lead to reduced cost through mass action, even with individual small scale measures.

3.3.2.2 Regulator function in roads sector

The roads sector differs from both the rail and aviation sectors in that it is not generally operated as a business. However, it has industries within it - vehicle manufacture, public transport operators, and commercial vehicle operators - and highway authorities are responsible for the safe operation of their roads.

A variety of recent reports have considered what represents good road safety management (e.g. OECD, 2008; Bliss and Breen, 2008; WHO, 2004). These stress the importance of "a lead agency within central government with responsibility for road safety - with the precise form of the agency varying…. A lead agency that is politically accountable for achieving the targeted improvements in road safety is more likely to

drive coordinated effort and outcome achievement across the range of stakeholders" (OECD, 2008).

Strongly sustained government commitment at the highest level is seen (OECD, 2008) as increasing the chances of

- Securing appropriate and sustainable funding
- Securing supportive policy and legislative changes
- Actively engaging stakeholders
- Implementing effective measures which may not be popular in the short term
- Building institutional capacity.

But a purely political led process can be criticised both in terms of its objectives (as indicated by the negative reaction to speed camera enforcement as a revenue generating measure) and its process ("the nanny state"). And without any body to call it to task, a government can pursue the actions listed above less vigorously. Elvik (2007) has argued that there is a gap in Norway between outcomes that can be delivered by a traditional road safety lead agency (in this case the road authority) and those potentially available with the full support of government.

The role of an independent Road Safety Review function might therefore be to "audit" how well the lead agency and other stakeholders are fulfilling their stated commitments to improved safety. Areas where strengthened institutional management capacity is often required include (OECD, 2008)

- Socially inclusive promotion and advocacy
- Robust monitoring and evaluation arrangements.

Many countries have used Road Safety Councils to work with the public to promote and foster a safe driving environment. In Britain there are a variety of NGOs seeking to promote road safety (e.g. RoSPA, PACTS) but none have a formalised role that equates to a "regulator". Department of Transport also regularly meets with a Road Safety Advisory Panel, made up of representatives of a wide range of groups with safety interests, but their role does not extend beyond comments on government plans.

There is a strong argument that the primary responsibility for leading road safety action should remain with government. Equally, the delivery of safety actions by national and local highway authorities is likely to be impaired if their responsibilities are substantially altered. The gap that it can be argued does appear to exist is for an independent body that has formal responsibility for reviewing both safety action plans across all road safety executive groups, and auditing progress towards agreed objectives by each of them. This body could also play a substantive role in engaging the public in debate on safety issues, and representing their views. In Sweden, there is currently consideration of a cross-mode organisation which takes this auditing role, and that is a model that should be explored.

3.3.3 What would be involved

3.3.3.1 Annual programme

It is not clear whether annual monitoring of roads activity is either useful or practical. Work to investigate this concept further should seek to

- Assess the scope for collating data from existing plans
- Assess how this information might be merged nationally to indicate the proposed change in performance over time

- Consider the appropriate frequency for a national plan against which performance could be monitored - possibly reflecting the current 3 year strategy review

Consultation with highway authorities and other safety delivery groups would be important to ensure that there would not be a loss of commitment at local level if programmes were defined remotely and did not enable some local view on priorities.

3.3.3.2 Regulatory functions

Taking this idea forward would largely involve consultation internal and external to the Department, including a thorough review of existing arrangements. One potential option would be to incorporate auditing activities into the role of the Delivery Board - however part of the audit responsibility may be to assess the performance of that Board, so there would have to be a clear independent input to this function. External consultation, with both authorities delivering safety plans and with bodies representing the public more broadly, would be important in establishing to degree of autonomy and independence of the group to whom the function was assigned.

It would be necessary to ensure that any responsibilities given to a group to carry out this function did not result in less vigorous action by current stakeholders, either as executive agencies such as road authorities, or safety campaigners, such as PACTS. The group would also largely only be effective if it was successful in encouraging public and political demand for improved safety practice.

4 Issues relating mainly to the rail, air and maritime sectors

4.1 Recording and reporting of rail asset defects found during maintenance & inspection, and use of this info in "bottom up" risk modelling

4.1.1 The issue

Recommendation 2 of the RAIB Report into the derailment at Grayrigg in February 2007 is that[2]

"Network Rail should implement processes to:

a) capture, and record on a single national database, data about component failures, and interventions made during maintenance and inspection activities, for each set of S&C;

b) use the data from a) above to monitor failure and intervention rates locally and nationally in the behaviour of S&C components;

c) identify precursor faults that might lead to more serious failures; and

d) identify those precursor faults where the failure and intervention rates indicate a need to reduce the risk of catastrophic failure."

From our discussions with railway stakeholders in the course of this work, it has become clear that there is a much wider issue for the railways. The aviation industry has a strong culture of recording and reporting defects found during maintenance (perhaps stemming from the very strong role played by aircraft manufacturers in the early industry in designing for safety, and then proving this via through-life reliability data collection), but is patchy in terms of recording and reporting of operational incidents (which are often apparent only to the crew of the aircraft involved).

In the railways this position is reversed; recording and reporting of operational incidents is generally excellent, whereas in many areas defects found during maintenance are simply fixed and the assets put back into service. The maintenance task and its cost are often logged, but the way in which the nature and cause of the defect, and its severity, are recorded and reported varies widely from asset to asset, even within the same asset group. Thus cracks in rails (the precursor to broken rails, which can cause derailment) are extremely well recorded and reported, and there can be high confidence that the risk of derailment from broken rails has become significantly better controlled in recent years. In contrast, as the Grayrigg recommendation above indicates, points on both the Network Rail and London Underground networks are regularly inspected, but have not historically been subject to systematic defect classification in terms of failure mode, causes and severity, or to upward reporting of such information to enable trends in safety performance to be reliably monitored.

This variability of approach is not confined to track assets, but extends to include all the major classes of railway assets – rolling stock, signals, civils, communication (etc) as well.

4.1.2 The opportunity

We propose that, in addition to the very specific and thoroughly researched recommendations made about points and crossings pursuant to the Potters Bar and

[2] Derailment at Grayrigg, 23 February 2007, Rail Accident Report 20/2008, Rail Accident Investigation Branch (DfT).

Grayrigg accidents, research should be commissioned to address the issue of defects found during maintenance and their significance for risk across the WHOLE body of railway assets, at least for the two largest UK railway systems (the Network Rail main lines and London Underground).

4.1.3 What would be involved

A logical approach would be:

a) Survey current practice across railway asset groups and key failure modes, and compare with practice in the aircraft industry

b) Identify exemplars of good practice (in rail as well as aviation)

c) Prioritise assets and failures modes in terms of their significance for risk

d) Pilot the introduction of new approaches to recording, reporting and using information on defects found during maintenance for selected organisations, assets and failure modes, and then

e) Use these to develop good practice guidance and (if appropriate) standards for application to safety-critical railway assets generally.

A natural way to progress a project such as this would be via a research project within the RSSB R&D programme, which is funded by DfT. This work would be of considerable interest to RAIB and ORR, and it would be valuable to have their involvement in steering the project and (in ORR's case at least) to helping secure the cooperation of the industry duty holders with whom most of the project work would be carried out. The key rail organisations to be actively involved would include

- Network Rail maintenance and engineering functions
- Train Operating Companies (TOCs, FOCs[3], London Underground)
- Major maintenance contractors (LU Infracos Metronet and Tubelines, major main line train and infrastructure maintainers)
- Other asset owners (e.g. ROSCOs[4])

We would envisage that, given the existing mechanisms within RSSB for engaging railway stakeholders in research projects and translating their findings into practical guidance, a substantial step change in future railway practice and culture could be achieved via:

- A scoping study involving modest resources
- A pilot study or studies with relevant industry partners, and then
- Development and roll-out of guidance, standards etc (as appropriate: substantial costs could be involved in development of local maintenance procedures, training, reporting systems etc across the whole of the industry. These costs would be subjected to rigorous value for money testing in the course of RSSB's processes for evaluating research and how best to translate it into action).

[3] Freight Operating Companies
[4] ROlling Stock Leasing COmpanies

4.2 Maritime: Synthesis and application of risk information

4.2.1 The issue

MCA has taken great strides in recent years to develop the flows of risk-related information from different sources into it. The most recent Safety Improvement Plan (modelled on aviation and railway practice) made a major advance in applying such information for each segment of MCA's business, as a foundation for engaging the many stakeholders involved in planning for safety improvement.

While representing a significant and valuable step forward, it is recognised that there would be high value in improving the "picture of risk" assembled in the latest Safety Plan, by bringing together the sources of information now available to enhance understanding of the factors associated with accident causation and consequences.

A number of information sources (incidents reported to MAIB, defects discovered during Port and Flag state inspections, Hazreps[5], Coastguard SAR[6] reports) are already available to MCA. Others are under development, in particular

- an Incident Information Management (IIM) system has been developed and is in place to make a step improvement in the causal and circumstantial information captured in the SAR database (covering the 12-15,000 incidents responded to by the Coastguard each year)
- DfT is funding the WAID (Water Accident and Incident Database), an initiative developed via the National Water Safety Forum to collect information on accidents and incidents involving water from the many bodies involved
- Large volumes of data are being received via Automatic Identification Systems for shipping.

In addition, there have been significant developments in shipping operators' own incident recording and internal reporting arrangements as a result of the introduction of Integrated Safety Management systems. There are further major potential sources of relevant information not currently available to MCA (e.g. via insurance claims records and via Classification Society inspection findings) that might in principle be used to enhance MCA's evidence base on risk and its precursors.

4.2.2 The opportunity

Many pieces of the risk information "jigsaw" are now available, or are becoming available. What would add great value would be a concerted programme of activity by MCA to pull this material together and analyse it to develop a richer assessment of maritime risk, tailored to policy uses. In the first instance this might be done as a one-off task, but it would be important also to develop the systems and processes to enable this to be done routinely on an ongoing basis.

4.2.3 What would be involved

A logical flow for this programme might involve

a) Surveying current and emerging information sources both inside and outside MCA

b) Clarification of the policy uses of risk information, and thus of the value of enhancing different aspects of risk information

c) Prioritising information sources based on (a) and (b)

[5] HAZardous incident REPort
[6] SAR – Search and Rescue

d) Identifying and addressing the detail of what information should be sought from each source, and the practicalities of obtaining it

e) Identifying and addressing how the information from various sources will be assembled, held and analysed within MCA (driven by (b) above), and then

f) Implementing the resulting design for a risk information and analysis architecture, systems and processes.

This would lend itself to a three-stage process involving:

- Initial scoping ((a) to (c) above)
- Design of processes for transfer, receipt, storage and analysis of information ((d) and (e) above), and
- Implementation

This would require significant cooperation from other maritime stakeholders (given the effort put in by MCA to engagement of stakeholders in its Safety Planning activity this should not be problematic). The process would benefit from the involvement of people external to MCA with experience in risk information synthesis and modelling in other walks of life and (as for most of the other recommendations in this report) from some form of supervision via a Steering Group with a strong focus on the value added for policy in relation to the costs and practicability of the technical implementation.

4.3 Air: Development of a System Risk Model

4.3.1 The issue

CAA has invested substantial effort in assembling information from many sources to produce a picture of global commercial aircraft risks. This is then used in combination with UK information on aircraft, incident reports, and their judgment as to the relative effectiveness of UK controls over various aspects of risk to prioritise accident scenarios and precursors for attention in their Safety Improvement Plan. This approach has been commended from many sides for its intelligent use of all the available evidence to set regulatory priorities.

The CAA approach does not currently combine this information into a UK-based model of risk, to provide a quantitative picture of current UK air accident risks and the key factors influencing their frequency and consequences. This contrasts with the railway approach, in which the various evidence sources are combined to produce a quantified risk assessment. This enables the railways to do a number of things that CAA cannot quickly and easily do with its risk evidence base:

a) Quantify the relative contributions to air accident rates from different accident scenarios and precursors (e.g. we know runway incursions and level busts are both potentially important, but not whether they are in 20:80 or 80:20 proportion as contributors to serious aircraft accidents – in the railways we DO have a model giving us the relative expected frequencies and casualties associated with derailments as opposed to collisions at level crossings)

b) Translate estimated aircraft accident rates (the foundation of Joint Airworthiness Requirements for many years) into risks to people to facilitate assessment of safety benefits and people-focused prioritisation of issues (some aviation authorities in other countries are already starting to do this), or

c) (Combining (a) and (b) above) present a whole-system picture of risks to stakeholders, which greatly facilitates explaining the safety implications of a given issue, and/or the reasoning behind CAA's policies (such as giving greater regulatory attention to large commercial aircraft than to smaller ones). It would also help

sharpen the focus of safety improvement planning (to reduce risk in areas of greatest opportunity) and safety research (to reduce uncertainty in identifying and prioritising issues in terms of their contribution to risk).

Some other countries (e.g. the Netherlands) have already invested large sums in developing risk models, so that some foundations are already available on which a UK-based model or framework might be built. In discussion with CAA in the course of this project, it has become apparent that much of the information necessary to construct a "rich picture" or model of aircraft accident risk is already to hand at CAA; it should therefore be feasible to develop a risk model or framework at significantly lower cost than that being spent overseas.

4.3.2 The opportunity

CAA is well placed to carry out a synthesis of the available risk information and to assemble it within a model or framework that would deliver the benefits described in (a) to (c) above. This would involve a significant one-off project to develop the framework/model and populate it, and then a relatively modest continuing effort to adapt existing information sources and systems to facilitate quick and easy updating in the future.

4.3.3 What would be involved

The work to develop an aircraft accident risk framework or model would divide naturally into two stages: a first scoping/architecture stage, and a second development stage. The first stage would involve

- Identification of the policy issues and customers the framework/model is to inform (i.e. ensuring from the start that it is driven by the information users, not the information providers)
- Reviewing work in this area already carried out by other aviation authorities overseas, and in the other transport modes (particularly railways) in the UK
- Definition of a framework architecture and structure
- Initial high-level population of that framework with international data
- First-pass development of a UK framework by high-level adaptation of the international data (this will help identify the most important areas for development and most important uncertainties to be reduced), and
- Developing the specification for more detailed development of modules or elements of the framework during the main development stage of the work.

The second stage would then involve development of the framework, populating it with relevant information, and development of the systems and processes that would be used both

a) to update and develop the framework into the future, and

b) to apply and use the framework to help inform safety decisions.

This process would benefit from the involvement, particularly during the first, scoping and definition stage of the work, of external expertise in relevant areas gained outside the aviation industry. Supervision by a Steering Group of senior CAA staff, plus a small number of other aviation stakeholders (e.g. industry representatives, AAIB), and possible a senior risk professional with experience in relevant work in other modes or walks of life, would also be of value.

5 Perception

The issue of risk perception is a central theme to the current project, in that it has a bearing on almost all cross modal decision making with regard to prioritising safety spending, and across and within modes relating to the choices people make when travelling. Put simply, people do not perceive risk in an entirely objective way—something that has been known to social psychologists and economists for decades—and subjective estimates of risk rarely, if ever, match the true risk present in the different modes. If we are to understand how risk is used in decision making relating to safety cross modally, and within any given mode, then as well as understanding how risk is used within the modes and industries by policy makers and engineers, it will be vital for us to understand the human factors elements of how people perceive, react to, and make decisions based on risk.

The key research questions in the current project surrounding the perception of risk were:

1. What role does the perception of risk play in 'societal concerns' and the willingness to pay for specific safety interventions?
2. What is the role of risk perception in people's mode choice decisions?

The first of these questions has been dealt with in Section 2.1, in what we see as a key recommendation regarding the prioritisation of safety spending based on cross-modal principles..

We believe that there is another opportunity related to the second of these questions that is specifically related to perception. This is dealt with below.

5.1 Understanding how to influence mode choice decisions

5.1.1 The issue

In Phase 1 of the current project, it was concluded that people rarely consider risk in their day to day assessment of whether to use rail, air and maritime modes; variables such as convenience, cost, comfort and reliability are more likely to guide decision-making. The same is true of people's decisions to travel by bus and car on the roads. Although they are perfectly capable of ranking the relative risks associated with each mode, the absolute levels of risk are small enough (typically even lifetime transport fatality risks to a given individual are less than 1 in 200, which is the figure for roads) to register as meaningful. In other words people take safety as 'given' for most modes, most of the time.

However, people certainly do consider risk when making decisions to cycle and walk in some specific road environments (for example, cycling on very busy roads, and decisions regarding whether to let children walk or cycle to school). Additionally there are some specific circumstances in which people do use their perception of risk to make mode choice decisions regarding buses, rail, air and maritime. Firstly in the wake of high-profile accidents in these modes people can be 'turned off' from using them, presumably due to the orienting of their attention onto the adverse consequences that typically accompany such incidents, or due to mistrust of the organisations that operate such services. Secondly, personal security is sometimes cited as a reason for not travelling on certain modes – particularly bus and rail.

5.1.2 The opportunity

Although it can be argued that for the majority of the time the notion of risk has no place in influencing modal choice decisions, it is still the case that modal choice itself has

a large effect on safety outcomes. If it were possible to move people from personal motorised transport to rail, air, maritime and bus transport, safety benefits would be realised. Additionally, persuading people to move from motorised transport to cycling and walking for shorter journeys is desirable as walking and cycling have health benefits that can be shown to outweigh the risks involved (e.g. Hillman (1993). Put simply then, persuading people to move from their cars and motorcycles to other modes for longer journeys, and to walking and cycling for shorter journeys, is desirable.

The same can be said of persuading people to change their route choice behaviour within the road context. Anecdotally there is a suspicion that people sometimes choose not to drive on motorways due to a perception that they are dangerous. In fact motorways are the safest type of road in the network, and it is likely that changing people's attitudes towards them would again have a net safety benefit.

In order to develop approaches to persuade people to make the kinds of mode switches described above, we need to understand more about the underlying factors that guide people's decisions. In Phase 1 of the current project it was concluded that long-term behavioural change is difficult to achieve, but one important step to achieving it is to know what motivates people to behave in one way rather than another. In effect these are the 'levers' that need to be pulled to change people's minds. Although we know that risk is not a day to day consideration in most mode choice decisions, we do not know—for the various mode options—which factors really do underlie those decisions. Research to understand these motivations will permit the development of approaches to influence mode choice. A report from PACTS (2008) echoes this. The report covers the issue of long term behavioural change, with a focus on road safety, in depth. In examining case studies which have had varying degrees of success (seat belt wearing, drink driving, speeding, and also non-road safety specific areas such as Smoke Free, Recycling, and transport modal shift initiatives) the report comes to a conclusion that

> "The overwhelming finding across all case studies was the need to be exhaustive in our efforts to understand the nature of the problem, the barriers to change and the specificity of attitudes, beliefs and values. On many issues we face very specific challenges and far-reaching research into the motivations and impediments to change…will be required to shape interventions and particularly communication campaigns." (PACTS, 2008, p3)

5.1.3 What would be involved

The way to take this issue forward divides naturally into three areas of work:

- A scoping activity to understand which types of modal choice decisions are a priority for achieving the best mix of safety and other benefits (e.g. health benefits of cycling and walking), which ones involve risk information in the decision making process, and which ones do not.
- Empirical work to understand—for those modal choice decisions that rely on risk perception (e.g. public transport in the wake of large incidents; resistance to cycling; resistance to use of motorways)—exactly how risk information is best communicated to people so that they understand the true relative and absolute risk levels and other benefits for a given activity.
- Empirical work to understand—for those modal choice decisions that do not seem to involve risk perception (e.g. day to day choices to drive rather than take the train or bus)—the information on which people do base their decisions (e.g. reliability, cost) and how this information can be presented to influence mode choice,

We anticipate the first of these areas of work would be relatively light in terms of resource, since it would simply expand on the Phase 1 work with a more comprehensive literature review centred specifically on the issue of mode choice. The second and third

areas of work would be moderate to heavy in terms of resource, since it is likely they would involve primary data collection from large numbers of participants, in empirical studies designed to answer specific research questions.

6 Recommendations

6.1 Cross-modal recommendations

Our cross-modal recommendations are as follows:

a) Development of an overarching Transport Risk Policy framework laying out the basis for prioritising and taking decisions involving safety, together with context-specific guidance on risk tolerability and the value of risk reduction, capable of application across all the modes

b) Improvement of the information available to support risk assessment and management across the modes, in the short term by enhancing information flow from other government bodies, and in the longer term by using data collected by automatic transport monitoring systems

c) Provision of peer review and challenge of regulatory policy and practices across the modes; a critical success factor (as for our other recommendations) will be the strengthening of DfT's capability to provide a "Guiding Mind" for transport risk.

6.2 Roads sector

Our main recommendations are as follows:

a) Enhancement of current casualty and safety performance data to enable better risk analysis, for example by linking to hospital and insurance data, including consideration of how road accident investigation might be made more useful for safety analysis

b) Exploration of the possible use of a system-based approach for roads, similar to those adopted in Sweden and the Netherlands, supported by risk modelling, and performance assessment

c) Assessment of the value of providing more independent input into audit of the process for delivery of road safety improvements

These activities could be linked into a central function involving comprehensive oversight of data collection, risk analysis, programme development, and performance monitoring.

6.3 Rail sector

The reporting and use of information on defects found during maintenance varies widely across asset types and failure modes, as was highlighted for points by the investigation into the derailment at Grayrigg in February 2007.

We recommend that research should be commissioned to address the issue of defects found during maintenance and their significance for risk across the whole body of railway assets.

6.4 Maritime sector

The Maritime and Coastguard Association (MCA) has recently put considerable effort into enhancing the information sources available to support risk assessment and policy. There would now be high value in enhancing the synthesis and analysis of this information in support of processes such as safety improvement planning.

We recommend a concerted programme of activity by MCA to assemble and analyse the data now available (and to develop the systems and processes to enable this to be done

routinely on an ongoing basis) to provide enhanced risk assessment in support of policy and regulatory practice.

6.5 Aviation sector

The Civil Aviation Authority (CAA) has a well-developed picture of global commercial aircraft risk which it combines with UK data on incidents and precursors to inform its safety improvement planning process. However, it does not currently combine these data into a risk model to provide quantitative insight into air accident risks, the relative importance of their causes, and their consequences for people.

6.6 Recommendations for further investigation of the factors affecting modal choice

It is recommended that DfT address the issue of risk perception and influence in modal choice in two ways. Firstly, it is necessary that we understand the precise modal decisions that we are trying to influence, and which of those involve risk perception as a possible causal factor, and which involve other factors such as convenience and cost. Secondly, it will be necessary to undertake work to understand the different aspects of risk information (or non-risk information) that need to be communicated, and how they need to be communicated to people in order that we can influence people in their mode choice decisions.

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Glossary of terms and abbreviations

AAIB	Air Accident Investigation Branch
CAA	Civil Aviation Authority
HSE	Health and Safety Executive
MAIB	Marine Accident Investigation Branch
ORR	Office of Rail Regulation
RAIB	Rail Accident Investigation Branch
RIDDOR	Reporting of Injuries, Diseases and Dangerous Occurrences Regulations
RSSB	Rail Safety and Standards Board
SAR	Search and Rescue

Appendix A Extended list of issues

N.B. coloured issues are short-listed

Number	Description
1	Review risk assessment approaches at modal intersections
2	Applying rail safety risk model concept to other modes
3	Applying aviation human factors expertise in other modes
4	Enhancing flow of road accident info to DfT
5	Identify "easy win" cross-modal issues/opportunities
6	Survey practices overseas (in joining up policy & practice across modes, or in other areas of common interest across modes)
7	Understanding how to influence people to drive more safely
8	Understanding attitudes underpinning modal choice
9	Dealing with public panic in reaction to major accidents
10	Cross-modal review of state of the art in addressing adverse public behaviour (road rage, speeding, railway trespass & vandalism, air rage, unsafe boating etc)
11	Exploring the use of precursor information in understanding road risk (e.g. for rural roads)
12	Exploring the use of a system-based approach for roads
13	Integration and use of aviation performance & safety information from multiple sources, including flight data recorder info.
14	Development of whole-system aviation risk model
15	Recording and reporting of rail asset defects found during maintenance & inspection, and use of this info in "bottom up" risk modelling
16	Cross-modal project on use of the exploding volume of data collected via automated recorders and systems to provide insights into risk-critical behaviours & trends
17	Cross-modal project to develop context-specific advice on WTP and value of preventing fatalities
18	Review of risk management arrangements at modal interfaces
19	Cross-modal survey of compliance testing (audit & inspection) practices; identification of best practice in securing compliance and desirable behaviours
20	Cross-modal comparison of approaches to prioritising the use of regulatory resources
21	Introduction of an independent, no-blame road accident investigation function
22	Introduction of an arm's length Road Safety Agency (effectively the road risk regulator)
23	Introduction of cross-modal stages in key risk management processes, e.g. review of modal improvement plans to produce Transport Safety Improvement Plan
24	Promote/establish culture of near-miss & precursor recording and reporting in the maritime sector
25	Synthesis of available info sources and risk assessment/modelling for commercial shipping

26	Cross-modal project to enhance info flows from hospital episode statistics, coroners' findings, fire services etc to transport regulators
27	Development of maritime safety decisions framework & values (to take to IMO to promote/resolve debate re priorities & values)
28	Project to explore all avenues for enhancing road risk evidence base (covering independent investigation, enhancing coordination & coherence of police best practice, data from insurance, NHS & other sources etc)
29	Review/enhancement of current police accident investigation methods and of associated recording & reporting of info
30	Enhance road accident evidence base via clarification/optimisation of use of existing system (e.g. clarifying what is a "serious injury")
31	Project(s) to enhance understanding and management of public acceptance of risk-reducing interventions (for roads in particular)
32	Explicit annual road safety improvement plan analogous to those produced for rail & aviation
33	Extension of safety case approach into other modes
34	Adoption of a unique numbering system for road accidents, used by both police and NHS [or indeed could do same for all (transport) accidents]
35	Create a national database of fatal road accidents (with particular attention to quality of root cause info)

Cross-modal safety: risk and public perceptions – phase 2 report

This report documents the second phase of a project into cross-modal risk assessment and public perceptions of transport risk. The project was commissioned by the Transport Safety Group (TSG) at the Department for Transport (DfT), and was carried out by TRL and TTAC Ltd. Phase 1 of the project generated a "snapshot" of current practice in the different transport modes (road, air, maritime, rail) with regard to how risk information is used in decision making surrounding managing transport risk, and also how public perception of risk influences the prioritisation of safety spending and mode-choice decisions.

This report involved presenting the findings of Phase 1 of the project (PPR521) to the major stakeholders in the various transport organisations and discussing their potential adoption. The cross-modal recommendations included: producing transport risk policies; improving the information available for the production of risk assessments and suggesting that the DfT could provide guidance relating to best practices and the production of policies and assessments. In addition details are provided of specific recommendations made to the roads, rail, maritime and aviation sectors. The report concludes by recommending that DfT addresses the issue of risk perception and influence in modal choice. It is suggested that research is carried out to establish aspects of risk and non-risk information that need to be communicated in an attempt to influence peoples' decision process in the selection of a mode of transport for a journey.

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