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Ross Silcock

TRL

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Guidelines for Estimating the Cost of Road Crashes in Developing Countries

Final Report

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TRL Limited Old Wokingham Road Crowthorne, Berkshire RG45 6AU Tel: 01344 773131 Fax: 01344 770356 International_enquiries@trl.co.uk	Babtie Ross Silcock 125 Pall Mall London SW1Y 5EA Tel: 020 7968 2720 Fax: 020 7968 2739 rsllondon@babtie.com

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DEFINITIONS/ABBREVIATIONS

Crash vs. accident:	The term (road) 'accident' has been used historically and is still often used within official publications, however the term (road) 'crash' is the term preferred by the Global Road Safety Partnership. It is considered that the use of the term 'accident' is misleading because it suggests that most crashes are not preventable. However, even though they may be unintentional, their incidence can be reduced through well-designed countermeasures.
DFID	The United Kingdom Department for International Development.
GRSP	Global Road Safety Partnership. GRSP is a global partnership between business, civil society and governmental organisations collaborating to improve road safety conditions around the world.
TRL	Transport Research Laboratory
WTP	Willingness-To-Pay
WHO	World Health Organisation

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EXECUTIVE SUMMARY

E1. Introduction

E1.1.1. In July 2000, the Department for International Development appointed a joint Ross Silcock and Transport Research Laboratory (TRL) team to investigate an improved methodology for road crash costing (hereinafter crash costing) in developing countries. The project followed on from a scoping study that identified potential methodologies and data sources, highlighted their deficiencies, and proposed case studies to test and apply preferred methods. Consequently, the second phase consisted of four case studies completed in South Africa, Ghana, Bangladesh and India (Bangalore). These locations were chosen to provide a range of geographic and economic circumstances, and they had active road safety initiatives (including those supported by the Global Road Safety Partnership) that provided local support and practical experience.

E1.1.2. Previously, little work on road safety in developing countries has been directed specifically towards the poor, despite the fact that the poor are over represented in crashes. There was also a lack of knowledge on the effects of crashes on the poor. For example the death or incapacity of the sole earner in a poor family group, which could result in plunging several dependants into deep poverty, will have a much wider social and economic effect than a crash with similar death or incapacity in a relatively well-off family group. This project has attempted to address this lack of knowledge through household surveys of low-income communities in the case study countries.

E1.1.3. Another important strand of the study has been to investigate the problem of large levels of under-reporting of crashes within official (i.e. police) statistics. To obtain an estimate of national crash costs per annum, average costs must be multiplied by the actual number of crashes occurring each year. Alternative sources of data on numbers of crashes and casualties have been pursued for comparison with official statistics.

E1.1.4. The project has culminated in the guidelines reported here, which are intended to be a useful aid to those undertaking a crash costing exercise in a developing country, perhaps for the first time. It also highlights a number of key issues, such as the wider effects of crashes on low-income households for decision makers and those more experienced in crash costing.

E1.2. Why do we need to assess crash costs?

E1.2.1. There are two main uses for estimates of crash costs in developing countries. Firstly, an estimate of total annual national crash costs can be used for resource allocation at a national level to ensure road safety is ranked equitably, in terms of investment in the improvement of road safety. On a national level, if a government is completely unaware of the likely annual cost of crashes, then even a relatively crude cost estimate (as long as it is realistic and likely to be a minimum value) will be useful to highlight the economic benefits of investing in national road safety programmes.

E1.2.2. Secondly, an estimate of unit crash costs can be used to ensure the best use is made of any investment, through economic appraisal and cost benefit analysis. Economic assessments of potential road safety measures can be used to predict the economic benefits of implementing the measure, based upon predicted unit crash savings. Economic assessment can also be used as an evaluator of benefits after a scheme has been implemented, based on actual recorded crash savings as part of monitoring of the scheme's success. The main methods of economic assessment that can be used are described briefly within Chapter 9 of the guidelines.

E1.3. Preferred methodology

E1.3.1. The Willingness-To-Pay method has replaced the Human Capital method as the preferred crash costing method in many developed countries. However,this method may be extremely difficult to use in developing countries, based as it is on the completion of complex questionnaires, which relate to perceived risk and payment by individuals to avoid a given (hypothetical) level of risk. As the Willingness-To-Pay method builds upon the Human Capital method, the Human Capital method (with sums added to reflect pain, grief and suffering of those involved and their loved ones) could be considered as the natural starting point for developing countries. Resolving the issues in the use of the alternative Willingness-To-Pay method in developing countries could perhaps form the basis of a subsequent study. The guidelines reported here describe the main cost components included within the Human Capital method. The advantages and disadvantages of possible data sources, data collection methods and calculations, as informed by our case studies, and based upon past experience of crash costing, are included within Part A of the guidelines. A summary of the main issues and opportunities related to each cost component are reproduced below. Within Part B of the guidelines, the final calculations to estimate national costs are described along with a description of the application of crash costing estimates.

E2. Cost components in the Human Capital method

E2.1. Property damage

E2.1.1. By far the largest portion of property damage is that which stems from damage to vehicles. Other property damage is less significant, and those who are undertaking a crash costing exercise are advised to concentrate on collecting and analysing data on the cost of damage to vehicles only.

E2.1.2. Previously, it has usually been the case that insurance company data has been used, but this is not representative of all crashes, and will only include the more costly examples of vehicle damage. Therefore, in the past, unit vehicle damage costs have tended to be overestimated. Despite this, total costs have been underestimated because the total number of crashes was not adjusted for under-reporting within official statistics.

E2.1.3. Although insurance company information is likely to remain as the main source of vehicle damage cost data, it might be possible to supplement this with data from other sources such as motor repair businesses, fleet owners or individual vehicle owner surveys. However, experience has shown that this is often difficult. Data is also required on the share of vehicles *involved* in each crash. Following this, the share of vehicles *damaged* in each crash will need to be determined, because in some cases a vehicle may be involved in a fatal collision with a vulnerable road user, but will suffer negligible vehicle damage.

Opportunities

- A more accurate estimate of vehicle damage may be obtained, by investigating the average cost of damage to vehicles involved in crashes with pedestrians or other vulnerable road users separately. Although these crashes may be of a high severity, the cost of vehicle damage may be low. Until further research is completed in this area, arbitrary assumptions may have to be used.
- If data from insurance companies claims assessors or motor repair companies is not presently recorded in a useful manner, then it may be possible with their co-operation to set up a system of recording new incoming claims that would, over time, provide useful data for a crash costing exercise. There would be merit in maintaining such a system over the longer term, to enable a yearly update.
- It may be possible for an insurance regulator or National Road Safety Council or co-ordinating body to insist upon data provision from insurance companies.
- Government departments should be required to monitor crash involvement of their vehicles, and the associated costs of vehicle damage, so that this information would be available for a crash costing exercise.

E2.2. Administration costs

E2.2.1. Police and administration costs are low compared to other cost components. The only source of data is from the police service, courts and insurance companies themselves. Alternatively a similar proportion of total costs to that used in other previous studies could be added. It is not worth spending much time and effort in producing detailed estimates of such costs.

E2.3. Lost output

E2.3.1. Lost output is typically the largest casualty related resource cost incurred, and can range from that resulting from as little as one day lost time for slight casualties, to decades of foregone work for those killed or permanently disabled. Lost output is believed to have been underestimated in previous costings, as it was traditionally limited to the primary victim only and to the number of work days lost to recovery (or death).

E2.3.2. Case study household survey data has shown that some injured will not be able to return to their former jobs, and will spend additional time looking for employment. In the Bangladesh case study the seriously injured also reported a decrease in income after a crash. Lost output estimates should also include that foregone by carers: in the past, lost output calculations have been restricted to the victim only. A further concern is the fact that previous costings have concentrated on the short term where injuries are concerned, with little information included on the longer-term disabled.

E2.3.3. Data is required on the amount of time lost by casualties and their carers, along with their average income. This may be available from nationally published statistics along with hospital or medical data and travel time surveys. It may be possible to collect more representative data via hospital or household casualty surveys (including information related to carers), though these can be difficult and time consuming.

Opportunities

- Lost output valuations have traditionally been limited to the casualty only and restricted to recovery time or years lost output in case of road fatality, thus the total lost output has been under-estimated. Here we have proposed that other lost time including that lost by carers is also taken into account.
- Adjustment factors such as discount rate and growth rate over a thirty-year period are important assumptions, which should be properly documented and tested.
- If casualty based incomes are used, the poor, with their lower incomes, may appear to be more expendable, the exact opposite objective of most donor programmes. Opportunity costs are not accurately reflected in earnings, and this will again affect the poor, as time may be the only asset they have. The longer-term effects on lost output of a loss or disruption to education are not understood. If a social objective of alleviating poverty is the aim, and the fact that it is not possible to estimate and include all such effects, supports the case for a greater amount to be added to reflect 'Human Costs' (described below).

E2.4. Medical costs

E2.4.1. Medical costs only usually constitute a small proportion of the total costs of crashes. However,the burden of road casualties on medical sector resources is likely to be significant. Also the medical costs will often be the first and most tangible economic burden experienced by the family.

E2.4.2. Traditionally medical costs have been assessed from the perspective of individual hospitals, with data provided on cost per bed estimated from overall public sector budget allocations. However,medical costs may consist of both private and public sector expenditure.

E2.4.3. To estimate the medical costs resulting from casualties of crashes, data is required on a range of items, for example the cost of at scene care, transport, in-hospital stay, out patient treatment, drugs and prosthetics. Data may be available from national hospital expenditure estimates, insurance payments, hospital studies and casualty surveys. While hospital based casualty surveys are much easier to undertake, they may not be as representative as household surveys.

Opportunities

- The burden of road casualties on medical resources is not likely to be fully reflected in current costings. For example, the knock-on effect of a patient not receiving treatment because resources are being used to treat a crash victim instead have not been assessed.
- Deaths may be inevitable, but when they occur thirty years premature, they can pose a sudden financial drain, which is not reflected in the discounted value.
- The above supports the case for a greater amount to be added to reflect 'Human Costs' (described below).
- Future research should attempt to assess the cost of disability and longer term effects.
- Greater collaboration is needed between road safety and public health professionals, as both need to estimate the burden of road traffic casualties.

E2.5. Human costs

E2.5.1. An amount to reflect 'pain grief and suffering', termed human costs is usually added to the total costs for each severity of crash when using the Human Capital method. The amount to be added could be considered as part of a social objective of poverty alleviation, as crashes are known to have a greater adverse effect upon the poor. The amount to be added is a political decision, and an element of judgement is unavoidable. However, the amount to be added can be informed by consideration of the amounts added, and used successfully in developed and developing countries previously. An appreciation of the wider effects of crashes on poorer households, including effects that it has not been possible to quantify accurately and include within other cost elements above, could also be used as justification for adding a greater amount to reflect pain grief and suffering.

Opportunities

- The Willingness-To-Pay method is considered to be the most relevant method for crash costing, and has now been adopted by many Developed Countries. However, this method may be very difficult to apply in Developing Countries, based as it is on complex questionnaires asking about perceived risk and payment for the avoidance of hypothetical risk. Therefore, we have recommended the use of the Human Capital method (with an amount added to reflect human costs) for crash costing in Developing countries. Overcoming the problems in the use of the Willingness-To-Pay method in Developing Countries could be the subject of future research.

E3. Calculation of national costs

E3.1.1. An estimate of the total number of casualties and crashes is required before the total national cost of crashes can be estimated. Police data will be starting point for making estimates of the number of crashes and casualties, and is likely to be the only source of data on the number of casualties per crash. However, it should be acknowledged that police data often suffers from under-reporting. Therefore, it is worthwhile pursuing data on the number of casualties from other sources that may be available, such as from medical sector hospital surveys and mortality and injury surveillance systems. This should be used to assess the possible level of under-reporting in police statistics and to provide a practical, conservative estimate.

Opportunities

- Police statistics should be publicised as being derived from police reports, to avoid any misconception that official statistics are based on hospital data.
- Efforts to improve police crash reporting systems should be encouraged, with all police officers being responsible for reporting crashes on a short concise report form. Improved police data would also assist in identifying, investigating and improving hazardous locations, thus demonstrating the value of accurate reporting.
- Medical sector casualty surveillance systems should include the monitoring of crash casualties. This information is useful to check the accuracy of police data, and will highlight the effect of road casualties on medical sector resources.

1. INTRODUCTION

1.1. Background

1.1.1. In a recent study by TRL (Jacobs et al 2000), it was estimated that the cost of crashes in developing and emerging nations was about US$65 billion per annum. This sum is slightly higher than the total amount of official aid received by developing countries from all bilateral and multilateral agencies combined. A strong case therefore can be made for reducing crashes in these countries on economic grounds alone, as they consume massive financial resources that the countries concerned can ill-afford to lose.

1.1.2. In order to assist in the decision-making process, it is important that all countries have available a method for determining the cost of crashes, and the value of preventing them. The first need for cost figures is at the level of national resource planning, to ensure that road safety is ranked equitably in terms of investment in it's improvement. The second need for crash cost figures, is to ensure that the best use is made of any investment, and that the most appropriate investments are introduced in terms of their cost-effectiveness.

1.1.3. If specific costs and benefits are not related to crashes taking place, then widely differing criteria in the choice of resources and the assessment of projects will result. As a consequence, the pattern of expenditure will be unlikely to be 'optimal' and the result is likely to be an overall under-investment in road safety.

1.1.4. This report is intended as a useful aid to those undertaking a crash costing exercise in a developing country, perhaps for the first time. It also highlights a number of key issues for decision-makers, and those more experienced in crash costing.

1.2. Effect of crashes (and associated costs) on low income communities

1.2.1. It should be recognised that relatively little work on road safety in developing countries has been directed specifically towards the poor. This was acknowledged in a TRL study (Jacobs et al 1999), which also made the point that the majority of low-income people will inevitably be either pedestrians or users of public transport. Hence, in order to assist the poor, particular emphasis should be placed on improving pedestrian and public transport safety.

1.2.2. This study has attempted to address the lack of knowledge on the effects of crashes on the poor, by carrying out household interviews of low-income communities in the four case-study countries. Consequently, a greater understanding has been obtained of the wider effect of crashes in low-income communities, including effects that may not easily be financially quantifiable.

1.3. Methods used to cost crashes

1.3.1. The methods that can be used to cost crashes have been well documented by Transport Research Laboratory (1995), and Alfaro et al (1994) and can be summarised as follows.

- “lost output/human capital” method.
- “life-insurance” method.
- “court award” method.
- “implicit public sector valuation method.
- “cost of restitution” method.
- “value of risk change” or “willingness-to-pay” method.

1.3.2. Over the last twenty years or so, at least four of the above methods (certainly 2 to 5) have been generally discredited, and in Western Europe and North America the Willingness-To-Pay method has become increasingly popular.

1.3.3. The majority of governments, senior economists and social decision-taking agencies will normally pursue many different objectives. However, these typically attempt to maximise either national output or social welfare (or both). Hills, P. J. and Jones-Lee, M. (1980) argue that the only two crash costing methodologies that appear to be directly relevant are the Human Capital method and the Willingness-To-Pay method. If government or society is genuinely concerned about individuals' quality of life and society's aversion to death and injury, then it is important that a sum to reflect 'pain, grief and suffering' is included in the Human Capital method. In fact, strictly speaking, if decision-makers are genuinely concerned about the quality of life and social well being of their citizens then the Willingness-To-Pay method should be used. However, this method may be extremely difficult to use in developing countries, based as it is on the completion of complex questionnaires which relate to perceived risk and payment by individuals to avoid a given (hypothetical) level of risk.

1.4. Work on crash costing in developing countries

1.4.1. In 1995 TRL produced Overseas Road Note 10, Costing road accidents in developing countries (Transport Research Laboratory (1995)), which advised economists, planners and engineers in developing countries on a workable method that could be used for costing crashes. Since the publication of this report, more work has been done on this topic, and problems have been identified with the application of the recommended method. Additionally, it is more clearly understood that much of the burden of crash costs fall on the poorer sections of communities in developing countries, and it was appreciated that more work is needed on data sources, and in addressing the deficiencies in existing systems and methods used to cost crashes.

1.4.2. The Department for International Development (DFID) subsequently appointed a joint Babtie Ross Silcock/TRL team to undertake a study on crash costing, with the work undertaken in two phases. The first phase Scoping Study (completed in May 2000), was a review of methodologies and data needs, an identification of deficiencies in existing systems and the design of a series of case studies to test and apply the preferred methods and sources of data. This review, which identified how the crash cost methodology can be improved, was particularly timely, taking into account both DFID's focus on sustainable livelihoods and the then recent launch of the Global Road Safety Partnership (GRSP) by the World Bank. This will undoubtedly raise the profile of road safety among decision-makers.

1.4.3. The second phase, which commenced in July 2000 and is reported on here, examines how the data collection processes needed for the Human Capital method, recommended in Overseas Road Note 10, could be improved. As recommended in the Scoping Study, the only other suitable crash costing method is the Willingness-To-Pay (WTP) method, but this was deemed (for now), to be too difficult to apply to developing countries. As the Willingness-To-Pay method builds upon the Human Capital method (ie lost output, medical costs, administration and property damage are costed in the same way), the Human Capital method (with sums added to reflect Pain, Grief and Suffering of those involved and their loved ones) could be considered as the natural starting point for developing countries. Resolving the issues in the use of the alternative Willingness-To-Pay method in developing countries could perhaps form the basis of a subsequent study. It should be noted that for almost twenty years, the UK Department of Transport used the Human Capital method. An EC-funded study (Alfaro et al 1994) showed that, throughout Western Europe, a number of countries are still using the Human Capital method or some variation of it.

1.4.4. An important strand of this study has been to investigate the problem of under-reporting of crashes within official (i.e. police).statistics. This is because to obtain an estimate of national crash costs per annum, average crash costs are usually derived by degree of severity. These average costs must be multiplied by the actual number of crashes (by severity) occurring each year. It is important therefore, particularly in the developing world, to estimate the level of under-reporting of crashes within police statistics. In this study, comprehensive surveys have been undertaken, in order to provide greater understanding of the level of under-reporting of crashes taking place in Africa and Asia.

1.4.5. The study has been based upon four case studies undertaken in collaboration with local organisations in the following countries :

- Bangladesh
- Ghana
- India (Bangalore)
- South Africa

1.4.6. These countries offered a range of geographic and economic circumstances and have active road safety projects (including those supported by the GRSP) that provided local support and practical experience.

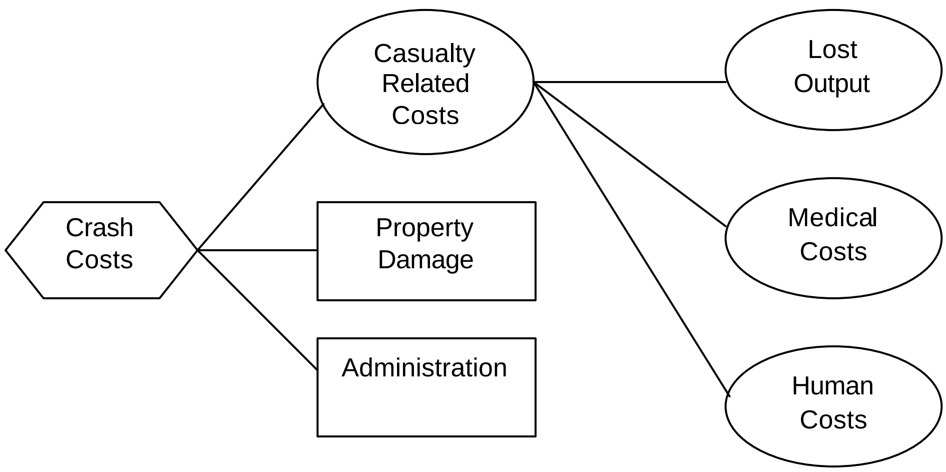
1.5. Classifying crashes by degree of severity

1.5.1. In order to cost crashes, it is important that a country has a consistent classification method. Crashes either involve injury to a person i.e. personal injury crashes (together with vehicle or property damage), or may only involve damage to vehicles and possibly other property, in which case they are termed damage only crashes. In the UK, as in most countries, personal injury crashes are reported to the local police, who then make a return to a central organisation (e.g. police headquarters or to a Ministry). It is standard practice for these crashes to be classified by injury severity as fatal, serious or slight, as follows:

- A fatal crash is one in which one or more persons are killed as a result of the accident, provided death occurs within 30 days (Vienna Convention 1968).
- A serious crash is one in which there are no deaths, but one or more persons are seriously injured. A serious injury is defined in the UK as either one for which a person is detained in hospital as an 'in patient', or if any one of the following injuries are sustained whether or not he or she is detained in hospital: fractures, concussion, internal injuries, crushing, severe cuts and lacerations, or severe general shock requiring medical treatment. In the UK this category includes deaths occurring after 30 days.
- A slight crash is one in which there are no deaths or serious injuries, but a person is slightly injured. This will be an injury of a minor character such as a cut, sprain or bruise.
- A damage only crash is one in which no one is injured, but damage to vehicles and or property is sustained.

1.5.2. The diagram in Figure 1 shows the main cost components that may result from a crash. The most serious casualty involved in the incident defines the severity of a crash. The 'cost of a crash' is therefore not the same as the 'cost of casualties' resulting from that crash. Failure to distinguish this difference when examining the benefits of different detailed remedial measures can result in different project cost-benefit rankings.

Figure 1: Crash Cost Components



1.6. Report structure

1.6.1. Following this introduction the report is presented in two parts. Part A covers each of the main cost components that should be included within the Human Capital method thus:

2. Property damage.
3. Administration costs.
4. Lost output.
5. Medical costs.
6. Human costs and Effect on the poor.

1.6.2. Within each of these Chapters we describe the possible data sources, highlighting their advantages and disadvantages, and provide suggestions for the collection and using the data as informed by our case studies, and based upon past experience of crash costing.

1.6.3. Part B presents Calculation of National Costs within three Chapters thus:

7. National road crashes and casualties.
8. Calculation of national annual crash costs.
9. Application of crash cost estimates.

PART A:
Cost Components

2. PROPERTY DAMAGE

2.1. Introduction

2.1.1. Within each crash, there may be damage to a number of vehicles, damage to road-side property or furniture and damage to goods carried within the vehicles. By far the largest portion of property damage cost is that which stems from damage to vehicles. The damage to other property is generally less significant.

2.1.2. For those crashes, where death or injury have occurred, property damage costs may well be small compared to the cost of lost output and human costs. However, because of the much larger number of damage only crashes (where there are no casualties), the cumulative costs of property damage can contribute to the greatest portion of the total cost of crashes in a nation.

2.2. Data sources

2.2.1. The main potential sources of data on vehicle damage costs include:

- Insurance companies/claims assessors.
- Fleet owners.
- Motor repair businesses.
- Owner surveys.

2.2.2. Traditionally, data collected from insurance companies have been used in assessing vehicle damage costs, and indeed it will rarely be the case that insurance data is not used. However, there are a number of weaknesses with insurance data, and data from other sources should be sought to supplement insurance data, and provide more reliable cost estimates. It should be noted however, that experience has shown that collecting data from the other sources is often difficult, and the availability of each data source will depend upon local circumstances, and the time and resources available to those undertaking the crash costing exercise. A summary of the main advantages and disadvantages of data sources for vehicle damage costs is provided in Table 2.1 below.

2.2.3. Typically, data held by insurance companies, fleet owners or repair businesses is not classified in the same way as that collected by the police for crash statistics. It may be possible, within the time available to those undertaking the crash costing exercise (and with the co-operation of the companies), to set up a system to ensure that additional classifications are added to new incoming claims to make them comparable with police crash statistics. Therefore, over time, enough data would be collected to allow an estimate of average costs to be made. There would be merit in maintaining such a system over the long term, in order that an estimate of vehicle damage costs could be updated on a yearly basis.

2.3. Insurance companies/claims assessors

2.3.1. The main advantages of this data are:

- There may be a large amount of historical data readily available.
- The information may relate to crashes for a range of types of vehicles that have occurred over a wide geographic area, especially if more than one company is approached.
- The data may already be in computerised format.

2.3.2. However, there are also a number of problems with insurance company data, and it may not be very representative of all crashes. The main problems are:

- Many vehicles are believed to be uninsured. For example in 1988 it was estimated that only about 33% of vehicles in South Africa were likely to be insured. Insured vehicles are likely to be more expensive, and consequently the cost of damage would be greater.
- Cost estimates by repairers tend to be inflated where insurance claims are involved.

- A large majority of crashes are damage only crashes where no one is injured, and the damage typically will be much less than in injury crashes. When the damage to the insured vehicle is small and less in value than the excess payable, then often no claim is initiated, especially if the claimant would lose their 'no claims bonus'.
- Data may not be classified by type of vehicle or severity in the same way as crash statistics collected by the police.
- Companies may be reluctant to share any information they may have, especially if any effort is required to provide it.

2.3.3. An example of the problem of insurance company data not being representative was highlighted within the South African case study. In South Africa, a previous estimate had been made using insurance data that had been adjusted using arbitrary assumptions to try to make the data more representative. It was assumed that half of damaged vehicles suffer only half the average damage cost obtained from insurance records. However, data collected from fleet owners, panel beaters, shade tree mechanics and household surveys in low-income areas provided results that were 67% 77% and 50% of the previous estimate for average vehicle damage costs per vehicle for killed seriously injured, slight and damage only crashes, and only 52% of the previous total overall estimate (using the same crash statistics not adjusted for under-reporting).

2.4. Fleet owners

2.4.1. Owners of vehicle fleets may include bus companies, utility companies, government departments or ministries, city councils or local authorities or other large private companies, who may all maintain information on the cost of crash damage to their vehicles. The advantages of this potential data source are:

- There may be a large amount of data readily available.
- There may a lot of information related to types of vehicle such as bus or heavy goods vehicles that is not available from other data sources.
- The data may already be in computerised format.
- The data may include cases where no insurance claim is made.

2.4.2. Experience has shown however, that attempting to collect data from these sources can be difficult:

- Few organisations in developing countries, even those with large vehicle fleets including government departments monitor their vehicle crash involvement.
- Feet owners may be reluctant to share any information they may have, especially if any effort is required to provide it. For example in South Africa following a spate of highly publicised coach crashes, coach companies were unwilling to provide any information that they considered sensitive.
- The data available may not be classified by severity of crash in the same way as that in crash statistics collected by the police.

2.5. Motor repair businesses

2.5.1. Private companies providing vehicle repair services may range from large companies with a number of repair garages, down to informal 'shade tree or back yard' mechanics. It may be possible to obtain data on the cost of repair of crash damaged vehicles through surveys of such businesses. The main advantage is that it is likely to be more representative of the true cost of damage to vehicles, because it could include insured and uninsured vehicles, cover a wide geographic area, and a range of different vehicle types.

2.5.2. However, experience has shown that the collection of data from these sources can be very difficult and labour intensive, with varying levels of success. For example, in the South African case study, contact with over 200 panel beaters and 'back yard' mechanics resulted in only 100 cases of useable data being obtained. A previous attempt at collecting such data in Nepal was also unsuccessful. If it is decided that surveys are worthwhile experience has shown that the following points are worth noting:

- The surveys could be completed using slightly different methods depending upon the type of businesses surveyed. It may be possible to survey larger established businesses through postal questionnaire, whereas face-to-face meetings may be required with informal 'backyard' mechanics.
- Careful design and piloting of the questionnaires to be used will be necessary, to ensure that the user will understand what information is being requested.
- It is likely that some businesses would be unwilling to share information that they consider sensitive. They will need to be reassured that any data they provide would remain confidential.
- Many businesses may not hold historic data so data on current repairs may only be available.
- Many businesses may be uncooperative and suspicious of surveyors who they may see as being government officials.
- The surveyors may need to be aware of the culture, language and terminology used by those in the motoring trade.
- The businesses repairing the vehicles may not know the official severity classification of the crashes that the vehicles they are repairing were involved in.

2.6. Vehicle owner surveys

2.6.1. As part of an overall crash costing exercise, it may be decided to undertake a household survey to collect information on a number of cost elements, such as lost output and the wider effect of crashes on the household. Experience from the case studies has shown that it is possible to collect some vehicle damage data from this source. However, it is a labour intensive option, and if the focus of the survey is lost output and other effects on the household, then the amount of vehicle damage data may be limited. Surveys of vehicle owners could be completed using other methods, such as through a vehicle licensing or registration authority, or through contacting those directly involved in crashes in hospitals.

Table 2.1: Summary of data sources for vehicle damage costs

Data Source	Advantages	Disadvantages
Insurance Companies/ Claims Assessors	Large amount of data readily available. Range of vehicles over wide area included. Already computerised.	Not representative of all crashes. Data may not be classified by type of vehicle or severity in the same way as crash statistics. Companies may not wish to co-operate.
Fleet Owners	Large amount of data readily available Data available on vehicles such as buses that is not available elsewhere. Data on damage to goods may also be available. May include cases where no insurance claim is made. Already computerised.	Data may not be classified by type of vehicle or severity in the same way as crash statistics. Companies may not wish to co-operate.
Motor repair businesses	Potentially more representative than insurance data.	Historical data may not be computerised or retained. The data may not be classified by severity. Labour intensive to complete surveys Companies may not wish to co-operate.
Vehicle Owner Surveys	If sampled carefully then representative Data on damage to goods may also be available.	Very labour intensive to complete extensive surveys. Unlikely to cover fleet owners.

2.6.2. To facilitate co-operation from companies holding data, it should be emphasised that the data required would be anonymous, and that individual company's data would remain confidential. A small payment to the company may be necessary to reimburse any administration cost incurred in providing any data. It may be possible for an insurance regulator, National Road Safety Council or co-ordinating body to encourage or insist upon such data provision.

2.7. Collisions with vulnerable road users

2.7.1. A generic problem exists with vehicle damage data for all of the above data sources, because it is unlikely to include cases where vehicles have been involved in a crash where the severity of the crash may be high, but where very little or no vehicle damage has occurred. A situation can be envisaged where a large goods vehicle or bus collides with one or more pedestrians causing fatal injuries, but insignificant vehicle damage. Although this is an extreme example, it is likely that many incidents of a similar nature occur in developing countries, where vulnerable road user casualties are known to be disproportionately high. Vulnerable road user collisions may also be under-represented in official statistics, as victims may settle for immediate compensation and not report the collision to the police.

2.7.2. The effect of the problem of these types of crashes not being included within the vehicle damage cost calculations would be to provide an overestimate of the average vehicle damage costs for each severity of crash. This goes against the general standard practice of tending towards conservative estimates when undertaking crash costing.

2.7.3. Previous crash costings completed in South Africa, by de Haan (1992) and Schutte (2000), have attempted to adjust insurance data for this problem using arbitrary assumptions. With regard to collisions with pedestrians, it was assumed that for motor cars, light delivery vehicles, minibuses and motorcycles, 50%suffer a quarter of the average damage and 50%suffer an eighth of the average damage as calculated from insurance data. For heavy vehicles, articulated vehicles and buses it was assumed that there is no damage.

2.7.4. The above assumptions used previously in South Africa are purely arbitrary, and it was not possible to investigate this issue further within the scope of our case studies. In the absence of further research, it is not known how accurate these assumptions may be. However, if the crash statistics allow, it is suggested that a conservative estimate would be achieved if it were assumed that vehicle damage is negligible for crashes where there are only pedestrian or other vulnerable road user casualties.

2.8. Calculation steps

Step 1: Determine the average number of each type of vehicle *involved* in each crash

2.8.1. The first step is to determine the distribution of vehicles involved in each type of crash severity. It would be hoped that published crash statistics based on records compiled by the police would document the total number of vehicles involved each category of crash severity, as well as the total number of crashes. However, police statistics suffer from under-reporting (discussed in Chapter 7) and are not likely to be representative. Therefore where possible, this data could usefully be supplemented by other data from victim surveys. An example of the final output from this step is shown in Table 2.2.

Table 2.2: Average number of vehicles involved in each crash (example)

Type of vehicle damaged	Fatal	Serious	Slight	Damage only
Motorcar	0.59	0.67	0.81	1.12
Minibus	0.16	0.18	0.13	0.13
Light Delivery Vehicle	0.23	0.22	0.24	0.28
Heavy vehicle	0.11	0.06	0.06	0.09
Articulated vehicle	0.01	0.00	0.00	0.00
Passenger bus	0.02	0.01	0.01	0.02
Motorcycle	0.02	0.04	0.05	0.01
Bicycle	0.03	0.04	0.06	0.01
Animal drawn	0.00	0.00	0.00	0.00
Tractor	0.01	0.01	0.00	0.00
Total (Average number of vehicles involved in each crash)	1.18	1.23	1.36	1.66

This example was derived from Automobile Association of South Africa Traffic Safety Foundation, (1998)

Step 2: Determine the average number of vehicles *damaged* in each crash

2.8.2. As discussed previously, the average number of vehicles *involved* in each crash will need to be adjusted to account for those crashes where there may be vulnerable road user casualties, but negligible vehicle damage. For example, it may be found that on average, 0.5 motorcars are involved in fatal crashes, but that of these, 20 percent are involved in crashes with vulnerable road users and suffer negligible damage. Therefore, on average 80% * 0.5 = 0.4 motorcars suffer *damage* in fatal crashes.

2.8.3. In previous examples in South Africa (de Haan, 1992 and Schutte, 2000) arbitrary assumptions were used (described in section 2.7). In the absence of any research into this topic, it is suggested that a conservative estimate would be achieved if it were assumed that vehicle damage is negligible for crashes where there are only pedestrian or other vulnerable road user casualties.

Step 3: Estimate the average costs of damage per vehicle

2.8.4. Using the data source(s) described previously, the information on each case of vehicle damage should be classified by type of vehicle and severity of crash (fatal, serious, slight and damage only). It will be important to note what categories of vehicles are included within centrally collated official crash statistics, so that the same categories can be used when collecting damage costs by type of vehicle and severity of crash for any of the data sources.

2.8.5. An average cost of vehicle damage by severity of crash should then be calculated. If only insurance data is used, it is suggested that downward adjustments could be made to the results, to account for the unrepresentative nature of insurance company data. An example of the output for just one category of vehicle (motorcar) is shown in Table 2.3.

Table 2.3: Average costs of damage for motorcars (example)

Motorcar	Fatal	Serious	Slight	Damage only	Total
Average damage cost (in monetary unit)	17,585	14,505	7,858	2,585	8,698
Sample size	400	700	890	1,124	3,114

Step 4: Calculate the average vehicle damage cost per crash severity

2.8.6. From Step 1, the average numbers of each type of vehicle *involved* in each crash has been established. In Step 2, an estimate of the average numbers of each vehicle *damaged* in each crash has been established. In Step 3, an estimate as to the cost of damage to each type of vehicle in each crash has been made. We now need to combine these to determine the average total vehicle damage cost per severity of crash.

2.8.7. For example, of the average 1.18 vehicles on involved in fatal crashes, 0.59 are motorcars. From this it is estimated that only 80%of motorcars involved in crashes are damaged. Therefore, in each fatal crash on average 0.47 motorcars are damaged. If the average cost of motor vehicle damage in fatal crashes is 17,585 monetary units, then the average cost per fatal crash is 0.47 * 17,585 = 8,264. This should be repeated for other categories of vehicle. An example calculation for fatal crashes is shown in Table 2.4.

Table 2.4: Calculation for average vehicle damage for fatal crashes

Type of vehicle damaged	Average cost of damage in monetary unit (from Step 3)	Number of vehicles damaged in each fatal crash (from Step 2)	Cost of damage in an average fatal crash in monetary unit
Motorcar	17,585	0.47	8,265
Minibus	16,585	0.13	2,156
LDV (up to 5000 kg)*	15,789	0.18	2,842
Heavy vehicle	26,437	0.08	2,115
Articulated vehicle	21,369	0.01	214
Passenger bus	18,559	0.02	371
Motorcycle	8,964	0.02	179
Bicycle	-	0.02	0
Animal drawn	-	0.00	0
Tractor	-	0.01	0
Total		0.94	16,142

Step 5: Present final results and highlight assumptions

2.8.8. Where there has been a lack of data and where assumptions and adjustments have been made, these should be highlighted when presenting the final results. The sensitivity of the adjustments or assumptions could be investigated. The aim is to present final estimates that can be considered as a conservative, but practical minimum estimate. The main assumptions that are often necessary when calculating vehicle damage costs include:

- If using only insurance company data, adjustments may be necessary to reflect that it will not be representative of all vehicles involved in crashes.
- The average number of vehicles involved in each crash may have to be adjusted downwards to account for crashes with vulnerable road users where negligible damage is incurred. The revised figure would be the average number of vehicles *damaged* in each crash rather than just *involved* in crashes.

2.8.9. The final results could be presented in a similar manner to that shown in Table 2.5:

Table 2.5: Average vehicle damage costs

	Fatal	Serious	Slight	Damage only
Average vehicle damage cost (in monetary unit)	16,142	10,568	8,647	5,213

2.9. Summary

2.9.1. By far the largest portion of property damage is that which stems from damage to vehicles. Other property damage is less significant, and those who are undertaking a crash costing exercise are advised to concentrate on collecting and analysing data on the cost of damage to vehicles only. Because of the typically large proportion of damage only crashes, the cumulative cost of vehicle damage can contribute to the greatest proportion of total costs of crashes in a country.

2.9.2. Previously, it has usually been the case that insurance company data has been used, but this is not representative of all crashes and will reflect the more costly crashes only. Therefore, in the past, unit vehicle damage costs have tended to be overestimated. Despite this, overall total costs have been underestimated because the total number of crashes was not adjusted for under-reporting within official statistics.

2.9.3. Although insurance company data is likely to remain as the main source of vehicle damage cost data, it might be possible to supplement this with data from other sources such as motor repair businesses, fleet owners or individual vehicle owner surveys, but experience has shown that this is often difficult. Data is also required on the proportion of vehicles *involved* in each crash. Following this, the proportion of vehicles *damaged* in each crash will need to be determined, because in some cases a vehicle may be involved in a fatal collision with a vulnerable road user but will suffer negligible vehicle damage.

Opportunities

- A more accurate estimate of vehicle damage may be obtained, by investigating the average cost of damage to vehicles involved in crashes, with pedestrians or other vulnerable road users separately, because although these crashes may be of a high severity, the cost of vehicle damage may be low. Until further research is completed in this area, arbitrary assumptions may have to be used.
- If data from insurance companies claims assessors or motor repair companies is not presently recorded in a useful manner, then it may be possible with their co-operation to set up a system of recording new incoming claims that would, over time, provide useful data for a crash costing exercise. There would be merit in maintaining such a system over the longer term, to enable a yearly update.
- It may be possible for an insurance regulator or National Road Safety Council or co-ordinating body to insist upon data provision from insurance companies.
- Government departments should be required to monitor crash involvement of their vehicles and the associated costs of vehicle damage, so that this information would be available for a crash costing exercise.

3. ADMINISTRATION

3.1. Introduction

3.1.1. Administration costs largely consist of police service costs in dealing with crashes, along with the costs of insurance and court administration. These costs are typically low compared to other cost components, such as vehicle damage. For example, in the UK in the year 2000, insurance administration accounted for just 2.8% of non casualty based costs and police costs accounted for only 0.6% of all non casualty based costs. Therefore, it is not worth spending much time and effort in producing detailed estimates of such costs. However, there may be interest within the organisations bearing the costs, such as the police service, as to how much they spend in dealing with crashes.

3.2. Data sources

3.2.1. The sources of data on police and insurance administration costs would be the police and insurance companies themselves. These organisations would have to be approached to provide their own estimates as to the amount of staff time, and hence the cost, in dealing with crashes. It would be hoped that this could be completed by severity of crash.

3.2.2. An alternative may be to add a similar cost or similar proportion of the total costs as used in other previous crash costing estimates. Some examples of the proportion added to reflect administration costs in previous studies are shown in Table 3.1. Assumptions would have to be used to decide the extent of administration costs per severity of crash.

Table 3.1: Examples of administration costs as a proportion of total crash costs

Country	Year	Cost of administration as a proportion of total crash costs
Argentina	1999	5%
Bangladesh	1998	1%
Jordan	1998	8%
South Africa	2000	5%
Vietnam	1998	3%

3.3. Calculation steps

3.3.1. Calculations would depend upon the form of data provided by the insurance companies or police service. If the amount of staff time is provided, then this would have to be multiplied by the staff wages to pay for that time. The output would be an estimate of the average cost per severity of crash. Alternatively, if a similar amount to that used in previous studies is used, then a simple proportion of total costs would be added to each severity of crash.

3.4. Summary

3.4.1. Police and administration costs are low compared to other cost components. The only source of data is from the police service, courts and insurance companies themselves. Alternatively a similar proportion of total costs to that used in other previous studies could be added. It is not worth spending much time and effort in producing detailed estimates of such costs.

4. LOST OUTPUT

4.1. Introduction

4.1.1. Lost output refers to the loss to the economy of the productive capacity from those affected by crashes. It is typically the largest casualty related resource cost incurred in developing countries, and can range from as little as one day for slightly injured casualties, to decades of foregone work for one killed or permanently disabled in a crash.

4.1.2. Key weaknesses of the traditional method of valuing lost output included:

a) Average incomes are usually used with little thought given to the opportunity costs, i.e. the next best use of the time. The poor will have few financial or property assets and their time may represent their greatest asset.
b) Previously, lost output calculations were limited to the primary victim, and did not include lost output of carers, visiting friends and family, or the lost output of those delayed by crashes. (Travel time delays were estimated to account for 11%of total economic costs lost in crashes in the US (National Highway Traffic Safety Administration, 2002).
c) National average incomes were the most common proxy used for estimating the income of road traffic casualties. While crashes will concentrate in the more developed areas of a country with the highest incomes, the poor are assumed to be at greater risk to crashes due to their restricted transport choices and limited means to protect themselves from the exposure to traffic. Thus the use of average incomes may overstate the incomes of this group of casualties.

4.2. Data sources

4.2.1. The two main types of data requirements for costing lost output are:

1) Amount of time, i.e. hours, days, months or years, lost by casualties.
2) Average wages of casualties.

4.2.2. While casualties' losses will be the priority of any costing, it is also useful to know these factors for others involved, i.e. carers, visitors, and those experiencing travel delays from crashes.

Data required on amount of time lost

4.2.3. The amount of working time lost for fatal casualties is the time they could have spent working in the future had they not suffered a premature death. This is usually measured from the time of death to the age of retirement. The main source of data on lost working time for fatal casualties is the average age at the time of the crash (taken from published crash statistics based on records compiled by the police), subtracted from the average age of retirement. The latter may be based on the public sector retirement age, with an adjustment made for private sector work practices.

4.2.4. For the seriously and slightly injured, the amount of working time lost is the time they would have spent working had they not been disabled, or whilst recovering in hospital or at home. This may include the number of days lost while visiting a doctor or clinic. It may also be worthwhile including the time lost whilst looking for a new job, as many of the injured may lose their job as a result of not being able to work due to being injured in a crash. There is also the lost output of the casualties' families and carers, who may not be able to work when looking after the casualties. It should be noted that only the lost time of those of working age should be included, because many of those injured or killed will not have been working as many will be children and/or students. While they may not miss any work, it is still assumed that a working family member may be required to care for them.

4.2.5. A source of data on lost working time spent in hospital or other medical facilities for serious and slight casualties is hospital or medical records. Casualty surveys are a more time consuming option but would provide more data. In the past these have often taken place in hospitals or have focussed on police reported crash casualties. However, these casualties may not be representative of all casualties, many of whom are not necessarily treated at hospital or are reported to the police. Surveys conducted in the hospital may not necessarily cover longer-term recovery at home, and subsequent visits to health facilities.

4.2.6. An alternative source (which was tried within the case studies) are household casualty surveys, which in the past have often been completed by the medical sector. Household casualty surveys will include casualties who did not necessarily receive formal medical assistance, and the working time lost by the casualty's carers can also be assessed. However, experience from the case studies showed that the amount of effort and difficulties involved in conducting household surveys should not be underestimated.

Data required on average wages of casualties

4.2.7. The basic sources for income data include:

- National income statistics.
- Travel time surveys.
- Casualty surveys.

4.2.8. National income statistics have been the traditional source for estimating the lost output calculations. Various census and living expenditure surveys produce national average income figures, which are often given for different occupations and for urban and rural classifications. However, these estimates will represent the general population rather than road traffic casualties.

4.2.9. Travel time surveys have begun to be conducted in developing countries in recent years. They are usually conducted at the road-side and road users, at least vehicle occupants, are asked about the length of their trip and their average incomes. However, in addition to excluding pedestrians and occasionally non-motorised vehicle users, travel time surveys can be very route sensitive, and vary widely according to road type and location. Income data from travel time surveys have been used to estimate the lost output in a previous crash costing in Bangladesh, with pedestrian income assumed to be that of the poverty line.

4.2.10. Casualty surveys (hospital or household) can provide information on the average wage rates of casualties as well as their carers. However, as mentioned previously, hospital casualty surveys may not be representative of all casualties, and household casualty surveys can be difficult and labour intensive. Housewife work, although not income earning, has previously been valued at the average female wage rate. It may be possible for casualty surveys to provide information on carers' income, but in the absence of such data, carers can be assumed to earn the average female wage rate.

4.2.11. A summary of the major advantages and disadvantages for the main sources of data is provided within Tables 4.1 and 4.2. It should be noted that even the most comprehensive of the above data sources will not include all possible effects upon lost output. For example, if a family has only been able to invest in one child's education and that child is then killed early in life (but after the education investment), the family has lost its chance of a return on its investment. Injuries may also effect career advancement or lost education, leading to a possible long-term loss of income. The fact that it is not possible to estimate and include all such effects on potential future lost output supports the case for a greater amount to be added to reflect 'human costs' (described later within Chapter 6).

Table 4.1: Summary of data sources for amount of time lost

Data source	Advantages	Disadvantages
Fatal Casualties:		
Crash statistics and average age of retirement	No alternatives.	Crash statistics will not include cases of under-reporting. Average age of retirement based on the public sector will have to be adjusted to include private sector practices.
Serious and slight casualties:		
Hospital/medical records	Relatively easily to obtain.	Not representative, and will not cover longer term home recovery or time spent looking for a new job.
Hospital casualty survey	More data (including income) can be obtained.	Not representative, and will not cover longer term home recovery.
Household casualty survey	Representative and even more data (including income, home recovery and effect on others) can be obtained.	Costly and time consuming to conduct such surveys.

Table 4.2: Summary of data sources for average wages of casualties

Data source	Advantages	Disadvantages
National income statistics	Easy to obtain and default choice for many studies.	May overestimate casualties' output as they are expected to be lower income.
Travel time surveys	Better estimate of vehicle occupant's income. Likely to include value of leisure time as well.	Will not include pedestrians. Likely to be influence by area, road type and mode of transport.
Hospital casualty survey	Casualty specific and other data (such as loss of working time) can be obtained.	Costly and time consuming.
Household casualty survey	Casualty specific and other data (including loss of working time, home recovery and effect on others) can be obtained.	Even more costly and time consuming.

4.3. Lost output calculations

Step 1: Identify average amount (time) of lost output per casualty, by severity

4.3.1. Information on the amount of missed work will need to be identified from the potential data sources described above. The amount of lost time per casualty should be categorised by severity of casualty. Ideally this should include the work time:

- Foregone in the case of death or disability.
- Spent recovering from an injury (or pre death) in hospital or home.
- Spent looking for new employment.

Step 2: Identify average amount (time) of lost output per carer, by severity

4.3.2. Casualties of crashes will usually require caring for, which is often provided by another family member. If available, information on the amount of work missed due to having to care for road casualties should be included in the crash costing. This should be identified where possible from the potential data sources described above, and should be categorised by severity of crash.

4.3.3. As an example, findings from the Bangladesh case study as to the amount of lost time of casualties and carers are shown below in Table 4.3

Table 4.3: Bangladesh case study average lost time of casualties and carers

Casualty severity	Average Amount	Note
Fatality	30 years	Retirement age of 58 and average road death age of 28.
Serious injury	35 days	20 days recovery and 7 days looking for new work, 8 days by carer.
Slight injury	5 days	3 days recovery and 2 days looking for new work.

Step 3: Identify average wages of casualties and carers, by severity

4.3.4. The average wages of road casualties should be identified from the potential data sources described previously. The average wages per casualty should be categorised by severity of casualty. The average wages of carers should also be categorised by the severity of casualty that they are caring for. An example of the output from this Step is shown in Table 4.4.

Table 4.4: Average wage rates of casualties and carers (example)

Casualty severity	Average wages of casualty ($US per month)	Average wages of carers ($US per month)
Fatality	416	327
Serious injury	431	316
Slight injury	499	298

Step 4: Estimate the cost of lost output for fatal casualties

4.3.5. A typical value for the average number of years of lost output for road deaths is about 30 years. Each future year's lost output will need to be discounted to a present value. Information on appropriate discount rates should be available from nationally published statistics.

4.3.6. The total average lost output for a fatal road casualty is the sum of each future year's lost output (described by the formula below).

$$\text{Lost output (fatality)} = \sum_0^n \frac{w}{(1+r)^n}$$

Where w = average yearly wages of fatal crash casualty.
r = discount rate (e.g. if the discount rate is 10% then r=0.1) .
n =average number of years of lost output per fatal casualty.

4.3.7. If information is available to be able to consider those permanently disabled, their future lost output would need to be discounted in the same manner as a road death. Also, if information on the average amount of lost working time and average wages of carers associated with fatal casualties is available, then this should also be included. The average amount of working time lost by carers should be multiplied by the average wages of carers.

Step 5: Estimate the cost of lost output for injured casualties

4.3.8. From the data collected and compiled in Steps 1 and 2, the average total number of lost working days should be known for those seriously and slightly injured, along with their carers. It should be noted that the seriously injured range from those who spend one night in hospital to those who are permanently paralysed or die beyond the 30-day definition of a fatal casualty. Hence, the range in time lost by the seriously injured can be large. From Step 3, the average wages of the serious and slightly injured casualties (and their carers) will have been estimated. Therefore, the average lost output for serious and slight casualties can be calculated thus:

Lost output (serious) = {(no. in-patient days and days visiting medical facilities + no. days at home recovering from injuries + no. days searching for new employment) * (average wages of casualty)} + {(no. days spent caring for casualty by carer) * (average wages of carer)}.

Lost output (slight) = {(no. days spent visiting medical facilities + no. days at home recovering from injuries + no. days searching for new employment) * (average wages of casualty)} + {(no. days spent caring for casualty by carer) * (average wages of carer)}.

Step 5: Check sensitivity of assumptions

4.3.9. Where there has been a lack of data, and where assumptions and adjustments have been made, these should be highlighted when presenting the final results. The sensitivity of the adjustments or assumptions could be investigated. Lost output, especially discounted future lost output, is not an exact calculation, and values will be influenced by such key assumptions as the discount rate, growth rate, and recovery time. The effect of these assumptions should be checked. The aim is to present final estimates that can be considered as conservative and practical.

4.3.10. The final results of average lost output per casualty could be tabulated for each severity category. Table 4.5 shows typical ratios for the values of lost output compared to slight casualties.

Table 4.5: Typical average lost output ratios for each severity of casualty

	Fatal	Serious	Slight
Average lost output per casualty	1,200	17	1

4.4. Summary

4.4.1. Lost output is typically the largest casualty related resource cost incurred, and can range from that resulting from as little as one day lost time for slight casualties, to decades of foregone work for those killed or permanently disabled. Lost output is believed to have been underestimated in previous costings, as it was traditionally limited to the primary victim only and to the number of work days lost to recovery (or death).

4.4.2. Case study household survey data has shown that some injured will not be able to return to their former jobs, and will spend additional time looking for employment. In the Bangladesh case study, the seriously injured also reported a decrease in income after a crash. Lost output estimates should also include that foregone by carers: in the past, lost output calculations have been restricted to the victim only. A further concern is the fact that previous costings have concentrated on the short term where injuries are concerned, with little information included on the longer term disabled.

4.4.3. Data is required on the amount of time lost by casualties and their carers, along with their average wages. This may be available from nationally published statistics, along with hospital or medical data and travel time surveys. It may be possible to collect more representative data via hospital or household casualty surveys (including information related to carers), though these can be difficult and time consuming.

Opportunities

- Lost output valuations have traditionally been limited to the casualty only and restricted to recovery time or years lost output in case of road fatality, thus the total lost output has been under-estimated. Here we have proposed that other lost time including that lost by carers is also taken into account.
- Adjustment factors such as discount rate and growth rate over a thirty-year period are important assumptions which should be properly documented and tested.
- If casualty based incomes are used, the poor, with their lower incomes, may appear to be more expendable, the exact opposite objective of most donor programmes. Opportunity costs are not accurately reflected in earnings, and this will again affect the poor, as time may be the only asset they have. The longer-term effects on lost output of a loss or disruption to education are not understood. If a social objective of alleviating poverty is the aim, the fact that it is not possible to estimate and include all such effects supports the case for a greater amount to be added to reflect ‘human costs’ (described later within Chapter 6).

5. MEDICAL COSTS

5.1. Introduction

5.1.1. Medical costs of those injured in crashes range from at-scene through to recovery, or death, and include first aid and rescue services (ambulance), hospital costs (food and bed, operations, x-rays, medicines, doctors services) and rehabilitation costs (treatment and prosthetics). These are all direct costs with some being private and some being public, and can be long term costs, depending upon the severity of injury.

5.1.2. In the past in developing countries, medical costs have only accounted for a small percent of total crash costs and have not been given much priority. This approach has failed to appreciate the effect medical costs have had on the families involved. The medical costs will often be the first and most tangible economic burden experienced by the family. Insufficient consideration has also been given to the effect on hospitals of road casualties. For example, if a crash victim is using a hospital bed, this means it may not be available to others requiring medical treatment. The medical resources available to treat other patients as a result of a reduction of road casualties requiring treatment could be significant.

5.2. Data sources

5.2.1. The basic sources for estimating medical costs include:

- National hospital expenditure estimates, i.e. average cost per in-patient day.
- Insurance (or social security) payments.
- Individual hospital studies.
- Road traffic casualty surveys.

5.2.2. Although much effort has been put into establishing national trauma and/or injury surveillance systems in many developing countries, these do not usually include cost data.

5.2.3. National average hospital bed expenditure, i.e. average cost per bed, has been the traditional proxy for medical costs, and these can often be found disaggregated by main facility type, i.e. tertiary centre versus local health care clinic.

5.2.4. Insurance companies are often able to provide estimates of medical costs of road traffic casualties from their claim data. Several Southern African countries, including South Africa, have a fund which pays for the medical treatment of all road casualties. Other countries, including Ghana, have a fund which pays for casualties of hit and run collisions, and will contain data on medical costs incurred.

5.2.5. Individual hospitals may be able to provide information on costs, but these will be indicative of the specific hospital and can vary widely. While private hospitals in developing countries can be assumed to have better cost information, they will not be representative of the public hospitals where the vast majority of road traffic casualties will be treated.

5.2.6. Casualty surveys have been undertaken in some countries and were attempted in the case studies. A recent costing in Iran reviewed 500 patients' files and divided them into 18 injury levels (Ayati, 2002). It would be possible to include the costs of travel to visit medical facilities within such casualty surveys.

5.2.7. It should be noted that none of the data sources are able to reflect the opportunity costs involved. Casualties are often emergency cases, which take precedence over the patients who have scheduled operations. Table 5.1 below provides a comparison of the different data sources.

Table 5.1: Summary of data sources for medical costs

	Advantages	Disadvantages
Published data	Readily available and regularly updated.	National averages do not include costs paid by families.
Hospital studies	Data from more relevant public and trauma hospitals.	Private hospitals likely to have better information but not be representative. Likely to be hospital average and not ward specific (surgery, orthopaedic). Unlikely to include costs paid by families.
Insurance claims	Road traffic casualty specific and include information on treatment.	Unrepresentative of all casualties. Compensation amounts may be reduced for contributory negligence.
Road traffic casualty surveys	Better understanding of usage, i.e. length of hospital stay, number of out-patient visits. Information on families' out of pocket costs. Better understanding of cost burden on the low income.	Costly exercise and expenses can vary widely with range of casualty severity. Dependent on memory recall and casualty honesty. Costs may not be representative as they will be influenced by what can be afforded, i.e. private hospitals.

5.3. Medical cost calculations

Step 1 Identify available medical cost and usage data

5.3.1. While crash costings tend to be conducted by transport economists or road safety professionals, epidemiology, public health and health economics departments should be contacted for information on medical costs. Table 5.2 shows the basic data requirements:

Table 5.2: Data requirements for medical costs

	Usage (units) and cost
Death	At scene care, transport, in-hospital stay, out-patient treatment.
Serious injury	At scene care, transport, in-hospital stay (doctor fees, food, room, operations and tests), drugs, out-patient treatment, prosthetics and rehabilitation.
Slight injury	Out-treatment care, drugs.

Step 2 Consider road traffic casualty survey

5.3.2. Medical cost estimates are believed to be 'computed best bottom-up' (Miller, 2001), and consideration should be given to undertaking a road traffic casualty survey, as few countries are believed to have done so. As the case studies showed, it is much more difficult and time-consuming to try to identify casualties on a random basis. A much more affordable method is to interview casualties recorded in police or hospital databases, although these may not be representative of all casualties. They will allow a prospective survey to be undertaken, which would avoid the problem of memory recall.

Step 3 Calculate average medical costs by casualty severity

5.3.3. Different costs are likely to be estimated by different data sources. After comparing and adjusting for any duplication between sources, conservative but practical estimates should be adopted. Calculations should be undertaken using the following formulas:

Medical costs for a fatal casualty = at scene and transport costs
+ in-hospital costs
+ out patient costs
+ discounted funeral cost
(see Section 4 on Lost Output for discounting future costs)

Medical costs for a serious casualty = at scene and transport costs
+ in-hospital costs
+ out patient costs
+ rehabilitation and prosthetic costs

Medical costs for a slight casualty = out patient costs

5.3.4. Medical costs have tended to receive less priority, as they were much lower than property damage or lost output estimates. However, in terms of the burden to the victims and to the health sector, they are much more important. In developing countries, where per capita health care budgets can be as low as less than US$10, medical expenditure on road casualties are quite costly.

Step 4 Document assumptions and sensitivities

5.3.5. Estimated costs will depend on the statistical interpretation of the results, but large standard deviations can be expected. For example, the standard road casualty definition of a serious injury can cover a wide range of situations. Although the majority of serious injury casualties will recover completely, if not quickly, a few cases will incur multiple operations, permanent disability and long-term care requirements.

5.3.6. Where there has been a lack of data, and where assumptions and adjustments have been made, these should be highlighted. The sensitivity of the final results to the source data could be investigated. The aim will be to provide a conservative and practical estimate.

5.4. Summary

5.4.1. Medical costs only usually constitute a small proportion of the total costs of crashes. However, the burden of road casualties on medical sector resources is likely to be significant. Also the medical costs will often be the first and most tangible economic burden experienced by the family.

5.4.2. Traditionally medical costs have been assessed from the perspective of individual hospitals, with data provided on cost per bed estimated from overall public sector budget allocations. However, medical costs may consist of both private and public sector expenditure.

5.4.3. To estimate the medical costs resulting from casualties of crashes, data is required on a range of items for example the cost of at scene care, transport, in-hospital stay, out patient treatment, drugs and prosthetics. Data may be available from national hospital expenditure estimates, insurance payments, hospital studies and casualty surveys. While hospital based casualty surveys are much easier to undertake, they may not be as representative as household surveys.

Opportunities

- The burden of road casualties on medical resources is not likely to be fully reflected in current costings. For example, the knock-on effect of a patient not receiving treatment because resources are being used to treat a crash victim instead have not been assessed.
- Deaths may be inevitable, but when they occur thirty years premature, they can pose a sudden financial drain, which is not reflected in the discounted value.
- The above supports the case for a greater amount to be added to reflect 'human costs' (described later within Chapter 6).
- Future research should attempt to assess the cost of disability and long term effects.
- Greater collaboration is needed between road safety and public health professionals, as both need to estimate the burden of road traffic casualties.

6. HUMAN COSTS AND EFFECT ON THE POOR

6.1. Introduction

6.1.1. As well as the cost elements described previously, which directly or indirectly affect the economy of the country, there are also other effects of crashes such as suffering and bereavement and other adverse effects on the quality of life. Therefore, a sum to reflect these human costs, usually defined as 'pain grief and suffering', is added to the overall estimate of crash costs.

6.1.2. If crash costs are ultimately intended for use in conventional cost-benefit analysis, or in an assessment of effects on resource allocation efficiency, then the most relevant method is the Willingness-To-Pay method. This has been specifically designed for use in conventional cost-benefit analysis. However, as stated earlier in section 1.3, this method may be extremely difficult to use in developing countries, based as it is on the completion of complex questionnaires which relate to perceived risk and payment by individuals to avoid a given (hypothetical) level of risk. Therefore, the Gross Lost Output (or Human Capital) method, with an amount to reflect pain grief and suffering, is the preferred method for use in developing countries.

6.1.3. The amount to add to reflect pain grief and suffering within the Human Capital method is essentially a political decision, to be made for each crash costing undertaken. Because of the disproportionate effect of crashes upon the poor, an amount added to reflect pain grief and suffering could be considered as part of an overall objective of poverty alleviation. The greater the amount added, the higher the value society would place upon the prevention of crashes. Therefore, although an element of judgement is unavoidable in deciding how much should be added to reflect pain grief and suffering, the decision can be informed by the following:

- Consideration of the wider effects of crashes on low-income households (described below), and other effects not included within other cost elements.
- Consideration of the amounts that have been added and used successfully in developed and developing countries (described below).

6.2. The wider effect of crashes on low income households

6.2.1. As stated earlier, the addition of an amount to reflect pain grief and suffering could be considered and justified as part of an overall social objective of poverty alleviation. In developed countries, the poor are known to be at greater risk to crashes. For example, the UK Road Safety Strategy acknowledges how children in the lowest economic stratum are five to six times more likely to be killed or seriously injured than those in the highest stratum (Department of the Environment, Transport and the Regions 2000). It has been long suspected the same applies to developing countries, as the poor will have limited, if any, transport mode choice and they will be less able to protect or distance themselves from the exposure to traffic. Both their homes and work place are assumed to be physically closer to the threat of crashes.

6.2.2. Where it was possible to collect suitable data, our case study surveys showed how difficult it can be for the poor to suffer the consequences of crashes, as they have less savings and financial assets to absorb the shock of having a family member killed or injured in a crash. We describe below some of the wider effects of crashes on the vulnerable, using data from the Bangladesh case study as an example. We also provide a description of the consequences suffered by an individual and their household, as a result of being a crash victim, recorded during an interview as part of the South African case study.

6.3. Summary of the effects on poorer households from Bangladesh case study

6.3.1. **Age:** Children accounted for one quarter of those killed on the roads (24%). Of the 49 child road deaths identified in the household survey, only two were under the age of 5. While 40%of Bangladesh's population are under the age of 15, children are assumed to travel much less than adults and in most high income countries, account for a much smaller share of road deaths. Children did account for a smaller share of the seriously injured (12%).

6.3.2. **Females:** As was expected, females accounted for a minority of road deaths (18%) in Bangladesh and slightly less of those seriously injured (16%). While boys still outnumbered girls, what was surprising was the relatively high involvement of girls in road deaths. Females under the age of 16 accounted for over half (52%) of all females killed, three times the proportion of boys who accounted for only 17.5%of all males killed.

6.3.3. **Road user type:** Vulnerable road users (pedestrians, non motorised vehicle users and two/three wheel motor vehicle occupants) accounted for almost 65% of all those killed and 78%of those seriously injured on the road. Pedestrians represented the largest proportion of road deaths (41%) and seriously injured (25%). Non motorised vehicle users accounted for 12%of deaths and 29%of seriously injured (rickshaw 22% and bicycle 7%). Two/three wheel motor vehicle occupants were 13%of deaths and 24%of seriously injured.

6.3.4. Four wheel motor vehicle occupants represented only 35%of those killed and, 22%of those seriously injured. Bus occupants accounted for 23 percent of deaths and 14%of serious injured.

6.3.5. **Urban/rural distribution:** Rural households were involved in almost three-quarters of fatal crashes (73%), but with 30%occurring in urban areas.

6.3.6. **Poor:** The poor were defined as the bottom 45%in terms of per capita income (household income divided by the number of household members). This definition was based on the finding of a recent study by the Bangladesh Bureau of Statistics. Both rural and urban poor were over-represented in fatal crashes, as poor households accounted for 57 percent of households involved in fatal crashes.

6.3.7. **Victim's role in household:** When asked about the social role of the victim in the household, most of those killed were described as children of the head of the household (44%). With the age distribution given, many of those killed appeared to be young adults living with their parents. Many do not appear to have started earning yet, as 36%were described as not contributing to the household income, and students accounted for the largest number of road deaths (28%). Parents may well be losing their social security source as their children are dying before them.

6.3.8. Poor families are more likely to lose their head of household or their spouse, and thus suffer immediate economic effects. Among the poor, 32%of road deaths occurred to head of households or spouses, compared to 21%for non-poor.

6.3.9. **What were effects on victim and household?** Over 70%of poor households reported their household income, food consumption and food production to have decreased after a road death. Among the non-poor households, the effects were less, with 57%reporting household income to have decreased, and slightly fewer (54%) stating their food consumption and production had worsened. Three quarters of all poor households affected by a road death reported a decrease in their living standard, compared to 59%of non-poor households.

6.3.10. **What was the coping strategy adopted?** Some 61%of poor households were forced to arrange a loan after a road death, while only 34%of non-poor had to do so. A larger proportion (35%) of poor bereaved households sold an asset, compared to 21%of non-poor. Few households reported having to give up work or take on extra work after a road death, but again poor families were more likely to report these effects.

6.3.11. Only a minority of bereaved households received any compensation. Approximately one-quarter of poor households received private compensation, compared to 14%of non-poor. Compensation from insurance companies was virtually non-existent, with only one poor and one non-poor bereaved households reporting receiving any insurance compensation.

6.4. Individual example from South Africa

6.4.1. Mr V was riding in a taxi. When he climbed off the taxi – a vehicle knocked him down. The vehicle that knocked him down just drove on, and did not stop to assist him. He was unconscious, and eventually passers-by assisted him and an ambulance took him to hospital. He is now physically disabled – in a wheelchair. He had school going children, one of which has lost 2 years of education, because she has to look after her father. Mr V used to do piece jobs wherever he could, but because of his disability is unable to work. He has applied to the Road Accident Fund, but after 2 years is still awaiting a response. Mr V was very disillusioned during the interview, and said that the accident has changed his life for the worse. His daughter has stopped going to school to take care of him, and this saddens him greatly. He tries to phone the lawyers in charge of the case, but they still have no answer for him. His wife has a casual job doing housework, to bring whatever means of income in that she can, to help the family survive.

6.5. Amounts to reflect human costs used in developed countries

6.5.1. In 1967, Dawson estimated net lost output, i.e. lost output net of consumption of goods and services for the UK. This led to negative values for non-productive members of the community, such as pensioners and housewives. To offset this, a 'notional' allowance for 'pain, grief and suffering' or 'human costs', was added to the costs.

6.5.2. The use of an amount to reflect 'pain grief and suffering' in Great Britain has been well documented, since Dawson first produced his cost methodology for use by the (then) Ministry of Transport. Table 6.1 shows how 'pain grief and suffering', expressed as a percentage of the total cost of a fatal accident, has changed over time.

Table 6.1 Human costs (or equivalent) as a percentage of the total fatal crash cost Great Britain

Period	Cost methodology	Percentage	Comment
63 - 67	Human Capital (net)	62	Derived by Dawson.
68 - 76	Human Capital (Gross)	30	Derived by Dawson.
77 - 78	Human Capital (Gross)	40	Increase recommended (SACTRA 1992).
79 - 85	Human Capital (Gross)	28	Lost output component doubled with change in discount rate used.
1986	Human Capital (Gross)	48	Pain, grief and suffering increased to keep accident costs comparable with values of time in COBA.
87 - 99	Willingness-To-Pay	65	Change in methodology gives value for 'human costs'.

6.5.3. The pattern for serious and slight crashes is fairly similar. Thus the pain, grief and suffering component for serious crashes was as low as 32%in the early 1990's, with finally the 'human cost' component within the introduction of the Willingness-To-Pay method being over 80 per cent. Similarly for slight crashes pain, grief and suffering has ranged from six to about 14%of total costs. With the introduction of the Willingness-To-Pay method, human costs were estimated to be 66%of total costs for a slight crash.

6.5.4. In a study of the socio-economic cost of road accidents in 1994, Alfaro et al (1994) reviewed the methodology used in eleven countries of the European Community to cost a fatality. This analysis showed that four countries used the WTP method to determine 'Human' costs whilst seven did not. Of the seven that did not, all determined lost productive capacity but two of these, namely Germany and Norway made no inclusion for 'Human' costs. Table 6.2 shows data compiled from the Alfaro et al 1994 study.

Table 6.2: Human costs as a proportion of the total fatal casualty cost for a crash in European countries (listed in ascending order of total costs)

Country	Method for Human costs	Lost productive capacity (%)	Human costs (%)	Other costs (%)	Total cost ECU (1990)
Spain	Human costs estimated as 50% of production loss.	66	34	<1	170,989
France	Loss of life expectancy calculated by special model of optimisation of time utilisation. Pain Grief Suffering estimated from compensation payments by the court.	92	7	1	234,794
Norway	-	100	-	-	251,619
Belgium	Court compensation payments.	95	4	<1	398,815
Austria	Insurance payments for pain, disfigurements and permanent damage.	99	-	<1	592,640
Denmark	The level is politically determined.	34	67	<1	628,050
Germany	-	100	-	<1	670,776
United Kingdom	Individual Willingness-To-Pay.	29	71	<1	931,274
Sweden	Individual Willingness-To-Pay.	46	54	<1	956,110
Finland	Social Willingness-To-Pay, calculation based on welfare payments.	39	61	<1	1,414,418
Switzerland	Social Willingness-To-Pay, crash prevention costs in industry and other sectors related to acceptance of risk.	38	62	<1	2,165,560

Source: COST313 Socio-economic cost of road accidents (Alfaro et al, 1994)

6.5.5. For those countries not using the Willingness-to-Pay method, but including a sum to reflect 'pain, grief and suffering', values ranged from four to seven% of total costs in Belgium and France, to 67%in Denmark, where the values were assigned on a purely political basis.

6.5.6. A follow-up study to that carried out by Alfaro et al (1994) was undertaken by Trawen et al (2002), who examined costs and changes in methodology used by Western countries over the period 1990 to 1999. The study showed that a range of methods was still being used in Western European and North American countries to cost fatal crashes. Germany was found in 1999 to include a small sum (1.3 % of total costs) to reflect human costs, whereas in 1990 no human costs were included. In Austria, human costs were excluded in 1990, and in 1999, they were 'expected to be included in other costs and estimated from insurance payments'. In 1999 Switzerland, reduced human costs by changing from a social Willingness-To-Pay method to court compensation payments. This had the effect of reducing the cost of a fatal crash in 1990 by over 50%in 1999. Also in Australia, human costs in 1999 were estimated from court compensation methods and 'political standards', and represented about 30%of total costs. This study showed that whilst different methods are still being used throughout the developed world to cost fatal crashes, there was now a tendency for most to use the individual Willingness-To-Pay method.

6.5.7. In using the Gross Output (Human Capital) method with sums to reflect 'pain grief and suffering', a number of points should be borne in mind. Firstly, if the Willingness-To-Pay method is used instead of the Human Capital method, then costs would be considerably greater. In other words, values derived by the Human Capital method even with sums added to reflect 'pain, grief and suffering', can be considered a minimum estimate of costs. For example, in Great Britain in 1987/88 when the change was made to the Willingness-To-Pay method, the valuation of a fatal crash virtually doubled. Similarly, the Alfaro et al (1994) review of crash costs in Western Europe showed that, in those countries using the Willingness-To-Pay method, the average cost of a fatal crash was up to four times greater than in those countries which made little or no allowance for human costs. Even when correcting for the effect of standard of living, costs were still two to three times greater.

6.6. Amounts to reflect human costs used in developing countries

6.6.1. The costing of crashes was undertaken as far back as the early 1960's in a few developing countries, and Jacobs (1976) collated information on crash costs as follows.

Table 6.3: Crash costing in developing countries 1960 - 1971

Country	Year	Method	Comments
Kenya	1961	Net output.	No addition for 'pain grief and suffering'.
Ivory Coast	1970	Gross output.	"
Thailand	1963	Net output.	"
(Then) S Rhodesia	1961	Net output.	"
South Africa	1963	Insurance payments.	"
Ghana	1970	Net output.	"
Turkey	1971	Gross output.	"

6.6.2. Over the above time period, some countries switched from the net approach to the gross output method described by Dawson in 1967. None of the countries incorporated a sum to reflect 'pain, grief and suffering' in their analyses, confining their assessments to resource costs only. In concluding his analysis, Jacobs made the point that: 'by basing the cost of a fatality on the loss in output (net or gross) of the average person involved, the implicit assumption is that the objective of 'life' appears to be to maximise national output or personal savings'. On this basis, the State will continue to invest in accident prevention schemes up to the margin where the value of either output or personal savings of the individual who is saved no longer exceeds (the extra cost) of the accident prevention. Needless to say, this is an extremely limited outlook on life's objectives which actually ignores the quality of life itself'.

6.6.3. In their detailed review of crash cost methodology prepared for use by the World Bank, Hills and Jones-Lee (1980) advised that if the gross output approach is to be used to cost crashes in the developing world, then sums should be added to reflect the pain, grief and suffering of those involved and their loved ones. They point out that, even where a full output-based method is justifiable, the inclusion of the subjective element of cost to cover pain, grief and suffering may need to be interpreted somewhat differently in many developing countries. In situations where insurance may cover only damage to the vehicle, but not to third parties, and in which ordinary disability or widow's pensions are rare or unknown, the death or serious injury of the breadwinner can have disastrous consequences for the dependants. At worst, starvation and, at best greatly reduced consumption are very real prospects for the family of a man killed in a crash. Dawson's type of analysis, centred upon the individual rather than the family, is arguably insufficient to accommodate this type of situation.

6.6.4. A more recent TRL review of crash costs in developing countries (Jacobs et al 2000), showed that almost all countries for which data were available used the Human Capital method. A previous report (Transport Research Laboratory (1995), provides guidance on the basic Human Capital method, including a recommendation to add a sum for pain, grief and suffering. Since then, a number of countries have adopted this method, usually with variations which relate to financial and time constraints and also availability of data. In Transport Research Laboratory (1995), it is suggested that sums to reflect pain grief and suffering should be:

- 28%of total costs for a fatal crash.
- 50%of total costs for a serious crash.
- 8%of total costs for a slight crash.
- 0%of total costs for a damage only crash.

6.6.5. These values were in fact those used in costing crashes in Britain in the early 1980's, and many countries have adopted these values. However others, including Bangladesh, Vietnam and Kerala State, India, used the values recommended in a study of crash costs in India.

These again appear to be fairly subjective, but were fairly close to those recommended in Transport Research Laboratory (1995), as follows:

- 20%of total costs of a fatal crash.
- 50%of total costs of a serious crash.
- 30%of total costs of a major crash.
- 1%of total costs of a minor crash.

6.7. Summary

6.7.1. An amount to reflect pain grief and suffering is usually added to the total costs for each severity of crash when using the Human Capital method. The amount to be added could be considered as part of a social objective of poverty alleviation, as crashes are known to have a greater adverse effect upon the poor. The amount to be added is a political decision, and an element of judgement is unavoidable. However, the amount to be added can be informed by consideration of the amounts added, and used successfully in developed and developing countries (described above). An appreciation of the wider effects of crashes on poorer households (also described above), as well as the effects that it has not been possible to quantify accurately and include within other cost elements, could also be used as justification for adding a greater amount to reflect pain grief and suffering.

Opportunities

- The Willingness-To-Pay method is considered to be the most relevant method for crash costing and has now been adopted by many Developed Countries. However, this method may be very difficult to apply in Developing Countries based as it is on complex questionnaires asking about perceived risk and payment for the avoidance of hypothetical risk. Therefore, we have recommended the use of the Human Capital method (with an amount added to reflect human costs) for crash costing in Developing Countries. Overcoming the problems in the use of the Willingness-To-Pay method in Developing Countries could be the subject of future research.

PART B:

Calculation of National Costs and Application

7. NATIONAL CRASHES AND CASUALTIES

7.1. Introduction

7.1.1. Within the previous Chapters we have provided guidance on calculating the average costs of each cost element for each crash by severity. Using this data, the total national cost can only be estimated after the total number of casualties and crashes are known.

7.2. Data sources

7.2.1. The main potential data sources for estimating the total number of crash casualties are as follows:

- Police.
- Medical sector and injury surveillance systems.
- Insurance data.

Police data

7.2.2. The police have been the traditional source of road traffic casualty data, and they are the logical starting point, as most often they will have the legal responsibility for crash and casualty reporting. They are also usually responsible for providing a level of detail, to allow for hazardous location identification and thus analysis and design of remedial measures. However, it should be acknowledged that road traffic casualties and crashes, like other incidents recorded by the police, suffer from under-reporting, often severely so. The extent of under-reporting is described in more detail in the Section 7.3, and is due to three main problems:

- *Non-reporting* refers to the crashes that are never reported to the police. The parties involved may be unaware of any requirements to report a crash, locating the police may be too difficult or they might prefer to settle the matter independently. Private settlements are likely to be quicker, as involving the police and judiciary may postpone compensation for years, and there may be the risk that compensation might have to be shared with others, including low-paid police.

- *Mis-recording* occurs when the police misdiagnose the severity of the casualty. Police are not medically trained to diagnose casualty severity, nor is it always possible to identify casualty severity immediately after the crash, and police often do not have the resources to monitor change in severity status. In the UK, the police were estimated to under-estimate the casualty severity twice as often as they overestimated it, (Simpson, 1996). There may also be a problem with police only reporting the ‘extremely severe' injuries, as serious injuries.

- *Under-recording* is when crashes reported to the police are incorrectly excluded from the official statistics. For instance, where the police do not complete the data collection process and although the crash has been reported to the police, it is not included in the official statistics.

Medical sector and injury surveillance systems

7.2.3. In addition to the police, road traffic casualty data is often available from the health sector through mortality and/or morbidity surveillance systems. For example in South Africa a national non-natural mortality surveillance system (NMSS) and national non-fatal injury surveillance system (NNFSS) has recently been created. The NMSS collates information readily available from documentation that arises from post mortem investigations in mortuaries. The NNFSS was created to collate information from designated ‘sentinel’ hospitals.

7.2.4. While hospitals can be assumed to record more road traffic injuries than the police, they will not be able to estimate the actual number, as many casualties may choose alternative treatment or due to lack of hospital resources, be unable to visit or be admitted to a hospital. Some casualties with fractures, which would qualify them as seriously injured, may be sent home for recovery due to lack of bed space.

7.2.5. A possible alternative to hospital-derived data is that which is collected directly from communities. For example in addition to its hospital trauma registries, Uganda has also developed a community based surveillance system, which can provide an accurate estimate of road traffic casualty incidence and prevalence. Local injury surveillance programmes are a key requirement of WHO's Safe Communities programme. Low-income countries participating in the Safe Communities programme, include Bangladesh, South Africa, and Vietnam. Many countries undertake national disability and injury surveys every several years to estimate the actual extent of injury.

7.2.6. However, such community surveys may be infrequent and also costly to undertake. They also suffer from the fact that the information is self-reported, and so is subject to memory recall problems, especially for cases of slight injuries.

Insurance company data

7.2.7. Although insurance data is rarely the best source of road casualty data, on occasion, it has been useful in highlighting the extent of under-reporting. In Indonesia, insurance companies reported over 15,000 road deaths in 1995, over a third more than that recorded by the police (Downing, 1997). However, as discussed with vehicle damage costs in Section 2, the low level of motor insurance coverage in many countries will limit the likelihood that insurance claim data will include many of the road traffic casualties actually occurring.

Newspaper reports

7.2.8. In the absence of any other data, newspaper reports have occasionally been used to monitor the minimum number of road deaths occurring.

Table 7.1: Summary of road casualty data

	Advantages	Disadvantages
Police	Official source of crashes & casualties. Usually includes level of detail required for hazardous location identification and analysis.	Under-reporting problem (often serious) includes non-reporting, miss-recording and under-recording.
Medical Sector Surveys and Surveillance Systems	Trauma and orthopaedic (if not all) hospitals likely to be monitoring road traffic casualties. Community based surveys include those not receiving hospital treatment with the potential to reveal the true incidence.	National hospital surveillance systems often need strengthening. Only in-patient data may be available. Hospital surveys may exclude those who cannot afford hospital, or those where no hospital bed available. Not all road deaths are reported to hospitals. Community based surveys can be infrequent, costly and rely upon self reported information which is subject to memory recall problems.
Insurance Company Data	Occasionally useful in highlighting the extent of under-reporting in official police statistics	Low level of insurance coverage will limit the likelihood that many casualties are included.

7.3. Extent of under-reporting in official police records

7.3.1. In 1998, the World Health Organisation (WHO) estimated global road deaths to be 1.17 million, approximately twice what official statistics were reporting (550,000), thus indicating a serious under-reporting problem with deaths. The extent of under-reporting of road deaths was reviewed in a recent TRL report (Jacobs et al, 2000) which concluded the number of road deaths worldwide (1999) ranged between 750,000 and 880,000.

7.3.2. With unintentional injuries predicted by WHO to be the second leading cause of premature mortality by the year 2020, and crashes a primary cause of injury, the health sector could be expected to give priority to monitoring injuries, including causation factors. Unfortunately, this is rarely the case, with traffic safety seen as a police or transport problem and not a public health responsibility. WHO's International Classification of Diseases, the internationally accepted morbidity and mortality monitoring system, does include specific codes for traffic injury (which can be even further sub-classified), but many hospitals and countries choose to use a generic injury code for all injuries, including road traffic casualties. Even among those countries that monitor road traffic injuries being treated in hospitals, police figures are still used for most comparisons, including international ones.

7.3.3. WHO has recently begun to give greater priority to injury, including road traffic injury, and this should lead to improved casualty databases. A WHO Working Group on Injury Surveillance and Methodology Development has been established, and WHO's first ever Action Plan on Road Trauma was developed in 2002, highlighting the need for improved surveillance systems. WHO's Road Injury Prevention Initiative for Africa had previously included the development of injury surveillance systems as a first priority. Uganda, where the initiatives' regional co-ordinator was based, has hospital based trauma registries in three districts, covering one-sixth of the nation's population.

7.3.4. It should be noted that under-reporting is not unique to developing countries. For example in the UK, a recent comparison between police records and trauma registries found that of those hospitalised for three days or more from road traffic injuries, only 61%were recorded in the police statistics (Broughton et al 2001). Scotland has monitored road traffic in-patients since 1980 and has found slightly over half to be included in police statistics (Keigan et al 1999). A European Commission funded project, (Transport Research Laboratory, 1999) estimated that twice as many people are injured in crashes than officially reported, with 3.5 million casualties compared to the 1.5 million injuries and 45,000 deaths reported in the European countries. In New Zealand, less than two-thirds of hospitalised motor vehicle occupant crash casualties were recorded by the police (Alsop and Langley, 2001).

7.3.5. Under-reporting is not unique to crashes. Other social problems, such as domestic violence and rape are known to suffer from serious under-reporting, but it is believed that the public and politicians better understand the data limitations of these crimes. In the UK, economic costings of crime and fire have accommodated under-reporting and used adjustment factors to reflect the reality of the situation, rather than rely on official statistics which were known to be under-estimates (Brand and Price, 2000, and Weiner 2001).

7.3.6. The problem of under-reporting of crashes in developing countries has been researched for two decades. Early TRL research found that almost half of all road deaths reported by hospitals in Colombo, Sri Lanka to have been excluded from police records (Sayer and Hitchcock, 1984). In 1983, WHO reported the proportion of hospital road traffic casualty admissions recorded by police to range from 20% in Thailand, 25% in Bangladesh to between 30% and 40% in India (Hutchinson, 1987). Table 7.2 presents a summary of some more recent examples of under-reporting of road traffic casualties from developing countries.

Table 7.2 Under-reporting of road traffic casualties in developing countries

	Country	Finding
Deaths	China	Road deaths estimated to be 111,000, 42% greater than that reported by police, according to study by Beijing Research Institute of Traffic Engineering (Liren, 1996).
	Taiwan	Department of Health reported 7,250 road deaths, 130% greater than the 3094 road deaths reported by the police (latter limited to those within 24 hours of the crash) (Lu, 1999).
	Karachi, Pakistan	56% road deaths reported by ambulance services were recorded in police statistics (Razzak, 1998).
	Bogota, Colombia	46% mortuary reported road deaths were in the police database (but with 19% listed as injured).
	Bangladesh	A national injury survey in Bangladesh undertaken in the mid 1990's found the rate of road death to be twice that reported by the police (Bangladesh Bureau of Statistics, 1996).
	South Africa	For the Pretoria urban area, the police recorded somewhere between 77 and 97%of the fatal casualties recorded in a mortuary surveillance system. For the Cape Town Municipality and Urban Area as a whole the figure was 94 and 81%respectively (2002).
Injuries	Mauritius	2,100 hospital reported serious road traffic injuries, 8 times the 261 recorded by the police (Jones, 1998).
	Reunion	37% of non-fatal injuries estimated recorded by police (Aptel, 1999).
	Kazakhstan	50% more road traffic injuries reported by ambulances than police (Transport Research Laboratory (1997).
	Dhaka, Bangladesh	3-12% of hospital road traffic casualties were recorded by the police (Aeron-Thomas, 2000).
	Hanoi, Vietnam	17-33% of hospital reported road traffic casualties were recorded by the police (Aeron-Thomas, 2000).
	Bangalore, India	24-53% of hospital road traffic casualties were recorded by the police (Aeron-Thomas, 2000).

7.3.7. A number of previous studies have highlighted the relationship between the number of crash deaths and injuries. Barrs et al (1998) quoted a generic ratio of 10-25 injuries to deaths (with half requiring hospitalisation), but the only developing country example included was from an urban hospital study in Ethiopia, which reported 16 injuries for every death (Dessie and Lawson, 1991). A three-month study conducted by Malaysia's Public Health Department (Rahman 2002) reported 19,271 casualties receiving treatment at hospitals in a three-month period. Of these, 1.3% were fatal and 79% received outpatient treatment. Thus for every road death, there were 15 hospitalised and another 61 slightly injured.

7.3.8. Jacobs et al (2000) stated that while injuries had not been the focus of their study, under-reporting was believed to be much greater for injuries than deaths. In order to estimate global road traffic casualties, the study adopted a ratio of 100 injuries to a fatality for high-income countries, while a conservative road death to injury ratio of 20-30 was used for low-income countries. In the 1st Safe Community Conference on Cost Calculation and Cost-effectiveness in Injury Prevention and Safety Promotion, a ratio of 70 slight injuries and 15 serious injuries for every death was suggested to apply to most countries (Mohan, 2001).

7.3.9. The number of permanently disabled as a result of crashes is not well understood. In the recent British Medical Journal's special traffic safety issue 'War on the Roads', the number of permanently disabled was estimated to be ten times the number killed (Abassi, 2002), but this same ratio was also applied (separately) to the number of injuries (Peden and Hyder, 2002) and the number of serious injuries per road death (Roberts et al, 2002).

7.3.10. While exact ratios may be unknown, an injury pyramid clearly exists with more people being hospitalised than killed and more people requiring slight treatment than hospitalisation. However, official statistics do not always even show this basic relationship. For example, in Bangladesh, the police report approximately twice as many deaths as they do those seriously injured and four times as many slight injuries. In other countries, the problem is with the steepness of the injury pyramid, with relatively few injuries being reported for every road death. India and China, the two nations with the largest number of road deaths in the world, report very low injury:death ratios (4:1).

7.4. National casualty and crash estimation steps

Step 1: Collect available official (police) data

7.4.1. As stated above, while the logical starting point is to obtain the most recent official police data, it will most likely suffer from under-reporting, which may be quite extensive with only a small fraction of the true number of injury crashes and casualties being recorded. Even when police have a computerised reporting system, it is still advisable to enquire about any complementary manual reporting systems, as these are still often used to provide weekly, if not daily, updates to senior police management. For example in Bangladesh, the number of road deaths in the official statistics, i.e. computerised system, was less than that reported manually by the police. The official police data should include the number of *crashes* as well the number of *casualties* associated with those crashes.

Step 2: Compare official data with other casualty data sources

7.4.2. Alternative data sources as to the number of *crashes* are unlikely. However, in order to check the accuracy of official statistics in the number of *casualties*, enquiries should be made about other data such as hospital data, injury surveys, and burden of disease (mortality and morbidity) studies (described above). Reporting definitions should be clarified, as police may only record those deaths within 24 hours of a crash, and injury surveys may define seriously injured differently from the police.

7.4.3. As an example, in the Bangladesh case study where a large scale household survey was undertaken, a check on number and type of casualties was completed through comparisons with the following:

- Previous mortality and morbidity incident rate derived from national injury and disability survey.
- Previous injury costing studies at district level.
- Casualty severity ratio derived from hospital studies, i.e. the number of slight injuries to serious.
- Internal consistency between enumerators, especially between those working in same area.

7.4.4. In the South African case study, official police casualty statistics were compared with data collected as part of the non-natural mortality surveillance system (NMSS) and national non-fatal injury surveillance system (NNFSS).

7.4.5. After compiling results from multiple data sources, assumptions will be required to provide a conservative but practical final estimate of the number of casualties. Estimates should be made for deaths, seriously injured, slightly injured, and if possible, permanently disabled, and any assumptions clearly documented.

Step 3: Estimate number of crashes and associated casualties, by severity

7.4.6. As noted above, police records may be the only source of data on the number of *crashes*, and the number of *casualties* associated with those reported crashes. Casualty surveys, for example, are rarely able to provide information on the number of other casualties involved in each crash. However, due to under-reporting, only a portion of crashes will be recorded in police data, and it can be assumed to be more biased towards the larger scale multi-casualty crashes and less representative of collisions involving pedestrians or non-motorised vehicles.

7.4.7. Therefore, police data should be seen as the starting point, but it should be compared with any data available from other countries with better reporting records and similar motorisation levels. Using this data, the average number of casualties per crash by severity should be derived. Examples of the casualty share per crash used in recent costings is shown within Table 7.3 below.

Table 7.3: Examples of road casualty shares used in recent costings

Country/study/year	Number casualties per crash by severity			
Crash by severity	Fatalities	Seriously injured	Slightly injured	Total casualties
Bangladesh (RHD, 2000)				
Fatal	1.2	1.4	1.4	4
Serious		1.7	2.2	3.9
Slight			1.5	1.5
Indonesia (TSVW& DP, 1996)				
Fatal	1.63	0.2	0.1	1.93
Serious		1.2	0.1	1.3
Slight			1.1	1.1
Nepal Katmandu Valley (TESU, 1997)				
Fatal	1.1	0.3	0.7	2.1
Injury		0.3	1.0	1.3
Nepal Prithi Highway (TESU, 1997**)**				
Fatal	1.5	0.7	5.2	7.4
Injury		0.7	1.3	2

Step 4: Calculate the total number of road casualty crashes

7.4.8. Once a casualty proportion has been determined for the various severity of crashes, the total number of casualty crashes can be calculated in a sequential manner. The number of fatal crashes is determined by dividing the number of road deaths by the assumed fatality rate. For instance, if 3000 road deaths were estimated with 1.2 average number of road deaths per crash (as in the Bangladesh example above), then the average number of fatal crashes is 3,000/1.2 or 2,500. With the number of fatal crashes known, the number of serious and slight casualties involved in fatal crashes can be estimated. After subtracting these figures from the estimated national totals, the casualties remaining will be assigned to serious and slight crashes in the same manner.

Step 5: Estimate the number of property damage crashes

7.4.9. While some police collect data on property damage crashes, the low numbers involved usually indicate massive under-reporting. For instance in Bangladesh the police report an average of 200 property damage crashes per year, less than one-tenth the number of fatal crashes reported (Bangladesh Police, 2000). This can only to be expected, as the resources required to record every single crash would be enormous.

7.4.10. It may be possible to obtain an estimate from insurance records as to the number of vehicles involved in damage only crashes as a proportion per vehicle involved in personal injury crashes. However, there are a number of problems with insurance company data in developing countries (described in Section 2). Therefore, it may be necessary to use ratios of non-injury crashes derived in other, similar countries.

7.4.11. Overseas Road Note 10 (Transport Research Laboratory, 1995), advises that in the UK it has been estimated that there are at least 6 non-injury crashes taking place in urban areas and a ratio of 4.5 in rural areas for each injury crash. Broughton in *Road Accidents Great Britain* (1990) estimated that the ratio of damage only to personal injury crashes was eight to one. In South Africa in 1998 there were 5.3 damage only crashes for each injury crash within the official statistics.

Step 6: Present final estimates

7.4.12. An estimate of the total annual number of crashes and casualties for each severity of crash should be clearly tabulated, and any data sources and assumptions used should also be presented. The aim will be to produce conservative and practical estimates.

7.5. Summary

7.5.1. An estimate of the total number of casualties and crashes is required before the total national cost of crashes can be estimated. Official police data will be starting point for making estimates of the number of crashes and casualties, and is likely to be the only source of data on the number of casualties per crash. However, it should be acknowledged that police data often suffers from under-reporting. Therefore, it is worthwhile pursuing data on the number of casualties from other sources that may be available, such as from medical sector hospital surveys and mortality and injury surveillance systems. This should be used to assess the possible level of under-reporting in police statistics, and to provide a practical, conservative estimate.

Opportunities

- Official police statistics should be described and publicised as being derived from police reports to avoid any misconception that official statistics are based on hospital data.
- Efforts to improve police crash reporting systems should be encouraged, with all police officers being responsible for reporting crashes on a short concise report form. Improved police data would also assist in identifying, investigating and improving hazardous locations, thus demonstrating the value of accurate reporting.
- Medical sector casualty surveillance systems should include the monitoring of crash casualties. This information is useful to check the accuracy of police data, and will highlight the effect of road casualties on medical sector resources.

8. CALCULATION OF NATIONAL ANNUAL CRASH COSTS

8.1. Introduction

8.1.1. The overall objective is to estimate at the national level the annual total costs of crashes. The cost of the crash will include the incident or crash related costs, i.e. property damage and administration costs, as well as the casualty-related costs such as lost output and medical costs multiplied by the average number of casualties involved in each crash. An amount will also be added to each crash severity to reflect human costs (pain, grief and suffering).

8.1.2. The previous Chapters 2 to 6 have described how to make estimates of the average values of the cost components, and Chapter 7 describes how to make an estimate of the total number of crashes and casualties. Here we describe how to combine that information to provide an overall annual total cost.

8.2. Cost calculation steps

Step 1: Estimate the average casualty component costs

8.2.1. Methods used to calculate the average cost component per casualty severity were outlined in the previous Chapters. In order to determine the total component cost per crash, the per casualty estimate must be multiplied by the respective number of casualties. Table 8.1 below shows how average medical costs per crash would be estimated. This same table structure should be used with the other casualty-related costs.

Table 8.1: Example of average medical costs per crash (derived from Bangladesh case study)

Per casualty cost (Bangladesh Taka)		Crash severity					
		Fatal		Serious Injury		Slight injury	
		Number of casualties per crash	Total cost (Taka)	Number of casualties per crash	Total cost (Taka)	Number of casualties per crash	Total cost (Taka)
Fatality	12,074	1.2	14,489	-		--	
Serious injury	18,803	0.3	5,641	1.1	20,683	--	
Slight injury	1,431	0.3	429	0.5	716	1.1	1,574
Total		1.8	20,559	1.6	21,399	1.1	2,147

Source: Bangladesh case study 2002.

8.2.2. After estimating the casualty costs, the incident related costs can be added to produce the overall average crash cost. This is illustrated by Table 8.2. It can be seen that figures in the bottom row of Table 8.1 correspond to the figures under the column 'Medical Costs' Table 8.2.

Table 8.2: Example of average crash cost by severity (derived from Bangladesh case study)

	Incident related costs (Bangladesh Taka)		Casualty related costs (Bangladesh Taka)			Total Cost (B'desh Taka)
	Property damage	Administration	Lost output	Medical cost	Human cost	
Fatal	60,300	1,000	498,165	20,559	115,697	695,721
Serious	58,500	1,000	18,989	21,399	21,049	120,937
Slight	41,400	1,000	1,923	2,147	9,294	55,764
Property damage only	4,500	1,000	--	--	--	5,500

Source: Bangladesh case study 2002.

Step 2: Estimate the total national cost

8.2.3. Once the average cost of a crash has been estimated, it can be multiplied by the number of crashes (determined within Chapter 7) to produce the overall national cost. An example calculation is shown in Table 8.4.

Table 8.4: National cost of crashes (derived from Bangladesh case study)

	Estimated number of crashes	Average crash cost (Bangladesh Taka x 1000)	Total Cost (Bangladesh Taka x 1000)
Fatal crashes	11,049	695.7	7,686,789
Serious injury crashes	102,136	120.9	12,348,242
Slight injury crashes	311,890	55.8	17,403,462
All casualty crashes	425,075	-	37,439,493
Property damage only crashes	1,275,226	5.5	7,013,743
Total crashes	1,700,301	-	44,453,236

Source: Bangladesh case study 2002.

Step 3: Highlight assumptions and sensitivity

8.2.4. There are many assumptions regarding the estimation of just the numbers involved, let alone the direct and indirect costs of crashes. It is strongly recommended therefore, that total costs are presented as a range, with a lower and upper bound estimate. Due to the ease of use a single figure may also be required. This should be presented as being an estimate only tending towards a minimum, rather than a precise figure.

8.3. Summary

8.3.1. The national annual total costs of crashes are calculated by combining the estimates of the average cost components of each crash (described in previous Chapters 2 to 6), and the estimates of the total number of crashes and casualties occurring each year (described in Chapter 7).

8.3.2. A number of assumptions are required when estimating the average cost of each crash cost component, the total number of crashes, and the average number of casualties involved in each crash. Therefore, it is recommended that a range with an upper and lower estimate is presented. If a single overall figure is also required, this should be presented as being an estimate only, tending towards a minimum, rather than a precise figure.

9. APPLICATION OF CRASH COST ESTIMATES

9.1.1. There are two main uses for estimates of crash costs in developing countries:

- Resource allocation at a national level to ensure road safety is ranked equitably in terms of investment in the improvement of road safety.
- To ensure the best use is made of any investment through economic appraisal and cost benefit analysis.

9.2. Resource allocation at a national level

9.2.1. An estimate of total national crash costs summed for all severities is essential to inform the level of investment in road safety. Knowledge of total costs is more likely to lead to increased investment.

9.2.2. Within Great Britain, it was estimated (PACTS Research Briefing RB1/00, 2000) that in 1997 the total estimated expenditure on road safety was over £2.1 billion. This included expenditure by the Government on such items as hospital and ambulance services, law enforcement, safety engineering, licensing, education, and vehicle standards, as well as expenditure by the general public on such things as roadworthiness and driver training and testing and licensing. The total cost of injury crashes was estimated to be £11 billion, thus the equivalent of only 20% of the total estimated annual cost of injury crashes was being spent on crash reduction and prevention.

9.2.3. In many developing countries the amount spent on road safety is often a much smaller proportion of the cost of crashes. For example in a study undertaken in the early 1990's in Mauritius (unpublished), the annual cost of crashes was estimated at the equivalent of £20 million. A series of recommendations were outlined at an annual cost of £100,000 which, over a five year period, could reduce crashes and hence costs by five%p.a. (ie saving £1-million p.a.). High rates of return such as these are fairly common in road safety appraisals and, apart from humanitarian aspects, indicate the economic benefits of investing in national road safety programmes.

9.2.4. It is suggested that fairly broad estimates of annual crash costs are usually sufficient for the purpose of national resource allocation in road safety measures. Although there is no exact guideline figure as to how much of a country's Gross Domestic Product should be spent on road safety, it is suggested that if a government is completely unaware of the likely annual cost of crashes, then a relatively crude cost estimate (as long as it is realistic and likely to be a minimum value) will be useful to highlight the economic benefits of investing in national road safety programmes.

9.3. Economic assessments

9.3.1. Economic assessments of potential road safety measures can be used to predict the economic benefits of implementing the measure based upon predicted unit crash savings. This can assist in deciding which types of measure may be the most cost effective and potential measures can be placed in priority order on the basis of best economic returns. This can apply to publicity, education and traffic law enforcement campaigns, as well as to engineering treatment. Economic assessment can also be used as an evaluator of benefits after a scheme has been implemented based on *actual* recorded crash savings as part of monitoring of the scheme's success.

9.3.2. The main items of information required to complete an economic assessment of a road safety measure are described below. Although many relate to engineering countermeasures it should be noted that such economic assessments do not have to be limited to engineering countermeasures, but can also include publicity and enforcement initiatives.

- Initial cost (such as engineering and capital). This is the capital costs to design and implement the countermeasure. If the implementation is expected to span two or more financial years then the annual breakdown of expenditure is also required.

- Annual maintenance and operating costs. This is an estimate of the expected regular maintenance required, if indeed this is necessary by virtue of the type of countermeasure implemented. For example traffic signals will incur operating and maintenance costs.
- Service life of scheme. Account should be taken of how long the installation is likely to last; that is, before major rehabilitation or replacement is necessary.
- Best estimate of predicted resulting crash or casualty changes (taking into account general trends: normal growth in accidents), or in the case of evaluating a scheme that has already been implemented, the actual recorded crash or casualty changes.
- Estimate of any disbenefits if applicable. Some engineering countermeasures will inevitably produce secondary effects on traffic movement and journey times and hence fuel consumption, which could be considered as negative effects
- Monetary values for the different classifications of crashes as determined from crash costing study.
- Discount rate used for schemes. In any economic appraisal of a countermeasure it is important to identify a given base year from which all future costs and benefits can be assessed. The relevant discount rate is that used nationally by government economists and need not be calculated by the road safety practitioner.

First year rate of return

9.3.3. The most simple of economic evaluation methods is the first year rate of return (FYRR) which is simply the net monetary value of the crash savings (and other savings and costs) expected (or subsequently measured) in the first year of the scheme, expressed as a percentage of the total capital cost of implementing the scheme. The following formula is used:

$$\text{FYRR} = \frac{\text{Value of annual crash savings}}{\text{Cost of scheme}} \times 100$$

9.3.4. In the case of engineering schemes a more accurate figure would be obtained by including maintenance costs only for the first year and increased journey time costs if applicable.

9.3.5. Although providing a good rough guide to the worth of a scheme, a more detailed assessment would be more appropriate where circumstances are expected to change more markedly from year to year. For example an engineering scheme with a good first year rate of return may not be worthwhile if subsequent road closures restrict the benefit to just one year.

Net present value

9.3.6. The net present value method may be more appropriate where the benefits of the scheme may accrue over a period of several years. Net Present Value (NPV) is a way of comparing the value of money now with the value of money in the future. A dollar today is worth more than a dollar in the future, because inflation erodes the buying power of the future money, while money available today can be invested and grow. The net present value method expresses in a single lump sum the difference between costs and future benefits of a road safety measure discounted to a 'present value' thus:

NPV = PVB – PVC

Where NPV = Net Present Value
PVB = Present Value of Benefits
PVC = Present Value of Costs
(costs must also be discounted if they are spread over more than one year)

9.3.7. The choice of discount rate and hence discount factors that are applied to costs and benefits in future years is critical when using NPV and NPV/C methods. The discount factor is calculated thus:

$$\text{Discount factor} = \frac{1}{(1+r)^n}$$

Where r = discount rate
n = number of years

If the discount rate is 10%then r = 0.1.

Net present value/present value cost ratio

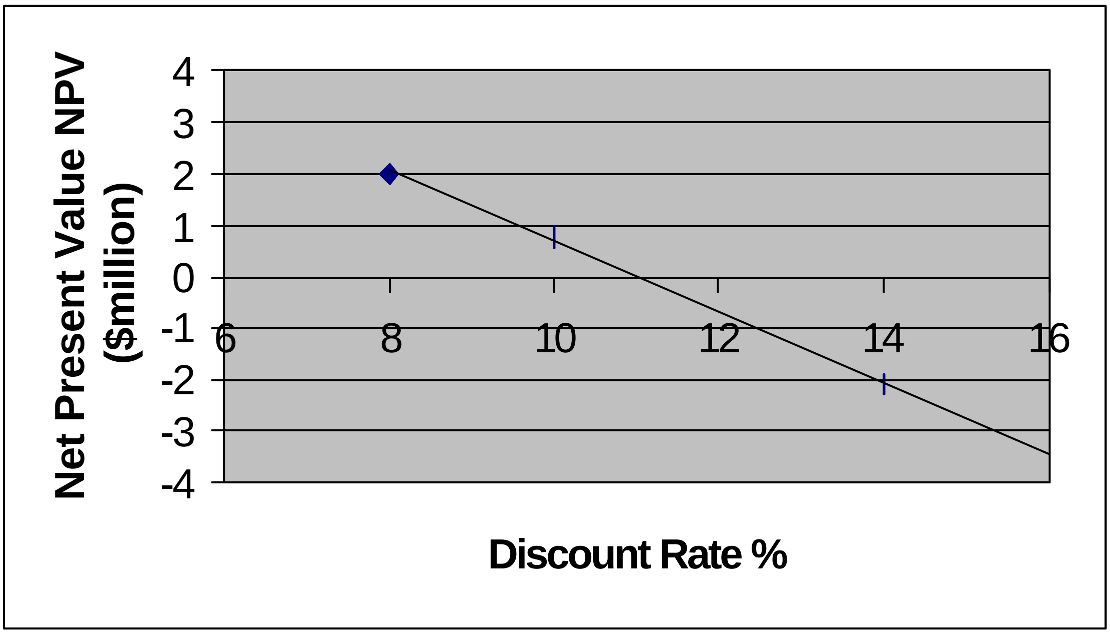
9.3.8. Perhaps the criterion which provides the best indication of how to rank a number of alternative schemes is the Net Present Value (NPV) to Present Value Cost (PVC) ratio. In this approach, the NPV, as calculated above is divided by the sum of all (discounted) costs. Projects can then be ranked according to the NPV/PVC ratio derived.

Internal rate of return

9.3.9. Finally it should be noted that another important way of assessing costs and benefits of highway schemes is to use the Internal Rate of Return. This is in effect the discount rate that makes the NPV equal to Zero or makes the Benefit/Cost ratio equal to 1.0 precisely. A theoretical example of how the discount rate affects the NPV of a project is shown in Figure 9.1 below.

9.3.10. At a discount rate of 8%the project has a positive NPV and at 10%also positive but of less value. At 12 and 14%the NPV is seen to be of negative value. At 11.75%discount rate the project has an NPV of zero and this is known as the Internal Rate of Return (IRR). The IRR is preferred by multilateral aid agencies such as the World Bank because it avoids the use of local discount rates, which, depending on their value, can significantly affect the value of an NPV or NPV/PVC calculation. The IRR is not particularly useful in attempting to rank projects, but normally investors such as the World Bank may stipulate a minimum IRR for a project to be considered.

Figure 9.1: How the discount rate affects NPV calculated 'theoretical' values shown.



9.4. Summary

9.4.1. There are two main uses for estimates of crash costs in developing countries:

- Resource allocation at a national level to ensure road safety is ranked equitably in terms of investment in the improvement of road safety.
- To ensure the best use is made of any investment through economic appraisal and cost benefit analysis.

9.4.2. On a national level, if a government is completely unaware of the likely annual cost of crashes, then a relatively crude cost estimate (as long as it is realistic and likely to be a minimum value), will be useful to highlight the economic benefits of investing in national road safety programmes.

9.4.3. Economic assessments of potential road safety measures can be used to predict the economic benefits of implementing the measure, based upon predicted unit crash savings. This can assist in deciding which types of measure may be the most cost effective and potential measures can be placed in priority order, on the basis of best economic returns. This can apply to publicity, education and traffic law enforcement campaigns, as well as to engineering treatment. Economic assessment can also be used as an evaluator of benefits after a scheme has been implemented based on *actual* recorded crash savings as part of monitoring of the scheme's success.

9.4.4. The main methods of economic assessment that can be used include:

- First Year Rate of Return.
- Net Present Value.
- Net Present Value/Present Value cost ratio.
- Internal Rate of Return.

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