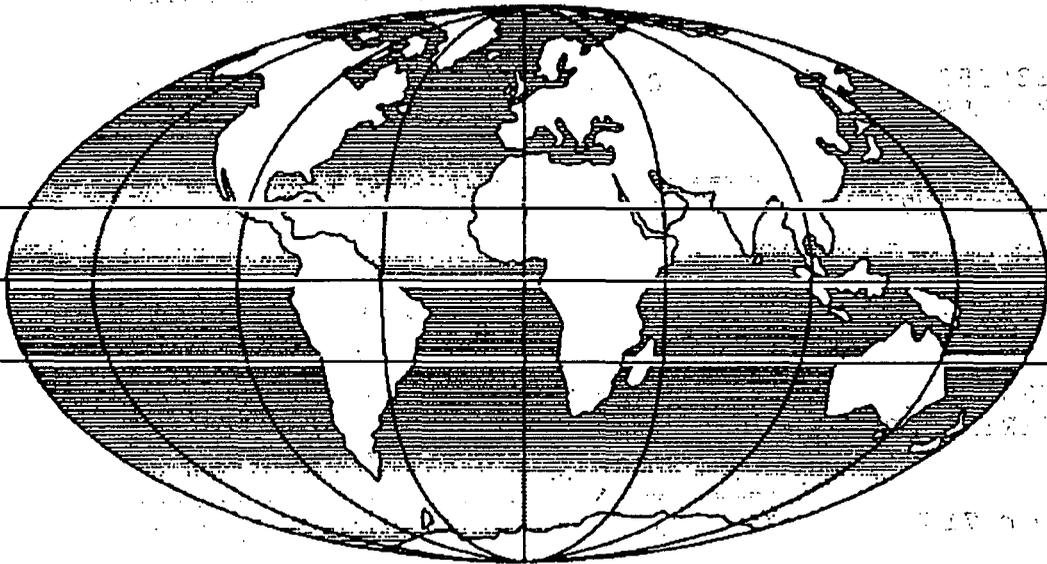




Reprint

**TITLE The inclusion of benefits from reduced accident rates in highway cost benefit analysis**

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# THE INCLUSION OF BENEFITS FROM REDUCED ACCIDENT RATES IN HIGHWAY COST BENEFIT ANALYSIS

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## ABSTRACT

*Savings from reduced accident rates are rarely included in highway cost benefit analyses carried out in developing countries. Reasons often put forward for this are that road accident costs are difficult to determine and that changes in accident rates following a specific road improvement are difficult to predict. Whilst this is undoubtedly true, the difficulty associated with including accident savings is not necessarily an excuse for their exclusion. This paper briefly outlines way in which accidents can be costed and how a range of estimates can be derived of changes in accident rates following a given improvement. Case studies are then used to show that economic benefits from reduced accident rates may add significantly to net present values or rates of return derived.*

## 1. INTRODUCTION

Over the last fifteen years or so a number of organisations, in particular the World Bank and the Transport Research Laboratory (TRL), have spent a great deal of time and effort on developing highway investment models for use in developing countries. In order to appraise a highway project these models are used to determine the costs associated with the project and the benefits that are likely to occur. Use is made of empirically derived relationships established from studies made in Kenya, Brazil, India, Ethiopia and the Caribbean. The model currently used by the World Bank is the Highway Design Model (HDM) and that developed by the TRL is known as the Road Transport Investment Model (currently RTIM III).

In any highway project, be it in the developed or developing worlds, the benefits that might be considered are:

- (i) direct savings on the costs of operating vehicles
- (ii) economies in road maintenance
- (iii) time savings by travellers
- (iv) reductions 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 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.

After commenting on points (i) and (ii) above, this paper presents the results of work carried out in a number of countries, which indicate that economic benefits from reduced accidents may add significantly to Net Present Values or rates of return derived and that the ranking of alternative schemes may change with the inclusion of accident savings.

## 2. METHODS OF COSTING ROAD ACCIDENTS

Whilst few people would deny the extent and importance of the road accident problem in developing countries, many planners, politicians and economists avoid the explicit quantification of the cost of accident prevention on the grounds that to do so would be too difficult and indeed too controversial. If in fact accidents are not costed, then the overall expenditure on road safety is unlikely to be "optimal". Furthermore, if no indication is provided of the cost of road accidents in a country, it becomes extremely difficult to identify a realistic annual budget of expenditure on road accident reduction and prevention measures. For example in a recent study by TRL of the accident situation in Mauritius it was shown that road accidents were costing the equivalent of about £20 million per annum. It was pointed out that a realistic annual expenditure of about £400,000 on road safety should result in a yearly savings of ten times this sum. Thus by the costing of road accidents, an annual budget of highway and other road safety improvements can be both assessed and justified. If road safety effects are ignored in transport planning and design, then there will certainly be a severe under investment in safety. Even within a given transport budget, too much might be spent on some aspects of safety and too little on others. The inefficient allocation of resources in this way could certainly be avoided by the constant use of costs of accidents and values of accident prevention in highway and transport planning.

The question is then how are costs of accidents and values of accident prevention to be defined in principle and estimated in practice? In order to assist with this problem, the Overseas Centre is presently preparing a document advising developing countries on how to cost road accidents. Whilst no single method can be said to be ideal (not least because the definition of accident costs and values depends crucially upon the use to which they are put), two methods appear relevant. The first of these is the "value of risk change" approach, which is based on the premise that the typical public sector investment in safety improvement in effect provides each individual affected with a very small reduction in the risk of involvement in a fatal accident. The value of preventing one accident involving one fatality is defined as the amount in aggregate that all the affected individuals in society are willing to pay for these small (marginal) risk reductions, both for themselves and for those they care about. Whilst ideally suited for use in conventional cost-benefit analysis, the major difficulty with this method is deriving a value based in turn on complex questionnaires, where individuals are asked to place a monetary value on what they would pay for very small reductions in accident risk.

The second acceptable method is the "gross output" (or "human capital") approach in which the cost of a traffic accident involving one fatality is treated as the sum of real resource costs (such as vehicle and property damage, medical and police costs) and the discounted present value of the victim's future output (based in turn on average current wage rates). The value of the prevention of an accident is correspondingly defined as the avoided cost. In this approach it is common to add a significant sum to reflect the "pain, grief and suffering" of the accident victim and those who care for him or her. This method was, until 1988, used by the British Department of Transport and was used by the author in the case studies presented in this paper.

### **3. PREDICTING CHANGES IN ACCIDENT RATES**

Apart from the problem of costing road accidents, another reason put forward above for their common exclusion in highway cost-benefit analyses is that changes in accident rates following a specific road improvement are difficult to quantify. Indeed, few studies of factors affecting accident rates have been carried out in developing countries and at this stage, predictions cannot be made with any certainty. Also, study findings from developed countries cannot with certainty be transferred to the Third World because of the different physical, cultural and traffic conditions found in most developing countries.

In spite of a scarcity of data, specific comments on the effects of highway engineering improvements on accident rates in developing countries can be made and are described in Overseas Road Note 5... "A guide to road project appraisal" (TRRL Overseas Unit, 1988). In considering the effects of highway improvements on road accidents, Overseas Road Note 5 draws a distinction between:-

- (i) accident prevention resulting from improved standards of highway design and planning

and

- (ii) accident reduction resulting from low cost engineering countermeasures introduced to improve the safety of specific sites.

A number of highway design and safety studies in developing countries (TRRL Overseas Unit, 1988; Jacobs, 1976) have investigated the relationship between (personal injury) accident rates and geometric design characteristics for rural roads. In these studies, the number of junctions per kilometre, horizontal and vertical curvature and road width were found to affect accident rates. In one particular study (TRRL Overseas Unit, 1988) the construction of a dual carriageway road carrying up to 20,000 vehicles per day was found to reduce injury accidents by up to 50% and fatal and serious accidents by about 25%. The effects of the different improvements in highway design are not additive and there is clearly a limit to the likely benefits that can be obtained from improved design. From the studies referred to above, it may be possible to expect up to a 40% reduction in accident rates on an existing road with comprehensive improvements in geometric design and planning. Although these studies only allow for broad estimates of accident reductions to be made for any given road improvements, the costs and benefits, can of course, be examined over a range of likely outcomes.

### **4. THE EFFECTS OF INCLUDING ACCIDENT SAVINGS IN ECONOMIC APPRAISALS**

In order to illustrate the effects of including accident savings in highway cost-benefit analyses, use is made of data collected by the Overseas Centre 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 projects the "gross output" or "human capital" method approval was used and in most cases costs were derived both with and without sums added to reflect pain, grief and suffering. 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.

#### 4.1 Feasibility studies in Cyprus

Over the period 1980 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 (1982), the main port of Cyprus, to Paphos, the centre of a thriving tourist industry (see Fig 1) and an appraisal (1985) 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 1) and the options were to either improve routes A and C or routes B and C.

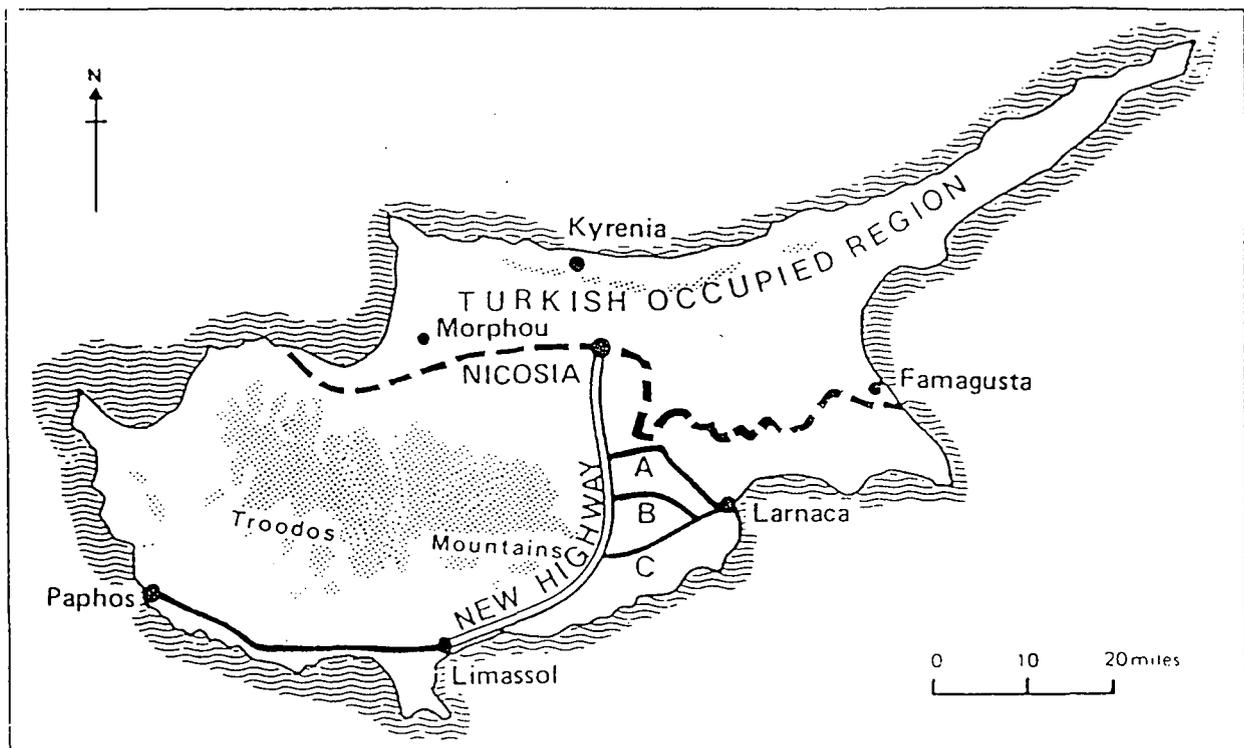


Fig. 1 Roads studied in Cyprus

The Overseas Unit was asked to assist in these two studies by providing estimates of road accident costs on each of the routes and the benefits likely to result from reduced accident rates following the proposed road improvements.

Having derived above, the effect of including accident savings on the Net Present Value (NPV - defined as the total discounted net benefits estimated over the life of the project minus total discounted costs) assessed by the consultants for the Limassol - Paphos Road was determined. The results are given in Figure 2. The proposed improvements to the highway included road widening 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 (Jacobs, 1976) carried out by the Overseas Centre suggests that the combined effect of these improvements might be to reduce accidents by some 25 - 35%. Thus the effect of including accident savings in the appraisal (with benefits covering the period 1984 - 2004) would be to increase the NPV, assessed at about £14.5 million at 1984 prices, by 16-20% if accident costs included sums to reflect pain, grief and suffering and 10-15% if they did not.

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. From the results given in Table 1, it can be seen that by including possible accident cost savings in the appraisals, the NPV's are increased by 10 to 25% depending on either the standard of improvement or the routes selected.

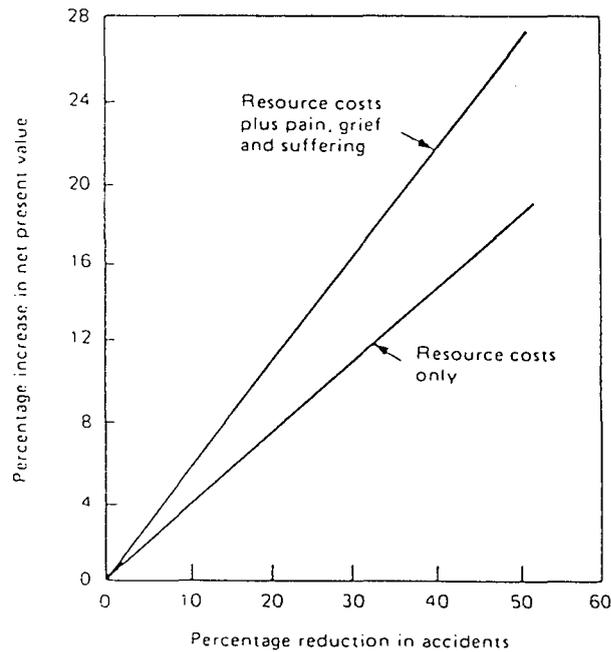


Fig. 2 Feasibility Study Limassol – Paphos Road Cyprus 1982: percentage increase in net present value by including accident cost savings

Table 1 Larnaca Link Study Cyprus 1985

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

In these analyses therefore, it would appear that the inclusion of possible accident savings increases the derived Net Present Value significantly and that accident savings, when measured against the more traditional benefits from reduced vehicle operating costs, are by no means insignificant.

#### 4.2 Feasibility studies in Jordan

Over the period 1980 - 1981 the British transport consultants Halcrow-Fox were involved in a range 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 3). The former involved the upgrading of 8.4km of road from single to dual two-lane carriageway and the latter the upgrading of 2.2km 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.

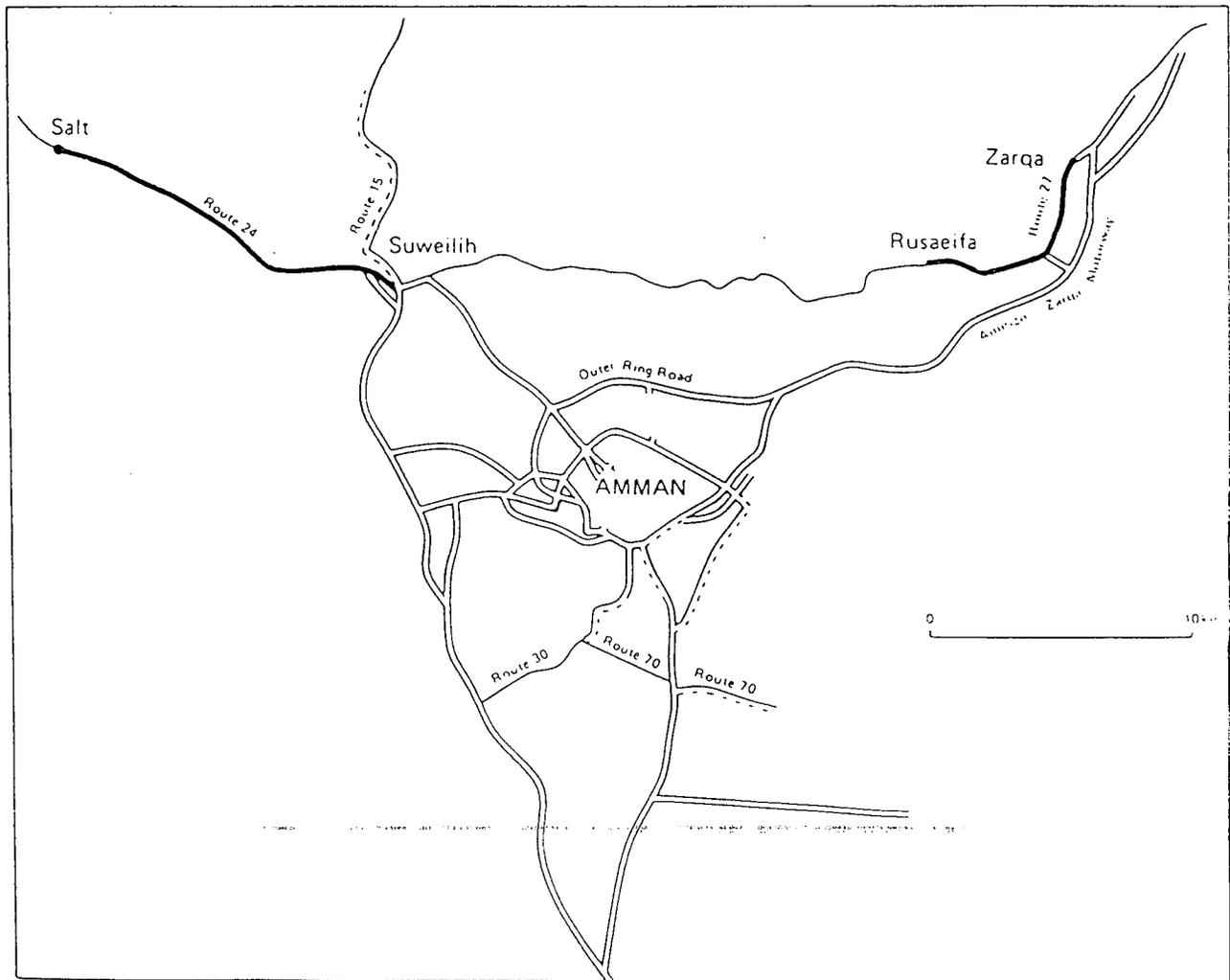


Fig. 3 Roads studied in Jordan

Whilst the studies by Halcrow-Fox were drawing to a close, a joint British-German consortium was making a broad review of the transport sector in Jordan and they asked the Overseas Centre, TRL to advise on road safety issues including the costing of road accidents. Using the data collected for this review it was thus possible to determine the likely accident cost savings

in two of the feasibility studies undertaken by Halcrow-Fox and the results are shown in Fig 4 and Fig 5.

Work carried out by the Overseas Centre suggests that the upgrading of a single carriageway to dual carriageway may have the effect of reducing accidents by 30 to 50%. On the Salt to Suweilih Road the effect of including accident savings might be to increase the estimated First

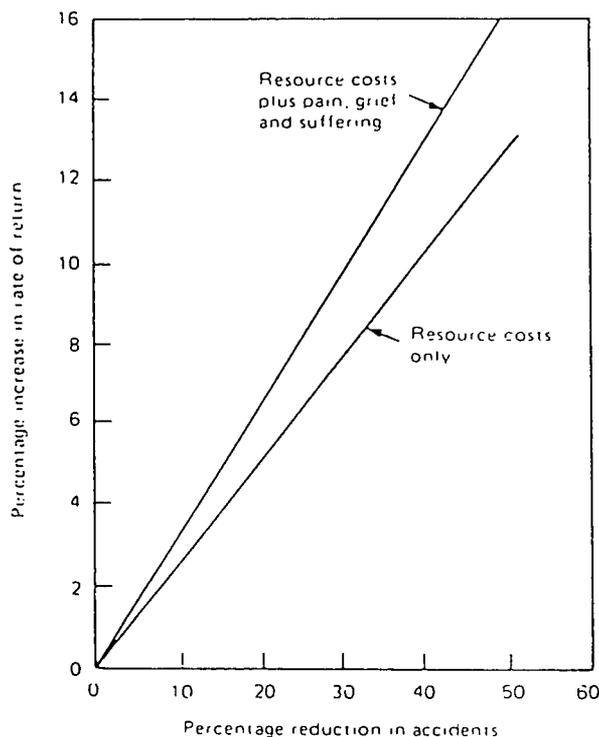


Fig. 4 Salt - Suweilih Road Jordan: percentage increase in first year rate of return by the inclusion of savings in accident costs

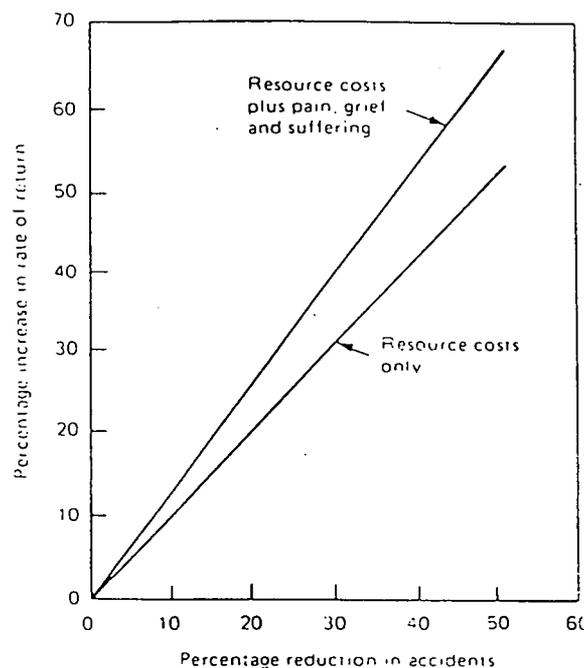


Fig. 5 Zarqa - Rusaeifa Road Jordan: percentage increase in first year rate of return by the inclusion of savings in accident costs

Year Rate of Return by 10 to 16% (assuming sums are included to reflect pain, grief and suffering). On the Zarqa to Rusaeifa Road however possible increases range from 40 to 60%. 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 and, in the case of the Zarqa to Rusaeifa Road, represent almost 50% of benefits from time and operating cost savings. This road is in fact 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 (ie with a First Year Rate of Return below the discount rate) may become so by the inclusion of accident savings.

## 5. SUMMARY

Over the last ten years or so there has been a growing awareness of the seriousness of the road accident problem in developing countries. With scarce financial resources it is important to ensure that any safety improvements that are introduced to deal with this problem can be justified on a cost-effective basis. In order to do this and also to determine the amount of money in total that can justifiably be spent on road safety, it is essential that a recognised

method be used to cost road accidents. The Overseas Centre TRRL is presently preparing a manual on how best to do this.

Another problem associated with the inclusion of accident savings in highway cost-benefit analyses is that changes in accident rates following a specific road improvement are difficult to quantify. Whilst it is true that relatively little work has been done on the relationships between accident rates and highway design in developing countries, sensitivity analysis can be used to determine for a given road improvement the possible benefits over a range of likely outcomes.

This approach has been used on a number of case studies with results presented in this paper. These analyses indicate that far from being a matter of subsidiary importance, the size of accident costs or values of accident prevention can (and in most cases almost certainly will) have a marked effect on both 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 on 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 the sensitivity tests presented in this paper is that such costs are potentially very important indeed.

## **6. ACKNOWLEDGEMENTS**

The work described in this paper forms part of the research programme of the Overseas Centre of the Transport Research Laboratory.

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