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Review of the Highways Agency Value of Life Estimates for the Purposes of Project Appraisal.

A Report to the NAO

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Contents

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1   Introduction and summary

1.1   Background to this project

The valuation of fatal and non-fatal casualties that are avoided as a result of a particular transport intervention can be a key variable in informing the decision on whether the investment in the intervention should be made. Within the context of its framework for conducting cost-benefit analysis, the Department for Transport ("**DfT**") has developed a series of estimates, based on a willingness to pay approach, of the value of preventing casualties in various categories.

The estimation of the value of casualties prevented presents a number of theoretical and practical challenges. These include:

- difficulties in estimating willingness to pay;

- concerns around the applicability of this figure in the appraisals of other non-road investments, since the DfT value was explicitly developed in the context of road accidents; and

- concerns around the continued appropriateness of the estimates, given that they are based on research which dates back in some cases to the early nineties.

Concerns around the transferability of the DfT value have been one of the motivating factors behind the setting up of an interdepartmental group to conduct a review into the valuation of life and health across government. The Interdepartmental Group for the Valuation of Life and Health ("**IGVLH**") consists of twelve government departments, including the DfT. According to Kelly (2008), its review aims to:

- survey the approaches to and the practice of the valuation of life and health current in different parts of the public sector;

- survey current academic thinking and international practice; and

- highlight issues requiring further research and, where appropriate, commission that research.

The key output of the IGVLH review is to produce revised guidance for government departments in support of the appraisal process.

The IGVLH review has, to date, produced two reports. The first of these (Wolff and Orr, unpublished) examines the moral and methodological issues that have been raised in the valuation of life and health, as well as the question of whether it is possible to bring greater uniformity and consistency into the valuation of life and health across government departments. A second report details a series of interviews conducted by researchers from Leeds University with key personnel at the twelve government departments involved in the IGVLH review (Kelly, 2008). We have drawn on the findings of these two reports in our work.

Against this background, the NAO has commissioned a Good Governance study to review the DfT's value per casualty prevented figure, its validity and its use in both the transport sector and wider economy.

1.2   Objectives

This study has a number of specific objectives.

1. **To summarise and critique the current DfT estimates and their derivation.** The component parts making up the DfT estimates of value per casualty prevented and value per accident prevented are the product of a number of studies, written up in a series of separate reports. There is no single overall summary explaining the derivation of the values, apart from the guidance produced by the DfT (DfT, 2008) which only provides limited detail. One objective of this study is to provide a comprehensive summary of the derivation of the DfT estimates. Furthermore, there are a number of practical and theoretical challenges underlying both a willingness to pay approach and the specific methodology used in the estimation of the DfT values. This study aims to highlight any key areas of concern and assess the extent to which the available evidence and current best practice suggest alternative approaches, while remaining conscious of the need for pragmatic solutions.

2. **To examine the practical application of the DfT estimates within a highways context.** The DfT estimates form a key input into the project appraisals of both small and major highways schemes. This study aims to assess the appropriateness of the use of the DfT estimates, their importance relative to other considerations in cost-benefit analysis and the robustness of their application in the appraisal approval and evaluation process.

3. **To briefly assess the key theoretical issues relating to the transferability of the DfT estimates to contexts other than roads.** There are a number of concerns relating to the use of the DfT estimates in non-road contexts, such as whether society values the reduction in risk of death in different contexts equally, whether consideration of blame should affect DfT estimates and whether the DfT estimates relating to non-fatal casualties can be applied in different contexts.

4. **To investigate the practical application of the DfT estimates outside of a highways context.** This study aims to understand at a high level the use and amendment of the DfT estimates, their application in project appraisals and the relative importance of these estimates in assessing an intervention in other government departments, in DfT agencies outside of the Highways Agency, and in other bodies such as local authorities.

5. **To compare the DfT estimates with those used in other contexts and internationally.** Other valuations of life exist in other countries; furthermore, other approaches to the valuation of life and health are used in the UK, most notably the Quality Adjusted Life Years approach. This study briefly compares and contrasts the DfT estimates with these alterative estimates.

1.3   Approach

To achieve these objectives, our study has consisted of three types of activity.

- **Literature review**: we have carried out a review of the available literature on the valuation of life, focusing primarily on studies which explain the DfT approach and on the literature around transferability of value of life estimates to other contexts. We have also examined the evidence on other valuations of life at an international level. Given the scope of our study and the large body of literature on the valuation of life, our review has by necessity not been fully inclusive. Nevertheless, we have drawn on a number of studies which have comprehensively surveyed the literature in this area, as well as on the advice of experts in the field, and so believe we are able to present an overview of the key issues relating to the subject.

- **Interview programme**: we have conducted a series of interviews with key personal in the DfT and Highways Agencies, with representatives from related bodies such as Network Rail and the Rail Safety and Standards Board, and with local authority safety practitioners. Furthermore, we have interviewed representatives from the Home Office, the Health and Safety Executive ("HSE"), the Food Standards Agency and the Department of Communities and Local Government to gain further insights into their use of the DfT estimates, following the earlier interviews conducted as part of the IGVLH review. A full list of interviewees is given in Appendix B.

- **Review of appraisals**: we have examined a limited number of Highways Agency project appraisals and post-appraisal evaluations to understand the practical application of the DfT estimates in project appraisals.

Our study has been limited by the short time period over which it has been conducted. Its intention is to provide a high-level overview of the topic and point out areas which are worth further examination.

1.4   Summary of findings

1.4.1   Derivation of the DfT estimates

Value per casualty prevented figure

The DfT's value per fatal casualty prevented figure is based on an estimation of the value which society is prepared to pay for a small reduction in the risk of being killed or injured. It is the aggregate of individual willingness to pay for small risk reductions which will on average prevent one fatality. The Willingness to Pay (**"WtP"**) value is therefore **not** the value of saving a life, but that of a small reduction to a statistical risk. This differentiation is important: most people are not prepared to accept any level of compensation for death, and so the value of preventing a fatality is not in fact the value that individuals would pay to save their lives. The terminology used by the literature is the value of preventing a *statistical* fatality, or "**VPF**". Similarly, the value per non-fatal casualty prevented is the value of preventing a *statistical* injury, or "**VPI**".

The DfT VPF value consists of three components: the WtP component, ambulance and medical costs, and net lost output. The WtP component encompasses the pain and distress felt by the relatives of the victim, as well as the victim's intrinsic loss of enjoyment of life. This includes consumption, because it is assumed that consumption of goods and services is part of the enjoyment of life.

Net output is defined as the excess of gross output[1] over and above lifetime consumption. Net rather than gross output is used because the WtP value already includes the value of consumption. However, in order to allow comparison with some European countries using the Human Capital approach[2], the DfT VPF figure is presented with gross output as one of its components. It is therefore restated as the sum of ambulance and medical cost, **gross** lost output, and '**human costs'**, where human costs are equal to the WtP value less consumption. The value of 'human costs' has therefore not been built up as a separate estimate, but is derived by subtracting the value for consumption from the WtP value. This is purely to be able to present gross loss output as a separate figure. This derivation has the potential to be misleading, particularly where the value is transferred to contexts outside the DfT.

The DfT VPI values consist of the same three components as the VPF values. The human cost component reflects the pain and suffering felt by both the victim and the relatives of the victim, as well as the reduction in enjoyment of life during the period of injury3. The lost output component reflects the working days lost following the accident. The final component is an allowance for ambulance costs, hospital treatment costs, district nurses and state benefits.

The relative importance of each of the VPF and VPI components is shown in Figure 1 below. Note that the two graphs in the figure have different axes.

Figure 1: Components of the DfT VPF and VPI figures
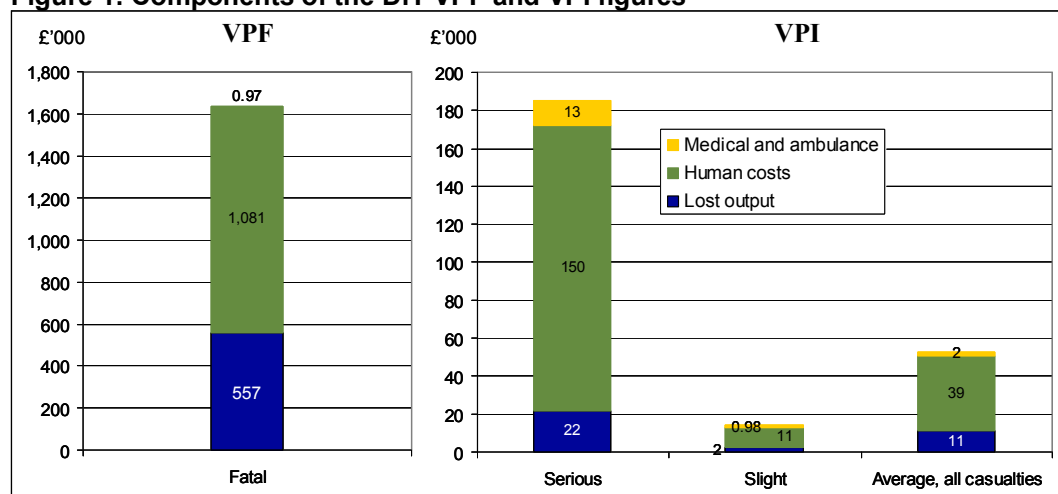
Source: DfT (2008)

The WtP approach underlying the DfT values per casualty prevented has a number of theoretical and practical limitations. These include the following.

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[1] Gross lost output consists of the present value of expected lost earnings before tax, as well as any non-wage payments from the employer such as overheads and national insurance contributions.

[2] The Human Capital approach is based only on the lost gross output associated with a fatality.

[3] In this case, the human cost component is set equal to the WtP value, rather than being equal to the WtP value less consumption as for fatalities. This is because the WtP value does not include consumption, as non-fatal casualties still consume for the duration of their injury.

- **Difficulties in understanding individuals' preferences.** It is generally accepted that government actions should be based on the needs of its citizens, and that these needs are reflected through individual preferences. There are two main approaches to eliciting individuals' preferences and both have methodological difficulties. Revealed preference approaches attempt to derive preferences from prices – in this context, from the identification of situations where choices involve different safety consequences; for example, the wage premia expected for risky jobs. This depends on the separation of risk-related wage differentials from other factors influencing wage differentials, which is difficult in practice. The Contingent valuation approach, which is used in the UK, involves asking a representative sample of people more or less directly about the sums that they would be individually willing to pay for something that is not explicitly priced by markets – in this context, improved safety. The two main difficulties associated with this approach are:

- **Valuing small risks.** Contingent valuation requires individuals to estimate the value of a small reduction in risk. However, individuals appear to have difficulty understanding and valuing small reductions in risk.

- **Aggregating the preferences of individuals to derive an average value for society.** An individual would need to value equally many small risks of the same size for the WtP approach to be accurate. However, it is argued that if an individual faces many small risks of similar magnitude, then she is likely to be prepared to pay a diminishing sum for the reduction of each successive risk because this makes her more aware of her overall budget constraint.

However, despite its limitations, the WtP approach appears to offer the best approach currently available for valuing a reduction in risk of death or injury. In particular, it is clearly superior to the alternative Human Capital approach to estimating the value of life, which only includes the economic value of lost output and neglects aspects of human cost such as pain, grief and suffering.

That said, we note that the WtP estimates underlying the DfT figures is based on a relatively small sample (167 people). It also uses an innovative approach to mitigate the issue of individuals finding it difficult to value small risks[4]. This has been used elsewhere, but only to a limited extent[5].

Value per accident prevented figure

In addition to the value per casualty prevented, the DfT also provides a value per accident prevented. This differs from the value per casualty prevented as an accident may involve more than one type of casualty; an accident is classified according to the most severe casualty but may involve more than one casualty or casualty type. Furthermore, a number of other costs are included in the value of an accident in addition to casualty costs: material damage costs to vehicles and property, police costs, and insurance administration costs. However, accident costs do not include

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[4] In a "chained" approach, respondents were asked to compare one type of physical risk against another, without having to directly trade money off against risk.

[5] To our knowledge, this methodology has been employed in a survey carried out in New Zealand (Guria et al., 2005) and in a study for the Department of Health and NICE (Baker et al., 2008), as well as in a three-year study into the value of statistical life of adults and children, funded by the European Commission ((www.oecd.org/env/social/envhealth/verhi).

the time costs to others as a result of accidents and the delays associated with them. The DfT is currently developing software and guidance on how to assess the travel time implications of incidents, including accidents6. Initial guidance will be released in April, with a view to including this aspect in project appraisals once the Reliability Model has been fully tested7. Although the value of the time savings associated with avoiding accidents is currently unclear, it may comprise a considerable part of the overall value per accident prevented.

Uprating of the DfT estimates over time

The casualty and accident-related components of the values per accident prevented have been estimated by research conducted primarily in the 1990s. These are annually uprated based on real per capita economic growth and inflation, on the assumption that the real cost of each element of accident costs will rise in line with increases in GDP. Extensive research went into the determination of the underlying structure of costs for each component; for example, police time per accident or treatment required for a subcategory of injury. These cost structures may well have changed since the research was conducted; however, it is not clear whether they have changed sufficiently to materially impact the results. Repeating the detailed cost research may therefore be very costly for little additional benefit. However, it seems likely that the unit costs associated with these cost structures (such as the cost of police time or treatment costs) may well have evolved differently to nominal per capita output growth and may now be out of date.

Furthermore, there have been changes to the guidance provided by central government which will have an impact on the cost estimations underlying the DfT VPF and VPI figures. In particular, the revised Green Book guidance released in 2003 changed the real discount rate from 6% to 3.5%. However, the original estimations of the cost of net lost output used the 6% rate, thus placing a lower value on future earnings. Re-estimating lost output costs with the current 3.5% discount rate will have the effect of increase the value of net lost output and so increasing the VPF and VPI figures, although this increase is unlikely to be substantial given the relatively small contribution of net output to the total VPF and VPI figures.

1.4.2   Practical application in a highways context

The appraisals of Highways Agency schemes and the major local authority schemes which require funding from the DfT go through a well-established review process. Once a scheme appraisal has been developed by the project sponsor, it is reviewed by dedicated teams within the Highways Agency or the DfT who complete a Value for Money assessment once they are satisfied that the cost-benefit analysis is correct. The Transport Analysis and Review team within the DfT then conducts a second stage review of the Value for Money assessments to ensure consistency.

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[6] The current value per accident prevented does not include time savings as a result of avoided accidents because of the difficulties in deriving this measure; indeed, lost time after accidents is not included in the value per accident prevented in any European country (Bickel, 2005).

[7] Time savings as a result of accidents will ultimately be included in project appraisals under the reliability of travel time objective, rather than under the accident saving objective.

Finally, completed Highways Agency schemes over £10,000[8] go through the Post Opening Project Evaluation ("**POPE**") process.

Quantification of the impact of an intervention on risk

Determining the estimated impact of an intervention on the number and severity of road accidents is a key part of project appraisal. A cost-benefit analysis computer programme ("**COBA**"), owned and maintained by the DfT, is used to determine the impact of an intervention on the number of accidents and casualties for major schemes. Smaller highway schemes are not required to inform their cost benefit appraisals through data from COBA. Instead, project appraisers use a variety of approaches to estimate the expected percentage reduction in accidents resulting from an intervention. These include expert judgement and analysis of local data. Average expected accident reductions resulting from a particular intervention can also be useful. This is based on past scheme data. A consultancy called GreenSafe holds a database which provides average expected reductions in accidents resulting from particular interventions. Called UK Morse, this offers free access to safety practitioners on a reciprocal basis; that is, if they are prepared to load data from their projects into the database for others to use. No DfT or Highways Agency-sanctioned alternative currently exists[9], although the Highways Agency is investigating options for making the results of POPEs available to smaller scheme appraisers to assist them in estimating accident reductions. A central database of evidence would appear to be something which would be welcomed by local authorities in particular.

Appropriate use of DfT values

The benefits of accident savings from Highways Agency schemes are presented in Project Appraisal Reports ("**PAR**"), which summarise the costs and benefits relating to a project. Safety-related details are recorded in two worksheets in a PAR. Historic accident data is entered into the **Background Traffic and Accidents Data** page of the PAR for at least the previous three years and preferably the previous five years, consisting of the annual number of accidents and casualties of the different severities. In the **Worksheet for Safety** page, the predicted number of personal injury accidents saved in the opening year is estimated. The PAR then automatically applies the correct value per accident prevented based on the road type of the scheme. If COBA analysis has been undertaken, this page also contains the results of the COBA analysis relating to the accident impact of the proposal on the number of personal injury accidents saved as well as the impact on fatal, serious and slight casualties. COBA automatically calculates the associate benefits of these prevented accidents. COBA analysis is generally not provided for non-major scheme appraisals, due to the large quantity of underlying data on aspects such as traffic flows which COBA requires. In this case, the appraiser is expected to include reference data to support the prediction relating to the number of personal injury accidents saved. In the appraisals we examined, this generally took the form of a detailed description of the accidents which had previously occurred in the locality, and

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[8] Approximately 15% of the Highways Agency schemes under £5m cost less than £10,000 to implement; this comprises 0.4% of the total spending on such schemes over the past five years (Highways Agency, 2008)

[9] A database called Molasses which held such guidance was previously maintained by the DfT. It appears to have been allowed to lapse during the transfer of responsibilities from the DfT Road Safety Department to ITEA in the late nineties.

assumptions around the proportion of these accidents which may be prevented by the proposed scheme[10].

The length of time required to complete a PAR varies widely depending on the project type and amount of supporting material required. The process to complete a PAR is in itself not onerous, but the process of collecting the supporting information may include a safety study, a modelling exercise to determine traffic flows and potential impact of the scheme on traffic movement and environmental assessments, which can take several months. In particular, it is common for a stand-alone safety assessment to be carried out, which may later be used as supporting evidence for a PAR.

Relative importance of DfT value in scheme appraisal

The importance of the DfT accident values relative to other cost-benefit factors varies among scheme appraisals, and tends to be related to the size of the project. On average, safety benefits make up only 22% of total benefits in major highways schemes (Highways Agency, unpublished); however, for smaller safety-orientated schemes, all benefits may be safety related. Since all smaller highways schemes compete for the same funding, the value of the DfT accident values can be critical in determining the ranking of the scheme relative to other schemes which have additional economy benefits.

However, value management guidelines are provided by the Highways Agency to assist in the appraisal of projects. These specify a scoring method for awarding an intervention a value management score, and provide relative weightings for different types of benefits. The relative weightings are informed by judgement. This means that an assessment of the relative importance of VPF and VPI values on project appraisals should not be taken independently of an analysis of value management scores.

Evidence from post-project appraisal

The Highways Agency monitors the performance of highways schemes through the POPE process, which is now in its fifth year. Atkins, a transport consultancy, has been appointed to provide technical analysis of completed highways schemes and advise on improvements to the appraisal process. There still appear to be some issues around the accuracy of predicted safety benefits: the POPE process has found that the safety benefits from smaller schemes are generally underestimated, with average outturn safety benefits being 16% and 49% higher than predicted for small and medium schemes, respectively. For major schemes, the reverse is true, with the total level of savings from accident reduction being 27% lower than predicted (Highways Agency, unpublished). However, the comprehensive post-scheme evaluation programme carried out by Atkins and their brief to advise on improvements to the appraisal process is evidence that the DfT and Highways Agency are aware of the need for evaluation evidence to inform the case for revisions to the appraisal process and methodologies.

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[10] We note that underreporting of accidents may lead to the underestimation of accidents prevented by an intervention, if accident savings are calculated as a proportion of accidents previously occurring in the locality.

1.4.3 Theoretical issues around the transferability of the DfT estimates into other contexts

The DfT VPF and VPI figures were developed specifically in the context of death or injury in road accidents, which raises the question as to whether the estimates are appropriate in valuing reductions in risk of death or injury in other contexts. Our understanding from discussions with experts in the field is that a single, core VPF value across all contexts is appropriate, and that the DfT figures represent the best estimates that are currently available for the UK.

Nevertheless, there are still contexts where people may genuinely be willing to pay more to reduce some risks than others. These preferences will tend to vary considerably not only by context, but also depending on the nature of the interventions. This suggests that these preferences should be reflected by separate add-ons to the core VPF value, rather than by an attempt to re-estimate different VPF values for different contexts. For example, a separate allowance may be appropriate to reflect the additional value placed on reducing death where a period of ill-health precedes death (such as death from cancer). Similarly, where hazards result from incompetence or negligence, a separate allowance may be the best way to value the additional benefits[11] of reducing these hazards.

A related argument applies to some hazards which are associated with additional levels of dread, such as fear of death from crime. Fear of crime is related to numbers of crime-related deaths, but not in a linear way, since other factors such as media coverage of crime and individuals' feelings of vulnerability also drive fear of crime. An intervention which leads to a small reduction in the risk of crime-related death may therefore have a less than proportional impact on fear of death from crime. It is therefore likely not to be appropriate to build in a specific premium relating to reduction of fear of crime to the VPF value. This might rather be added in as an additional benefit in the cost-benefit analysis relating to the intervention in question, depending on how fear of crime could be reduced through the specific interventions.

In many contexts, however, there is insufficient evidence to suggest that either an amendment of the core VPF figure or an add-on is required.

- Although additional levels of dread are associated with specific kinds of death such as murder, drowning and fires in public places, surveys have shown that the level of baseline risk associated with these hazards is low enough to cancel out the dread effect. This is because people's willingness to pay for risk reduction is partly determined by the current level of risk prior to any risk reduction policy.

- There is research evidence to suggest that preventing the risk of multiple fatalities is not more highly valued by the public than preventing the risk of an equal number of single fatalities.

- In terms of age-adjustments, it is not clear how in practice a VPF that varies with the age of the group targeted by the safety intervention might be estimated. Furthermore, there is no

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[11] These benefits include the avoidance of fines, enquiries and reduction in public confidence and trust which can result from an accident involving incompetence or negligence.

policy support for allowing differentiation due to age, except, potentially, in the case of children. Even in the case of children, where it might be thought that society would be willing to spend more to reduce the risks to children, there is currently insufficient evidence to support a particular adjustment in a VPF. Any premium would therefore be more a policy decision than one based on the currently available evidence.

Considerations of age may also impact transferability. This relates particularly to the age basis for lost output associated with a fatality. The cost of lost output was derived by estimating the value of the lost output of the average road accident victim, over the course of their expected remaining life. This component will not be transferable into other contexts if the average age of a road accident fatality is different to that of an average fatality in another context. This shortcoming is partly mitigated by the small relative importance of the cost of net lost output in the overall VPF figure: it makes up only 6% of the overall VPF figure currently used.

The transfer of the value per non-fatal casualty prevented may also be problematic. Levels of severity within the non-fatal casualty group vary considerably. Indeed, eight injury subgroups were identified as part of the studies to estimate the value per non-fatal casualty in road accidents. The overall VPI figures were determined by weighting the various components of the non-fatal casualty figure by the relative proportions of the different injury state subgroups. It is unlikely that the same prevalence of injuries will occur in different contexts, meaning that caution should be exercised when transferring these values.

1.4.4   Practical application of the DfT figures in other contexts

Use in the rail sector

 In the rail sector, the DfT's VPF is directly transferred to estimate a monetary value of casualty reduction benefits. Following previous research work, the same value is applied for single as for multiple fatalities. Similarly, the same value is applied to all individuals, whether they are passengers, rail employees or members of the public[12]. For non-fatal casualties, the rail industry has estimated their own VPI values. These are estimated in relation to the overall DfT VPF; for example, a major injury is valued at 10% of the value of a fatality. Research has been undertaken to estimate these relative weights.

The DfT VPF plays a critical role in many rail interventions, given the considerable number of schemes which are explicitly safety focussed and where safety benefits make up a large proportion of total benefits. However, a further set of criteria is also instrumental in the approval or rejection of an appraisal in addition to the cost-benefit analysis. These are aspects which are harder to

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[12] The only exception is for suicide, where our understanding from discussions with rail sector officials is that the benefits of reducing risk of suicides are generally not included in appraisals of interventions. This approach does not have much significance in practical terms: the interventions required to reduce suicide – such as fencing off long sections of railway tracks – are generally too costly to be considered proportionate whether a full or discounted VPF were to be used, and there are strong arguments that such measures would just displace risk rather than eliminate it. The issue of suicide prevention is more nuanced than can easily be represented in cost-benefit analysis, and requires a co-ordinated approach with other agencies. Prevention strategies such as awareness campaigns are therefore put in place by the rail industry, but generally outside of a cost-benefit framework.

monetise, and relate to wider business and social concerns, such as the loss of reputation, civil damages and legal costs resulting from an accident. These may mean an intervention is approved, even if safety benefits alone were insufficient to justify the intervention.

Application by local authorities

Local authorities also rely on the DfT figures in their road project appraisals. The average value per accident prevented, averaged across fatal, serious and slight accidents, appears to be the most commonly used of the DfT values in local authority project appraisals. This is partly because there is inadequate data at a local level to predict accident savings by severity, but it is also possible that using this value rather than the value per slight accident prevented increases the rate of return of the intervention and gives it a better chance of being approved.

At a local authority level, a significant proportion of schemes are focussed on safety[13]. However, the relevance of the precise magnitude of the DfT estimates seems to vary between local authorities, and depends upon the structure of transport scheme funding and approach to cost benefit analysis. In some case, ringfenced safety funding means that the same schemes would tend to be approved even with a change in the DfT values, because the relative positioning of the schemes would remain unchanged.

Even where there is no ringfenced safety funding, our discussions with local authorities suggested that there seems to be an implicit allocation of a certain amount of funding to safety schemes, given the high priority of traffic safety at a local authority level. Many local authorities employ a weighting system to aggregate the various benefits associated with an appraisal, such as air quality, time savings and safety benefits. If the DfT values were to change such that safety schemes compared poorly against schemes with other benefits, the local authorities we spoke to felt that it is likely that the weighting system would be revised to place a higher weight on safety benefits.

Application elsewhere in central government

At a central government level, seven out of the twelve departments making up the IGVLH take their VPF values from the DfT. A number of these departments have expressed concerns around transferability during interviews undertaken as part of IGVLH research and during interviews conducted as part of this study. However, given the limited research budgets available to most departments, and the perception that it is difficult to obtain context-specific values which are robust, using the DfT values is generally seen as the most pragmatic solution.

More issues appear to arise in the transferral of serious and slight casualty values; indeed, only four of the seven departments using the VPF values also use the DfT values per non-fatal casualty prevented figures ("**VPI**"). Some departments have conducted mapping exercises to adjust the non-fatal casualty figures to the types of injury prevalent in their interventions. Other departments have used the values as they stand, despite the considerable differences between a serious or slight road injury and those occurring in other contexts.

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[13] For example, a third of the total spending on transport initiatives in one authority we interviewed was spent on safety schemes.

In the application of the DfT estimates to project appraisals in other departments, the most critical issue appears to relate to the determination of the risk reduction associated with an intervention, rather than the precise magnitude of the DfT estimates. Political and other considerations also affect the assessment of the appraisal, the importance of which appear to vary between departments.

Several department representatives expressed a desire for clearer guidance from the DfT around the VPF and VPI figures. The guidance currently provided by the DfT provides a high-level summary of the approach behind the derivation of the estimates. However, where departments wish to make adjustments or include add-ons to the core numbers to allow for specific factors, sufficient information on the derivation of the numbers which would allow them to understand which adjustments were needed was not readily accessible. And, although extensive references are provided in the DfT guidance note, these are not all easily available. Moreover, the DfT values have undergone a process of development since the early 1990s, and it is not always easy to understand from a set of separate studies which is the current underlying methodology.

1.4.5   Comparison with other value of life figures

QALYs

Quality Adjusted Life Years (**"QALYs"**) are an alternative approach to valuing the impact of interventions, and have the advantage of being able to compare interventions which extend life to those that provide health improvement without extending life. The process for defining a QALY value involves assessing the trade-off between years in an impaired health state and years in a state of perfect health. It therefore does not involve any consideration of monetary value; the determination of an associated monetary threshold or value is a secondary stage required in order for QALYs to be used in cost-benefit analysis. One of the main approaches to valuing QALYs involves using the DfT VPF. QALY values derived in this way are therefore of limited value in benchmarking VPF values. The alternative approach to valuing a QALY is to set a threshold based on budget concerns, which is the basis for the National Institute of Clinical Excellence's (**"NICE"**) current threshold of £20,000 to £30,000[14]. The value attached to the QALY therefore relates more to what is considered to be affordable for the health service, given its other commitments, than to the underlying value of a QALY to the public.

International figures

Other countries use estimates analogous to the DfT figures. An European Commission-funded research project found a range of approaches and values used to estimate savings in accidents in European countries. The study found that the value of a fatality lies between about EUR 200,000 and EUR 1,650,000[15] (Bickel et al., 2005). GDP per capita is strongly correlated with VPF values: in North or West Europe all countries except Denmark use VPFs exceeding 1,100,000 EUR, while

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[14] In general, health interventions tend to be approved if their cost per QALY is less than this threshold, and tend to be rejected if they cost above this threshold (Devlin and Parkin, 2004, quoted in Wolff and Orr, unpublished)

[15] The study converted values from different European countries to a common basis, using EUR 2002 prices and purchasing power parity exchange rates. Using this approach, the DfT VPF is EUR 1,458,190

in Eastern Europe VPFs are on average less than half the average in North and West Europe. In terms of approach, estimates varied greatly between countries using WtP approaches, including the UK, and those using the Human Capital approach. Southern European values are even lower, due to VPFs being based on liability values. The VPF used in the UK is towards the high end of those used in Europe. However, it is only somewhat above the average value when benchmarked against those derived using a WtP approach. It is also comparable to those used in North/West Europe.

The VPF used by the US Department of Transportation ("**DOT**") is based on a WtP approach. It has recently been revised to $5.8 million (£3.13 million using the average 2008 exchange rate) and represents the average value derived from a number of US academic studies. This value is considerably higher than the DfT estimates. However, the studies selected to inform the US VPF estimates explicitly exclude studies focussing on non-US countries; it is similarly not clear that it is valid to use international figures to justify claims about what a UK tax payer is prepared to pay. Furthermore, the meta-studies relied upon by the DOT yield a very wide range of values, and it is far from clear that the mean of these provides any consensus point. It is therefore not clear that the DOT values are useful in confirming the validity of the DfT VPF figures.

1.5   Summary of conclusions

During this study, we have reviewed the derivation of the DfT's VPF and VPI values, their validity and their use within a highways context and in the wider economy. Given the short time period over which it has been conducted, the intention of this study is to provide a high-level overview of the topic and point out areas which are worth further examination.

We have accordingly highlighted seven areas worth further consideration, which the NAO and DfT may wish to take forward.

1. Within the context of the acknowledged limitations of the WtP methodology, the approach appears to offer the best means currently available for valuing a reduction in risk of death or injury. That said, we note that the WtP estimates underlying the DfT figures are based on a relatively small sample (167 people) and on an innovative approach to mitigate the issue of individuals finding it difficult to value small risks. This has been used elsewhere, but only to a limited extent.

2. The relative age of the studies underlying these figures creates some concerns. The underlying structure of costs – for example, police time per accident or treatment required for a subcategory of injury – may have changed since the research was conducted. However, full scale repetitions of these studies is likely to be very costly and may bring little additional benefit. We therefore suggest conducting limited checks of some of the underlying cost structures to determine whether these have changed sufficiently to materially impact results, for the purpose of deciding whether the studies should be repeated fully.

3. Even if the underlying cost structures determined through the original studies are retained, it would be sensible to investigate whether the unit costs associated with these cost structures (such as the cost of police time or treatment costs) have evolved differently to nominal per capita output growth. If they have, it would be relatively straightforward to revise the uprating factors accordingly.

4. The DfT value per accident prevented figures currently do not include the time savings to other road users as a result of fewer accidents. The DfT is currently developing software and guidance on how to assess the travel time implications of accidents. Given the potentially considerable contribution to accident costs, this aspect should be incorporated into project appraisal. We note that this is the intention of the DfT once the software is fully tested.

5. Green Book guidance on the real discount rate changed in 2003, with the recommended real discount rate falling from 6% to 3.5%. This will have the effect of increasing the value of net lost output and so increasing the VPF and VPI figures, although this increase is unlikely to be substantial given the relatively small contribution of net output to the VPF and VPI figures. Lost output costs should therefore be revised to incorporate the change in the discount rate.

6. Determining the impact of an intervention on the number and severity of road accidents is a key challenge encountered in the appraisal of smaller Highways Agency schemes and local authority schemes. One approach involves the use of expected accident reductions resulting from particular interventions based on past scheme data. No DfT or Highways Agency-sanctioned database currently exists, although the Highways Agency is investigating options for making the results of POPEs available to scheme appraisers to assist them in estimating accident reductions. The creation of such a central database would be helpful for project appraisers, provided appropriate caveats were made by the Highways Agency regarding the currently limited sample size for some types of projects and the implications of this.

7. Finally, we found the derivation of the components of VFP/VPIs to be somewhat complex, suggesting that clearer guidance would be helpful. This would facilitate transferability of the DfT values into other contexts: clearer guidance from the DfT around the VPF and VPI figures clarify for other departments how to make adjustments or include add-ons to the core numbers to allow for specific factors. A supplementary and more comprehensive guidance note which outlined the details of the current methodology in one place would be helpful. Given the interest in the DfT values from other central government departments, there may be a role for a central agency such as the Treasury or an interdepartmental group such as the IGVLH to develop this guidance.

2 The DfT's value of life figures

In this section, we explain the component parts of the DfT's value of life figures, and examine how they were derived.

Before looking in detail at the DfT estimates, it is worth explaining what is meant by 'value of life' in this context. The DfT's value per fatal casualty prevented figure is based on an estimation of the value which society is prepared to pay for a small reduction in the risk of being killed or injured[16]. It is the aggregate of individuals' willingness to pay for small risk reductions which will on average prevent one fatality. The WtP value is therefore **not** the value of saving a life, but that of a small reduction to a statistical risk (Jones-Lee, 1979). This differentiation is important. As Broome (1978) argues, most people are not prepared to accept any level of compensation for death, and so the value of preventing a fatality is not in fact the value that individuals would pay to save their own lives. The terminology used by the literature is the value of preventing a *statistical* fatality, or "**VPF**". Similarly, the value per non-fatal casualty prevented is the value of preventing a *statistical* injury, or "**VPI**".

This argument is highlighted by the Health and Safety Executive's risk document, *Reducing Risk, Protecting People* (HSE, 2001).

> "VPF is often misunderstood to mean that a value is being placed on a life. This is not the case. It is simply another way of saying what people are prepared to pay to secure a certain averaged risk reduction. A VPF of £1,000,000 corresponds to a reduction in risk of one in a hundred thousand being worth about £10 to an average individual. VPF therefore, is not to be confused with the value society, or the courts, might put on the life of a real person or the compensation appropriate to its loss."

Note that in the above example, a safety improvement which leads to a reduction in ex-ante risk of one in a hundred thousand for individuals in a group of a hundred thousand people may in reality prevent no deaths, or one death, or two deaths, and so on. However, the average or statistical expectation of the number of deaths prevented is one. Hence, the VPF of £1,000,000 is the value of prevention of one statistical fatality.

The remainder of this section is structured as follows. Section 2.1 summaries the DfT approach, Section 2.2 examines the component parts of the value per casualty prevented figures, and Sections 2.3 and 2.4 look at the additional component parts of the value per accident prevented figures. We also explain how the values are uprated over time in Section 2.5. Section 2.6 provides a summary table of the component parts of the value per accident prevented figures and their origins.

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[16] We note that the value to the public of preventing a statistical life is not the same as what is affordable in practice. The cost-benefit analysis into which the DfT figures feed does not necessarily provide any insight into whether a scheme is affordable. Because a number of the benefits are not monetisable, the scheme may not generate the funds to make it affordable even if benefits outweigh costs. Therefore, the valuation of a benefit should not be confused with the calculation of what is affordable for a government department given its budget constraints.

The summary presented in this section draws on the work of Hopkin and Simpson (1995).

2.1   Summary of DfT's approach

DfT's value per casualty prevented includes the value of lost output, ambulance and hospital treatment costs, and human costs based on a WtP approach.

The value per casualty prevented differs according to the injuries sustained, which are categorised as either:

- fatal, where death occurs within 30 days from causes arising out of the accident;

- serious, where casualties require hospital treatment and have lasting injuries, but do not die within the recording period for a fatality; or

- slight, where casualties have injuries that do not require hospital treatment, or, if they do, the effects of the injuries quickly subside.

As discussed earlier, the value per fatal casualty prevented is known at the VPF value, while the value per non-fatal casualty prevented (serious and slight casualties) is known as the VPI value.

In addition to the VPF and VPI values, DfT also provides a value per accident prevented. This differs from the value per casualty prevented as an accident may involve more than one casualty and more than one type of casualty, although it is classified according to the most severe casualty. Furthermore, a number of additional costs are included in the value of an accident; namely:

- material damage costs to vehicles and property;

- police costs; and

- insurance administration costs.

These values are reported in the Transport Analysis Guidance ("**TAG**"), a section of which has replaced the Highways Economic Note which originally reported these values (DfT, 2008).

An accident is classified as fatal, serious or slight according to the most severe casualty in the accident.

2.2   Overall casualty figure

As outlined above, the value per casualty prevented includes three key components: lost output, human costs, and medical and ambulance costs. We discuss each of these in turn.

Table 1 below shows the average value of prevention per casualty by severity and element of cost. The values in the table can be further combined in order to derive average values for the prevention of road casualties by type of road user, such as car occupant, bus occupant or motorbike rider. This is done by calculating the proportions of fatal, serious and slight casualties for each type of road user, based on road accident data, and using this to derive an average value.

Table 1: Average value of prevention per casualty by severity and element of cost

Injury severity	Lost output	Human costs	Medical and ambulance	Total
June 2007 £				
Fatal	556,660	1,080,760	970	1,648,390
Serious	21,830	150,180	13,230	185,220
Slight	2,310	10,990	980	14,280
Weighted[1] average, all casualties	11,200	39,300	2,350	52,850

Source: DfT 2008

[1] The average figure across all casualties is weighted by the relative proportions of fatal, serious and slight casualties from road accident data.

2.2.1   Cost of output component

The value of a prevented casualty includes a component to represent the value of loss in gross economic output due to injury or death. Gross lost output consists of the present value of expected lost earnings, as well as any non-wage payments from the employer such as national insurance contributions.

The methodology to derive gross lost output differs between fatal casualties and serious or slight casualties, as we now discuss.

Fatal casualties

For fatal casualties, lost output was determined by estimating expected future income for a number of age and gender groups. This was estimated in the following steps.

1. The average current income for each age and gender group was estimated by combining the average income of employees and self employed people. Income was assumed to include overheads and other non-wage payments such as National Insurance contributions.

2. An adjustment was made for activity rates. Since not all people within each group are actively making a contribution to the economy - for example the long-term unemployed - the average income for each group was multiplied by the activity rate[17].

3. Future income was estimated by calculating the stream of future income for each group (based on life expectancy tables). Future income was uprated by a two percent long term growth rate to take into account the long term growth of the economy. The uprated income was then

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[17] No adjustments are made for those in receipt of state benefits, meaning that the average income for each age group is not reduced to take account of those making negative contributions to the economy in terms of output.

discounted to factor in current income being worth more to an individual than future income. The discount rate used was the 6%Treasury rate which was in use at the time.

Road accident data for 1990 provided the number of fatalities in each age and gender group, so that the average lost output per fatality could be calculated.

We note that the 6% Treasury discount rate is no longer in use; this is discussed further in Section 3.2.3.

Serious and slight casualties

Levels of severity within each of the serious and slight casualty groups vary considerably. For example, a fractured finger and paraplegia are both categorised as serious. The serious and slight casualty groups were therefore subdivided into eight injury state subgroups according to characteristics such as extent and duration of pain, period of hospital treatment, recovery time and level of residual disability. This is the so-called Galasko classification (Hopkin et al., 1993).

The percentage distribution of these subgroups was then estimated, based on the results of statistical studies of police and hospital data as well as expert clinical judgement on likely recovery rates. A study was then carried out between 1990 and 1992 of a sample of casualties treated in the Manchester areas, which looked at actual recovery rates (ibid.). This was used to refine the initial estimated distribution.

Average lost output costs were then estimated for each subgroup. The surveys of road accident casualties treated in the Manchester area were used to estimate lost output using information on the number of days off work and the length of time to recover for each subgroup. An allowance was made for the casualties recorded by the police as slight who did not require hospital treatment. This was combined with average income per day, as described in the section on fatalities above, in order to estimate lost output for each subgroup.

Average costs were calculated across the serious and slight casualty groups as a whole by weighting the lost output costs per subgroup by the relative proportions of the different injury state subgroups within each group.

2.2.2   Ambulance and hospital costs

The second component in the value per casualty prevented reflects an allowance for medical costs, consisting of ambulance costs, hospital treatment costs, district nurses and state benefits.

For fatalities, ambulance costs and the cost of hospital treatment costs were estimated from 1984/1985 data provided by the Department of Health based on assumptions about the use of hospital facilities.

For serious and slight casualties, medical costs were estimated for each of the eight injury state subgroups. As described in Section 2.2.1 above, surveys were carried out in the Manchester area which involved 6-monthly interviews with patients for an 18 month or four year period, depending on the severity of injury. From these surveys, a level of use of medical facilities was estimated. This was then converted into costs based on the unit costs of providing each service in the Manchester

area or in England, depending on data availability. Costs were based on 1991/92 costs, and adjusted to 1994 costs using the health services cost index.

State benefits were based on the same Manchester area surveys, which examined the details of all benefits received by patients that were directly a result of their road accident.

2.2.3   Human cost component

The third component of the value per casualty prevented is the 'human cost' component, which again differs between fatal and non-fatal casualties.

Fatal casualties

For fatalities, the human cost component is derived from a WtP approach. We first describe the WtP approach, and then the subsequent derivation of the human cost component.

A WtP approach considers what people would be willing to pay to reduce the risk of being killed or injured in a road accident. The fatality WtP value is based on a 1997 survey (Carthy et al., 1999), where a representative group of 167 respondents were surveyed on how much they would be willing to pay to reduce the risk of death or injury in a road accident.

The WtP values provided by the respondents are assumed to include consumption, as the ability to consume goods and services is assumed to be taken into account by survey respondents as part of the enjoyment of life (Jones-Lee et al., 1985). This means that the total value of preventing a statistical fatality figure is comprised of the WtP value, medical costs and net output, where net output is defined as the excess of gross-of-tax lifetime output over and above lifetime consumption[18]. However, in order to allow comparison with some European countries still using the Human Capital approach[19], the overall VPF figure is presented with gross output as one of its components. This is simply the result of an "accounting" exercise. The following derivation is based on the argument developed in Jones-Lee and Loomes (2006), as follows:

VPF = WtP + net output + medical costs;

But since WtP includes consumption, and

Gross output = consumption + net output,

then

VPF = (WtP –consumption) + gross output + medical costs.

If we denote WtP less consumption as "**human costs**", then

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[18] Approximately 80 percent of the value of personal incomes is consumed, where consumption is taken to be the value of personal expenditure and also the value of government expenditure on goods and services (i.e. the proportion of personal income which is spent by the government in the form of taxation). This means that net lost output is equivalent to 20 percent of the gross figures (Reilly, 1992).

[19] The human capital approach is based only on the lost gross output.

> *VPF = human costs + gross output + medical costs.*

Essentially then, the value of "human costs" has not been built up as a separate estimate, but is derived from the WtP value less consumption.

Serious and slight casualties

The approach taken for serious and slight casualties is somewhat different. A WtP study conducted in 1991 (Hopkin and O'Reilly, 1995) was used to estimate the relationship between various injury states and death, and so uses the VPF as a peg to deduce a relative value for each injury state.

Specifically, a "Standard Gamble" approach was employed, whereby respondents were asked to compare a normal medical treatment for a given road accident injury with an alternative risky treatment. If successful, this alternative treatment would restore them to full health but if unsuccessful would leave them in a specified "worse" health state (sometimes death).

Respondents were presented with a range of possible risks of failure and success of the risky treatment, so that researchers were able to identify the level of risk where respondents were indifferent between accepting or rejecting the risky treatment. This was used to derive an estimate of the relationship between the two injury states, and thereby indirect estimates of the value of each injury state relative to the value of a fatality.

These relative valuations were not revised during the later 1997 study (Carthy et al., 1999). However, relative valuations for a limited number of the injury states were estimated as part of the 1997 study and were found to be broadly similar.

A variation on this approach was employed for some slight injuries. Slight casualties were divided into two groups: those suffering whiplash injuries, and those with other slight injuries[20]. The WtP values relating to whiplash injuries were estimated as outlined above for serious injuries. Other slight injuries were valued through a question which asked about the sum of money that would "just about make up for" an injury involving minor cuts and bruises with a quick recovery.

The total value per non-fatal casualty prevented was then obtained by summing together medical costs, gross lost output and the relative WtP value.

2.3   Costs relating to the wider accident

In addition to the value per casualty prevented, DfT also provides a value per accident prevented. The value per accident prevented includes further costs relating to the accident, such as:

- material damage costs to vehicles and property;

- police costs; and

- insurance administration costs.

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[20] The slight injuries listed here are characteristic of road accident injuries, and may therefore not be transferable into non-road contexts. We discuss this point further in Section 5.1.5.

These accident related costs were revised in 1994, based on research carried out by the Transport Research Laboratory (Hopkin and Simpson, 1995).

Note that accident costs do not include the time delays to other road users as a result of accidents. The DfT is currently developing software and guidance on how to assess the travel time implications of incidents, including accidents[21]. Initial guidance will be released in April 2009, with a view to including this aspect in project appraisals once the reliability model has been fully tested[22]. Although the value of the time savings associated with avoiding accidents is currently unclear, it may comprise a considerable part of the overall value per accident prevented and so should be incorporated into project appraisals as is currently planned.

Damage costs

Damage costs cover costs of damage to vehicles, third party property, excess, assessors' fees and payments made for hire of alternative vehicles.

In order to derive damage costs resulting from accidents of different severity - fatal, serious, slight and damage only accidents - and the number of damage only accidents relative to the number of injury accidents, a comprehensive survey of insurance claims dealt with by a major insurance company was carried out. This examined estimates of the cost of damage arising from accidents on different road types[23] and at different levels of severity. These were weighted by the number of accidents occurring on different road types to obtain an average by level of severity.

The average values thus obtained were adjusted to take account of accidents where no claim is made, as these tend to have lower costs. A national survey of car and van drivers (Taylor, 1990, quoted in Hopkin and Simpson, 1995) was used to provide these estimates.

Insurance administration costs

Insurance administration costs are based on the average handling costs per road accident claim, and were estimated from information provided by a number of insurance companies on the average cost per claim for different levels of severity. Data was gathered based on the average amount of time to process a claim, as well as an allowance for overheads and expenses. Not all accidents lead to a claim; therefore average administration costs by level of severity were also adjusted to take account of the proportion of accidents with no claim which will have no administration costs.

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[21] The current value per accident prevented does not include time savings as a result of avoided accidents because of the difficulties in deriving this measure; indeed, lost time after accidents is not included in the value per accident prevented in any European country (Bickel, 2005).

[22] Time savings as a result of accidents will ultimately be included in project appraisals under the reliability of travel time objective, rather than under the accident saving objective.

[23] These are motorway, built-up and non built-up roads. Built-up roads are those roads other than motorways with speed limits of 40pmh or less, while non built-up roads are those other than motorways with speed limits greater than 40mph.

It is noted that insurance administration costs represent minimum costs, as an accident may have more than one claim.

Police costs

Police costs are based on the average time spent by police officers and administrative staff on fatal, serious and slight accidents on different road types. These costs were estimated by a study of accidents dealt with by the Avon & Somerset Constabulary in the early 1990s. Serious and fatal accident costs were estimated through interviews with police officers, and supplemented by data from other sources such as police records and control logs. Police officers' time was then valued using the police ready reckoner. These figures were then circulated for review to a number of other police forces.

2.4   Average values per accident prevented

An accident may include more than one casualty, and more than one type of casualty. Using road accident data from the previous year[24], the average number and type of casualty associated with fatal, serious and slight accidents is calculated. This is done by road type and time (hours of darkness or hours of light). Accident related costs – police, insurance and damage costs – are then added on to provide the total cost per accident.

The following table shows the 2008 values per accident prevented, averaged across severity of accident. Damage-only accidents refer to accidents without casualties.

Table 2: Average value of prevention of road accident by severity and element of cost

£ June 2007	Casualty related costs			Accident related costs			
Accident severity	**Lost output**	**Medical**	**Human costs**	**Police costs**	**Insurance and admin**	**Damage to property**	**Total**
Fatal	624,190	6,310	1,232,800	1,920	300	11,320	1,876,830
Serious	24,940	14,940	169,700	250	190	5,130	215,170
Slight	3,070	1,300	14,620	60	110	3,060	22,230
Weighted average[1], all injury	15,240	3,200	53,470	110	130	3,460	75,610
Damage only				4	50	1,910	1,970

Source: DfT 2008

[1] The average figure across all injury accidents is weighted by the relative proportions of fatal, serious and slight accidents from road accident data.

The next table shows the values per accident prevented, averaged across severity and road type. Road accident data does not include data on damage-only accidents –as statistics on damage-only

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[24] The most recent value per accident figures are given in TAG (DfT, 2008); these are based on 2007 road accident data.

accidents are not generally reported to the police – so the ratio of damage to injury accidents outlined in Section 2.3 is used to estimate the number of damage-only accidents and therefore their contribution to average accident costs.

Table 3: Average value of prevention per road accident by severity and class of road

£ June 2007	Road class			
Accident severity	Built up	Non built-up	Motorway	All
Fatal	1,769,900	1,930,740	2,145,280	1,876,830
Serious	207,120	231,110	235,690	215,170
Slight	21,000	24,750	29,490	22,230
All injury	59,240	121,420	91,930	75,610
Damage only	1,840	2,720	2,620	1,970
Average cost per injury accident including an allowance for damage only accidents	91,810	142,640	111,810	104,900

Source: DfT 2008

2.5   Uprating over time

Sections 2.2 and 2.3 described the origins of each component of the value per accident prevented. These values are annually uprated to current figures based on real per capita economic growth and inflation (i.e. on nominal per capita economic growth). This is on the assumption that the real cost of each element of accident costs will rise in line with increases in GDP (or are proportional to average income). We discuss the validity of this assumption further in Section 3.2.3.

As described in Section 2.4, these components are combined together based on up-to-date road data to obtain an average value per accident prevented for each severity and road type, and time of day.

2.6   Summary of components

The table below summarises the discussion in this section by setting out the component parts making up the value per fatal accident prevented figure, the origin of each component and the contribution of each component to the total.

Table 4: Summary of components of value per fatal accident prevented

Component category	Component	Value (£ 2007)	Contribution to total	Origin
Casualty related costs	Lost output	624,190	33.26%	Estimated in the early nineties based on road accident data and national income distributions
	Medical	6,310	0.34%	Estimated through study of casualties treated in the Manchester area during the early nineties, combined with statistical studies of police and hospital data
	Human costs	1,232,800	65.69%	Derived from WtP values estimated during 1997 study
Accident related costs	Police costs	1,920	0.10%	Estimated through a study of accidents dealt with by the Avon and Somerset Constabulary in the early nineties
	Insurance and admin	300	0.02%	Estimated through survey of insurance companies in the early nineties
	Damage to property	11,320	0.60%	Estimated through survey of insurance claims in the early nineties

Source: DfT (2008) and Hopkin and Simpson (1995)

3   Critique of methodology

In this section, we first discuss some general shortcomings of the general WtP methodology underlying the DfT VPF and VPI figures in Section 3.1. We then discuss a second set of concerns in Section 3.2, relating to the specifics of the approach taken in estimating the DfT VPF and VPI figures.

3.1   Underlying Willingness to Pay methodology

Any transport appraisal requires a monetary measure of the value of safety, allowing safety improvement benefits to be valued consistently and explicitly against other costs and benefits in deciding on an intervention.

The WtP approach is one of the two generally accepted methods for valuing the cost of road accident fatality or injury, and considers what people would be willing to pay to reduce the risk of being killed or injured in a road accident. It has clear advantages over the alternative Human Capital approach, which focuses primarily on the economic value of lost output and neglects aspects of human cost such as pain, grief and suffering, as well as having the the disadvantage of allocating little value to those who are not economically active. A Human Capital approach was the standard approach used in the UK before 1988, when a WtP approach was adopted, and is still used in some EU countries.

There are three key methodological difficulties which affect a WtP approach. These are:

- the means of eliciting individuals' preferences;

- determining the value placed on a small reduction of risk; and

- aggregating individual willingness to pay.

We discuss these difficulties in turn in the following sections. Nevertheless, despite these methodological concerns, a WtP approach appears to offer the best approach currently available for valuing a reduction in risk of death or injury. As recognised by the European Council of Transport Ministers (ECMT, 2000), it is better to value the right thing imprecisely, than the wrong thing precisely.

3.1.1   Understanding individual preferences

It is generally accepted that government actions should be based on the needs of its citizens, and that these needs are reflected through individual preferences. A WtP approach accordingly tries to value the rate at which members of the public are willing to trade off safety against other things which might be purchased, so reflecting the preferences and attitudes towards risk of people who are likely to be affected by accidents.

However, eliciting these preferences creates methodological difficulties. There are two main approaches used to empirically estimate individuals' willingness to pay: revealed preference and contingent valuation approaches. Revealed preference approaches involve the identification of

situations where choices involve different safety consequences; for example, labour market studies which examine how people trade off income against physical risk, such as the wage premia expected for risky jobs. Contingent valuation approaches involve asking a representative sample of people more or less directly about the sums that they would be individually willing to pay for improved safety[25].

In general, revealed preference approaches are recommended by the Treasury Green Book (Section 5.31, box 10) over a contingent valuation approach, with contingent valuation only recommended where values cannot be inferred from revealed preference studies. However, a revealed preference approach depends on the separation of risk-related wage differentials from other factors influencing wage differentials. For example, a person may have chosen the job because it is close to home, rather than because of the nature of the risk/wage trade-off. Furthermore, some people appear to pick risky jobs because of some innate preference for risk, and hence will not seek a wage premium. This means that the revealed preference approach can be inaccurate, and also produces values which are highly variable. For example, studies in the US have produced VPFs of less than a million up to 16 million dollars (Wolff and Orr, unpublished).

Contingent valuation studies have therefore been relied upon in the UK. However, this approach has a number of weaknesses; some examples of its limitations are provided below.

- Individuals appear to have difficulty understanding and valuing small reductions in risk.

- An individual would need to value equally many small risks of the same size for the WtP approach to be accurate. However, it is argued that if an individual faces many small risks of similar magnitude, then she is likely to be prepared to pay a diminishing sum for the reduction of each successive risk because this makes her more aware of her overall budget constraint.

- Aggregating individuals' willingness to pay may not produce the social willingness to pay, as individuals may ignore external social costs.

- Willingness to pay does not necessarily imply ability to pay. Respondents' responses to hypothetical WtP questions may overstate what they would actually be able to pay[26].

- Personal experience may affect individuals' willingness to pay. There is some limited evidence that willingness to pay is increased if the persons surveyed has had an accident (ECTM, 2000).

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[25] There is a third approach, called "relative valuation". This approach takes an absolute monetary amount determined through contingent valuation – such as the DfT VPF value – and then works out the value of reducing other risks (such as the risk of a non-fatal accident) in relation to this absolute value. This is how the DfT VPI values are derived.

[26] We note that respondents are asked what they are willing to pay of their own money, although their responses will determine what is done with public money. This seems appropriate in as much as the needs of citizens determine government actions, and citizens fund government actions through their taxes. It is reasonable that government expenditure should reflect what citizens would on aggregate be willing to spend.

Of these concerns, the first two are the most significant, and we discuss them further in the following section.

3.1.2   Determining the value placed on a small reduction of risk

As discussed at the beginning of Section 2, a WtP value is not the value of saving a life, but that of a small reduction to a statistical risk. By aggregating enough small reductions across a population to add up to one statistical life, the value of preventing one statistical fatality can be derived.

However, individuals find it very difficult to appropriately understand and value small reductions in risk, to the extent that respondents often report identical willingness to pay for two risk reductions of considerably different size. Pilot work undertaken as part of the 1997 research work - which gave rise to the figure currently used by the DfT - suggests that this is not only because people find it hard to understand small risk changes, but also that any safety improvement is seen as a "good thing", which they typically value at a constant and relatively low amount regardless of the risk reduction (Carthy et al., 1999).

The research upon which the DfT value is based used an ingenious approach to mitigate the issue of respondents being unable to consistently value risks. In a "chained" approach, respondents were asked to compare one type of physical risk against another, without having to directly trade money off against risk.

Specifically, this involved a number of steps which we summarise below (see Carthy et al. (1999) for a full discussion of the methodology.)

1.   Respondents were asked questions regarding their willingness to pay for the certainty of a quick and complete cure for a certain non-fatal road injury, as well as their willingness to accept compensation for the certainty of sustaining the same injury.

2.   Respondents were then asked to trade off risk of the non-fatal injury against death. This was done by asking the respondent to suppose that they had been injured in an accident and two treatments were available:

   • Treatment A: If successful, this treatment will result in a return to the same state as the non-fatal injury in Step 1, but if unsuccessful will result in death with probability x.

   • Treatment B: If successful, this treatment will result in a return to normal health within 3–4 days, but if unsuccessful will result in death with probability y (greater than x).

   The objective was then to find the level of y for which respondents are indifferent between the two treatments for a given level of x. This allowed researchers to understand the willingness of respondents to trade off risk of the non-fatal injury against the risk of death. This is essentially a Standard Gamble approach, as described in Section 2.2.3.

3.   Researchers were then able to infer the respondent's implicit rate of trade-off of wealth against risk of death by using the value derived in step one.

Because the initial non-fatal injury was chosen to be a type that respondents could easily conceptualise, this allowed a more accurate initial value to be determined. The later steps all involved the comparison of the risk of one injury against another (i.e. the risk of the non-fatal injury against risk of death) rather than asking respondents to directly value a reduction in the risk of death. This approach was perceived as more manageable by respondents, and led to responses showing more sensitivity to changes in risk.

Effectively, this approach entailed asking respondents to value certainties of injury, and then trade these off against very significant probabilities of death, rather than just focussing on a small reduction in statistical risk. However, the VPF figure is intended to represent the value of reducing a very large number of low probability risks to many people, which together add up to a saving of a life. Estimating the value of reducing a risk of high probability would only provide the same answer if individuals are linear in their attitudes to risk; that is, if reducing a small risk is worth £x to an individual, then reducing a risk a thousand times as great must be equal to £x times a thousand.

Various authors have argued that human risk preferences are not linear in this way. Kahneman and Tversky (1979) demonstrated that individuals have a systematic tendency to overestimate the likelihood of very low-probability events, and underestimate the likelihood of high-probability events. Asking individuals what they are prepared to pay to reduce a single large risk may therefore provide a different estimate than asking them what they are prepared to pay to reduce many small risks, even if these add up to the same probability as the large risk.

However, Wolff and Orr (unpublished) note that it is impossible to determine the extent to which this is actually true. Given the difficulties involved in valuing small risk reductions, it is impossible to compare the values people would have put on reducing small risks with those they put on the reduction of a large risk. It is therefore impossible to determine the extent to which the approach underlying the DfT figures has inflated the WtP value.

We note that this chained approach has been used elsewhere, but only to a limited extent. To our knowledge, this methodology has been employed in a survey carried out in New Zealand (Guria et al., 2005), and in a study for the Department of Health and NICE (Baker et al., 2008), as well as in a three-year study into VPFs for children and adults funded by the European Commission[27].

3.1.3   Aggregation of individual Willingness to Pay values

A WtP approach aims to estimate the value of a small risk reduction, which when aggregated together with a large number of similar small risk reductions adds up to a statistical life. This creates the challenge discussed in Section 3.1.2, that it is difficult to obtain estimates of the value of small risk reductions. It also creates a further difficulty: that for this to be accurate, an individual must value equally a series of small risks of the same size.

However, Wolff and Orr (unpublished) argue that if an individual faces many small risks of similar magnitude, then she is likely to be prepared to pay a diminishing sum for the reduction of each successive risk. This is because the opportunity cost of what she is foregoing increases with each successive risk, on the assumption that people give up first what they care about the least.

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[27] See www.oecd.org/env/social/envhealth/verhi for more details.

Effectively, asking an individual what she is prepared to pay for a combination of reduced risks makes her more aware of her overall budget constraint.

Similarly, even though an individual may be prepared to separately pay x for a risk reduction in one area and y for a risk reduction in another area, she may not be willing to pay as much as x and y for both risk reductions together. In order to obtain a better understanding of the value of both risk reductions together, the individual should be asked about her willingness to pay for the entire package rather than simply aggregating the two separate WtP values.

Extending this argument to all health and safety measures provided at a government level implies that the government should ideally seek to understand the values of package of risk reductions together, rather than adding up individual values per risk reduction. Without this, health and safety may be over-supplied, relative to genuine public preference (ibid.). There are currently almost no studies which attempt to do this, due to the methodological challenges of such an approach[28].

Nevertheless, even though reductions in risk may be over-valued, the WtP values still allow projects offering different levels of risk reduction to be compared against each other and prioritised within a set budget constraint.

3.2   Derivation of the DfT's VPF and VPI values

Having examined the shortcomings of the WtP approach in general, we now discuss some specific concerns relating to the derivation of the DfT's VPF and VPI values.

Out of the total value per casualty prevented as well as per accident prevented, the WtP component makes up the largest part. For example, the 1997 figure per casualty prevented was estimated as approximately £1 million, with net output costs and medical costs making up only £65,000 of this value. It is therefore worth examining in more detail a key issue affecting the magnitude of the WtP value used in the DfT VPF and VPI figures – the aggregation of individual preferences. We also examine some issues relating to the age of the respondents in the WtP sample and the impact this has on the applicability of the WtP value to different road interventions.

Since the DfT values were based on research carried out more than ten years ago, it is also worth looking at whether the values remain appropriate over time.

3.2.1   Aggregation of individual preferences in the WtP survey

Research was carried out in 1997 to estimate individuals' willingness to pay to reduce the value of death in a road accident (Carthy et al., 1999). This was intended to improve on the value then used by the DfT, which was a consensus estimate based on earlier studies.

The survey resulted in the estimation of a WtP value for each respondent in the survey. However, the range of individual responses was very diverse, and these then needed to be aggregated in

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[28] Wolff and Orr (unpublished) do however point to work done by Costa-Font and Rovira (2005), which presented a variety of healthcare programmes to respondents and asked them to assign an amount out of a fixed budget to each programme.

order to derive an average overall WtP value. There are two main approaches to aggregation: using the mean value or using the median value[29]. The choice of either of these has substantial bearing on the final aggregated value.

Typically, responses from WtP studies are right skewed (Wolff and Orr, unpublished), since a higher income has been shown to increase the willingness to pay and the income distribution of most populations is right skewed. Since the sample chosen for the 1997 study was selected to be representative of the national socio-economic structure, the sample distribution from the 1997 study was considerably skewed to the right, as would be expected. This meant that while the median value was in the region of £500,000 – since the willingness to pay of the majority of respondents was close to £500,000 – the figure based on the mean was in the £1,000,000 to £1,500,000 range. The choice of mean versus median therefore had significant impact on the value per casualty prevented.

There is no clear answer to which approach to use. Some commentators have argued that using the mean value puts more weight on the high values of a minority of individuals rather than on the lower values of the majority. Additionally, people's responses to hypothetical willingness-to-pay questions may overstate what they would actually be prepared to pay, which would suggest giving weight to the median response which tends to be lower. However, an opposing argument holds that more emphasis should be placed on mean responses as these represent aggregate willingness to pay for safety and maximum aggregate welfare, which may be most appropriate as road safety is paid for out of the public purse.

There are no theoretical grounds for preferring either of these options. The choice of option is rather a policy decision, albeit one which has significant impact on the final value.

Furthermore, the treatment of outliers also had a considerable impact on results. Out of the sample of 167 respondents, 16 respondents gave values effectively equal to infinity (i.e., they would be willing to pay an infinite amount to reduce the risk of death in a road accident). A further two respondents gave values above £15m. By including these responses, the average WtP value is technically infinity.

In addition to the aggregation issue discussed above, the small size of the sample is also worth noting. The WtP survey was intended to provide an approximation of society's valuation, based on the responses of a sample of the population. However, the survey used a relatively small sample of 167 individuals, which may have reduced the representativeness of the final estimate. There is clearly a trade-off between representativeness and cost, as a WtP survey is time-consuming and expensive, requiring lengthy one-on-one interviews to ensure respondents are able to provide answers which fairly reflect their preferences.

3.2.2   Age-based concerns

The DfT VPF figure is based on the willingness to pay of a group of respondents who are representative of the age demographics of the UK population. The question therefore arises as to

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[29] The mean is the average value while the median refers to the middle value of an ordered set of values

whether this is appropriate in the case where an intervention is targeted at a group which does not fit this profile.

For general road safety interventions, it is not necessarily clear that a particular group will benefit from the intervention, as the road user population is not markedly different from the average UK population. However, if an intervention were skewed towards a particular segment of the population (for example, a speed-reducing intervention which would reduce the risk associated with drivers who tend to speed more than average, such as younger men) the correct approach would be to assess how society as a whole values reducing the risk to this particular group. However, there is currently no well-justified methodology for estimating how one person is prepared to spend his or her own money for the benefit of others (Wolff and Orr, unpublished). What limited evidence there is suggests in fact that people are willing to pay very little for anyone outside of their immediate family, which would imply that relying on willingness to pay values estimated in this context would lead to socially suboptimal spending on health and safety.

In the absence of a means of estimating how society values risk reductions for others, an approach could be to use the willingness to pay to reduce risk of those affected as a proxy; in other words, estimate the willingness to pay of a sample who is representative of the targeted segment. However, to continue with our earlier example, suppose that younger men have a much higher (or lower) willingness to pay than the average individual. Since taxpayers' money is funding the safety intervention, it is surely not reflective of society's preferences to pay more (or less) to reduce the risk of death than the average willingness to pay of the population at large. In any case, there is a lack of clear evidence of how willingness to pay varies with age. For example, it is not clear that older people put a proportionally lower value on life than younger people. Studies (Sunstein, 2004, Anderson and Treich, 2008, both quoted in Wolff and Orr, unpublished) suggest that there is neither empirical nor theoretical support for the claim that elderly people will pay less to preserve their lives than younger people.

Moreover, current policy is not to allow for age-related differences[30]. For example, paragraph 4.26 of the HM Treasury appraisal guidance document, Managing Risks to the Public (H.M Treasury, 2005) states: "Adjustments to the benchmark willingness to pay value above should not be made for old age alone."

In summary then, it is not clear how in practice a VPF that varies with the age of the group targeted by the safety intervention might be estimated. There appears to be no policy support for allowing differentiation due to age, although a possible exception is in the case of children, which we now consider.

Age-based adjustment for children

Society might be willing to spend more to reduce risks to children, potentially because children are less able to take rational decisions about risk and so may justify more safety interventions (HM Treasury, 2005). However, converting society's preferences relating to children's safety into a VPF is subject to the same difficulties as for any other particular target group. Estimates may be further

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[30] An exception may be made for children; see the discussion at the end of this section.

distorted by what Jones-Lee and Loomes (2006) refer to as the "I'd pay anything to protect my children" type of 'virtuous' response.

Equally, understanding children's own preferences is highly challenging. Children are not necessarily even able to express their own preferences, either through an inability to make judgements about risk-wealth trade-offs or through a lack of an independent budget (ibid.).

HM Treasury guidance acknowledges that there is insufficient evidence to support a particular adjustment to the VPF in the case of children (HM Treasury, 2005). What little evidence does exist suggests that adults are not willing to pay much more for children than they would for themselves (Leung and Guria, 2006). Given the lack of supporting evidence, any premium on a VPF relating to children would therefore need to be justified on policy grounds alone.

3.2.3   Uprating of the VPF and VPI figures

The components of the value per accident prevented (casualty-related costs and accident-related costs) have been uprated to current prices based on real per capita economic growth and inflation. This is on the assumption that the cost of each element of accident costs will rise in line with increases in GDP.

However, the components of the DfT values are at least twelve years old, and some date back to the early 1990s. The question therefore arises as to whether the underlying values remain applicable over time, so making an uprating approach based only on increases in GDP appropriate.

In general, extensive research went into the determination of each cost component. For example, as described in Section 2.3, the process of estimating ambulance costs and the cost of hospital treatment involved surveys consisting of six-monthly interviews with patients for an eighteen month or four year period. Similarly, police costs were estimated through extensive interviews with police officers, as well as being supplemented by data from other sources such as police records and control logs.

It is not clear whether the underlying structure of costs determined through these studies – for example, police time per claim, treatment required for a subcategory of injury or life expectancy assumptions used to calculate lost output – have changed sufficiently in the intervening years to materially impact the results. Repeating the exercises may therefore be very costly for little additional benefit. Before a full revision of the studies is undertaken, it would be sensible to conduct limited tests of some of the underlying cost structures to determine whether these are still appropriate.

However, the associated unit costs may have changed more fundamentally than has been captured by nominal per capita GDP growth. For example, while in general medical costs have risen faster than overall GDP growth, the unit costs associated with a particular type of treatment may even have fallen over time. Even if the underlying cost structures determined through the original studies are retained, it may still be a worthwhile exercise to revise the associated unit costs.

Furthermore, there have been changes to the guidance provided by central government which will have an impact on the cost estimations underlying the DfT VPF and VPI figures. In particular, the

revised Green Book guidance released in 2003 changed the real discount rate from 6% to 3.5%. However, the original estimations of the cost of net lost output used the 6% rate, thus placing a lower value on future earnings. We suggest re-estimating lost output costs with the current 3.5% discount rate. This will have the effect of increase the value of net lost output and so increasing the VPF and VPI figures, although this increase is unlikely to be substantial.

4   Practical application in a highways context

In this section, we examine how the DfT VPF and VPI values are used in practice in a highways context, for both major and smaller highways schemes. In particular, we are concerned with the importance of the DfT's values compared to other factors in cost-benefit analyses, how the associated risk reduction resulting from an intervention has been determined and the evidence from the post-scheme evaluation process.

4.1   Description of appraisal process

Only appraisals of road projects using DfT funding are reviewed by the DfT; these consist of Highways Agency schemes and a small proportion of local authority schemes. The majority of local authority schemes are funded internally through the Local Transport Capital Settlement from central HM Treasury, and therefore are not submitted to the DfT for approval. Those which are financed by the DfT are generally major project bids with values of £5m or more.

The project appraisal follows the following key stages.

- **Appraisal development**. The scheme appraisal is developed by the project sponsor within the Highways Agency or local authority. For larger Highways Agency schemes, a private contractor is generally commissioned by the Highways Agency project sponsor to prepare part or all of the analysis underpinning the appraisal. For smaller schemes, the local Managing Area Consultant[31] ("MAC") will generally take a leading role in both the strategic development and appraisal of the scheme. Similarly, it is common for local authorities to commission private sector transport consultants to prepare the scheme appraisal.

- **Initial certification by the DfT or the Highways Agency.** Once the scheme appraisal has been submitted by the project sponsor, it is scrutinised by either the TAME team (Traffic Appraisal Monitoring and Economics) within the Highways Agency, or by the ERLT team (Economics of Regional and Local Transport) within the DfT. This stage of the process is designed to ensure that the scheme appraisals are compliant with DfT guidance, that the correct modelling has been undertaken and that the scheme complies with wider policy considerations such as deliverability. For Highways Agency schemes, the ITEA team (Integrated Transport and Economics) conducts a further review to ensure that the appraisal is prepared and presented consistently with TAG guidance, and once satisfied carries out a value for money assessment.

- **Second stage review by the DfT**. The TAR (Transport Analysis and Review) team within the DfT conducts a second stage review of the value for money assessments. This is designed to ensure consistency across all DfT and Highways Agency scheme appraisals, and to approve the value for money assessments.

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[31] The highways network is divided into fourteen areas, each of which is associated with a Managing Agent Contractor. The MAC is a private company which partners with the Highways Agency; its roles include taking a degree of responsibility for highways management, undertaking routine maintenance and having input into the strategic planning of maintenance needs, design and whole life costing of maintenance plans.

- **Post-project evaluation.** Completed Highways Agency schemes in excess of £10,000[32] are evaluated through the Post Opening Project Evaluation ("**POPE**") process. The POPE process examines two types of schemes: Major Schemes, costing greater than £5m, and Local Network Managements Schemes ("**LNMS**"), which cost under £5m and are improvements of existing routes which do not involve the construction of new roads or bypasses.

4.2 Quantification of impact of intervention on risk

Determining the impact of an intervention on the number and severity of road accidents is a key part of project appraisal. The approach taken to estimating the impact of the intervention is intended to be proportionate to the cost of the intervention, so differs between major and smaller highways schemes. The requirements outlined below are taken from the TAG guidance provided by the DfT (2008).

4.2.1 Major highways scheme

A computer programme called COBA is used to determine the impact of an intervention on the number of accidents and casualties. COBA contains established parameters, maintained by ITEA, for the number of accidents of different degrees of severity per million vehicle-kilometres on different types of road. This requires details of the average accident severity split[33] and the proportion of fatal, serious and slight accidents on different types of road, which is based on 1999-2001 road data. Since accident rates and severity have been reducing over recent years and the trend is expected to continue (DfT, 2004), the data is adjusted by 'accident rate change coefficients', which account for trend reductions in the rate and severity of accidents over time.

The user is required to enter a number of inputs into COBA, such as local data for three to five years preceding the assessment, and COBA will assess the impact on accident numbers and severities using its inbuilt assumptions. Changes in the number of vehicle kilometres (i.e. the flow rate), the length of the road, as well as changes in the type of road and in the number and type of junctions resulting from the intervention all affect the number of accidents.

Once the change in the number of accidents resulting from the intervention has been calculated, COBA uses the values per casualty and accident prevented to value the safety benefits associated with the intervention. The same data is used as is reported in TAG, with the difference that COBA uses a finer disaggregation of road categories and also details junctions separately.

COBA is freely available to project appraisers, who can obtain the software for a minimal handling charge from the Transport Research Laboratory. Extensive guidance is also available online. The level of familiarly with the programme among project appraisers is relatively high, since COBA has been in operation for thirty years. However, COBA is designed for looking at large road schemes, and requires users to enter large amounts of data, particularly relating to traffic flows. Gathering data on historic flows and determining the impact of the scheme on traffic flows can be complex

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[32] Approximately 15% of schemes costing under £5m are under £10,000.

[33] The number of fatal, serious and slight casualties per accident

and require extensive modelling, so COBA is not generally used for smaller highway schemes. We now discuss alternative approaches to quantifying risk for smaller schemes.

4.2.2   Smaller highways scheme

Although smaller highway schemes are not required to inform their cost benefit appraisals through data from COBA, DfT guidance (2008) requires that a similar methodology be taken to estimate the impact on number and severity of accidents brought about through the intervention.

The number of accidents before and after the intervention should be estimated. If possible, these should be broken down by accident severity, where there is data available on the number of fatal, severe and slight accidents for the part of the network under consideration. However, as mentioned in Section 4.3, there is usually insufficient data to support a robust forecast of the future severity mix, so DfT guidance is to use the average value for all injury accidents in this case.

Guidance requires project appraisers to collect data on the number of accidents before the intervention, and then estimate the likely number of accidents after the intervention. This requires the identification of the type of accident the intervention is expected to address (such as accidents caused by skidding), and then the percentage reduction expected in the specified accident type resulting from the intervention.

Project appraisers use a variety of approaches to estimate this expected percentage reduction, including expert judgement, analysis of local data, and experience of reductions resulting from similar local schemes. Additionally, guidance is available to help project appraisers estimate the impact of the intervention. One such database is held by a consultancy, GreenSafe[34]. Called UK Morse, this database offers free access to safety practitioners on a reciprocal basis; that is, if they are prepared to load data from their projects into the database for others to use.

No DfT or Highways Agency-sanctioned alternative database currently exists[35]. Although some Highways Agency contractors make use of the GreenSafe database, the Highway Agency has not officially signed up to it due to concerns around being seen to favour a particular consultancy as well as issues around data formats. The Highways Agency is investigating options for making the results of post-scheme evaluations available to scheme appraisers to assist them in estimating accident reductions, but this is still in the planning stage. There are concerns around the currently limited sample size for some types of project, which may be misleading to project appraisers hoping to use this information to inform their assumptions around average expected reductions in accident rates. Collecting this data in one location and making it available to project appraisers would seem sensible, provided appropriate caveats were made regarding limitations of sample size.

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[34] Available at http://www.greensafe.co.uk/morse.html

[35] A database called Molasses which held such guidance was previously maintained by the DfT. However, it appears to have been allowed to lapse during the transfer of responsibilities from the DfT Road Safety Department to ITEA in the late nineties.

4.3   Use of DfT values in project appraisal

The DfT VPF and VPI values are applied directly to the estimated reduction in accidents from an intervention in order to calculate the monetary value of these benefits. Where possible, the values per fatal, serious and slight accidents corresponding to the relevant road type are used. However, for many smaller schemes there is often insufficient data to support a robust forecast of the anticipated severity mix or time of accident. In this case DfT guidance is to use the average value for all injury accidents corresponding to the relevant road type.

We examined at a high level a small sample (four) project appraisals to understand the use of the DfT values. These consisted of a major scheme, two large LMNS schemes and one smaller LMNS scheme. We observed that the appraisal process laid out by the Highways Agency would appear to have been consistently followed in these appraisals.

Predicted accident savings are presented in the Project Appraisal Report ("**PAR**"). A PAR is a mandatory requirement for all Highways Agency construction projects, which provides information on all costs and benefits relating to a project. Safety is only one of the aspects covered by the PAR, which other sections covering economy, environmental and accessibility aspects. The safety coverage of a PAR consists of two key sections, which we now discuss.

Historic accident data is entered into the **Background Traffic and Accidents Data** page of the PAR for at least the previous three years and preferably the previous five years, consisting of the annual number of accidents and casualties of the different severities.

In the **Worksheet for Safety** page, the predicted number of personal injury accidents saved in the opening year is estimated (the basis on which this prediction is made was explained in the previous section). The PAR then automatically applies the correct value per accident prevented. This is an average value across all injury accidents, and depends on the road type and time of day. The value used is taken from COBA, and is the same data as is reported in TAG, with the difference that there are a finer disaggregation of road categories. Based on the traffic growth entered elsewhere in the PAR, the accident benefits for the lifetime of the scheme[36] is then automatically calculated.

If COBA analysis has been undertaken, the Worksheet for Safety page also contains the results of the COBA analysis relating to the accident impact of the proposal on the number of personal injury accidents saved as well as the impact on fatal, serious and slight casualties. COBA automatically calculates the associated benefits of these prevented accidents, which must also be included.

However, no COBA analysis is provided for any of the LMNS appraisals we examined – and we understand for most LMNS in general – due to the large quantity of underlying data on aspects such as traffic flows which COBA requires. In this case, the appraiser is expected to include reference data to support the prediction relating to the number of personal injury accidents saved. In the appraisals we examined, this generally took the form of a detailed description of the accidents which had previously occurred in the locality, and assumptions around the proportion of these accident which may be prevented by the proposed scheme.

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[36] The default scheme lifetime is sixty years.

The length of time required to complete a PAR varies widely depending the project type and amount of supporting material required. The process to complete a PAR is in itself not onerous, but the process of collecting the supporting information may include a safety study, a modelling exercise to determine traffic flows and potential impact of the scheme on traffic movement and environmental assessments, which can take several months. In particular, it is common for a stand-alone safety assessment to be carried out, which may later be used as supporting evidence for a PAR.

4.4   Relative importance of DFT value in scheme appraisal

The importance of safety benefits (as quantified by the values per accident prevented figures) relative to other benefits is variable, and tends to be related to the size of the project. We confine our discussion here to Highways Agency projects, as these comprise the majority of schemes assessed by the DfT.

Safety benefits associated with major highway schemes are generally a small proportion of total benefits. They are usually outweighed by time saving benefits, as any safety improvements associated with major highways schemes are usually as a result of measures to reduce congestion[37]. This is also partly because many of the "big win" schemes in terms of safety improvement have already been implemented; the majority of accidents now occurring on major roads tend to be due to random, human error-related factors which are difficult to avoid.

Figure 2 below shows safety benefits as a proportion of total benefits for major highway schemes, taken from a Highways Agency draft meta-data report into major schemes evaluated over the past five years (Highways Agency, unpublished). It demonstrates that safety benefits make up a relatively small proportion of total benefits for most schemes. Figure 3 shows overall averages: the average predicted split of predicted benefits between travel time savings and accident savings was 78% from travel time savings and 22% from accident savings. This varied by type of scheme, with bypass schemes being forecast to derive an average of 26% of their benefits from safety impacts.

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[37] For example, accidents at junctions on motorways are often as a result of cars queuing to leave the motorway; improvements to the junction therefore reduce accident rates by reducing congestion and speeding up the passage of cars off the motorway.

Figure 2: Safety benefits as a proportion of total benefits for major schemes
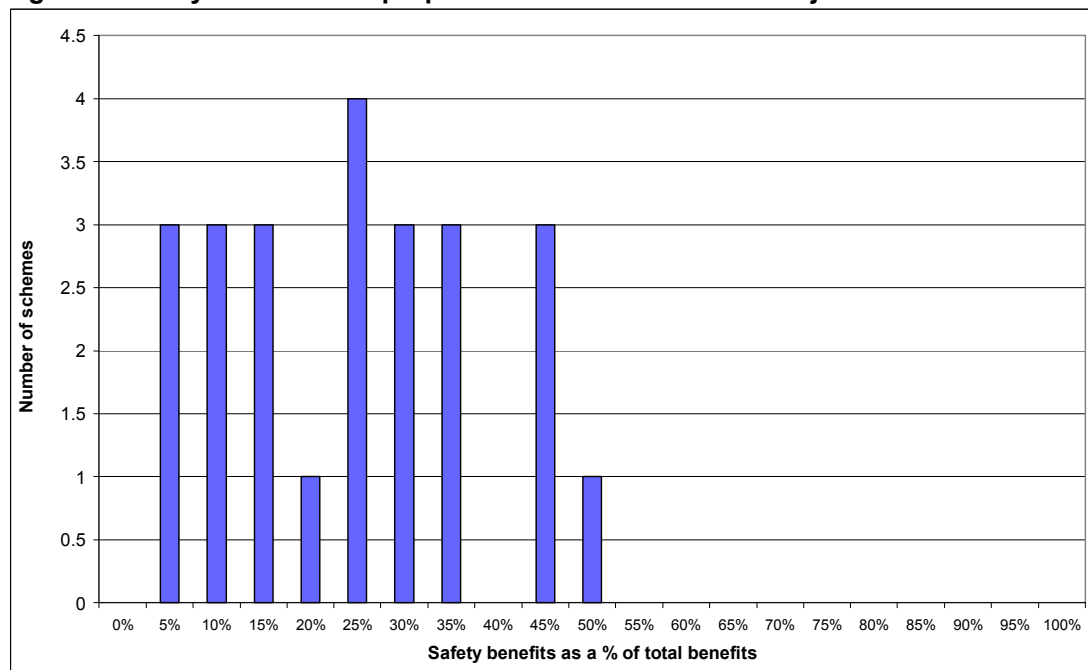
Source: Highways Agency, Draft Meta-data report into major schemes

Figure 3: Average benefit split by major scheme type
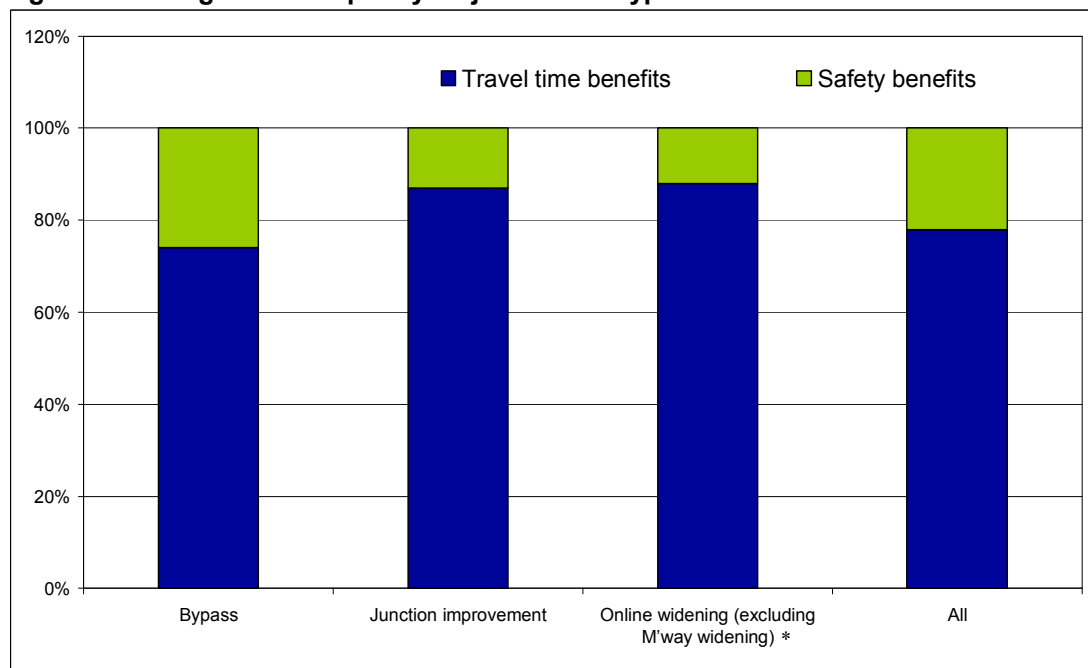
Source: Highways Agency, Draft Meta-data report into major schemes
* Online widening refers to widening of existing roads

The smaller LMNS schemes are separated into "safety" or "economy"[38] schemes, depending on the intention of the intervention. As expected, the majority, if not all, of the benefits relating to safety LMNS schemes are safety benefits. For economy LMNS schemes, safety benefits generally make up a far smaller proportion of total benefits. Figure 4 and Figure 5 below show predicted safety benefits as a proportion of total benefits for 38 economy and 289 safety LMNS schemes, respectively. The schemes where more than 100% of benefits are safety benefits reflect negative time benefits from increases in journey time brought about by the scheme.

Figure 4: Safety benefits as a proportion of total benefits for LMNS economy schemes
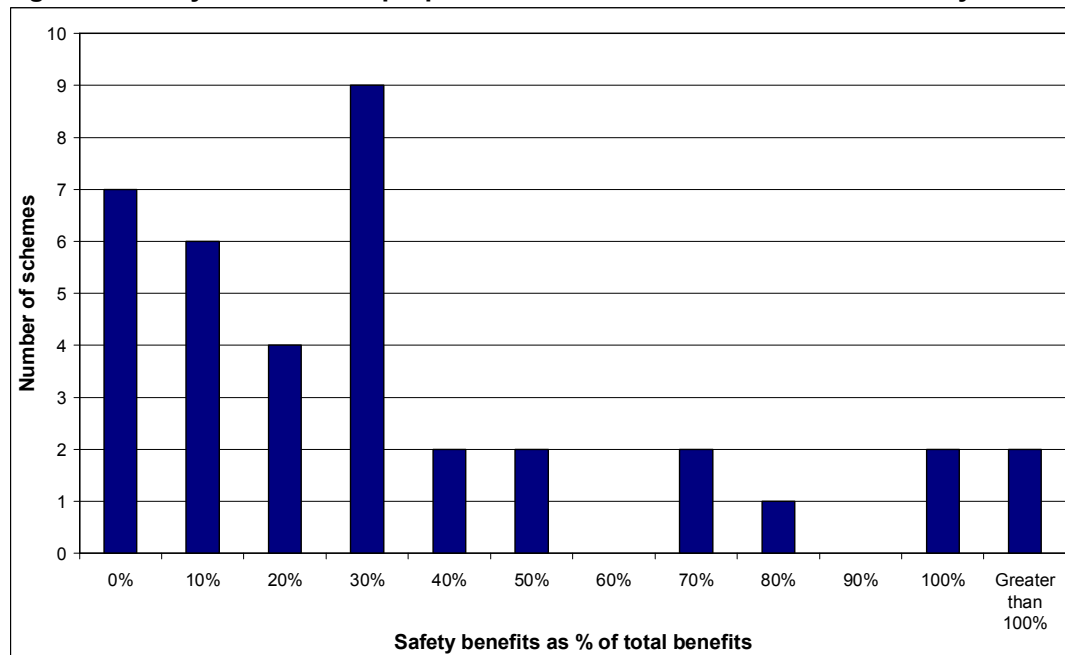
Source: Highways Agency
*Safety benefits which are greater than 100% of total benefits occur when other benefits are negative; for example if journey time increases as a result of the scheme

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[38] Benefits associated with economy schemes include aspects such as reliability, time saving and wider economic benefits.
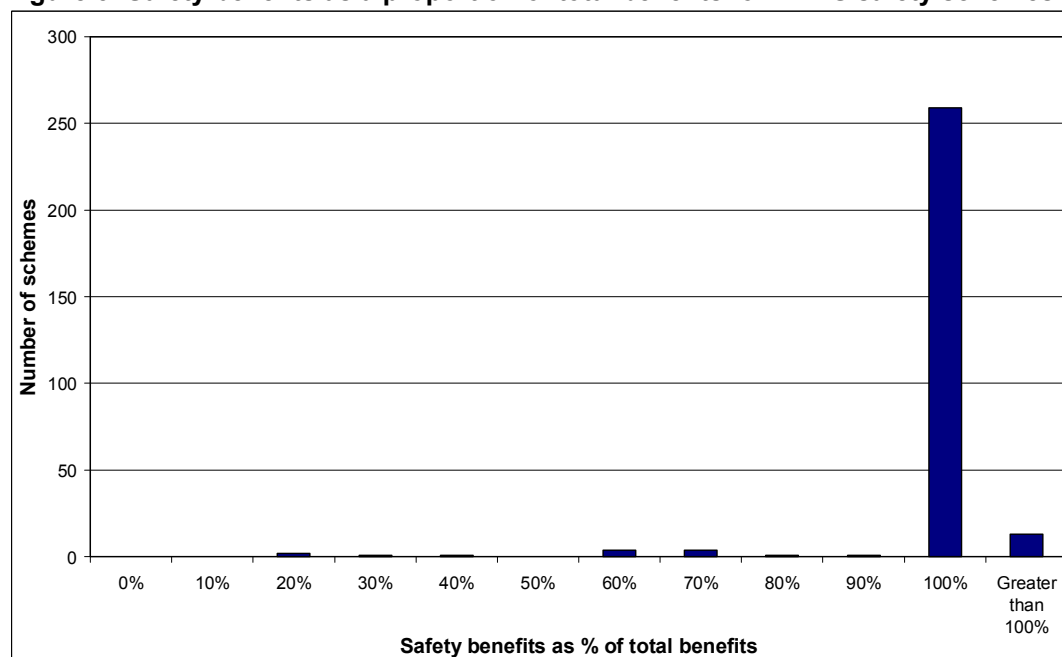
Figure 5: Safety benefits as a proportion of total benefits for LMNS safety schemes

Source: Highways Agency
*Safety benefits which are greater than 100% of total benefits occur when other benefits are negative; for example if journey time increases as a result of the scheme

Safety and economy schemes compete against each other for a set pool of funding. Where safety is the key determinant of the scheme's benefit, the value of the DfT VPF or VPI estimates can be critical in determining the ranking of the scheme relative to other schemes which have additional economy benefits.

However, value management guidelines (Highways Agency, 2007) are provided by the Highways Agency to assist in the appraisal of projects. These specify a scoring method for awarding an intervention a value management score, and provide relative weightings for different types of benefits. The relative weightings are informed by judgement. This means that an assessment of the relative importance of VPF and VPI values on project appraisals should not be taken independently of an analysis of value management scores.

4.5   Evidence from post-project evaluation

POPE is part of the process by which the Highways Agency monitors the performance of major highway schemes and LMNS. Atkins, a transport consultancy, has been appointed to provide technical analysis of completed highways schemes and advise on improvements to the appraisal process[39].

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[39] Atkins has been separately commissioned to examine major schemes and LMNS. The first phase of the contracts ran from 2000 to 2005, and now both commissions are in the second contract period which finishes in August 2009. A third phase has already been let for major schemes, running to 2011, and the Highways Agency is intending to let a similar third phase for LMNS.

The evaluation process differs between major schemes and LMNS. The reporting process for major schemes comprises:

- a "Before Study", whereby data is collected immediately prior to construction to provide a baseline against which to assess the impact of the scheme;

- one-Year and Five-Year After reports, which are full safety and environmental evaluations conducted one year and five years after scheme opening; and

- a "POPE-E" assessment, which is an assessment of the other transport objectives such as environment and accessibility

The reporting process for LMNS schemes is less involved, and usually consists of only a single report addressing primarily the safety and economic impact of the scheme (Highways Agency, 2007a).

Around 28 major schemes have been evaluated so far, and around 380 LMNS (Highways Agency, 2008).

The POPE process has found that the safety benefits from LMNS are generally underestimated, with average outturn safety benefits being 16% and 49% higher than predicted for small and large LMNS, respectively (Highways Agency, 2008)[40].

The overall underestimation of safety benefits hides significant variability at an individual scheme level. Figure 6: Comparison between prediction and outturn safety benefits for LMNS below shows the predicted versus outturn benefits for LMNS. The one-to-one line (where predicted benefits equal outturn benefits) is shown. In general, the figure shows a fairly high level of correlation between the predicted and outturn benefits. Despite this, it is apparent that there are a number of outliers, where predicted benefits are significantly higher or lower than outturn benefits.

Corrected predicted benefits, rather than predicted benefits are shown as these can be compared on a like-for-like basis. The POPE evaluation summary (Highways Agency, 2008) has suggested that the appraisal of benefits emerging from a scheme are not as accurate as cost predictions, as it was necessary to make a significant number of corrections to the PAR benefit values. A common correction was where it was not possible to replicate the 'before' accident data in the appraisal, in which case the POPE evaluation calculated a corrected number of accidents based on the same criteria in terms of geographical area and accident types.

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[40] We note the caveat that this result is based on only one year of post opening accident data, not the three years required for major schemes.

Figure 6: Comparison between prediction and outturn safety benefits for LMNS
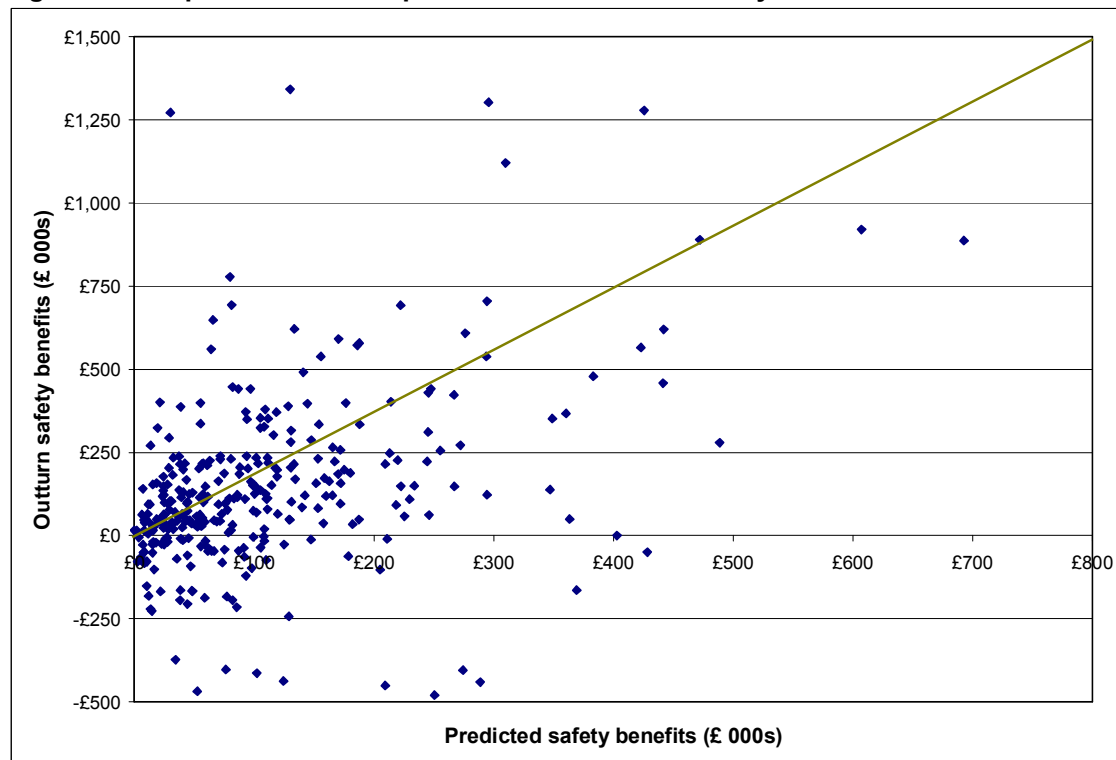
Source: Highways Agency

For major schemes, the reverse is true, with the total level of savings from accident reduction being 27% lower than predicted after the first year of evaluation. A possible explanation is that it takes time for the full accident benefit of the scheme to accrue, and so the full level of accident savings may not appear in data collected in the first scheme year. Additionally, incorrect predictions of traffic flow may have led to lower than predicted outturn accident benefits. The improved accuracy of predictions for smaller schemes could be a consequence of the greater appraisal complexities associated with larger schemes, although it must be noted that only 28 major schemes have been evaluated so far and this result could be due to the small sample size and statistical variance.

A comparison between predicted and outturn benefits by scheme is shown in Figure 7 below. Again, the one-to-one line shows where predicted benefits are equal to predicted costs. Although most schemes are close to this line, there are a number of outliers. In particular, there are a number of outliers where predicted benefits are considerably lower than outturn benefits (those in the bottom right hand section of the figure).

Figure 7: Comparison between prediction and outturn safety benefits for major schemes
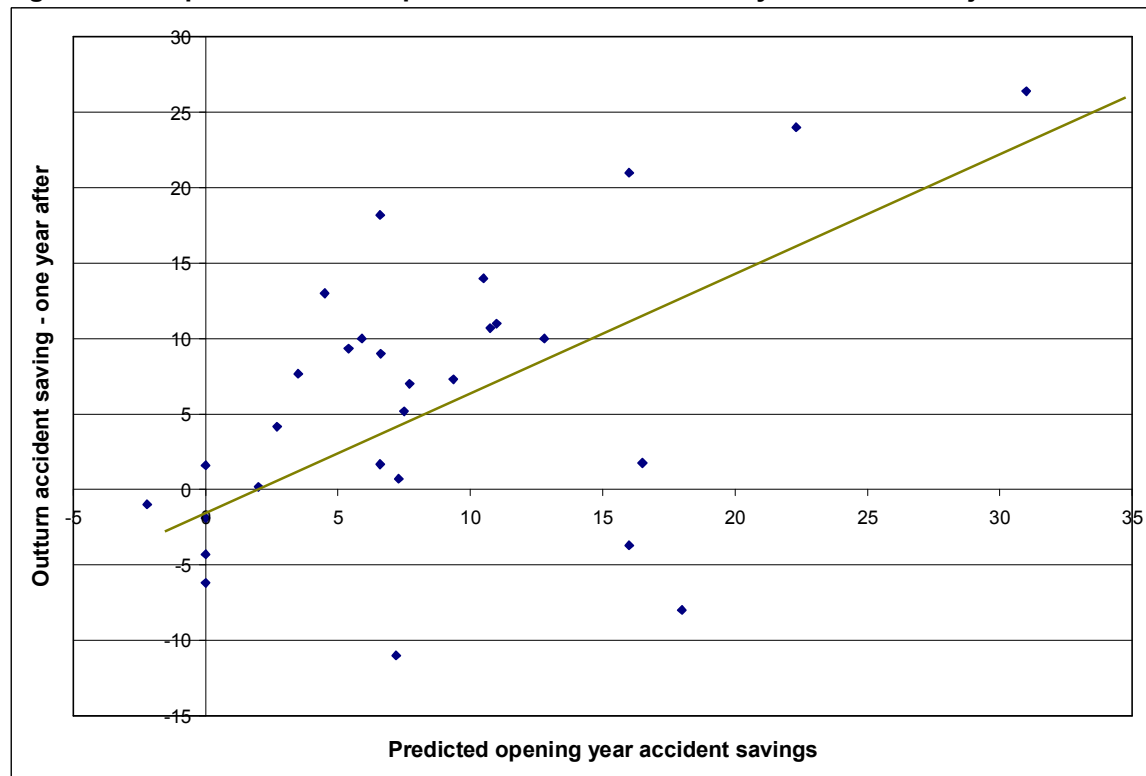
Source: Highways Agency

5   Use of the DfT VPF in a non-highways' context

The issue of whether the DfT VPF and VPI figures are transferable into other contexts has generated large amounts of interest. In Section 5.1, we examine some of the key concerns relating to transferability. We also examine the practical application of the DfT estimates, in the context of other DfT agencies (Section 5.2), and in bodies outside the DfT such as local authorities (Section 5.3) and wider government departments (Section 5.4). Finally, we provide some suggestions on how the DfT can adjust its published guidance to facilitate the transfer of its estimates outside a highways' context (Section 5.5).

5.1   Transferability of values

The DfT VPF and VPI figures were developed specifically in the context of death or injury in road accidents, which raises the question as to whether the estimates are appropriate in valuing risk reductions in other contexts. A considerable amount of literature has been devoted to this issue, which has also been highlighted by many of the departments interviewed in the course of this study and in the wider IGVLH review.

It is possible that society's preferences may not be the same in all contexts. In particular, the following are key areas of concern.

1. **Dread risk.** There may be different degrees of dread at the prospect of different types of death or injury, which may affect the willingness to pay for reducing the related risks.

2. **Multiple fatalities**. Preventing the risk of multiple fatalities may be more highly valued by the public than preventing the risk of an equal number of single fatalities.

3. **Blame and culpability**. Considerations of blame relating to the causation of the hazard might impact a VPF, either in the sense of voluntary risk-taking on the part of the victim, or in terms of culpability on the part of those charged with ensuring public safety.

4. **Age-related concerns**. Society may place a different value on reducing risks to victims in certain age groups; additionally, the output component of the VPF may no longer be appropriate for a different average age of victim.

5. **Severity splits within the serious and slight injury categories**. The transferral of VPI for slight and serious casualties requires that the same prevalence of injuries occurs in different contexts. This is not necessarily the case.

We now examine each of these areas in turn.

5.1.1   Dread risk

WtP values represent the willingness of society to pay to reduce the risk of death in a particular context. If there are differing degrees of dread at the prospect of death or injury in different circumstances, then it may be inappropriate to use the VPF derived in one context in another. This

is because individuals' willingness to pay for risk reduction may vary depending on the particular hazardous situation.

There are three main factors which seem to influence people's preferences relating to different ways of dying. These are aversion to the nature of the death itself, dread of the period of mortality preceding death, and perceptions of the degree of control associated with that risk, which we explain below.

- **Dread of preceding morbidity.** It is possible that different levels of dread relating to death in different contexts may actually represent a dread of the period of morbidity associated with that death. In other words, the ill-health, pain and suffering which precede some deaths may cause the additional dread of death rather than the death itself. This has been used to justify the premium on the DfT's VPF applied by the HSE for death caused by cancer.

- **Perceptions of the degree of control.** The risk of death in different contexts may be associated with different perceptions of the degree of control associated with that risk. For example, the VPF arising from a nuclear accident may potentially be greater than the VPF arising from a sporting accident, since the risk arising from nuclear generation is generally viewed as outside of people's control and poorly understood in comparison to the risks associated with sporting activities, which are more controllable and largely the sportsman's own responsibility.

- **Fear of nature of death.** The degree of fear associated with different hazards may vary. For example, some people find the experience of plane travel more fearful than train travel; similarly, crime-related deaths appear to generate more fear than, say, road deaths.

If people are genuinely willing to pay more to reduce some risks than others, then in as far as VPFs are used as a basis for allocating scarce resources, these preferences should be taken into account.

It may be, though, that the factors affecting dread risk are not necessarily part of the VPF, and should be dealt with separately. For example, fear of crime may be related to crime-related deaths, but not in a linear way. Fear of crime is generally more to do with other factors such as media coverage of crime, individuals' feelings of vulnerability and so on, and so may not be objectively and evenly related to actual crime levels. An intervention which leads to a small reduction in the risk of crime-related death may therefore have no - or a less than proportional - impact on fear of death from crime. It may therefore not be appropriate to build in a specific premium relating to fear of crime to the VPF value. This might rather be added in as an additional benefit in the cost-benefit analysis relating to the intervention in question, depending on how fear of crime could be reduced through the specific intervention.

Similarly, the additional value placed on reducing risk of death due to the associated reduction in risk of the ill-health preceding death may be better treated separately. In many cases, such as death caused by cancer, the length and extent of ill-health preceding death may be predictable, and so could be separately specified in a cost benefit analysis. Jones-Lee and Loomes (2006) point out this is very much how the prevention of non-fatal injuries is currently valued.

A further issue to bear in mind is the counteracting effects of baseline risk. Chilten et al. (2007) note that the current level of risk faced by the individual prior to any risk reduction intervention seems to matter to people when deciding on their willingness to pay for risk reduction. Their study for the HSE found that although certain types of death[41] were associated with dread – such as murder, fires in public places, train accidents and drowning - since the baseline level of risk associated with these hazards was substantially lower than in the case of road deaths, the baseline risk effect effectively cancelled out the dread effect.

In summary then, although people may genuinely be willing to pay more to reduce some risks than others, there is insufficient evidence to suggest an amendment in the core VPF figure. In many cases, where dread is associated with specific kinds of deaths, the low level of baseline risk associated with the hazard is low enough to cancel out the dread effect. Other factors causing dread risk should be dealt with separately, as they vary depending on the nature of the intervention; namely fear of preceding morbidity and fear of the nature of the death. These additions should be estimated on a cause-specific, case by case basis.

5.1.2   Multiple fatalities

Previous policy understanding held that preventing the risk of multiple fatalities was more highly valued by the public than preventing the risk of an equal number of single fatalities. Indeed, the railways VPF originally used a premium for multiple fatalities.

However, research has demonstrated that this is not the case. A study for London Underground (Jones-Lee and Loomes, 1995) showed that 67% of respondents disagreed that a single accident with multiple fatalities was worse than the same number of deaths in separate accidents, while a further 13% were neutral. Similarly, research conducted for RSSB (Covey et al., 2008) found that survey participants gave equal weight to the reduction in risk of multiple fatalities as to an equal number of single fatalities, as long as other aspects such as blame were held constant.

5.1.3   Blame and culpability

Considerations of blame and culpability of the causation of the hazard may impact a VPF in two ways:

- from the perspective of the victim who may be responsible in some way for his own safety; and

- from the perspective of those charged with ensuring public safety.

We discuss both of these in turn.

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[41] These hazards were deliberately chosen so as to have no preceding period of ill-health associated with the death

Blame from the perspective of the victim

Issues about how to handle irresponsible behaviour are currently underdeveloped in the literature (Jones-Lee and Loomes, 2006). One possibility is to place a lower value on preventing harm to people who wilfully place themselves in danger. A survey conducted for RSSB (Covey et al., 2008) found that respondents valued preventing risks to those who had placed themselves in danger (including adult trespassers engaged in acts of vandalism, car drivers behaving irresponsibly at level crossings, drunks falling from platforms and suicides) at roughly 40% of the value of preventing risks to an innocent individual. However, it should be noted that this survey employed a technique called "matching" questions. Respondents were asked about the number of rail fatalities of a given type that would need to be prevented by a certain safety improvement in order for that safety improvement to be considered equally desirable as another safety improvement which prevented a given number of baseline case fatalities[42]. This approach does not involve the consideration of costs in any way, and so may not be suitable to do more than identify general perceptions of the public concerning rail safety (Jones-Lee and Loomes, 2006).

Blame on the part of those charged with ensuring public safety

There may be a case for spending additional resources to reduce risks relating to hazards resulting from incompetence or negligence. Jones-Lee and Loomes (ibid.) suggest this can be seen in terms of the additional benefits of avoiding the resulting fines, enquiries and adverse impacts from lack of public confidence and trust. This may make higher spending to prevent such negligence or incompetence justified, even though it would not be justified on the basis of VPFs alone. This again appears to be an area which is better dealt with separately as a benefit rather than being incorporated into a VPF, and depends on the particular nature of the intervention.

5.1.4   Age-related concerns

Age-related concerns affect the transferral of the DfT VPF in two ways; firstly, in relation to the value society places on reducing risks to victims in certain age groups, and secondly, in relation to the lost output component of the VPF.

Reducing risks to victims in certain age groups

As we have outlined in Section 3.2.2, it is not clear how in practice a VPF that varies with the age of the group targeted by the safety intervention might be estimated. In addition, there is no policy support for allowing differentiation due to age, except, potentially, in the case of children. Even in the case of children, where it might be thought that society would be willing to spend more to reduce the risks to children, there is currently insufficient evidence to support a particular adjustment in a VPF. Any premium would therefore be more a policy decision than one based on the currently available evidence.

However, it is important to consider how the safety intervention will be financed. We have suggested in Section 3.2.2 that it is inappropriate to use the WtP of a specific target group if the intervention is going to be financed by tax payers in general. However, if the intervention is paid for

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[42] A baseline case fatality is a single fatality of a responsibly behaved, adult passenger

by consumers, and therefore by the specific target group who are affected by the intervention, then this argument no longer holds. In this case, it may be more appropriate to use the average WtP of the target group when valuing the benefits of the intervention, because they are the only people affected in both benefit and cost terms. We note, however, that in most cases this concern would not apply to government departments.

VPF lost output component

One of the components of the DfT's VPF is the cost of lost output. This was derived by estimating the value of the lost output of the average road accident victim, over the course of their expected remaining life. This component will not be transferable into other contexts if the average age of a road accident fatality is younger than that of an average fatality in another context, as the period over which lost output is calculated will be longer than in the other context.

This shortcoming is partly mitigated by the small relative importance of the cost of lost output in the overall VPF figure, as explained in Section 2.2.3. Because individuals' willingness to pay to reduce the risk of death is thought to include the value of consumption, only net output (gross output less consumption) is added on to the WtP figure. Net output is only one fifth of gross output, and so comprises only approximately 6% of the overall VPF figure currently used. Note that the WtP figure itself is not age-related, as the survey to estimate the figure used a sample which was reflective of the national breakdown of age, so as to attain an average figure.

5.1.5   Severity splits within the serious and slight injury categories

Similar issues to those discussed above for VPF values apply to the transfer of the VPI values into other contexts. However, there is also an additional concern around the mapping of injury categories.

Casualties differ according to the injuries sustained, which are categorised as either fatal, serious or slight. Levels of severity within the serious and slight casualty group vary considerably, as explained in Section 2.2.1. In order to derive average medical, human and lost output costs, the serious and slight casualty groups were subdivided into eight injury state subgroups. Average costs were then calculated across each casualty group by using the relative proportions of the different injury state subgroups within each group.

In order for the value per serious or slight casualty prevented to be transferable into different contexts, the definition of a serious or slight injury needs to be held constant. However, these categories cover a very wide range of injuries, making it likely that the same prevalence of injuries will not occur in different contexts. This means that the value per serious casualty prevented is unlikely to be strictly transferable.

5.2   Use by other DfT agencies

5.2.1   Use in the rail sector

Use of DfT values

The Office of the Rail Regulator publishes guidance on the use of cost-benefit analysis techniques in support of decisions to invest in new safety related projects[43]. This recommends that the DfT's value for prevention of a fatal casualty should be used to estimate a monetary value of casualty reduction benefits. This value only includes the value of a fatal casualty prevented, rather than of a fatal accident prevented. This recognises that the wider components of accident cost (such as police or damage costs) are road-specific and need to be addressed separately for a rail accident.

The use of a consistent VPF across roads and rail is a relatively recent development. Before 2003, the rail industry used a scaling factor of 2.8 to the VPF to increase the amount of spend justified for multiple fatality train accidents. The use of a consistent figure was endorsed in a Parliamentary debate in 2003:

> Lord McIntosh of Haringey: It is true that in the past there has been a different assessment of the value of a fatality in a road accident as opposed to a rail accident. … If you have lost a loved one, it does not matter whether that occurred in a road, rail or aviation accident. [...]
>
> We think that there should be the same standards for rail safety as for road safety. That is the principle that we adopt. The rail industry itself has set a higher figure but, clearly, it is up to that industry to review the figure that it uses. (Rail Standards and Safety Board, 2007)

Following the outputs of the research commissioned by the Rail Standards and Safety Board (Covey et al., 2008), and resulting industry discussion and agreement, the same fatality value is applied to each fatality prevented whether the accident relates to a single or multiple-fatality accident. This is described in Section 5.1.2. The same value is also applied to all individuals, whether they are passengers, rail employees or members of the public. Although the survey for RSSB discussed in Section 5.1.3 also found that respondents put a lower value on reducing risk to people who had wilfully put themselves in danger, given the unclear legal interpretation of this issue, the industry has elected to take a conservative approach and value the reduction in risk of death equally for all individuals. The only exception is for suicides[44]: the benefits to reducing risk to suicides are not normally included in appraisals of interventions. However, the benefits to passengers in terms of time savings from interventions to reduce suicides are factored into such appraisals. This approach does not have much significance in practical terms. The interventions required to reduce suicide and other forms of voluntary risk taking – such as fencing off all railway tracks – are generally too costly to be considered proportionate whether a full or discounted VPF

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[43] Office for Rail Regulation (ORR, 2008a): Internal guidance on cost benefit analysis (CBA) in support of safety-related investment decisions.

[44] There are approximately four suicides a week on the UK rail network.

were to be used, and there are strong arguments that such measures would just displace risk rather than eliminate it[45].

In order to estimate the value for prevention of less severe injuries, rail appraisals weight these relative to fatalities rather than using the DfT VPI figures, which were felt not to be strictly transferable. For example, whiplash injuries make up a large proportion of slight road injuries but are far less prevalent in rail accidents. Weighting is currently set at 10% of the total value of a fatality for a major injury and 0.5% for a reportable minor injury.

The weightings were revised by industry agreement following research commissioned for RSSB into the empirical basis of these ratios (RSSB, 2008). This research considered the frequency of injuries in rail-related accidents corresponding to each classification in the eight point injury classification system used by the DfT, the Galasko scale. This process used data from RSSB's database on safety related events occurring on Network Rail managed infrastructure, as well as injury data from the Trauma Audit and Research Network. Various rail-related injury categories, such as major injury and reportable minor injury, were created by combining subsets of the eight injury classifications. Using the relative valuations of each of the eight injury classifications from the DfT research, and weighting these by the respective frequencies, the study was able to assign 'injury to fatality' ratios to each injury category, as shown in the table below.

Following this research, and after consultation within the industry and with DfT and ORR, this approach was approved by RSSB.

Table 5: Injury to fatality ratios for rail- related non-fatal injuries

Injury	Description	Weight	Average value, £ June 2007
Fatality	**Fatality within one year of the causal accident**	**1**	**1,648,390**
Major injury	An injury as defined in schedule 1 of RIDDOR 1995, or where the injury resulted in hospital attendance for more than 24 hours	0.1	164,840
Reportable minor injury	For workforce, any injury resulting in more than 3 days off work, which is not a major injury. For passengers and members of the public, any injury that leads to a person being taken from the site of the accident to hospital for treatment, which is not a major injury	0.005	8,240
Non-reportable minor injury	Any other physical injury that is not a fatality, major or reportable minor injury	0.001	1,650
Class 1 shock/trauma injury	Shock/trauma injuries due to witnessing all fatal incidents, attempted suicides, passengers struck by trains, train accidents (except 'Collision of train with object on line (not resulting in derailment)')	0.005	8,240
Class 2 shock/trauma injury	Shock/trauma injuries due to physical and verbal assaults, witnessing non-fatal incidents or near misses, assaults, trespasser and workers struck by train, and all other miscellaneous events	0.001	1,650

Source: DfT 2008

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[45] The issue of suicide prevention is more nuanced than can easily be represented in cost-benefit analysis, and requires a co-ordinated approach with other agencies. Prevention strategies such as awareness campaigns are therefore put in place by the rail industry, but generally outside of a cost-benefit framework.

Quantification of impact of intervention on risk

A comprehensive set of principles and guidance to support project decision making has been developed by the industry, under a process facilitated by the RSSB, in order to assist Network Rail and the train operators in the appraisal of safety investments[46]. These principles are outlined in the RSSB publication 'Taking Safe Decisions'[47]. RSSB also produces the "Safety Risk Model", a probabilistic safety model which estimates the risk profile of the rail industry. This is produced by RSSB approximately every two years, and estimates typical outcomes from causal events in order to predict risk. It is one of the inputs used by the rail industry into project appraisals to inform safety appraisal decisions on new investments.

The impact of optimism bias and uncertainty (quantified through sensitivity analysis) is also taken into account when estimating the impact of an intervention on risk.

Relative importance of the DfT value in scheme appraisal

Safety benefits are of variable importance depending on the nature of the intervention. A proportion of rail schemes are focussed on reliability and timeliness, and have a very small impact on safety. However, a number of schemes are explicitly safety focussed; indeed, during Control Period three (2004 to 2009), £552m of ringfenced funding was provided to Network Rail for schemes justified on the grounds of safety, of which approximately £400m has already been spent.

Two key sets of criteria determine whether an intervention is approved. The results of a cost-benefit analysis provide an objective indication of which interventions should be funded. Where safety benefits outweigh costs, the train company is obliged to implement the intervention in order to comply with the legal requirement to reduce risks so far as is reasonably practicable ("**SFAIRP**"). Where costs exceed safety benefits, professional judgement is applied in determining whether the cost is grossly disproportionate to the safety benefit[48] and it is reasonably practicable to implement the improvement (RSSB, 2007). This means that the point value of the DfT's VPF may have a critical impact on whether an intervention is approved. Rail companies may also take other benefits into consideration, such as passenger time savings or operational cost savings, but these are not part of a SFAIRP judgement.

However, a second set of criteria is also instrumental in the approval or rejection of an appraisal. These are aspects which are harder to monetise and relate to wider business decisions and societal concerns, such as the effect on reputation, civil damages and legal costs, and changes to insurance premiums. Network Rail has developed a corporate risk scoring matrix to help management make judgements relating to these other considerations. An intervention may be

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[46] RSSB additionally plays a role in assisting in wider business appraisals, but its key focus is on safety-focussed interventions.

[47] http://www.rssb.co.uk/safety/safety_strategies/sdmoukr.asp

[48] However, there is no authoritative guidance as to what constitutes gross disproportion. 'Taking Safe Decisions' clarifies that the industry considers 'in particular, the level of confidence in risk and cost estimates made' – therefore it is interpreted as relating to the degree of uncertainty in numerical estimates.

approved based on these criteria, even if the rate of return resulting from the cost-benefit analysis were insufficient for the intervention to be approved on pure monetary grounds.

In summary then, a change in the DfT VPF or VPI figures would have an impact on which schemes were approved, particularly for those schemes where safety benefits made up a large proportion of total benefits. However, other management considerations also have an impact on the final decision.

Process of appraisal

Project appraisals are conducted by the individual rail companies, and are not subject to DfT scrutiny[49]. For Network Rail, funding is allocated from the DfT for the specific Control Period[50], but any auditing of spending or appraisals is conducted by the independent regulator, the Office of Rail Regulation. Similarly, passenger or freight train operators manage all their appraisals internally[51].

5.2.2   Use in the aviation and maritime sectors

As with road interventions, the impact of aviation or maritime interventions should be quantified and expressed as differences in the number of persons who are expected to be injured between the 'with' and 'without' development scenarios. In its TAG guidance, the DfT recommends that the equivalent monetary value of these impacts should also be estimated using the values for prevention of casualties presented (DfT 2008). However, these values should only be seen as a benchmark to value the impact of an intervention. The guidance notes that the cost based components of the value per casualty prevented (specifically the value of lost output and ambulance/hospital costs) may differ due to differences in injury types and the context in which they are sustained. The guidance therefore recommends the use of sensitivity analysis to reflect the uncertainty around casualty values.

Values used should not, as in the rail sector, include the wider values per accident prevented.

5.3   Application in local authorities

The majority of local authority road interventions are financed through the Local Transport Capital Settlement from HM Treasury, rather than through DfT, and the associated project appraisals are not approved by the DfT. Nevertheless, the use of the DfT VPFs and VPIs appears to be widespread among local authorities as part of project appraisals.

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[49] The only exceptions to this are in the case of exceptionally large projects such as the Thameslink, and even then the DfT is only involved in the initial funding decision.

[50] The current period, Control Period 3, has run from 2004 to 2009, with Control Period 4 running from 2009 to 2014.

[51] These operators receive income from passengers rather than from the DfT, although franchised passenger train operators may additionally pay a premium to or receive a subsidy from DfT for the right to run the franchise

5.3.1   Use of DfT values

The average value per accident prevented by class of road appears to be the most commonly used of the DfT values in local authority project appraisals. This value is a single average, and shows the average costs of an accident weighted by the average proportions of fatal, serious, slight and damage-only accidents by different road types. This value is applied over the lifetime of the scheme[52].

An average value is used because there is often inadequate data available at a local level to predict whether accident savings will be in terms of fatal, serious, slight or damage-only accidents. In the absence of more detailed data, the most accurate approach is taken to be using national average figures. Furthermore, it is felt that the difference between a slight, serious and fatal accident is sometimes arbitrary, being due to other factors such as the car occupants not wearing seatbelts.

It is also possible that using this value rather than the value per slight accident prevented increases the rate of return of the intervention and gives it a better chance of being approved.

We also found examples of authorities differentiating between fatal/serious accidents and slight accidents, due to the Killed and Seriously Injured ("**KSI**") target. For example, one County Council derives a weighted average value per fatal and serious accident prevented, with weights determined by the average proportions of fatal and serious accidents within the local authority. This value was then applied to the number of KSI accident assumed to be prevented by an intervention, with the DfT slight accident value being used for slight accidents. We note, however, that even with the differentiation between slight and KSI accidents, the same proportional reduction in KSI and slight accidents is applied by this local authority for each intervention; effectively providing the same result as using an average accident figure.

 In general, approaches seem to vary even within a local authority, depending on the amount of data available for the particular intervention and general practice.

5.3.2   Quantification of impact of intervention on risk

Local authorities estimate the impact of the proposed intervention on the number of accidents, in terms of the percentage of accidents avoided. There are a number of approaches used by local authorities to estimate potential accident savings, often used in combination. These include the following.

1. **Expert opinion.** Most of the local authorities we spoke to relied primarily on the expertise within their accident prevention teams to estimate potential accident savings resulting from an intervention.

2. **Historic local data**. Some local authorities collect extensive data on accident rates in their area. For example, Nottinghamshire populates a map of all the roads in the county with clusters of KSI or slight accidents, which is used to inform the impact of specific interventions.

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[52] The default lifetime for a road safety scheme is 60 years

Similarly, Kent has a database of local accident data, which they use to determine expected average accidents associated with different traffic interventions.

3. **Published guidance.** Various bodies publish guidance on the effectiveness of various interventions in reducing road traffic accidents which are used by local authorities to inform their estimates. In particular, the Royal Society for the Prevention of Accidents ("**RoSPA**") publishes average percentage reductions in expected accidents resulting from particular accident remedial measures. For example, a "controlled crossing" scheme leads to an average reduction in accidents of 31%, an anti-skid scheme results in an average 57% reduction in accidents and so on[53]. RoSPO also provides training courses for safety practitioners, including local authorities. Other bodies such as the DfT's Transport Research Laboratory also publish guidance.

4. **DfT tools**. The DfT's COBA model is also available to assist local authorities, although it did not appear to be very commonly used for project appraisals in the authorities we interviewed. As described in Section 4.2.1, COBA is available from the Transport Research Laboratory for a small handling fee and extensive guidance is available online. However, COBA is designed for looking at large road schemes, and requires users to enter large amounts of data, particularly relating to traffic flows. This means it is less suitable for smaller local authority projects.

5.3.3   Relative importance of the DfT value in scheme appraisal

The relative importance of safety benefits seems to vary between local authorities, and depends upon the structure of transport scheme funding and approach to cost benefit analysis.

Structure of transport scheme funding

For some authorities, internally ringfenced funding is provided for safety schemes. This means that an increase or decrease in the DfT VPFs or VPIs may not have much of an effect on which projects are approved. Because projects with the highest safety benefits are approved until the year's funding is exhausted, and changing the DfT values would not affect the relative positioning of schemes, the same schemes would therefore tend to be approved even with a change in the DfT values.

Approach to cost-benefit analysis

At a local authority level, a significant proportion of schemes are focussed on safety. For example, a third of the total spending on transport initiatives in one authority we interviewed was spent on safety schemes.

Even where there is no ringfenced safety funding, there seems to be an implicit allocation of a certain amount of funding to safety schemes, given the high priority of traffic safety at a local authority level. Many local authorities employ a weighting system to aggregate the various benefits associated with an intervention, such as air quality, time savings and safety benefits. If the VPF or

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[53] http://www.rospa.com/roadsafety/advice/highway/local_schemes.htm

VPI values were to change such that safety schemes would compare poorly against schemes with primarily other benefits, the local authorities we interviewed felt that it is likely that the weighting system would be revised to place a higher weight on safety benefits. This suggests that cost-benefit analysis is one part of the overall judgement regarding a scheme, and other aspects such as consideration of local priorities are also taken into account.

5.4   Application in Government departments

As part of the IGVLH review, representatives of the 12 government departments which made up the IGVLH group were interviewed by Charlotte Kelly of the University of Leeds (Kelly, 2008).

The study found that every department which used a VPF transferred the value from the DfT study. Out of the 12 departments interviewed, six transferred the value directly from the DfT, while the Department of Health used the DfT value to derive a QALY value. Of these six departments, four were interviewed further as part of this study due to their more extensive usage of the DfT values. Table 6 below summarises the findings of Kelly (2008) and our interviews with four departments on the use of the DfT VPF/VPI values in central government non-transport contexts.

Table 6: Examples of the use of the DfT VPF or VPI values in government departments

Department	Use of DfT VPF or VPI	Additional interviews conducted
Food Standards Agency	Food borne illness section of the departments uses values based on DfT VPF and VPI for food borne illness interventions.	✓
Communities and Local Government	DfT values for fatal, serious and slight casualties used for fire and flood interventions. The DfT values are inputs into the Cost of Fire model used for fire planning and investments. This model develops average costs associated with different types of fires, to be used in impact assessments. The assessment of the impact of the hot water safety scheme also uses DfT VPFs and VPIs. This is a programme to fit thermostatic devices in baths to prevent death from scalding, particular among the elderly.	✓
Home Office	DfT VPF used to value a homicide.	✓
HSE	DfT VPF used to value fatalities in workplace accidents.	✓
Environment Agency	Valuations of life are not routinely included in assessments, but there are a few exceptions. The DfT	

Department	Use of DfT VPF or VPI	Additional interviews conducted
	VPF and VPI are used for fatalities and injuries.	
Health Protection Agency	The department uses the DfT values when investigating guidance, although the department focuses on risks and not values of life. DfT VPF used to value fatalities.	
Department of Health	Where values are applied for a QALY they are derived from the DfT value. This includes the Department of Health in Scotland.	

Source: Kelly (2008) and Deloitte interviews

5.4.1   Amendments of DfT value

All departments covered in the study use the VPF values, rather than the values per accident prevented which include damage costs from road accidents[54]. They then added on damage costs which were context specific. For example, the Home Office includes criminal justice system costs in the value of preventing a homicide.

Some amendments were made to the DfT values, but these tend to be relatively minor. The amendments set out in the table below were drawn to our attention:

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[54] The value per accident prevented not only includes the value of casualties in the accident – of which there may be more than one or more than one type - but also damage, police and administration costs

Table 7: Amendments to the DfT VPF and VPI figures

Department	Amendment
Food Standards Agency	Replace the medical/ambulance cost component with average costs of treating a food borne illness
Home Office	No amendment
CLG	No amendment
Scottish Government	Adjusted VPF to take account of the average age of death from various smoking diseases, which is higher than the average age of death in a road accident
HSE	Base non-fatal injuries on the human cost component of the DfT VPF, but use different injury state classifications Cancer premium of 2 times the DfT VPF

Source: Kelly (2008) and Deloitte interviews

Concerns were expressed about the transferability of the DfT value, particularly in relation to dread risk. In some cases, research studies have have been commissioned to consider these questions. Similarly, a CLG report suggests that amendments may need to be made for dread risk in the case of fire deaths (OPDM, 2004), although in fact in this case later research by the HSE (Chilten et al., 2007) indicates that this is not required, as discussed in Section 5.1.1. The department representatives we interviewed indicated that limited research budgets seem to be the primary factor preventing departments investigating whether amendments are required, as well as the perception that it is difficult to obtain context-specific values which are robust.

In a point related to dread risk, the use of the DfT VPF figure is generally not considered to be appropriate where death is preceded by a period of morbidity. Where this was felt to be a significant factor, QALYs and DALYs (disability adjusted life years) were employed to value the benefits of the intervention.

The FSA has also expressed concerns relating to the need for age-related adjustments. Dietary related diseases tend to occur later in life than the average age of fatalities in road accidents, and so there were concerns that the productivity and medical costs in the DfT VPF may not be fully transferable. The conclusion was that since net output[55] and medical costs made up only a small proportion of the total figure, and since the increased medical costs relating to dietary related deaths could be considered to offset reduced lost output costs, no further adjustments were made.

One of the few amendments to the DfT VPF value is made in relation to death by cancer, where a a VPF of twice the DfT VPF has been adopted. However, there appears to be no empirical evidence to justify this premium (Wolff and Orr, unpublished). As we discussed in Section 5.1.1,

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[55] Treasury guidance does note that the DfT VPF consists of the WtP component, medical costs and **net** output (HM Treasury 2005).

this premium is intended to act as a proxy to reflect society's additional dread at the period of pain and ill-health preceding death from cancer, which would be better costed explicitly and separately.

Serious and slight casualty values

More issues appear to arise in the transferral of serious and slight casualty values. Some departments and agencies, such as the FSA, have conducted mapping exercises to adjust the serious and slight values. Similarly, the HSE have defined three injury states seen as most relevant to the workplace accidents, and mapped these onto the eight injury states used in the DfT estimates. This has allowed them to use the values for these injury states relative to death that were derived during the 1991 (Hopkin and Simpson, 1995) research to value the human costs associated with the three workplace accident injury states. Further research was then conducted into lost output and medical costs (HSE, 1999). Other departments have used the values as they stand. For example, the CLG cost of fire model assumes that all injuries involving burns and 25% of injuries involving smoke inhalation are classified as serious injuries, while the remainder are assumed to be slight (ODPM, 2004). Although there is likely to be considerable differences in the cost of a serious road injury and the cost of a serious fire injury, thus defined, the lack of detail in the recording of fire statistics creates practical barriers to a more precise mapping[56].

Some departments have elected to use the DfT values for a fatality, but use other values for non-fatal injuries. For example, the Home Office uses QALYs to value the prevention of non-fatal crimes such as robbery and assault. However, as described in Section 6.1, the derivation of the value of a QALY is based on the research underlying the DfT values.

In general, the use of DfT values is viewed as the most pragmatic solution, despite some concerns around transferability. Given the limited research budgets available to most departments, and the perception from the literature that it is difficult to obtain context-specific values which are robust, using the DfT values is accepted as a practical approach.

5.4.2   Determining the risk reduction associated with an intervention

Determining the risk reduction associated with an intervention appears to provide departments with the greatest challenge, a point highlighted in both our interviews and during the intergovernmental group interviews (Kelly, 2008). Using the value per casualty prevented numbers requires departments to estimate the change in casualties brought about by an intervention. Where large numbers of people engage in similar forms of behaviour, such as transport, estimating risk reductions is more straightforward. However, numbers can be much smaller in other sectors, and it is hard to predict frequency of accidents from past data.

Nevertheless, most departments appear to use historical data to predict the impact of interventions. For example, the CLG cost of fire model uses operations data gathered over several years, while the hot water safety intervention uses data gathered from A&E departments. The Home Office bases the impact of its interventions on the analysis of existing data – for example, offending patterns – or may collect specific data in order to test the specific intervention. Similarly, HSE may

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[56] Although general categories of burns, smoke inhalation, physical injuries and other injuries are recorded, there can be significant variation within these categories in the severity of injuries (CLG, 2004).

commission research from its inhouse research department, the Health and Safety Laboratory, to estimate the risk reduction of an intervention. Historic data may be adjusted for the specific intervention; for example, the FSA applies an upward adjustment to historic data on incidence of food borne disease, as not all cases are recorded.

In some cases, none or very little historical data is available. This is an issue faced by the HSE for low frequency events. Similarly, the CLG notes that assessing the impact of interventions aimed at reducing violent extremism can be problematic due to lack of data. Although some departments, such as the Home Office, report that simulation analysis can be helpful in cases where little data is available, results are strongly driven by the assumptions used.

5.4.3   Relative importance of the DFT value in scheme appraisal

As highlighted in the previous section, the most critical factor in cost-benefit analysis appears to be determining the risk reduction associated with an intervention. Nevertheless, the value of the DfT VPFs and VPIs also plays a role, with their relative importance depending upon the nature of the intervention being appraised. For example, the FSA pointed to the appraisal of a risk-based approach to addressing contamination in the food chain, where the intervention only needed to reduce food borne disease by 0.5% to be cost-effective. In this case, the point value of the DfT VPF and VPI figures were relatively unimportant. In contrast, interventions in other contexts can be more marginal. The example of dietary health interventions was provided in this context, and the CLG noted that a number of other benefits resulted from preventing fires, including property damage and lost business. For all except domestic and outdoor fires, these far outweighed the benefits from avoided human costs. However, in the case of the hot water safety scheme, safety benefits were far more critical in determining the rate of return of the scheme.

There also appears to be a number of other considerations which affect the assessment of the appraisal, the importance of which appear to vary between departments. Departments such as DfT seem to base the appraisal primarily on the outcome of the cost-benefit analysis. In other departments political and other considerations also have considerable weight. To some extent, this depends on the data underlying the cost-benefit analysis and therefore its robustness. Because of the lack of evidence relating to some interventions, results of the cost-benefit analysis are considered less robust in some cases. This point was reinforced during the interviews conducted for the IGVLH, where departments noted that it was not possible to quantify all the benefits from a particular intervention and so cost-benefit analysis accounts only for one element of the overall assessment (Kelly, 2008).

5.5   Caveats and safeguards provided by DfT

The DfT (DfT, 2008) currently provides accompanying guidance for the VPF and VPI values in the form of the TAG Guidance, a section of which has replaced the Highways Economic Note. The TAG guidance provides the latest values, as well as a high-level summary of the approach used to derive the numbers. It also notes that the value of life estimates are derived primarily for use in the appraisal of road scheme, and must be carefully applied in other contexts.

However, several department representatives that we interviewed commented that the explanation on the underlying basis for the numbers was insufficiently comprehensive. The high-level summary

provided by the current guidance is adequate for those applying the values directly in their current form. However, where departments wish to make adjustments or include add-ons to the core numbers to allow for specific factors, information on the derivation of the numbers which would allow them to understand which adjustments were needed was not readily accessible. Moreover, although extensive references are provided in the note, these are not all easily available[57]. Furthermore, the DfT values have gone through a process of development since the early 1990s, and it is not always easy to understand from a set of separate studies which is the latest methodology. A supplementary and more comprehensive guidance note which outlined the details of the current methodology in one place would be helpful.

In particular, the following aspects may benefit from further elaboration in the recommended supplementary note.

- **Derivation of serious injuries and weights**. This would include details of the eight point injury classification system, the valuation of each injury state relative to the VPF, and the relative proportions of each injury state which were used as weights to obtain an average value.

- **Average age used to calculate lost output.** Average income was calculated for a number of age and gender groups. An overall average was obtained by weighting average income in each group by the number of fatalities in each age and gender group; understanding the composition of these groups would be helpful if adjusting the output component for fatalities of different ages.

- **Human cost component.** As explained in Section 2.2.3, the human cost component of the DfT VPF is essentially the result of an accounting exercise rather than having any conceptual status of its own. This was intended to allow ready comparison with some European Human Capital-based approaches, but has the potential to be misleading. For example, if a department decided that the average age of an individual targeted through their proposed intervention was much older than the average accident victim, then they may reduce the lost output component accordingly. However, lost output is currently given in its gross form, while in reality only net lost output is separately calculated from the WtP element.
  Although we did not come across any such adjustment, this area clearly has the potential to cause confusion.

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[57] For example, several are not available online and must be purchased in hard copy from the Transport Research Laboratory.

6   Comparison with other value of life figures

Other countries use estimates analogous to the DfT figures; additionally, other approaches to the valuation of life and health are used in the UK, most notably the Quality Adjusted Life Years approach. In this section, we compare and contrast the DfT estimates with these alteratives.

6.1   Other evaluation techniques: QALYs

The concept of a QALY is used to measure health states for the purposes of cost-benefit analysis. QALYs have the advantage of being able to compare interventions which extend life to those that provide health improvement without extending life.

A full discussion of QALYs is outside the scope of this work, so we will confine our comments to the extent to which the value of a QALY may be used to benchmark the value of the DfT VPF.

It is important to understand the basis on which a QALY is allocated a cash value. The procedure for defining a QALY value involves assessing the trade-off between years in an impaired health state and years in a state of perfect health. It therefore does not involve any consideration of monetary value. However, an associated monetary threshold over which an intervention is no longer considered cost-effective is required in order for QALYs to be used in cost-benefit analysis; the derivation of this value has presented considerable challenges.

One approach has been to use the DfT VPF value to derive a value for a QALY. Two main approaches[58] have been used, outlined by Wolf and Orr.

- Simple division, whereby an average life is calculated as 32 QALYs[59]. This approach was used by the Department of Health (Dept of Health, 2007) in their National Stroke Strategy Impact Assessment, and generated a value of £38,000 per QALY.

- Using information from some of the preliminary steps in the VPF estimation: as described in Section 2.2.3, the approach used by the DfT involved asking respondents to value particular injuries, which were then traded off against probability of death. By estimating the number of QALYs associated with the initial injury state, a value per QALY can be derived. This approach was used in a study for the Home Office in obtaining a QALY value of £81,000 (Dolan et al., 2005).

However, a value derived from the DfT VPF is clearly of no use in benchmarking the value of the DfT VPF.

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[58] Wolf and Orr also discuss a third approach which does not yet seem to have been applied by any government department. This divides the value of life into two components: the value of healthy life years, and a "pure value" of life, which factors in aspects of life other than health, such as relations with family and friends. This approach offers a solution to the observation that older people still place a substantial value on preventing their death, although individuals' WtP does decline somewhat with age.

[59] That is, if an average age is 46 – 48, and such a person has 32 years left to live.

The alternative approach to valuing a QALY is to set a threshold based on budget concerns. In the UK, NICE uses QALYs partly as a budgeting tool. Interventions tend to be approved if their cost per QALY is below a certain threshold - currently in the region of £20,000 to £30,000 - and rejected if they cost above this threshold (Devlin and Parkin, 2004, quoted in Wolff and Orr, unpublished). The value attached to the QALY therefore relates more to what is considered to be affordable for the health service, given its available funding and other commitments, than to the underlying value of a QALY to the public.

In contrast, the DfT VPF relates directly to the value of preventing a statistical life to the public, whether or not this value is actually affordable in practice. In general, the cost-benefit analysis into which the DfT VPF figures feed does not necessarily provide any insight into whether a scheme is affordable. Because a number of the benefits are not monetisable, the scheme may not generate the funds to make it affordable even if benefits outweigh costs. Therefore, the valuation of a benefit should not be confused with the calculation of what is affordable for a government department given its budget constraints (Wolf and Orr, unpublished).

More fundamentally, QALYs and VPF may not act as useful comparators because of differences in their aims. VPFs do not attempt to capture the benefits of interventions which improve quality of life without extending life, or differentiate between interventions which extend life for different lengths of time. QALYs make adjustments for both these aspects. Moreover, VPFs attempt to value the aggregation of many small risk reductions, while QALYs put a value on actual lives (ibid.).

6.2   International values

6.2.1   Europe

A recent European Commission-funded research project, HEATCO (Developing Harmonised European Approaches for Transport Costing and Project Assessment) examined current practise in transport project appraisal in the EU. The study found that savings in accidents are included in some form in the appraisal framework for all European countries under consideration. A range of approaches and values were used to estimate these.

The value of a fatality lies between about EUR 200,000 and EUR 1,650,000 (Bickel et al., 2005). The study identified the key factors determining these differences.

- **Differences between regions.** In North or West Europe all countries except Denmark use VPFs exceeding 1,100,000 EUR, while in the East VPFs are on average less than half the average in North and West Europe. South European values are even lower; and

- **Differences in approach.** Although most countries include the value of material damages, personal loss of casualties and costs to society in their estimates, the study found considerable differences in approach. Estimates varied greatly between countries using contingent valuation/WtP approaches, including the UK, and those using the Human Capital approach. The latter use VPFs of about half of those derived from contingent preference approaches. Some countries, such as Spain and Portugal, used liability payments which gave even lower estimates than the Human Capital approach.

Table 8 below shows a summary of the approaches used in the surveyed European countries, and Figure 8 shows a comparison of the VPFs used. These have been converted to a common basis, and so are shown in EUR 2002 prices, and on a factor price basis. Converted in this manner, the UK VPF is EUR 1,458,190. The figure shows the relationship between GDP per capita and the VPF, demonstrating the tendency towards higher values in countries with higher GDP per capita. The values based on WtP are marked with a triangle, while values based on the Human Capital or other approaches are marked with a square.

Table 8: Approaches for estimating personal loss for casualties

Approach	Countries
Stated preference/contingent valuation	Finland ("**FI**"), Ireland ("**IE**"), Netherlands ("**NL**"), Sweden ("**SE**"), Switzerland ("**CH**"), UK, Italy ("**IT**"), France ("**FR**"), Estonia ("**EE**")
Human Capital	Germany ("**DE**"), Lithuania ("**LT**"), Slovenia ("**SI**"), Slovak Republic ("**SK**"), Denmark ("**DK**"), Poland ("**PL**")
Other	Austria ("**AT**"), Czech Republic ("**CZ**"), Latvia ("**LV**"), Portugal ("**PT**"), Spain ("**ES**")

Source: Odgaard et al., HEATCO Deliverable 1 (2005)

Figure 8: European comparisons of value per fatality, EUR 2002
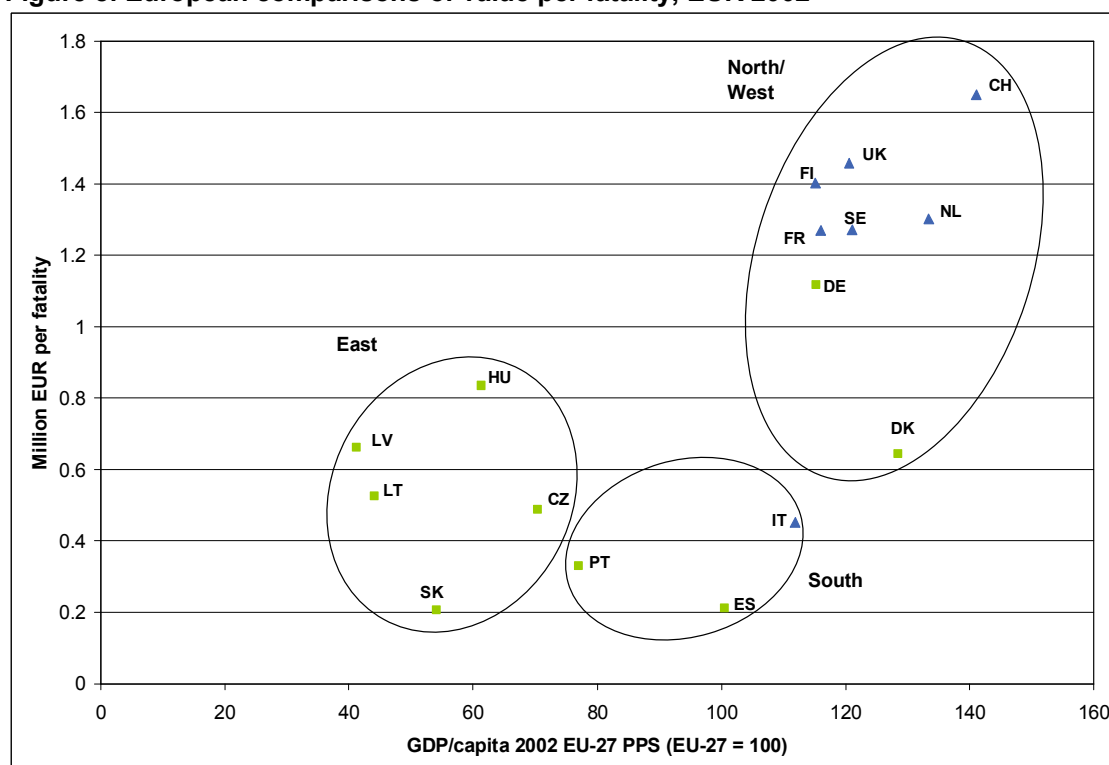
Source: Bickel et al, 2005, HEATCO Deliverable 2

The VPF used in the UK is towards the high end of those used in Europe. However, it is only marginally above the average value when benchmarked against those derived using a WtP approach. It is also comparable to those used in North/West Europe.

The HEATCO study argues that it is not possible to define a single European VPF, given that this value can be expected to vary with country-specific characteristics. Most important of these is income levels, as seen in the figure above, but other characteristics such as education, cultural and religious differences, and level of baseline risk also have a bearing on final values.

6.2.2   United States

The VPF used by the US Department of Transportation ("**DOT**") is based on a WtP approach. It has recently been revised to $5.8 million, or £3.13 million using the average 2008 exchange rate[60]. This value represents the average of five academic studies, three of which are meta-analyses of US studies (Miller, 2000, Kochi et al., 2003 and Viscusi and Aldy, 2003) and the remaining two are primary research studies conducted in the US (Mrozek and Taylor, 2001 and Viscusi, 2004). The Viscusi (2004) study is a revealed preference study based on wage premia for increased job risks.

DOT acknowledges the necessary imprecision of any assumption of the value of a statistical life. Scheme appraisals are therefore also expected to recognise uncertainty by considering the impact of assuming alternative values, namely $3.2m and $8.4m (£1.7m and £4.5m at average 2008 exchange rates).

The average VPF used by the DOT is considerably higher than that used by the DfT. However, the studies selected by the DOT to inform their average VPF estimates explicitly exclude studies focussing on non-US countries. It is similarly not clear that it is valid to use international figures to justify claims about what a UK tax payer is prepared to pay (Wolff and Orr, unpublished). Furthermore, the meta-studies relied upon by the DOT yield a very wide range of values, and it is far from clear that the mean of these provides any consensus point. It is therefore not clear that the DOT values are useful in confirming the validity of the DfT VPF figures.

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[60] The Bank of England provides an average rate of 1.85 US dollars to the pound for 2008.

Appendix A   Bibliography

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Appendix B   Interviewees

We thank all officials in the following departments and other individuals who were interviewed in the course of this work.

DfT

- Integrated Transport and Economics team

- Economics of Regional and Local Transportation team

- Network Analysis and Modelling team

- Transport Analysis and Review team

DfT agencies

- Network Rail

- Rail Safety and Standards Board – Safety Risk Assessment

- Highways Agency – Traffic Appraisal Monitoring and Economics team

Local authorities

- Leicestershire – Accident Investigation and Prevention team

- Nottinghamshire County Council – Accident Investigation Unit

- Kent – Road Safety team

Government departments

- Health and Safety Executive – Economic Analysis Unit

- Home Office – Economic Advisory team

- Local Government and Communities – Regulation and Appraisal Unit

- Food Standards Authority – Analytical Services

Academics

- Professor Michael Lee-Jones, University of Newcastle

Appendix C   Explanation of abbreviations

COBA	Cost-Benefit Analysis computer programme owned and maintained by the DfT
DfT	Department for Transport
DOT	US Department of Transportation
HSE	Health and Safety Executive
FSA	Food Standards Agency
IGVLH	Interdepartmental Group for the Valuation of Life and Health
KSI	Killed and Seriously Injured
LMNS	Local Network Management Scheme
MAC	Highways Agency Managing Area Consultant
NICE	National Institute of Clinical Excellence
PAR	Highways Agency Project Appraisal Report
POPE	Highways Agency Post Opening Project Evaluation
QALY	Quality Adjusted Life Year
RoSPA	Royal Society for the Prevention of Accidents
SFAIRP	So far as is reasonably practicable
TAG	DfT's Transport Analysis Guidance
VPF	Value of preventing a statistical fatality
VPI	Value of preventing a statistical injury
WtP	Willingness to Pay