

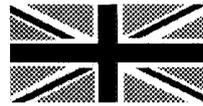
**OVERSEAS  
ROAD NOTE  
10**



***Costing Road Accidents in  
Developing Countries***



Overseas Centre  
Transport Research Laboratory, Crowthorne, Berkshire, United Kingdom



Old Wokingham Road  
Crowthome  
Berkshire  
RG11 6AU

Overseas Development Administration  
94 Victoria Street  
London  
SW1E 5JL

## OVERSEAS ROAD NOTE 10

# COSTING ROAD ACCIDENTS IN DEVELOPING COUNTRIES

Main Subject area: Urbanisation and Transport

Theme: Transportation

Project title: Road Safety

Project reference: R5613

This document is an output from an ODA-funded research project, carried out for the benefit of developing countries.

Crown copyright 1995. The views expressed in this report are not necessarily those of the Overseas Development Administration or the Department of Transport.

## **ACKNOWLEDGEMENTS**

This note was drafted by Dr G D Jacobs whilst a member of the of the TRL Overseas Centre. The author gratefully acknowledges the advice and guidance provided by Professor M W Jones-Lee Newcastle University.

First published 1995

## **OVERSEAS ROAD NOTES**

Overseas Road Notes are prepared principally for road and transport authorities in countries receiving technical assistance from the British Government. A limited number of copies is available to other organisations and to individuals with an interest in roads overseas, and may be obtained from:

Transport Research Laboratory  
Crowthorne, Berkshire, RG11 6AU  
United Kingdom

© Crown Copyright 1995

Limited extracts from the text may be reproduced provided the source is acknowledged. For more extensive reproduction, please write to

Programme Director,  
Overseas Resource Centre,  
Transport Research Laboratory.

# CONTENTS

	Page
1. Introduction	1
Objectives	1
Why cost road accidents?	1
Value of life	1
2. Methods that can be used to cost road accidents	2
Classification of accidents	2
Different approaches to accident costing/valuation	2
Which method to use	3
3. Using the Gross Output Method in practice	4
Value of the loss of output	4
Cost of medical treatment	5
Cost of damage to vehicles and other property	6
Administrative and other costs	7
Subjective costs	7
4. Case study - Cyprus	8
Vehicle repair costs	8
Estimating lost output	9
Cost of medical treatment	10
Police and administration costs	11
Resource cost summary	11
Sums to reflect pain, grief and suffering	11
5. References	12
6. Appendix: The inclusion of accident savings in highway cost-benefit analyses	13
Background	13
Feasibility studies in Cyprus	13
Feasibility studies of two roads in Jordan	14
Feasibility study in India	16

# COSTING ROAD ACCIDENTS IN DEVELOPING COUNTRIES

## 1. INTRODUCTION

### Objectives

- 1.1 The objective of this Note is to advise economists, planners and engineers in developing countries on a workable method that can be used to cost road accidents.
- 1.2 There are many different methods and approaches to this particular problem; it must be stressed that no single method is ideal and that a considerable amount of data needs to be collected whatever method is used.
- 1.3 This Road Note attempts to explain the importance of costing road accidents in developing countries and outlines in Section 2 the various methods that can be used to do this. Section 3 describes how to use the (preferred) Gross Output method and Section 4 presents a case study of its use in practice. Finally an Appendix presents results of the possible effects of including accident savings in a number of highway cost - benefit analyses.

### Why cost road accidents?

- 1.4 It is now well established that many developing countries have a serious road accident problem (Jacobs and Cutting 1986). Fatality rates (per licensed vehicle) are high in comparison with those in developed countries and whilst in Europe and North America the situation is generally improving, many developing countries face a worsening situation. For example, over the period 1969 to 1986, the number of people killed in road accidents in 12 European countries combined actually fell by about 20 per cent. In 16 Third World countries combined there was, over the same time period, an increase in the number killed of over 150 per cent.
- 1.5 Whilst these trends give cause for concern in developing countries, road safety is but one of the many problems demanding its share of funding and other resources. Even within the boundaries of the transport and highway sector, hard decisions have to be taken on the resources that a Third World government can devote to road safety. In order to assist in this decision-making process it is essential that a method be devised to determine the cost of road accidents and the value of preventing them.
- 1.6 So, 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 its improvement. Fairly broad estimates are usually sufficient for this purpose, but must be compatible with the competing sectors. For example, in a

recent road safety study undertaken in a particular country by TRL, it was shown that the annual cost of road accidents nationally was about £20 million. A series of safety improvements were outlined which, it was estimated would reduce the national cost of accidents by 5 per cent per annum (i.e. saving £1 million p.a.). These improvements (in highway design and layout, education, training and enforcement) were estimated to cost £500,000 in a programme of measures set out over a five year period (i.e. at an average annual cost of £100,000). The average First Year Rate of Return on investment was therefore about 1000 per cent and the Benefit : Cost ratio about 10:1. High rates of return such as these are fairly common in road safety appraisals and (apart from the humanitarian aspects), illustrate the economic benefits of investing in national road safety programmes.

- 1.7 A second need for road accident cost figures is to ensure that the best use is made of any investment and that the best (and most appropriate) safety improvements are introduced in terms of the benefits that they will generate in relation to the cost of their implementation. Failure to associate specific costs with road accidents will almost certainly result in the use of widely varying criteria in the choice of measures and the assessment of projects that affect road safety. As a consequence it is extremely unlikely that the pattern of expenditure on road safety will, in any sense be 'optimal'. In particular, if safety benefits are ignored in transport planning then there will inevitably be an under-investment in road safety.

### VALUE OF LIFE

- 1.8 From the above it can be seen that rational decisions on the allocation of resources to road safety will require the use of cost-benefit analysis, with explicit costs of accidents and values of accident prevention. Ways in which such costs and values can be defined and estimated are described in the next chapter. However, to some people the monetary valuation of human life and safety may appear immoral and it should be stressed that at no point does this Road Note lay claim that it is possible to find a numerical sum which can be said to be the absolute "value of human life", as such. Rather, what this Note examines are the various methods that can be used to estimate the value that should be placed on various safety-improving activities (and the costs that should be associated with increases in risk) on the roads of developing countries.

## 2. METHODS THAT CAN BE USED TO COST ROAD ACCIDENTS

### CLASSIFICATION OF ACCIDENTS

- 2.1 In order to cost road accidents it is important that a country has a consistent classification method. Accidents either involve injury to a person i.e. personal-injury accidents (together with vehicle or property damage) or merely involve damage to vehicles and possibly property in which case they are termed damage-only accidents. In the UK and in many other countries, personal injury accidents are usually 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 accidents to be then classified as being either fatal, serious or slight. The definitions used in most Western European countries to define accident severity are as follows:

A fatal accident is one in which one or more persons are killed as a result of the accident, provided death occurs within 30 days.

A serious accident 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.

A slight accident is an accident 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 accident is one in which no one is injured but damage to vehicles and or property is sustained.

It should be noted that accident severity is defined by the most serious casualty class of any of the victims of the incident. The 'cost of an accident' is therefore not the same as the 'cost of casualties' resulting from that accident, at a more disaggregated level. Failure to distinguish this difference when examining the benefits of different detailed remedial measures can result in different project cost-benefit rankings. The interested reader is referred to Andreassen (1992) for a more detailed discussion of the problem.

### THE DIFFERENT APPROACHES TO ACCIDENT COSTING/VALUATION

- 2.2 In their papers on the cost of traffic accidents and evaluation of accident prevention in developing countries, Hills and Jones-Lee (1981, 1983)

identified six different methods that have been proposed for placing a cost on road accidents. All of the methods outlined were applicable to non-fatal as well as to fatal accidents but for reasons of clarity and simplicity, they concentrated on describing accidents involving one fatality only. They made the point that the appropriate method to use in any particular context may depend upon the objectives and priorities of those who intend to use the costs and values concerned (see para 2.10).

#### A) The "gross output" (or human capital) approach

- 2.3 In this method, the cost of a traffic accident involving a fatality can be divided into two main categories. Firstly there are the costs that are due to a loss or diversion of current resources and secondly there are the costs that are due to a loss of future output. Included in the former will be the cost of vehicle damage, medical treatment and police/administration costs and usually there is little disagreement as to what should be included here. Determining loss of future output of the persons killed however is less clear cut. Usually average wage rates are used (gross of tax) to determine lost output both for the year in which death occurred and then for future years. Costs in future years that the casualty might have lived have to be discounted back to give present day values. This is not done separately for every individual killed (or injured) in a road accident; estimates are based on average (i.e. national) output or earnings data together with appropriately estimated damage, medical and police costs. In some variants of this approach, a significant sum is added to reflect the "pain, grief and suffering" of the accident victim and to those who care for him or her (see paras 3.19-3.22).

#### B) The "net output" approach

- 2.4 This differs from A) in that the discounted value of the victim's future consumption is subtracted from the gross output figure. Again, it may be difficult to visualise how an estimate can be derived of what a person "consumes" (in terms of food, fuel etc.) throughout his or her lifetime. When this method was used in the UK to cost road accidents (being replaced in the early 1970's by the gross output approach), the 'total consumer expenditure and the public authorities' current expenditure on goods and services' was divided by the total population. A crude estimate of "consumption per head" was thus obtained. In this approach the difference between an individual's gross output and future consumption may be regarded as a measure of the rest of society's economic interest in his continued survival.

#### C) The "life-insurance" approach

- 2.5 In this method the cost of a road accident or the value of accident prevention is directly related to the sums for which 'typical' individuals are willing (or even able) to insure their own lives (or limbs).

However, whilst the amount of insurance cover provided might be considered to be some estimate by the insured person of the value of his life to his dependants, it says nothing whatsoever about the value of life to the insured person himself. Thus a wealthy bachelor with no dependants may have little or no life cover, whilst a much poorer person with several children may have his or her life insured for a much greater sum. The wealthy bachelor may well, nonetheless, place a very high value indeed upon his own continued survival. Another problem with this approach is that the level of life insurance cover may be well below what it 'ought' to be if the intention is to provide sufficient income on which his or her dependants are to survive. Further, to base any analysis on the insured population alone is almost certainly to choose a biased sample. This approach is of particularly limited value in developing countries where relatively few people carry life insurance.

#### D) The "court award" approach

2.6 With this approach, the sums awarded by the courts to the surviving dependants of those killed or injured as a result of either crime or negligence are regarded as an indication of the cost that society associates with the road accident or the value that it would have placed on its prevention. In the UK, the sum awarded by the court must take into account complex issues such as degree of negligence of the defendant, whether the person killed or injured was partly to blame, whether or not the employer of the injured person is continuing to pay them any wages and whether industrial injury benefits are to be paid. (These only include private costs, i.e. not necessarily hospital costs met by the state). In addition, any sum awarded by the court will have all taxes removed. From the above it can be seen that to use court awards as implied values for the loss of life (or limb) in a road accident would be very much an imperfect solution.

#### E) The "implicit public sector valuation" approach

2.7 With this method an attempt is made to determine the costs and values that are **implicitly** placed on accident prevention in safety legislation or in public sector decisions taken either in favour of or against investment programmes that affect safety. Unfortunately, an examination of some values as derived in Britain reveals a very wide range of implied values of life not only between different sectors but also within the same sector (Mooney 1977). Thus following the partial collapse in London of a block of high-rise flats, changes were made to building regulations. According to estimates made (Sinclair et al 1972), a few lives may have thus been saved at very high cost giving an implied minimum valuation of life at over £20 million. However it was also claimed at about the same time (Heys et al 1968) that a method of preventing stillbirths could be standard practice at a cost of only £50 per life saved. Since this method was not widely practised

in the UK at the time, it suggests that £50 could be regarded as a maximum value for life, giving from the two examples a range of less than £50 to over £20 million per life saved. These examples provide at the very least an indication that there is (or was) some misallocation of resources in life-saving activities and suggests that this would be a very imprecise method for valuing human life.

#### F) The "value of risk change" or "willingness to pay" approach

2.8 This approach is based on the fundamental premise that decisions made in the public sector concerning the allocation of scarce resources should reflect the preferences and wishes of those individual citizens who will be affected by the decisions (Jones-Lee 1976, 1989). Accordingly, the value of a given improvement in road safety (i.e. a reduction in risk) is defined in terms of the aggregate amount that people are prepared to pay for it. Conversely the cost of a reduction in safety is defined in terms of the amount people would require in compensation for the increased risk. More specifically, the value of a particular safety improvement is defined as the sum of all the amounts that people (affected by the improvement) would be willing to pay for the (usually very small) reductions in risk provided by the safety improvement. Thus the value of prevention of one accident involving one fatality is defined as the total amount that all affected individuals would pay for the very small risk-reduction, both for themselves and for those they care about.

2.9 Estimation of willingness-to-pay costs and values is far from straight forward. Various methods have been used and include an approach where estimates are obtained by observing situations where people actually do trade off wealth or income for physical risk. Another approach uses a complex questionnaire where samples of individuals are asked more or less directly how much money they would be willing to forfeit in order to obtain a small reduction in their own or other people's risk. For example, a detailed questionnaire might indicate that drivers were prepared to pay, on average £5 for a risk reduction of one chance in 500,000 that they would be killed on a particular journey. Then the 'value of an average life' in this instance would be £5 x 500,000 i.e. £2.5 million.

#### WHICH METHOD TO USE?

2.10 Not surprisingly, these six approaches produce substantially different costs and values for accidents involving one fatality. Typically figures derived from studies carried out in developed countries over the period 1965-1978 ranged from about £1500 to over £20 million. As stated earlier, Hills and Jones-Lee (1981, 1983) emphasise the point that the method used for costing road accidents depends on the objectives being pursued in a country by those planners and economists respon-

sible for investment planning. The reasons for costing road accidents are most likely to be either the maximisation of national output or the pursuit of social welfare objectives (such as the minimisation of injury accidents or fatalities in relation to traffic). The only accident costing/valuation methods that appear to be directly relevant to these two objectives are-

- a) the "gross output" method (well suited to the objective of maximising the wealth of a country) and
- b) the "willingness to pay" method (especially for social welfare maximisation and for use in cost-benefit analyses)

2.11 If accident costs and values are ultimately intended for use in conventional cost-benefit analyses in order to determine the most efficient way of allocating scarce financial resources, then the most appropriate method to use by far is the willingness-to-pay approach. However, whilst this method has been adopted in countries such as UK, USA, New Zealand and Sweden, the difficulty of obtaining reliable empirical estimates has been considerable. Furthermore, whilst the willingness-to-pay approach was adopted in the UK in 1988 to cost fatal accidents, the use of the method to cost non-fatal accidents presented certain problems which have only fairly recently been resolved (Jones-Lee et al 1993, Hopkin and O'Reilly 1993). Even in the case of fatal accidents, a wide range of empirical estimates was obtained from various studies and 'a considerable element of judgement' was necessary (McMahon 1991) in order to derive a value that was regarded as 'a reasonable working basis for the value of a fatal casualty for use in appraising transport investments'.

2.12 The willingness-to-pay approach as used in the UK can also be criticised on the grounds that values are obtained directly for adults only (children being unable to complete the complex questionnaires used to derive values). (It was inferred that children's values would be equivalent to adults.) Children form a very high proportion of people killed or injured in developing countries (about twice that of the UK) and the willingness-to-pay approach might therefore appear, at the moment to be inappropriate. Similarly the method is used in the UK to obtain values for drivers or passengers of motor vehicles only. Again this weakens the case for its use in developing countries where significant proportions of people killed and injured are pedestrians and pedal cyclists. Lastly it may be more difficult to value changes in risk in developing countries because of the difficulty in respondents providing a monetary value where the markets do not necessarily involve money exchange, i.e a much greater use of the informal sector of the economy.

2.12 It seems unlikely therefore that reliable willingness-to-pay based costs and values will be available for use in developing countries for some time. It is therefore recommended that the gross output approach is used to cost road accidents in developing countries. However, in order to try to capture some of the 'humane' considerations reflected in the willingness-to-pay approach, gross output values should be augmented by a further allowance for 'pain, grief and suffering' of those involved in road accidents. This, in fact was the approach employed in the UK prior to the recent adoption of the willingness-to-pay approach. The way in which such an allowance might be added to fatal, serious and slight accidents to reflect pain, grief and suffering is discussed in the next section.

### 3. USING THE GROSS OUTPUT METHOD IN PRACTICE

3.1 As described in section 2, costs associated with a road accident may arise from injury to persons, damage to property and administrative procedures. Using the gross output method, these costs can be further divided into two categories, namely those that are due to a diversion of current resources and those that are due to a loss of future output. This section describes how these various costs can be derived and includes a worked example from one particular country.

#### VALUE OF THE LOSS OF OUTPUT

3.2 Road accidents lead to a loss of output in the year in which the accident occurs and, in the case of fatal and very serious accidents, in future years also. In the case of a fatality, the loss of a person's output is of course complete. In this situation, costs in future years have to be discounted to give present day values. The discount rate used should be that which is currently in use by economists and planners in the country concerned. In order to determine 'lost output', certain assumptions have to be made. In the case of fatal accidents the number of 'person years lost', is obtained by obtaining the average age of road accident fatalities and subtracting this from the average age at which a person ceases to work. In the case of serious accidents, estimates must be obtained of the average number of days that the injured person spends in hospital and then spends recovering at home from the accident. In the case of a slight accident, an estimate must be obtained of the (relatively small) number of days that the person is not working due to attending a doctor's surgery, a clinic or hospital (as an out-patient) to receive treatment for their minor injury, or being at home convalescing. Information on days lost following serious and slight road accidents can be obtained from hospital records and from information on as

many case studies as can be obtained. Additional information may also be obtainable from insurance company records or employers records. Loss of output due to permanent and long term injuries depends on the number of cases, the length of absence from work and the percentage disability when work is resumed.

- 3.3 Having derived an estimate (and it should be stressed that it can be no more than an estimate) of the average number of days and years lost following a road accident, the value of those days and years lost must be determined. This is obtained by using figures published by government of national wage rates, before the removal of taxes.
- 3.4 In many developing countries, a significant proportion of the population will be agricultural workers, many being self-employed and probably cultivating small plots of land. For these and possibly other workers, (e.g. on short term employment), it is unlikely that published statistics of wage rates exist and estimates will have to be derived of annual incomes per capita.
- 3.5 The most important 'unpaid' workers in any country are housewives. The services rendered by house-wives are an important part of the real income of the country and the loss of these services is a loss to the country. A value must of course be placed on housewives services that are lost as a result of a road accident. In the UK this is set at the average wage of employed women and in the USA it is the value of replacing their services. In the UK, estimates of lost output are made separately for males and females, (for accidents taking place in urban and rural areas), and for road user type according to the annual distribution of accidents. If, in a particular country, separate costs are required for males and females then the way in which house-wives time is costed is important. If this subdivision is not required then, as described above, national average wage rates can be used.
- 3.6 It is important to note that it is **accidents** by degree of severity that are being costed but that lost output is obtained on a 'person-injured' basis. The average number of persons injured per type of accident taking place must then be obtained. In the example given later there were, on average 1.45 casualties per accident in Cyprus. Ideally this information should be obtained separately for fatal, serious and slight accidents. (See also 2.1).

### COST OF MEDICAL TREATMENT

- 3.7 The medical costs resulting from road accidents arise from hospital treatment (in-patient and out-patient), treatment by general practitioners (not included in UK), and the use of ambulances.

The total costs will be determined, apart from the number of casualties, by:

- the percentage of serious or fatal casualties who become in-patients,
- the average length of stay in hospital,
- the average cost per day of hospital treatment,
- the average number of out-patient visits,
- the average cost per out-patient visit,
- the average costs incurred by general practitioners,
- the costs incurred by the ambulance service.

All these factors have to be taken into account in the case of serious injuries; out-patient and general practitioners treatment can be ignored in the case of fatalities, and by definition in-patient costs cannot arise in the case of slight injuries. Some of this information may be available from sources published (usually) by the Ministry of Health. It is unlikely however that annual reports will state categorically the average cost per day of hospital treatment. Rather, it will be a case of using available statistics to produce this information. Thus it should be possible to break down total cost of all health treatment into that provided by hospitals and that provided by health centres, clinics etc. Information on the total number of hospital beds in a country is usually available from published statistics and assuming full occupancy at all times (which is not unreasonable), the average cost per bed per day can be obtained.

- 3.8 Efforts should be made to collect information on cost of treatment from hospitals in both urban and rural areas covering, if possible, all regions of a country. In many developing countries, hospitals often cater for patients from different income groups, religions or cultures. Information should be collected from as many classes of hospital (or private clinic) as possible. Average costs of treatment should then be weighted according to the proportion of accidents (by severity) taking place in urban and rural areas and by the distribution of patients to the different classes of hospital. As stated in paragraph 3.6, information must be obtained on a 'per accident' basis and average costs of treatment for persons killed, seriously or slightly injured must be multiplied by the average number of persons injured in the equivalent categories of accident to provide a cost of medical treatment per accident.

## **COST OF DAMAGE TO VEHICLES AND OTHER PROPERTY**

3.9 There are three basic sources for information on cost of damage to vehicles; the insurance companies, garages and large fleet operators such as bus companies and freight operators. The best method to use will depend on local circumstances.

3.10 If the large majority of cars carry comprehensive insurance in a country (as opposed to Third Party cover only) and if the cooperation of insurance companies is available, then making use of information held by insurance companies may be the best approach. A specially designed questionnaire should be sent to as many insurance companies as possible. (In the original study carried out in the UK by Dawson, 4410 replies were received from 15 different insurance companies). The questionnaire should seek to establish:

- (i) background information such as age and sex of persons injured, locality, severity of accident, degree of personal injury (if any), number of casualties and numbers of vehicles, etc.
- (ii) type of insurance: comprehensive, third party, fire and theft or third party only.
- (iii) the payment for damage to the insured vehicle and for damage to vehicles and other property belonging to third parties.

There are a number of factors that should be taken into account when using information provided by insurance companies

- (i) public service vehicles and some large fleets of commercial vehicles may not be insured.
- (ii) many vehicles are not comprehensively insured. If information is collected on comprehensively insured vehicles only, this may not be a truly representative cross-section of all vehicles.
- (iii) many policies involve the insurer paying part of the cost. Therefore some payments will be far less than the true cost, leading to an underestimate of the average cost of damage per vehicle.
- (iv) claims for small amounts will not be submitted if it means the insurer losing his or her 'no claim's bonus'.
- (v) claims to insurance companies may be overestimates of the real cost of damage incurred.
- (vi) usually the cost of damage to a vehicle is paid for by one insurance company. With comprehensively insured cars they may, under 'knock for knock' agreements, be paid by the company with which the damaged car was insured. In some cases however the cost to one vehicle may be shared between two companies and this should be identified.

From the above it can be seen that returns from insurance companies need to be treated with caution. If possible information should be obtained from local garages on the cost of vehicular repair. In the UK damage - only accident values now include an estimate of unclaimed and claimed values, a departure from Dawson's method (Simpson & O'Reilly 94).

3.11 Efforts should be made to ensure that information collected is representative of national accident figures. Thus proportions of the different categories of personal injury accidents, accidents in urban and rural areas and types of vehicles involved should be as close as possible to the national figures in order that the sample is not biased and is satisfactory from the point of view of coverage.

3.12 If statistics on cost of vehicular repair are unavailable from insurance companies then an alternative approach is to collect information from garages, repair shops and, additionally from bus companies, freight operators etc. As with insurance company records, it is important to collect information on all classes of vehicle involved in urban and rural areas in accidents of different severity. Using this method however, the number of vehicles on which information is needed can be predetermined by collecting information on a given proportion of the accidents taking place nationally. For example, if in a particular country 10,000 vehicles were involved in road accidents in a given year than a 5 per cent sample would mean collecting information on 500 vehicles. Ideally subtotals within this figure should reflect the proportion of accidents involved in the reported number of fatal, serious and slight accidents; those occurring in urban and rural areas; and finally the different classes of vehicles involved. Information must, of course also be collected on vehicles involved in damage-only accidents - see 3.14.

3.13 Information on the cost of private car repair is obtainable from garages and body repair shops. Information on buses and goods vehicles is best obtained from bus companies and freight operators. These can be both private and public sector companies and efforts should be made to collect data from both. In obtaining average values of the cost of repair of buses and trucks, values obtained from the investigation should be weighted according to the actual number of vehicles operated within the private and public sectors.

3.14 An estimate will have to be obtained of the total number of damage - only accidents taking place. In most countries these do not have to be reported to the police and accurate statistics are therefore likely to be unavailable. It may be possible to obtain an estimate from insurance records which can indicate the number of vehicles involved in damage accidents per vehicle involved in personal injury accidents. In some countries insurance records may not be available. Indeed, in some countries insurance may not even be compulsory. In these

circumstances ratios of non-injury accidents derived in other countries may have to be used. In the UK it has been estimated that there are at least 6 non-injury accidents taking place in urban areas and a ratio of 4.5 in rural areas for each injury accident.

- 3.15 Having collected information on the average cost of repair of vehicles involved in fatal, serious, slight and damage-only accidents, the average number of vehicles involved in these classes of accident needs to be determined from national accident statistics. By multiplying cost per vehicle by number of vehicles involved, the average cost of vehicular repair per accident (by degree of severity) is obtained.
- 3.16 In the example given in the next section, a cruder method of determining cost of vehicular repair is given which makes use of relative costs of spare parts and labour in UK and the other country. As a last resort, this sort of approach can be used but efforts should, if possible, be made to obtain information at least from insurance companies.
- 3.17 In a road accident, damage may also occur to movable property such as goods or personal effects carried by vehicles or to fixed property such as walls, lamp standards, signs etc. Information on claims for damage to property of third parties could again be obtained from insurance companies. Information on the cost of damage to street furniture can best be obtained from local authorities.

#### ADMINISTRATIVE AND OTHER COSTS

- 3.18 Other costs that arise as a result of road accidents include those associated with the administration of insurance, the police and court proceedings and possibly with the delays caused to other vehicles at the scene of the accident. None of these costs are particularly easy to determine. In the UK, 17% of the total cost of all insurance costs is set against administrative expenses. Half of this sum is connected with paying out of claims, the remainder (8.5%) being concerned with the handling of claims. Knowing the total sum spent on premiums paid in the UK, an estimate (8.5% of this total) can be allocated to insurance administrative costs. Specific support of the police may be required in order to obtain an estimate of the time spent by police in dealing with accidents of differing severity. Compared with other costs involved, administrative costs are likely to be low and it is probably not worth spending much time and effort in producing detailed estimates. In the example given later, percentages derived in the UK were used and ranged from 0.2% of cost of all other resource costs for fatal accidents to 14% in the case of slight accidents.

#### SUBJECTIVE COSTS

- 3.19 The last section brought together the costs of accidents which directly or indirectly affect the

economy of the country. However, there are, as pointed out in section 2, other important issues to consider, such as suffering and bereavement, that fall upon individuals. Although these are difficult to express in monetary terms their existence is very real to the persons concerned. Moreover they are costs which the community would usually be prepared to meet in order to avoid the misery involved. If the costs given in this Note are to be used in the economic assessments of road improvements, then it is important that they should reflect the value that the community places on the saving of life and the avoidance of suffering.

- 3.20 It would therefore appear to be necessary to try to estimate the value that the community places on the avoidance of loss of human life. As stated earlier, this ought ideally to be done using the willingness-to-pay approach to the valuation of safety and the costing of risk. However, implementation of such an approach in a developing country will be no easy matter and as outlined in section 2, the ideal willingness-to-pay based costs and values might be approximated by adding an allowance for "pain, grief and suffering" to gross output figures.
- 3.21 Early attempts to cost "pain, grief and suffering" in road accidents in the UK made use of awards made in courts in relation to people killed and injured in accidents. This provided some insights into possible values that could be used, but the figure that was finally adopted for fatal accidents was based on the fact that in 1967, the net output (and not gross output) method was in use. Using this method, 'average consumption' was subtracted from 'average output' with the result that an elderly non-productive person had a negative output and such a person's life would therefore be accorded a negative value. A figure was therefore added (£5000 in 1967) to make the value positive for all age and sex groups. The figure of £5000 was thus taken to reflect the minimum value accorded by society to the avoidance of the pain, grief and suffering associated with premature death.
- 3.22 Fairly arbitrary values of £500 were later added to the cost of serious accidents and £15 to slight accidents. These sums represented, at the time, additions to the total resource costs derived for fatal, serious and slight accidents of 46%, 100% and 8% respectively. By the early 1980's the additional value added as non-resource costs was amended slightly to 38% for fatal accidents with values added to serious and slight accidents remaining as above. It should be stressed that these values are more or less arbitrary but nevertheless, a case can be made for their inclusion - see paragraph 2.3. In the absence of more detailed research targeted at developing country societies and economics, it is suggested that an additional 38%, 100% and 8% of the resource (i.e. quantifiable) costs derived in each country are added to reflect pain, grief and suffering.

## 4. CASE STUDY - CYPRUS

- 4.1 Section 3 explained how the Gross Output method might be used to cost road accidents in developing countries. In this section a case study is presented of the application of this method to cost road accidents on major inter-urban highways in Cyprus. This, it is hoped, provides further insight into the practical use of this method to cost road accidents.
- 4.2 In 1984 the then Overseas Unit TRRL was asked (in support of a project being undertaken in Cyprus by British transport consultants), to cost road accidents taking place on a number of major inter-urban highways. Although the time available was little more than two weeks, the appraisal illustrates the approach that can be used to cost road accidents in a developing country and how the information given in sections 3.1-3.22 can be used in practice. Where information could not be collected in the time available, realistic estimates were derived, using in some instances information from the accident cost procedure used in the UK at that time.
- 4.3 In this analysis, the 'gross output' or 'human capital' approach was used and the costs included were as follows:
- (a) vehicle repair costs
  - (b) lost output due to death or injury. This was calculated as the present value of the expected loss of earnings plus any non-wage payments paid by the employer.
  - (c) cost of hospital treatment
  - (d) police and administrative costs
  - (e) costs of pain, grief and suffering to the casualty, relatives and friends.
- 4.4 Not all the costs incurred in road accidents in Cyprus could be readily quantified in monetary terms. For example it was virtually impossible to obtain data on items such as time delays to vehicles following an accident or out of pocket expenses to the casualty or to relatives and friends. Consequently these were excluded. The principle of not over-stating costs was followed and wherever alternative values presented themselves, the minimum value was taken in order to avoid the over-estimation of road accident benefits following highway improvements in Cyprus. Any upward revisions to the values derived would thus have the effect of increasing benefits from accident savings following the various road improvements. In this exercise, all costs (unless otherwise stated) are given in Cyprus pounds (1984 prices) with C£1 approximately = £1.27

### VEHICLE REPAIR COSTS

- 4.5 The cost of repair of vehicles involved in road accidents in Cyprus was obtained by collecting

limited information from insurance companies. In the time available this was the only approach possible and even this was completed on limited information from only two companies. Only vehicles which were comprehensively insured were included even though this may not have been a typical cross section. In addition, an attempt was made to include sums of money that insurees pay out themselves in the cost of repair, since policies in Cyprus usually state that the insurer pays approximately the first £50 of the cost.

- 4.6 In Cyprus, in 1984 there were 16,737 vehicles involved in 7,734 accidents, giving an average ratio of 2.16 vehicles per accident. This relatively large number of vehicles per accident (the equivalent ratio in the UK being 1.33) obviously had a significant effect on the overall average cost of vehicle damage per accident. The figures collected from insurance companies suggested that damage costs in injury accidents are about twice those incurred in non-injury accidents and were as follows:

- (a) Average cost of damage in injury accidents in Cyprus in 1984 = £1130
- (b) Average cost of damage in damage-only accidents in Cyprus in 1984 = £530

In this limited study, these values for average cost of repair applied to all injury accidents taking place (irrespective of severity) and an estimate needed to be made of cost of repair (separately) for fatal, serious and slight accidents. The cost of repairs in fatal and serious accidents tends to be greater than in non-fatal accidents, and adjustment figures derived in the UK were used as follows:

	Ratio
Repair costs in slight accidents	1.0
Repair costs of average personal injury accident	1.11
Repair costs in serious accidents	1.4
Repair costs in fatal accidents	1.8

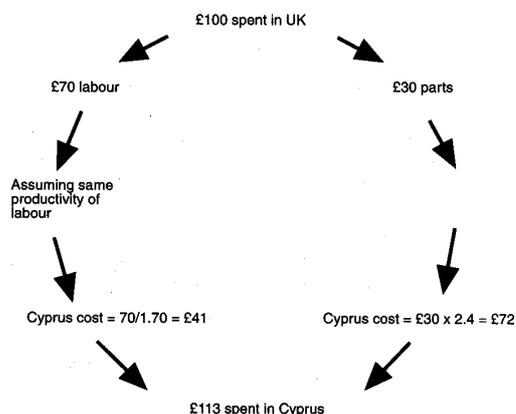
Applying these weighting ratios to the overall average cost of a personal injury accident in Cyprus gave the following values:

Repair costs in fatal accidents	£1780
Repair costs in serious accidents	£1430
Repair costs in slight accidents	£990
Repair costs in damage-only accidents	£ 530

- 4.7 If costs of vehicular repair had not been available from insurance companies (or alternatively, garages specialising in repair work) then an alternative approach would have been to use the relative costs of spare parts and labour in the UK and the

country in question, in this case Cyprus, and to adjust costs derived in the UK using these ratios. To use this (albeit crude) approach, average costs of typical cars and spare parts used in both countries were required. In Cyprus, vehicles commonly in use were the 1600cc Mazda 626 family saloon and the 1300cc Mazda 323 small saloon. Common vehicles used in the UK were the B.L. Maestro, family saloon and the B.L. Metro, small saloon. Comparable costs are shown below. The purchase price of the vehicles in Cyprus and the UK were very close. The overall ratio of spare parts, Cyprus: UK, however, showed costs to be about twice as high in Cyprus as the UK as shown below.

The cost of labour in UK garages was in 1984 about £12.00 per hour and the cost of labour per hour in Cyprus was £7.00 (taxes excluded). In the UK the total cost of vehicular repair was typically 70 per cent labour costs and 30 per cent replacement of spare parts. Thus the breakdown of £100 spent in a garage in the UK might be used to derive costs in Cyprus adjusted as follows:



An expenditure of £100 sterling in UK on vehicular repair might thus equate to £113 sterling in Cyprus. In other words the cost of repair to a vehicle involved in a road accident was probably about 10 per cent higher in Cyprus than in UK. Comparing repair costs shown earlier for vehicles involved in accidents of varying severity in Cyprus with those derived in the UK indicates that costs were about 5-8 per cent greater in Cyprus. Thus using relative costs of spare parts and labour in any country to adjust vehicular repair costs derived in the UK may be a crude but acceptable method if information is unavailable from insurance companies or garages.

4.9 As a word of caution it should be pointed out that it was difficult to use this method on a later study. In this case there appeared to be no consistent pattern of ratios of spare parts in this country to costs in UK. This may well be the case elsewhere.

### ESTIMATING LOST OUTPUT

4.10 The 'Gross Output' method requires an estimate of current average wage rates. In the case of fatal accidents current wage rates were multiplied by the number of years 'lost' due to the road accident, and in the case of serious and slight accidents, days 'lost' were multiplied by the daily wage rate. With fatal accidents, the sums lost in future years were discounted back to a present value by using an appropriate discount rate. For Cyprus this was 9 per cent.

4.11 The average age of a person killed in a road accident was obtained from information provided in "Statistics of Motor Vehicles and Road Accidents" published by the Cyprus Department of Statistics and Research, Ministry of Finance. (see Table 3.1).

	In Cyprus	In UK	Ratio of cost & spares*
Mazda 626 (1600cc) or BL Maestro (1500cc)	3250	3307	
<i>Cost of spare part</i>			
bumper	102	42	2.42
wing	71	30	2.36
windscreen	78	38	2.00
	In Cyprus	In UK	Ratio of cost & spares*
Mazda 323 (1300cc) or BL Metro (1300cc)			
Purchase price	2600	2680	
<i>Cost of spare part</i>			
bumper	70	25	2.80
wing	56	28	2.00
windscreen	76	30	2.53

\* The overall average ratio is 2.4

**TABLE 3.1**

Average age of fatality in Cyprus (1984)

Age Groups	Average Age	Number	Total Years
0-9	5	1	5
10-19	15	11	165
20-29	25	30	750
30-39	35	9	315
40-49	45	13	585
50-59	55	10	550
60-69	65	18	1170
70-79	75	9	675
80+	85	4	340
Total		105	4555
Weighted Average		(43 years)	

- 4.12 In Cyprus, persons in government salaried employment retire at the age of 60, persons of non-salary status retire at 65 years and self employed persons retire at ages greater than these. The weighted average of retirement age in Cyprus was estimated to be 65.5 years. The average number of years of lost output following a fatal road accident was thus about 23. The average wage in Cyprus in 1984 was £4100 per annum per person. This value, plus a further 8 per cent national insurance contribution was applied to the 23 years lost due to a road accident and discounted at 9 per cent. The total discounted lost output was estimated to be £42,500 per person.
- 4.13 The average number of days spent in hospital in Nicosia for all cases, not only road accident patients, was 8.5 days. However an analysis of medical records showed that for road accident patients the average length of stay was longer, approximately 13 days. Information collected from persons injured suggested that a further 24 days, on average, were spent recovering at home from a serious road accident. Thus the average lost output for a serious road accident casualty was estimated to be 37 days. With an average daily wage rate of £15/day the cost of lost output for serious accidents was thus £555 per casualty. Lost output from slight injuries was small and on average 2 days were lost. Therefore the lost output following a slight road accident was estimated to be £30 per casualty.
- 4.14 The above figures were calculated on a 'per casualty' basis. In order to obtain costs 'per accident' the costs per casualty had to be multiplied by the number of casualties per accident. Over the preceding 10 years there had been on average some 1.45 casualties per accident in Cyprus.

However, examination of accident statistics on the main inter-urban routes (relevant in this particular study) showed a higher ratio of 1.83, as follows:

Route	Casualties	Accidents
Larnaca-Kophinou	71	38
Larnaca-Dhah	91	48
New Nicosia-Limassol Road (Oct 84-Jan 85)	58	34
TOTAL	220	120

Applying this ratio of 1.83, costs per accident became:

Lost Output in fatal accident = £77,775

Lost Output in serious accident = £ 1,015

Lost Output in slight accident = £ 55

**COST OF MEDICAL TREATMENT**

4.15 The mayor hospital in Nicosia provided the following information:

- (a) first class bed = £10 + £4 treatment (minimum) + cost of medicine + cost of operation
- (b) second class bed = £6 + £4 treatment (minimum) + cost of medicine + cost of operation
- (c) third class bed = £3 + 50% cost of operation

These values (which were in fact charges made to patients) did not reflect the true cost to the hospital because of subsidies received by in-patients from the government. The economic or resource costs were therefore considerably greater. Information collected from the Ministry of Health suggested that the overall average cost for one days in-patient treatment (including staff costs, cost of medicines, operations and overheads etc.) was £53. Using this estimate, costs of medical treatment for road accident casualties were derived as follows:

a) **Cost of fatal casualty**

Assuming 4 days spent in hospital before dying at a daily cost of £53 together with:

capital cost of ambulance } Estimated average  
 capital cost of hospital } overhead of £23  
 hospital administration costs }

= approx. £235

b) **Cost of serious casualty**

Assuming 13 days spent in hospital at a daily cost of £53 together with four outpatient visits at £14

one ambulance attendance  
on average and

capital cost ambulance                      Estimated average  
capital cost hospital                      overhead of £23  
hospital administration cost)

= approx. £770

**c) Cost of slight casualty**

Assuming 50 per cent of persons injured make an outpatient visit to the hospital and that one ambulance attendance was needed for 50 per cent of those injured. Also assumed that capital and administration cost of hospital includes one GP visit for 50 per cent injured

= average estimated hospital cost for slight injury = £35.

Taking into account the fact that there were 1.83 casualties per accident on major inter-urban roads in Cyprus, then

- (a) cost of medical treatment in fatal accidents = £430
- (b) cost of medical treatment in serious accidents = £1410
- (c) cost of medical treatment in slight accidents = £ 65

**POLICE AND ADMINISTRATION COSTS**

4.16 In the time available it was not possible to obtain detailed information on the average cost of police and administration costs for the different types of accidents taking place. Instead, values based on those derived in the UK were used which suggest that police administration costs represent about 0.2 per cent of the total resource cost of fatal accidents, 4.0 per cent of serious accidents, 14.0 per cent of slight accidents and 10.0 per cent of damage-only accidents.

**RESOURCE COST SUMMARY**

<b>(a) Cost of a fatal accident</b>	£
Damage to vehicle	1,780
Lost output	77,775
Medical	430
Police and administration (0.2%)	160
Total	<u>80,140*</u>
 <b>(b) Cost of serious accident</b>	
Damage to vehicle	1,430
Lost output	1,015
Medical	1,410
Police and administration (4%)	150
Total	<u>4,000*</u>

**(c) Cost of slight accident**

Damage to vehicle	990
Lost output	55
Medical	65
Police and administration (14%)	150
Total	<u>1,260</u>

**(d) Cost of damage-only accident**

Damage to vehicle	530
Police and administration (10%)	50
Total	<u>580</u>

\* Totals rounded down

**SUMS TO REFLECT PAIN, GRIEF AND SUFFERING**

4.17 As stated earlier, the Gross Output approach includes a sum to reflect pain, grief and suffering. These sums are 'notional' and are not based on detailed or complex calculations. In the estimation of lost output for persons killed in road accidents in Cyprus the average age of a fatality at 43 years was subtracted from the average age of retirement, which was 65.5 years. The average life expectancy in Cyprus, however, was as follows:

	Age	Additional Years	Average life expectancy
Male	35-39	39	74-78
Female	35-39	42-46	78-82

Thus the average life expectancy in Cyprus was about 79 years for males and females combined. In other words, people in Cyprus could hope to live another 14 years or so after retiring. This, however, was not included in the years of lost output and if no account is taken of this it implies that people's lives after they retire are of 'little value'. This is clearly not so in any country and the addition of sums for pain, grief and suffering to some extent compensate for this.

4.18 The percentage of resource costs used to reflect pain, grief and suffering were based on those values used in the UK at the time of the appraisal, and were as follows:

Fatal accidents	38%
Serious accidents	100%
Slight accidents	8%

Using these percentages, the estimated total costs of accidents on major inter-urban roads in Cyprus were as follows:

(a)	<b>fatal accident</b>	<b>£</b>
	Resource costs	80,140
	Non-resource costs	30,450
	Total	110,600
(b)	<b>serious accident</b>	<b>£</b>
	Resource costs	4,000
	Non-resource costs	4,000
	Total	8,000
(c)	<b>slight accident</b>	
	Resource costs	1,260
	Non-resource costs	100
	Total	1,360
d)	<b>damage-only accident</b>	
	Resource costs only	580
	Total	580

4.19 The above illustrates how the Gross Output (or Human Capital) approach was used to cost accidents in Cyprus. With limited time available, certain estimates and assumptions needed to be made but the methodology indicates this and above all acts as a reminder of the many factors that need to be taken into account in costing road accidents. The Appendix illustrates how costs derived were used in a number of highway cost-benefit analyses under-taken in Cyprus. These in turn showed that the inclusion of accident savings could have an effect on both the ranking of projects and on the magnitude of net benefits generated by the specific highway improvements.

## 5. REFERENCES

ANDREASSEN, D, 1992. Horations on the use of accident cost data. *Traffic Engineering and Control*, May 1992

BERGSTROM, T C, 1982. When is a man's life worth more than his human capital? in Jones-Lee, M W. (Ed). *The Value of Life and Safety: Proceedings of a Conference held by the Geneva Association*, Amsterdam, North Holland.

DAWSON, R F F, 1976. Cost of road accidents in Great Britain, *TRRL Laboratory Report 79*, Crowthorne: Transport and Road Research Laboratory.

HEYS, R F et al, 1968. Practicability and cost of oestriol assays for saving babies in a maternity hospital. *Lancet*, 331-332.

HILLS, P J and M W JONES-LEE, 1981. The Costs of traffic accidents and evaluation of accident prevention in developing countries. In: PTRC. *SummerAnnual Meeting. University of Warwick*, 13-16 July 1981. London: PTRC Education and Research Services.

HOPKIN, J M and D M O'REILLY, 1993. Re-valuation of the cost of road accident casualties in Great Britain 1992 revision. *TRL Research Report 378*, Crowthorne. Transport Research Laboratory.

HILLS, P J and M W JONES-LEE, 1983. The role of safety in highway investment appraisal for developing countries. *Accident Analysis and Prevention*, 15, 355-69.

JACOBS, G D, 1976. A study of accident rates on rural roads in developing countries, *TRRL Laboratory Report 732*, Crowthorne: Transport and Road Research Laboratory.

JACOBS, G D and C A CUTTING, 1986. Further research on accident rates in developing countries. *Accident Analysis and Prevention*, 18(2), 119-127.

JONES-LEE, M W, 1976. *The Value of Life: An Economic analysis*. London, Martin Robertson.

JONES-LEE, M W, 1989. *The Economics of Safety and Physical Risk*, Oxford, Basil Blackwell.

JONES-LEE, M W et al 1993. The Value of Preventing Non-Fatal Road Injuries: Findings of a Willingness-to-Pay National Sample Survey". *TRL Contractor Report CR330*. Crowthorne, Transport Research Laboratory.

McMAHON, K, 1991. The valuation of safety. *PIARC Conference September 1991*. Marrakesh, Morocco.

MOONEY, G H, 1977. *The Value of human life*. London: The Macmillan Press Ltd, SIMPSON HF and D O'Reilly, 1994. Revaluation of the accident related costs or road accidents *TRL Project Report 56*, Transport Research Laboratory.

SIMPSON, HF, and D O'Reilly, 1994. Revaluation of the accident related costs of road accidents. *TRL Project Report PR56*, Crowthorne, Transport Research Laboratory.

SINCLAIR, T C et al, 1972. *Human life and safety in relation to technical change*. Brighton: Science Policy Research Unit, University of Sussex.

TRRL, OVERSEAS UNIT, 1988. *A guide to road project appraisal. Overseas Road Note 5*, Crowthorne: Transport Research Laboratory.

## 6. APPENDIX: THE INCLUSION OF ACCIDENT SAVINGS IN HIGHWAY COST BENEFIT ANALYSES

### BACKGROUND

6.1 In order to appraise a project, estimates need to be made of the costs associated with the project and the benefits that are expected to occur. In Western countries, benefits associated with highway engineering improvements are usually

- (i) direct savings on the costs of operating vehicles,
- (ii) economies in road maintenance
- (iii) time savings by travellers
- (iv) reduction in road accidents
- (v) wider effects on the economic development of the region.

Historically, highway cost-benefit analyses carried out on projects in Third World countries have tended to be based on operating cost savings only, although in recent years time savings have become more common. Three reasons are usually put forward for excluding savings based on reductions in road accidents.

These are:

- (i) road accident costs (and values of prevention) are difficult to determine
- (ii) changes in road accident rates following a specific road improvement are difficult to predict
- (iii) even if accident benefits were to be included, their effect on the economic appraisal would be minimal.

6.2 Clearly it is the object of this Road Note to assist with (i) above. It is also true that relatively few studies have been made of factors affecting accident rates in developing countries. A recent review by TRL showed that only five such studies have been undertaken in developing countries over the last twenty years or so. No consensus was achieved between these studies, nor even between the dependent variables used or the methods of analysis. Differences in traffic composition, road user behaviour and road geometry suggest that results from similar studies in developed countries (where even here, success in model development has been limited) cannot be used on projects in the developing world with any degree of confidence. Insufficient information is available at present to enable accident savings to be incorporated into specific cost benefit analyses of highway improvements in developing countries. However, studies undertaken (Jacobs 1976) etc. can be used in a theoretical exercise to provide an indication of the range of the possible changes in accident rates

following a specific highway improvement (or improvements) (see below). With respect to point (iii) above, results are presented in this Appendix which indicate that economic benefits from reduced accidents following a highway improvement may add significantly to net present values or rates of return derived. It also shows that ranking of alternative schemes may change with the inclusion of accident savings.

6.3 In order to illustrate the effects of including the benefits of accident prevention in highway cost-benefit appraisal, use is made of data collected by TRL on projects undertaken in Cyprus and Jordan over the period 1982-84. As part of these studies it was necessary to cost road accidents either nationally or on specific roads under investigation. In all these studies the 'gross output' or 'human capital' method was used to cost accidents. In most cases costs were derived both with and without sums added to reflect pain, grief and suffering. The information collected as part of these studies has been used to illustrate the possible effects of including the value of accident prevention in proposed highway improvement schemes. As stated above, it is difficult to assess with any degree of accuracy the likely effects on accidents of specific highway improvements. Consequently results are presented such that economic benefits from reduced accidents are assessed over a range of possible percentage reductions in accidents. Information is also presented of a more 'hypothetical' exercise carried out using data obtained from a project in India.

### FEASIBILITY STUDIES IN CYPRUS

6.4 Over the period 1982 to 1986 the British transport consultants Hughes Economic Planning carried out a number of feasibility studies in Cyprus. These included a study of a proposed road improvement from Limassol, the main port of Cyprus, to Paphos, the centre of a thriving tourist industry (see Fig 6.1), and an appraisal of the likely benefits which would result from an improved road link between the new dual carriageway running from Nicosia to Limassol and the busy port of Larnaca. At the time of this study there were three roads all of relatively poor alignment linking the new road and Larnaca (see Fig 6.1). The options were to either improve routes A and C or routes B and C. The TRL was asked to assist in these studies by providing estimates of road accident costs on each of the routes and the benefits that might result from reduced accident rates following the proposed road improvements.

6.5 Having derived the above, the effect of including accident savings on the net present value (NPV) assessed by the consultants for the Limassol - Paphos Road was obtained. (NPV being defined as the total discount net benefits estimated over the life of the project minus total discounted costs). Results are given in Fig. 6.2. The proposed improvements to the highway included road widening

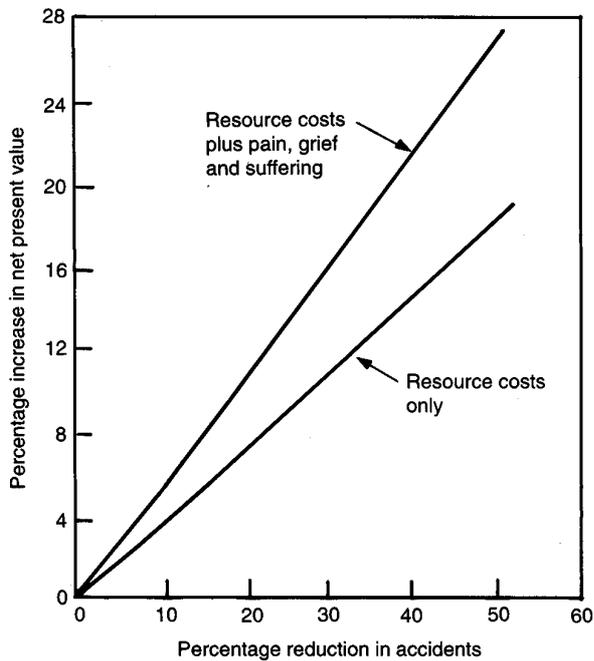
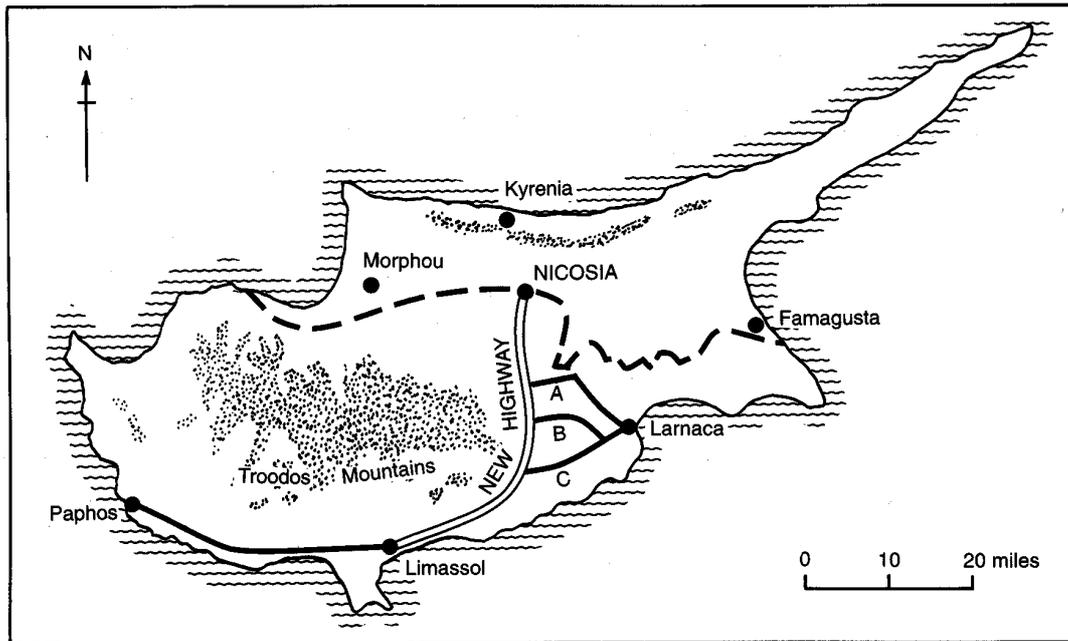


Fig. 6.2 Feasibility study Limassol - Paphos Road, Cyprus 1982  
Percentage increase in net present value by including accident cost savings

from an average of 6 metres to 7.5 metres, a reduction in the number of junctions per kilometre from 1.7 to 0.5, improved sight distances and reduced road roughness. Earlier research work carried out by TRL suggests that the combined effect of these improvements might be to reduce accidents by some 20 - 35 per cent. Thus the effect of including accident savings in the appraisal (with benefits covering the period 1984 - 2004) might be to increase the NPV, assessed at about £14.5 million at 1984 prices by 12 - 20 per cent if accident costs include sums to reflect pain, grief and suffering.

- 6.6 In the appraisal carried out in 1985 the alternatives were to improve the alignment of existing routes with the road being widened from 6 metres to either 7 metres or to dual carriageway standard. Results are given in Table 6.1. It can be seen that by including possible accident cost savings in the appraisals, the NPV's might be increased by 10 to 25 per cent depending on either the standard of improvement or the routes selected.
- 6.7 In these analyses, therefore, it would appear that the inclusion of possible accident savings significantly increases Net Present Values derived and that accident savings, when measured against the more traditional benefits from reduced vehicle operating costs are by no means insignificant.

#### FEASIBILITY STUDIES OF TWO ROADS IN JORDAN

- 6.8 Over the period 1980 - 1981 the British transport consultants Halcrow - Fox were involved in a range

**TABLE 6.1**

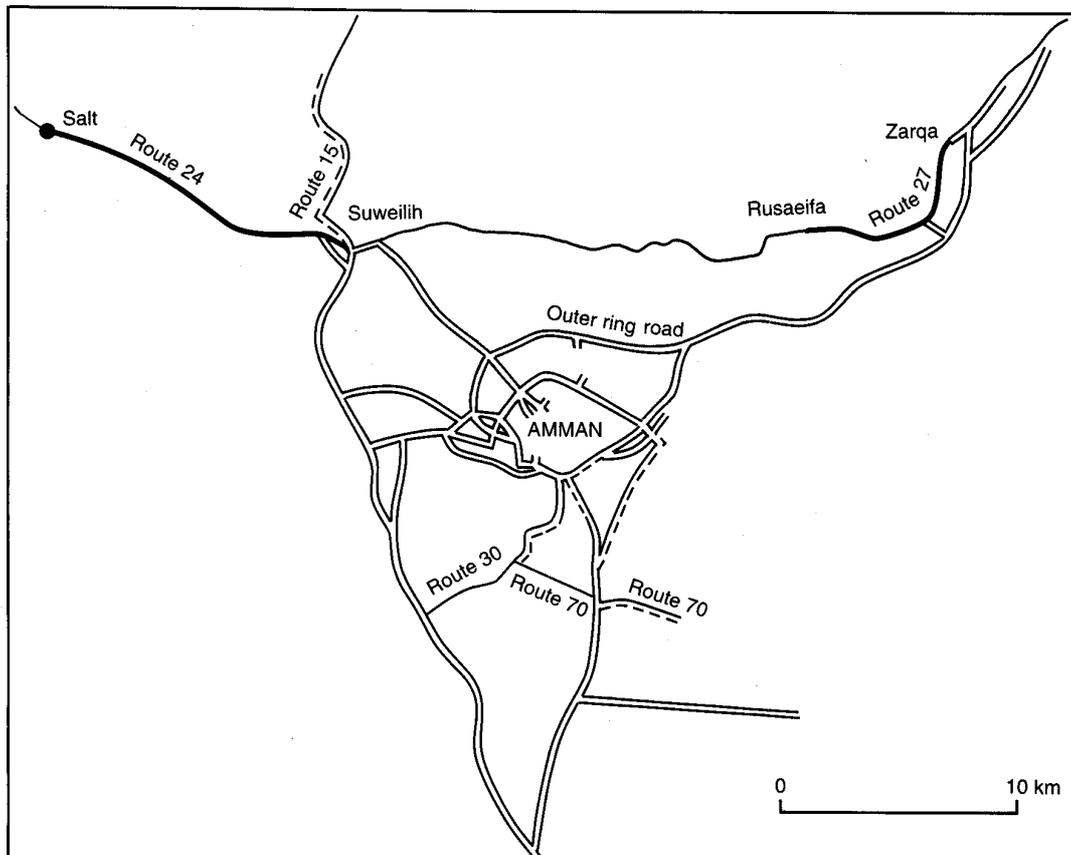
Larnaca Link Study Cyprus

Option	Description	Per cent increase in NPV by including accident savings
A+C	Both 7m	10
A+C	A = Dual carriageway C=7m	15
A+C	Both dual	20
B+C	Both 7m	11
B+C	B = Dual carriageway C=7m	16
B+C	Both dual	25

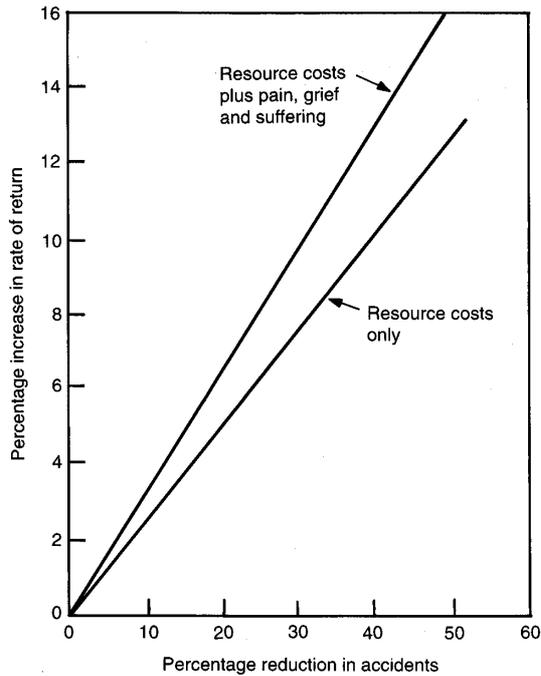
of transport projects in Jordan including feasibility studies of proposed major road improvements. Amongst these were proposed improvements to the roads from Salt to Suweilih and Zarqa to Rusaeifa (see Fig. 6.3). The former involved the upgrading of 8.4 km. of road from single to dual two - lane carriageway and the latter the upgrading of 2.2 km. of road from single to dual two - lane carriageway. The consultants estimated the first year rates of return of the proposed improvements using 1990 as the first year of full benefits.

6.9 Whilst the studies by Halcrow - Fox were drawing to a close, a joint British - German consortium were undertaking a broad review of the transport sector in Jordan and asked the TRL to advise on road safety issues including the costing of road accidents. Using the results of this study it was thus possible to include possible accident cost savings in two of the feasibility studies undertaken by Halcrow - Fox. Results are given in figures 6.4 and 6.5.

6.10 Work carved out by TRL suggests that the upgrading of a single carriageway to dual carriageway may have the effect of reducing accidents by 30 to 50 per cent. (It should however be pointed out that results from other studies showed different results



**Fig 6.3 Roads studied in Jordan**



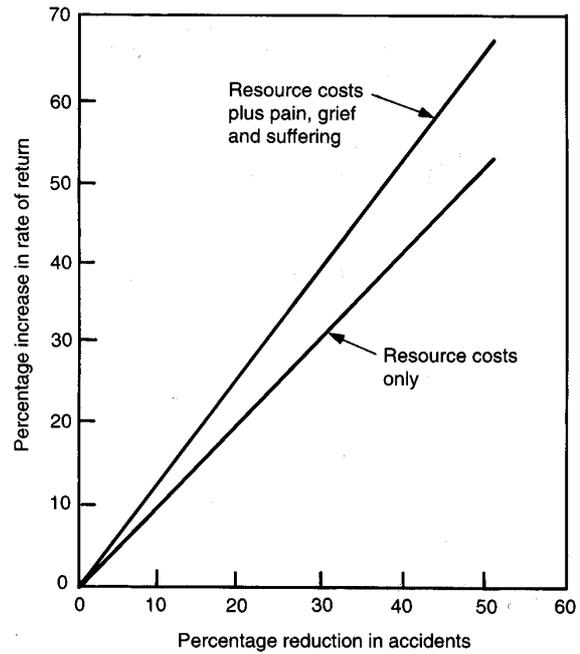
**Fig. 6.4 Salt - Suweilih Road, Jordan**

Percentage increase in first year rate of return by the inclusion of savings in accident costs

of the effects of road widening on accident rates.) On the Salt to Suweilih road the effect of including accident savings might be to increase the estimated first year rate of return by 10 to 16 per cent. (assuming sums are included to reflect pain, grief and suffering). On the Zarqa to Rusaeifa road, however, possible measures range from 40 to 60 per cent. In both cases (unlike those in Cyprus) benefits estimated by the consultants included time savings as well as changes in vehicle operating costs. Even so, possible savings from reduced accident rates are by no means insignificant; in the case of the Zarqa to Rusaeifa road they represent almost 50 per cent of benefits from time and operating cost savings. This road in fact is particularly dangerous with, on average, over 20 accidents taking place per kilometre of road per annum. In these circumstances it may well be that a project which appears not to be feasible (i.e. with a first year rate of return below the discount rate) may become so by the inclusion of accident savings.

**FEASIBILITY STUDY IN INDIA**

6.11 In order to determine the effects of including road accident savings on the ranking of projects, Hills and Jones -Lee (1981, 1983) used data from a study in India. Whilst the projects were in the strictest sense 'hypothetical', they were sufficiently typical of a Third World road



**Fig. 6.5 Zarqa - Rusaeifa Road, Jordan**

Percentage increase in first year rate of return by the inclusion of savings in accident costs

improvement decision to form a legitimate basis for the analysis. The example was as follows.

6.12 Two cities in India, with populations of 1 million and 400,000 respectively, about 190 kms apart, were connected by a two-lane stabilised gravel road. The highway authorities were considering a number of mutually-exclusive schemes to improve conditions for traffic between the two cities.

These were as follows:

Scheme A - the "invest-nothing" case, with continued maintenance of the existing gravel road;

Scheme B - paving the existing gravel road, with minor improvements to alignment and minimal local widening;

Scheme C - paving the existing gravel road, together with substantial improvements to the width and alignment of the right of way, reconstruction of bridges, drainage culverts etc. and

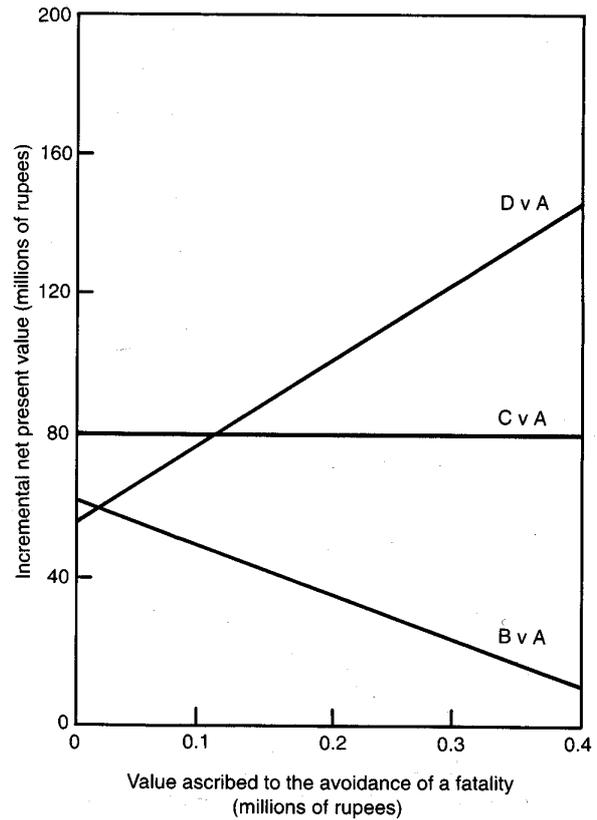
Scheme D - the construction of an entirely new and shorter road remaining in use, mainly for local traffic. The new highway will have some restrictions on access and a design speed of 100 km per hour throughout its length.

In all the schemes, 1969 was used as the base-year with a time horizon of 1990: the monetary units used for costs were the Indian Rupee and Paisa (R1 - 100 Paisa) at 1969 prices and, where appropriate, take into account the foreign exchange costs (using a shadow weighting of 1.75). All are net of taxes and subsidies. A 12% per annum discount rate was used throughout.

6.13 As far as capital costs, vehicle flow, vehicle operating costs etc. were concerned, assumptions (which were not based on the results of specific studies) were adopted that were realistic and representative of such schemes in developing countries. Following discussions with members of the World Bank who had direct experience of such schemes, it was assumed that Scheme B would raise accident-rates by 30%, Scheme C would have no effect on accident-rates, while Scheme D which was purpose-designed on a new alignment would incorporate a number of safety features which together would serve to reduce accident-rates by 30%.

6.14 The authors then examined the effect upon protect-rankings of varying the cost of a fatal accident from 0 - 400,000 Rupees and of varying the ratio of fatal to non-fatal accident-costs from five to twenty. For all ratios of fatal to non-fatal accident costs, variation in the cost of fatal accidents had a significant impact upon the net present value of those projects that alter accident rates and, more significantly, had a substantial effect upon project-rankings. The results for the intermediate fatal/non-fatal accident cost ratio are summarised in Fig. 6.6 and it can be seen that an increase in the cost of a fatal accident from 0 to say 100,000 Rupees serves to raise Scheme D from third to first place in the protect-ranking.

6.15 In summary, the results of this sensitivity exercise and the results from Cyprus and Jordan indicate quite clearly that, far from being a matter of subsidiary importance, the size of accident costs or values of accident prevention could have a marked effect both on the ranking of transport projects, in terms of net present value within mutually-exclusive groups, and on the magnitude of net benefits generated by any given project. In short it would appear that the issue of the "appropriate" cost to associate with particular types of accidents, or values to place upon their avoidance, is not one that can legitimately be ignored on the grounds that accident costs have little overall importance in project-appraisal. The message of these sensitivity tests is that such costs may be potentially very important indeed. However before such benefits can be assessed with any degree of certainty and incorporated into specific feasibility studies, more research is needed on the effects of highway improvements on accident rates.



**Proposed road improvement, India**  
**Fig. 6.6 The effect on overall net present value of accident-prevention**  
 (where a fatality is assumed to have a value 10 times that of an average injury)



# **Costing road accidents in developing countries**

**ORN 10**