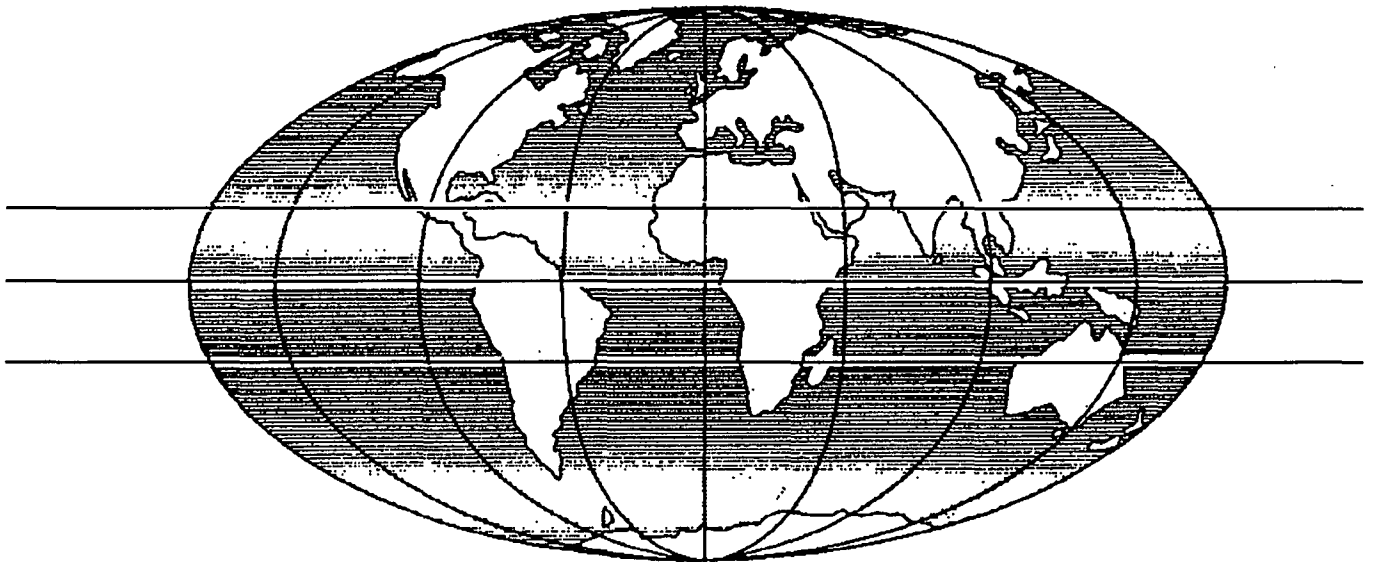




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ROAD SAFETY IN THE DEVELOPING WORLD

by

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1. INTRODUCTION

Recent and independent studies by both the World Health Organisation and the World Bank (1990) estimate that about 600,000 people lose their lives each year as a result of road accidents and over 15 million suffer injuries. The majority of these, about 70 per cent, occur in those countries of Africa and Asia which the World Bank classifies as low or middle income.

Whereas the road accident situation is slowly improving in the high income countries, most developing countries face a worsening situation. As infectious diseases are brought increasingly under control, road deaths and injury rise in relative importance. In Thailand for example, more years of potential life are lost through road accidents than from tuberculosis and malaria combined (Yerrell 1992); in Mexico, accidents as a cause of death rose from 4 per cent in 1955 to 11 per cent in 1980, with traffic accidents playing the leading role. The question needs to be posed whether or not this is the inevitable price that has to be paid by these countries for the mobility of people and goods which is the hallmark of an industrialised society?

This paper presents a broad review of the road safety problem in developing countries and outlines recommendations for improvement based on detailed research carried out by the Overseas Centre at the Transport Research Laboratory (TRL) over the last 20 years. The work described forms part of a programme of research at TRL on the highway and transport problems of

developing countries under funding from the Overseas Development Administration - which the author gratefully acknowledges.

2. BACKGROUND

Studies carried out by the TRL have demonstrated that road accidents in the Third World are:

- (i) A serious problem in terms of fatality rates, with rates at least an order of magnitude higher than those in industrialised countries (Jacobs 1986)
- (ii) An important cause of death and injury
- (iii) A considerable waste of scarce financial (and other) resources, typically costing at least one per cent of a country's gross national product per annum (Jacobs and Fouracre 1976)

2.1 Rates and trends

The rate used by TRL to compare the seriousness of the road accident problem in different countries throughout the world is the number of deaths from road accidents per annum per 10,000 vehicles licensed. This is far from ideal as an indicator of relative safety in different countries. For example, the injury accidents per million vehicle-km travelled per annum may be a much better parameter to use. Unfortunately, the reporting of non-fatal accidents in most Third World countries is poor and few carry out traffic surveys and censuses which provide information on annual travel by different classes of vehicle.

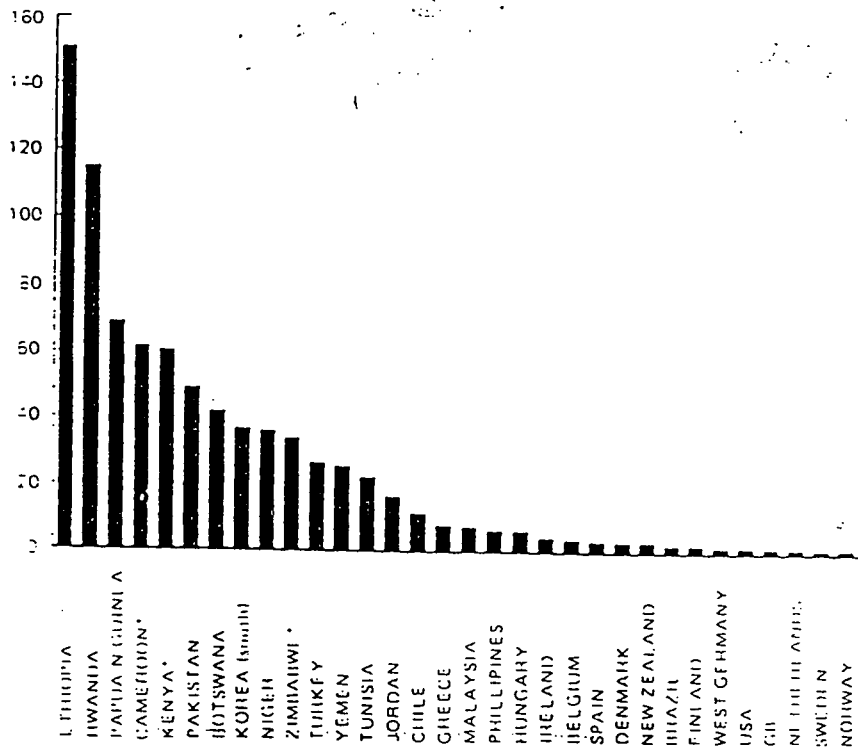


Fig.1 Road accident fatality rates (deaths/10 000 vehicles)

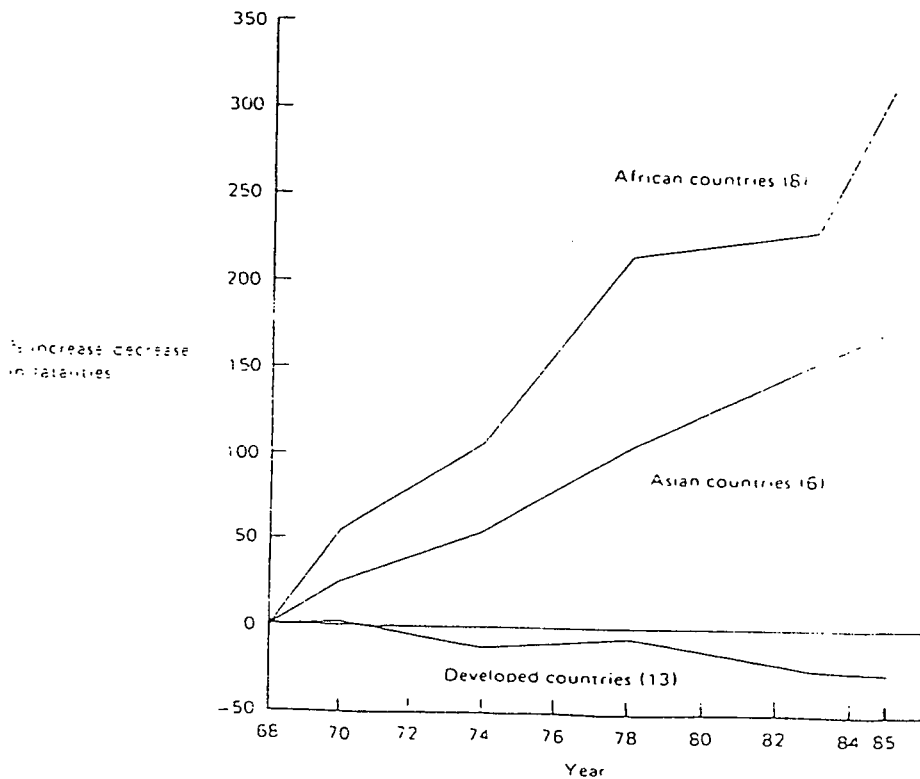


Fig.2 Percentage change in road accident fatalities

Results for a number of countries (1990) are shown in Figure 1. It can be seen that whilst countries of Western Europe and North America are characterised by a death rate (as defined above) of less than 4, some developing countries have a death rate in excess of 100. In most developing countries there will be an under-reporting of road accident deaths and an over-estimate of licensed vehicles because as vehicles are scrapped they tend not to be removed from the vehicle register. In a recent study in Bangladesh it was estimated that for the reasons given above, the actual fatality rate may be at least 50 per cent greater than the officially quoted figure of 60.

In 1984, TRL carried out a study in Colombo, Sri Lanka, comparing 'official' road accident statistics from police records with those held by hospitals. It was found that less than 25 per cent of the hospital records (of fatal and serious road accidents) were identified in the police data. Matching of accidents involving children was particularly low. Studies such as these suggest that the road safety problem in developing countries may be much worse than official statistics suggest.

Figure 2 shows the percentage increase or decrease in the actual number of road accident fatalities over the period 1968 to 1985 for three groups of countries. It can be seen that over this given time period the number of road accident deaths in 13 European countries actually fell by 25 per cent. Conversely in 6 Asian countries and 8 African countries (for which reasonably

accurate statistics were available) there were increases of about 150 and 300 per cent respectively. In these countries therefore there is need for much effort and investment in safety measures to reverse this trend - as has been the case in the developed world.

2.2 The importance of road accidents as a cause of death

In cooperation with the World Health Organisation, an early study (Jacobs and Bardsley 1977) compared deaths from road accidents in selected developing countries with other causes of death, including diseases considered to be of concern in the Third World. Information was obtained from 15 countries which tended to be at the top end of the 'Third World spectrum' (such as Jamaica, Colombia, Peru, Malaysia, Brazil, Venezuela, South Africa, etc) which could not be said to be representative of the entire Third World. The results nevertheless are of interest in that they show that in these countries road accidents were by no means insignificant as a cause of death. For all age groups combined, road accidents were the tenth most important cause of death (behind causes such as bronchitic, circulatory, parasitic and infectious, enteric, etc). For the age group 5-64 years, road accidents were the sixth most important cause of death and for the age group 5-44 years they were second in importance (to other accidents, suicides and homicides combined).

In order to investigate how death rates (per head of population) were changing over time, detailed data were obtained for Malaysia, Jordan and Jamaica over

the period 1960-1972. (These were the only countries for which data were available over such a long period.) Death rates were obtained for road accidents and also for four groups of diseases, namely infectious, intestinal, respiratory and neoplastic. These groups include diseases such as tuberculosis, dysentery, enteritis, malaria, cholera and smallpox. It was found that, in all three countries, death rates from road accidents and neoplasms increased over time while death rates from infectious, intestinal and respiratory diseases decreased. In Jordan, for instance, over the period 1954-64, the death rate from diseases of the respiratory system decreased by nearly 80 per cent whilst the road accident fatality rate increased by over 160 per cent. Similarly, in Jamaica the road accident fatality rate increased by over 120 per cent between 1958 and 1974 whereas the death rates from respiratory, intestinal and infectious diseases decreased considerably. An examination of the medical records of the three major hospitals in Nairobi, Kenya, also illustrated this trend.

This analysis was used to show that even twenty years ago, road accidents in developing countries were already a growing social problem.

Another important factor affecting the number of people killed in road accidents in developing countries is the level of medical facilities available. Thus in Western Europe with good ambulance services, road accident casualties are very quickly taken to hospital to receive immediate attention.

Even before reaching hospital trained paramedic services mean that expert assistance can be provided at roadside. Another useful measure of the seriousness of the road accident problem in a country is the Fatality Index (FI), ie the percentage of all casualties that are fatally injured. In a study carried out by TRL (Jacobs and Hutchinson 1973) the FI was determined for 32 (mainly) developing countries and was found to range from about 4 (Cyprus, Mauritius) to over 20 (Pakistan, Iraq). Reasons for high FIs were investigated by means of regression analysis and it was found that the level of medical facilities available in these countries (expressed as population per physician and population per hospital bed) were very closely correlated with the FI, the poorer the medical facility as defined above, the higher the FI. Clearly the level of medical facilities available in developing countries has a significant impact on the number of people dying in road accidents. By improving medical services generally, including ambulances and trained paramedics, the number of people injured in road accidents who subsequently die can be significantly reduced.

2.3 The cost of road accidents

Apart from the humanitarian aspects of road safety, it must also be borne in mind that road accidents are responsible in developing countries for a loss of scarce financial resources that these countries can ill-afford to lose. An analysis carried out by TRL (Fouracre 1976) showed that road accident costs

were the equivalent in any country, be it developed or developing, to at least 1 per cent of its annual gross national product. In current prices this suggests that road accidents in Indonesia for example may be costing about £600 million per annum, in Pakistan £260 million, in Egypt £200 million, in Chile £150 million, in Kenya £60 million, etc. If one assumes road accidents to cost 1 per cent of GNP in all countries, then for those countries of Africa and Asia below an average GNP/capita of \$3,500 (figure used by the World Bank to define 'developing' countries), it is estimated that the total annual cost of road accidents is approximately US\$25 billion. If the reduction in the substantial pain, grief and suffering caused by road accidents in the Third World is not sufficient motivation, there is also a very strong economic case to be made in the significant loss of resources each year due to accidents. Unfortunately, road safety is but one of the many problems demanding its share of funding and other resources in developing countries. 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.

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 was outlined which, it was estimated, would reduce the national cost of accidents by 5 per cent per annum (ie saving £1 million per annum). 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 5 year period (ie 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, quite apart from the humanitarian aspects, illustrate the economic benefits of investing in national road safety programmes.

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. TRL has recently produced a document (1995) outlining methods that can be used by developing countries to cost road accidents.

3. THE NATURE OF THE ROAD ACCIDENT PROBLEM

3.1 Accident Patterns

There are some accident characteristics which are common to a number of developing countries and yet are somewhat different from those in developed countries. For example, in the Third World (see Fig 3 and Table 1), a relatively high proportion of fatalities are pedestrians and children aged under 16 years, and many fatal accidents involve trucks, buses and other public service vehicles (Downing 1991).

In many cases these higher percentages are an obvious consequence of the differences between the traffic and population characteristics of developed and developing countries. For example, the average percentage of the population aged 5 to 14 years in a sample of 16 developing countries was 28 per cent compared with 15 per cent for 9 developed countries (Downing and Sayer 1982). As pedestrians, children and professional drivers constitute such a

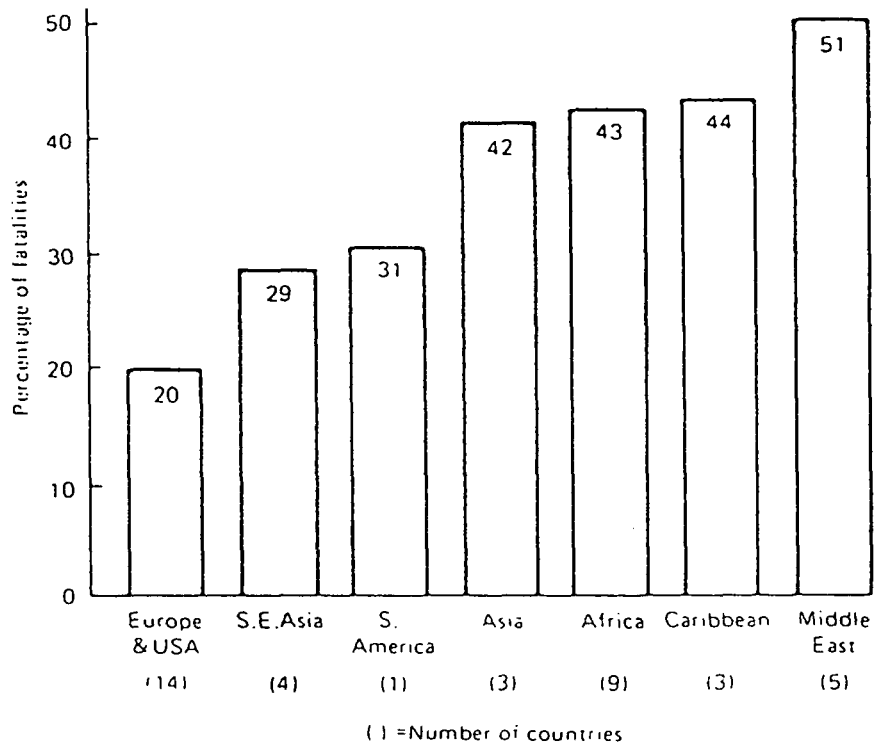


Fig. 3 Pedestrian fatalities as a percentage of all road accident fatalities

large proportion of the accident problem, it is clear that many Third World countries need to give priority to improving the safety of these particular three groups.

3.2 Contributory Factors

In most countries, police road accident reports give some information about the factors or causes which contributed to the accidents. In general these data have to be treated with some caution as the police investigating the accidents are unlikely to have been trained as engineers and they may therefore underestimate the contribution made by road engineering problems. Their main aim is usually to determine whether there has been a traffic violation and therefore the emphasis of the investigation is likely to be placed on detecting human error and apportioning blame.

In the United Kingdom in the early 1970s a more reliable approach, namely 'On-the-Spot' investigation, was carried out by a research team from TRRL in an area of South East England (Sabey and Staughton 1975). This study demonstrated the importance of the road-user factor which contributed to 95 per cent of the accidents and the strong link between road-user error and deficiencies in the road environment, which together contributed to over 25 per cent of accidents (see Table 2). Constraints of expertise or funding currently prevent a study of this type in developing countries, so police reports are the only source of information available. From Table 2 it can be

TABLE 1
Characteristics of fatal accidents

| Country | Percentage of fatalities which: | |
|---------------------------|---------------------------------|---------------------------|
| | were children under 16 years | involved trucks and buses |
| Botswana (1988) | 16 | 25 |
| Egypt (1984) | 12 | 37 |
| Ghana (1989) | 28 | 50 |
| Pakistan (Karachi) (1988) | 14 | 44 |
| Papua New Guinea (1987) | 20 | 37 |
| Zimbabwe (1989) | 11 | 45 |
| United Kingdom (1988) | 9 | 21 |

seen that, in general, the data highlight the seriousness of road-user errors in developing countries but give little indication of any road environment factor other than in the case of Iran. It seems likely that the road environment factor has been considerably underestimated by the police in their statistics. The condition of main roads is poorer in developing than in developed countries (see, for example, Harral and Faiz 1988) and the pace of introducing engineering improvements to reduce road accidents is considerably slower in the Third World.

TABLE 2

Causes of road accidents as determined by the police in developing countries

| Country | Main Cause of Accident (%) | | | |
|------------------------------|----------------------------|----------------|--|-------|
| | Road-user error | Vehicle defect | Adverse road conditions or environment | Other |
| Afghanistan 1984 | 74 | 17 | 9 | - |
| Botswana 1982 | 94 | 2 | 1 | 3 |
| Cyprus 1982 | 94 | 1 | 5 | - |
| Ethiopia 1982 | 81 | 5 | - | 14 |
| India 1980 | 80 | 7 | 1 | 12 |
| Iran 1984 | 64 | 16 | 20 | - |
| Pakistan 1984 | 91 | 4 | 5 | - |
| Philippines 1984 | 85 | 8 | 7 | - |
| Malaysia 1985 | 87 | 2 | 4 | 7 |
| Zimbabwe 1979 | 89 | 5 | 1 | 5 |
| TRRL On-the-Spot Study 1975* | 95 | 8 | 28 | |

*In about 30% of accidents, multiple factors were identified

3.3 Road User Behaviour and Knowledge

Studies of road-user behaviour (Jacobs et al 1981) at traffic signals and pedestrian crossings in a number of Third World cities indicated that road-users tended to be less disciplined than in the United Kingdom. Also, observations in Pakistan (Downing 1985) demonstrated relatively high proportions of drivers crossing continuous "no-overtaking" lines (15 per cent) and not stopping at stop signs even when traffic was near (52 per cent). Although the relationship between these differences in behaviour and accidents has not been determined, the results suggest that road safety measures which are not self enforcing, such as road signs and markings, may be much less effective unless they are integrated with publicity and enforcement campaigns. Poor road-user behaviour exhibited by drivers in some developing countries may be due to their lack of knowledge about road safety rules and regulations or their general attitude towards road safety matters. A study of drivers' knowledge in Jamaica, Pakistan and Thailand (Sayer and Downing 1981) indicated that there were only a few topics where a lack of knowledge was widespread. One such example was stopping distances where 87 per cent of the drivers underestimated the distance required to stop in an emergency when travelling at 30mph. Answering questions on stopping and following distances also proved to be a problem for professional drivers in Cameroon and Zimbabwe (Downing 1991), with truck and bus drivers unable to answer more

than half the questions on driving knowledge and skills correctly. Other areas of driver behaviour, such as not stopping at pedestrian crossings, traffic signals and stop signs were found to be due to poor attitudes rather than to poor knowledge. Although attitudes are notoriously difficult to change, there would seem to be some potential for improving them by introducing publicity and enforcement campaigns.

Another area of concern in some, but not all, Third World countries is the problem of alcohol and road-users. From Table 3 it can be seen that the blood alcohol levels found in accident fatalities in Trinidad (Simmons 1990) and Zimbabwe (Sandwith 1980) were considerably higher than those found in Great Britain (TRRL 1990). In addition, recent roadside alcohol surveys in Papua New Guinea at weekends between 10pm and 2am found that 24 per cent of drivers were over 80mg/100ml (the UK legal limit). This is much higher than the figure of 2 per cent found in similar surveys in the United Kingdom (Everest 1991).

Table 3.

Blood alcohol levels in road accident fatalities.

| Country | Road-user Type | Percentage with BAC exceeding (mg/100ml) | |
|----------------------|----------------|--|----|
| | | 0 | 80 |
| Trinidad (1988) | Driver | - | 41 |
| | Pedestrian | - | 41 |
| Zimbabwe (1979) | Driver | 56 | - |
| | Pedestrian | 72 | - |
| Great Britain (1988) | Driver | 31* | 20 |
| | Pedestrian | 37* | 28 |

(* = over 9mg/100ml)

Thus, overall there are wide differences between developed and developing countries in the behaviour, knowledge, attitudes and culture of the road-users, in the conditions of the roads and the vehicles and in the characteristics of the traffic. Consequently the effectiveness of transferring some developed country solutions to developing countries is uncertain and their appropriateness needs to be considered in relation to the problems and conditions prevailing in individual countries.

4. INSTITUTIONS AND INFORMATION SYSTEMS

4.1 Organisational Requirements

In road safety matters, as in many other sectors, there is a need to strengthen the various institutions responsible for the various aspects of road safety and to increase their capability for multi-sectoral action. The whole process of

planning and implementing road safety improvements should be multi-disciplinary and dynamic. Road safety organisations should be established on a full-time basis and be capable of:

- 1) diagnosing the road accident problem
- 2) drawing up an integrated plan of action including the setting up of goals and objectives
- 3) coordinating the work of all organisations involved
- 4) procuring funds and resources
- 5) producing design guides
- 6) designing and implementing improvements
- 7) monitoring implementation and evaluating measures
- 8) feeding back information from the evaluations and amending the action plan as necessary.

In a survey of African countries' road safety activities (Yerrell 1991) 35 per cent of the countries reported active national road safety organisations. Although this level of activity appears very encouraging, it should be noted that these reports were not independently verified. In many cases the functions of road safety organisations were somewhat limited and clearly more institutional improvements are still necessary in many countries.

4.2 Road Accident Databases

One of the key activities listed above was the diagnosis of the road accident problem. The most important source of data for this activity is the police road accident report. In the early 1970s, a survey of road accident information systems in use in developing countries (Jacobs et al 1975) indicated that only 15 per cent of the countries had adequate accident report forms and none had computer analysis facilities. Therefore, to help countries improve their accident investigation and research capability, TRL's Overseas Centre, with ODA's support, developed its Microcomputer Accident Analysis Package (MAAP), initially in collaboration with the traffic police in Egypt, (Hills and Elliott 1986) and it is now in use in over 14 countries. It is the nationally adopted system for Botswana and Papua New Guinea, and regionally adopted in most of the other countries; major cities in which MAAP is established include Bandung, Beijing, Karachi and Islamabad. The languages that MAAP operates in include Arabic, Chinese, French and Spanish. It is interesting to note that MAAP is also used by a number of Local Authorities in the UK.

MAAP is a powerful yet simple system which enables users to:

- 1) obtain good data for diagnosis, planning, evaluation and research purposes

- 2) set up low-cost engineering improvement schemes similar to those which have proved so successful in developed countries.

It consists of two key components: a police report booklet or form with a recommended structure, although details can vary considerably; and a set of software programs for data entry and analysis. The relatively low-cost and increased availability of microcomputers means that individual highway authorities can analyse their own data to help identify hazardous locations, the nature of the problems, choose appropriate countermeasures and assess their effectiveness, all with increased efficiency and, therefore it is hoped, accuracy.

5. ROAD SAFETY IMPROVEMENTS

In the Third World, evaluation of improvements is essential because of the lack of data on the benefits (or otherwise) of road safety measures. It is recommended that improvements are introduced on a pilot basis and evaluated before being implemented nationwide.

The Overseas Centre is giving priority to researching road safety countermeasures but, owing to the long term nature of many of the studies and the limited resources available, there are only a few published results.

In spite of this lack of information the remainder of this paper attempts to give an idea of likely priorities for future road safety action and research by reviewing studies of remedial measures in developing countries with reference to developed country findings where appropriate.

5.1 Engineering and Planning

Despite the fact that human error is probably the chief causal factor in most road accidents, there is little doubt that engineering and planning improvements can affect road-user behaviour in such a way that errors are less likely to occur or, when they do occur, the environment can be made more 'forgiving'. Thus, there has been a growth in emphasis on engineering and planning countermeasures over the past two decades both in Europe and North America.

Engineering and planning can improve road safety through two distinct mechanisms:

- 1) ACCIDENT PREVENTION, resulting from good standards of design and planning of new road schemes and related development and
- 2) ACCIDENT REDUCTION, resulting from remedial measures applied to problems identified in the existing road network.

5.1.1 Accident prevention

There has been very little research in developing countries into the relationships between highway design standards and accident rates. As a result, many developing countries have just adopted standards from developed countries or have modified such standards without evaluating the consequences. Often the traffic mix and road usage is very different in a developing country from that encountered in more industrialised countries. Also, there is usually a greater need to minimise costs; the challenge is to achieve this whilst at the same time maintaining an acceptable level of safety. To attain this balance, Hills et al (1984) have suggested that a radically different approach to the geometric design of highways may be required in developing countries, especially for low-volume roads. Studies of the relationships between geometric design and road accidents in Kenya and Jamaica (Jacobs 1976) and research in Chile and India indicated, not unexpectedly, that junctions per kilometre was the most significant factor related to accidents, followed by horizontal and vertical curvature. Kosasih, Robinson and Snell (1987) have examined geometric design research and standards around the world, and have made recommendations for developing countries. However, much more research is required before optimum standards can be determined for all developing countries. The TRL Overseas Centre currently has a research programme in Papua New Guinea that is

examining the effects of certain highway design elements on accident rates, in particular the road cross-sectional profile.

5.1.2 Accident reduction

The approaches used by developed countries for accident reduction would also seem to have considerable potential for developing countries. In particular, it is recommended that countries with limited resources should place initial emphasis on introducing low-cost improvement schemes at hazardous locations. Such schemes have proved very effective in industrialised countries; for example, in a survey of UK schemes (Hellier-Symons and Lynam 1990) First Year Rates of Return were estimated to range from 65 to 950 per cent.

A few developing countries have begun to introduce such schemes on a trial basis and the Overseas Centre is currently carrying out joint research to evaluate their effectiveness in Egypt, Ghana, Indonesia, Malaysia, Pakistan and Papua New Guinea. These trials, which have been made possible by the introduction of the TRL Microcomputer Accident Analysis Package (see earlier) are still at an early stage with many sites not yet improved. However, preliminary findings suggest that countries which have relatively low levels of road-user discipline are less likely to have success with very low-cost measures such as road signs and markings. For example, a study of the effects of introducing stop lines and lane lines at junctions and no overtaking

lines at bends in Pakistan (Downing 1985) indicated no improvements in driver behaviour apart from a small reduction in overtaking violations from 19 to 14 per cent. On the other hand, preliminary results from Papua New Guinea indicate that the introduction of roundabouts at uncontrolled major/minor junctions has halved the average injury accident rate (Hills et al, 1990).

It has already been noted that, since the 1970s, industrialised countries have benefited considerably from improvements in engineering approaches to road safety. Developing countries on the other hand, have been slower to adopt these approaches. In many locations, roads are being built or upgraded with little consideration given to road safety, and as a result blackspots are still being created. One factor contributing to this situation could well be the difficulty in acquiring information about the latest techniques and standards. To encourage the transfer of suitable technology in this field, the TRL has published "Towards Safety Roads in Developing Countries", a road safety guide for planners and engineers. This was produced in association with the Ross Silcock Partnership and is designed to be a first point of reference on road safety issues. It draws upon appropriate material from many existing manuals and standards around the world as well as giving many photographic examples of good and bad practices.

There are certain fields of engineering where many design standards from developing countries could be applied directly now. One such application would appear to be in the area of street lighting, and a developing country manual has been published by the Institute of Lighting Engineers (ILE, 1990). The manual predicts night-time accident savings of over 30 per cent for road lighting improvements in Third World countries, although the costs of the improvements are relatively high compared with other measures.

5.2 Vehicle Safety

Improvements in vehicle design, occupant protection and vehicle maintenance have made a significant contribution to accident reduction in industrialised countries. In developing countries, however, the safety design of vehicles sometimes lags behind that of developed countries, particularly when vehicles are locally manufactured or assembled. Similarly, vehicle condition is likely to be more of a problem when it is difficult to obtain spare parts. Overloading of goods and passenger vehicles is another vehicle factor which commonly contributes to high accident severity and casualty rates.

The benefits to individual road-users of improving vehicle design and of wearing seatbelts and helmets are likely to be much the same from one country to another so the general adoption of both primary and secondary vehicle safety measures is to be encouraged. However, the total benefit of such measures to a developing country as a whole will depend on the

characteristics of its accident and casualty problem and in some cases on the degree of road-users' compliance with traffic legislation. Thus, for example, seat belt wearing laws would lead to only small casualty savings if few casualties came from cars or if most drivers and passengers ignored the law. From Table 2 it is clear that the police in some developing countries have blamed a relatively high proportion (up to 17 per cent) of accidents on vehicle defects. Although many of these countries may have inadequate controls to ensure minimum safe standards of vehicle condition, it would seem more appropriate that they should start by introducing low-cost random roadside checks using simple equipment rather than expensive networks of vehicle testing centres with sophisticated technology.

The control of overloading passenger-carrying vehicles combined with improvements in the design of such vehicles would also seem to have some potential for accident and casualty reduction in many countries. For example, in Papua New Guinea (PNG), it is common for passengers to be transported in open pick-ups and, perhaps not surprisingly, an exceptionally high proportion (45 per cent) of the road accident casualties come from such vehicles. To help PNG deal with this problem, the Overseas Centre and Vehicle Safety Division of TRL designed a simple, robust protective cage to protect the occupants. Roll-over trials on TRL's test track demonstrated that

the cage provided improved protection and it is planned that the design will be field tested in PNG.

5.3 Education and Training

5.3.1 Road Safety Education

It is important for road-users to be educated about road safety from as young an age as possible. In developed countries a number of approaches have been tried both through school systems and through parents, and most children receive some advice. However, in developing countries where the child pedestrian accident problem is generally more serious (see Section 3.1), a study of children's crossing knowledge (Downing and Sayer 1982) indicated that children were less likely to receive advice (from members of their family, teachers or the police) than in the UK.

There is clearly a need to improve road safety education, but as some countries will have low school attendance figures it is important that education through community programmes is considered as well as through the school system.

With respect to teaching methods, a number of studies in Europe (OECD 1978) have evaluated teaching environments in terms of children's performances on crossing tests. Overall, the results demonstrated the importance of training on real roads; this need for frequent supervised

practice on local roads close to where children live is likely to apply to all countries.

It is recognised that road safety education programmes should be graded and developmental (OECD 1978, Downing 1987) and that teachers need guidelines on what and how to teach. To meet these requirements, many countries have produced syllabus documents and teacher guides, including a few in the Third World (Leburu 1990). However, it is in this area that the transferability of developed country solutions to developing countries is less certain and much more research is needed. Further, studies in Europe (Downing 1987, OECD 1986) and to some extent surveys in Pakistan and Zimbabwe, have indicated that measures such as producing teachers' guides and making road safety teaching compulsory, were not on their own sufficient to improve greatly the quantity and quality of road safety education in schools. For example, in the UK a 'core curriculum' document circulated to all schools was used by fewer than 4 per cent, and in Zimbabwe a schools 'road safety kit' was used by only 5 per cent of schools. Evidently teacher training and other actions are necessary to promote and increase the provision of road safety education in all countries. Currently TRL is involved in a programme of research in Ghana aimed at developing methods of improving road safety education in developing countries.

5.3.2 Driver training and testing

In developing countries, the problems of poor driver behaviour and knowledge described earlier are likely to be due, to some extent, to inadequacies in driver training and testing.

Professional driving instruction tends to be limited because:

- 1) driving instructors are not properly tested or monitored
- 2) there are no driving or instruction manuals
- 3) driving test standards and requirements are inadequate.

Consequently, there is likely to be considerable scope for raising driving standards by improving driver training and testing. One recent contribution by the Overseas Centre in collaboration with the United Nations Economic Commission for Africa (ECA), is a driving guide specifically for truck drivers (TRRL 1990). This group of drivers tends to have a greater involvement in accidents than in developed countries and inadequate training clearly plays some part in this. The guide was designed to be easy to read (average reading age of 9 years) and its usefulness appears promising, as a study by Downing (1991) demonstrated that reading sections of the guide helped drivers improve their scores on knowledge tests by up to 25 per cent on some topics.

As well as providing such advice on driving standards, many countries need to improve the licensing, training, testing and monitoring of instructors to ensure that these standards are taught. In training systems where learner

drivers are free to choose how they learn, it is important that driving tests demand a high standard of driving especially for the practical 'on the road' assessment. More difficult tests should encourage learners to purchase more lessons from professional instructors.

As with other countermeasures, there has been little research on the effectiveness of improved driver training in developing countries and accident savings as a direct result of training are, of course, very difficult to prove. A study of a retraining course for bus drivers in Pakistan (Downing 1988) failed to demonstrate any accident savings, although there was evidence of an improvement in knowledge test scores (13 per cent on average) and a reduction in driving test errors (67 per cent on average). It was also shown that the training had no effect on the drivers' behaviour when they were observed unobtrusively and they clearly returned to their old habits when driving in normal conditions. Therefore, to bring about a general improvement in driver behaviour it will usually be necessary to ensure that drivers are sufficiently motivated, and training courses will probably need to be integrated with publicity campaigns, incentive schemes and enforcement.

5.4 Enforcement

A large number of studies (OECD 1974 and Spolander 1977) have examined the effectiveness of enforcement systems in developed countries, particularly with respect to traffic police operations. Many of them demonstrated that a

conspicuous police presence led to improvements in driver behaviour in the vicinity of the police, but the evidence for accident reductions was less convincing.

In developing countries, the traffic police are generally less well trained and equipped and often they are non-mobile ie stationed at intersections. Traffic police operating under such conditions are likely to find it difficult to influence moving violations and this was certainly shown to be the case in a study by Downing (1985) of the effects of police presence in Pakistan. However, studies of improved training and deployment of traffic police have indicated large reductions in moving violations (see Downing 1985). Also, following the introduction of highway patrols on intercity roads, a 6 per cent reduction in accidents was achieved in Pakistan, and a similar scheme in Egypt produced accident reductions of almost 50 per cent (Gaber and Yerrell 1985). Therefore, it would appear that improvements in traffic policing have considerable potential for both improving driver behaviour and reducing accidents provided that the police's capability to enforce moving violations is enhanced.

Research in developed countries (Mercer 1985) suggests that changes in the way the traffic police operate need to be well advertised to ensure the maximum effect on road-user behaviour. This finding is likely to be universal and it is therefore equally important that developing countries integrate

changes in enforcement tactics with appropriate publicity campaigns. In many Third World countries it is likely that such improvements will need to be accompanied by modification in both the traffic legislation and the ways of dealing with offenders.

6. SUMMARY

Many developing countries have a serious road accident problem. Fatality rates 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. Apart from the humanitarian aspects of the problem, road accidents cost countries of Africa and Asia at least one per cent of their Gross National Product each year - sums that these countries can ill afford to lose. Compared with causes of death more commonly associated with the developing world, deaths from road accidents are by no means insignificant. Lack of medical facilities in these countries has been shown to be an important factor leading to high death rates.

In order to identify priorities for action, it is important that there is a clear understanding of the road accident problem and the likely effectiveness of road safety improvements. It is therefore a priority for countries to have an appropriate accident information system (such as TRL's MAAP) which can be used to identify accident patterns, the factors involved in road accidents and the location of hazardous sites. In order that an overall budget for, say,

a five year action programme can be determined, it is essential that developing countries set up procedures for costing road accidents. This will also do much to ensure that the best use is made of any investment and that the most appropriate improvements are introduced in terms of the benefits that they will generate in relation to the cost of their implementation.

Other basic requirements are for safety improvements to be coordinated by means of a National Road Safety Council (or the equivalent) and for a well trained safety team capable of implementing a wide ranging programme of road safety improvements, which are preferably low cost.

Although developing countries may have made a late start in road safety, many are now beginning to take appropriate action to reduce road accidents and there are some encouraging signs for the future. For example a survey of twenty three African countries (Yerrell 1991) suggested that nearly half were implementing a wide range of improvements. National aid agencies such as ODA and international lending agencies such as the World Bank are aware of the seriousness of the problem in developing countries and most loans for major highway or urban sector projects now have a road safety component built into them.

ODA is also to be applauded for the funding of TRL's long term programme of research in developing countries which has done much to draw attention to this growing problem. This, in turn, has led to other promising

developments. For example, at the second African Road Safety Congress (ECA 1989), one of the key recommendations was for the strengthening of research centres at the national or sub-national level. The Sixth Conference of the Road Engineering Association of Asia and Australia dedicated a special workshop to the problem of road safety (REAAA 1990). This year's REAAA Conference in Taiwan will also contain a special safety workshop.

Developing countries have accelerated their efforts to improve road safety in recent years. It is hoped that these trends will continue and that all countries will, through joint programmes of research and development and by sharing information, maintain an effective and scientific approach to reducing road accidents throughout the world.

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8. REFERENCES

Downing AJ and Sayer IA (1982). A preliminary study of children's road crossing knowledge in three developing countries. TRRL Supplementary Report 771. Crowthorne: Transport and Road Research Laboratory.

Downing AJ (1985). Road Accidents in Pakistan and the need for improvements in driver training and traffic law enforcement. In: PTRC. Summer Annual Meeting, University of Sussex, July 15-18, 1985, Proc of Seminar H. London: PTRC Education and Research Services.

Downing AJ (1988). The effectiveness of a retraining programme for bus drivers in Pakistan. In: Rotengatter J A and Bruin D E (Eds). Road User Behaviour: Theory and Research. Assen/Maastricht, The Netherlands: Van Gorcum, 682-689.

Downing AJ (1991). Pedestrian safety in developing countries. Proceedings of "The vulnerable road user", International Conference on Traffic Safety, New Delhi. McMillan India Ltd.

Downing AJ (1991). Driver training in Africa: the UN-ECA driving manual. Proceedings of the Second African Road Safety Congress. Oslo: Institute of Transport Economics (TOI).

Downing CS (1987). The education of children in road safety. Proceedings of the Symposium "The Healthy Community. Child Safety as part of Health Promotion Activities". Stockholm.

Economic Commission for Africa (1991). Conference recommendations. Proceedings of the Second African Road Safety Congress. Oslo: Institute of Economics (TOI).

Everest JT (1991). Drinking and Driving. Safety 91 - Proceedings and Programme. Crowthorne: Transport and Road Research Laboratory.

Fouracre PR and Jacobs GD (1976). Comparative accident costs in developing countries. TRRL Supplementary Report 206. Crowthorne: Transport and Road Research Laboratory.

Gaber Gen MA and Yerrell JS (1983). Road Safety Research in Egypt. In: IAATM. 9th International Conference, Mexico, September 1983. International Association for Accidents and Traffic Medicine.

Harral C and Faiz A (1988). Road Deterioration in Developing Countries - Causes and Remedies. A World Bank Policy Study. Washington, DC: World Bank.

Helliar-Symons RD and Lynam DA (1989). Accident reduction and prevention programmes in Highway Authorities - 1987. TRRL Research Report 187. Crowthorne: Transport and Road Research Laboratory.

Hills BL, Mansfield RS and Robinson R (1984). Appropriate geometric standards for roads in developing countries. Routes et Development - Comptes Rendu du Collogne International. Paris: Presses de l'ecole national des ponts et chaussees.

Hills BL and Elliott GJ (1986). A microcomputer accident analysis package and its use in developing countries. Indian Road Congress Road Safety Seminar, Srinigar. Proc of Seminar.

Hills BL and Downing A (1980). The application of road safety countermeasures in developing countries: a review. (Unpublished) Crowthorne: Transport and Road Research Laboratory.

Hills BL, Thompson NT and Kila K (1990). Accident blackspot research in Papua New Guinea. Fourth Annual Conference on Road Engineering, Jakarta. November 19-21.

The Institute of Highway and Transportation (1990). Guidelines for: The Safety Audit of Highways. London: The Institute of Highways and Transportation.

The Institute of Highways and Transportation (1990). Highway Safety Guidelines: Accident Reduction and Prevention - International Edition. London: The Institute of Highways and Transportation.

The Institute of Highways and Transportation (1991). Urban Safety Management. London: The Institute of Highway and Transportation.

The Institution of Lighting Engineers (1990). A manual of road lighting in developing countries. Rugby: ILE.

Jacobs GD and Hutchinson P (1973). A study of accident rates in developing countries. TRRL Laboratory Report 546. Crowthorne: Transport and Road Research Laboratory.

Jacobs et al (1975). Road accident data collection and analysis in developing countries. TRRL Laboratory Report 676. Crowthorne: Transport and Road Research Laboratory.

Jacobs GD (1976). A study of accident rates on rural roads in developing countries. TRRL Laboratory Report 732. Crowthorne: Transport and Road Research Laboratory.

Jacobs GD and Fouracre PR (1977). Further research on road accident rates in developing countries. TRRL Supplementary Report 270. Crowthorne: Transport and Road Research Laboratory.

Jacobs GD and Bardsley MN (1977). Road accidents as a cause of death in developing countries. TRRL Supplementary Report 277. Crowthorne: Transport and Road Research Laboratory.

Jacobs et al (1981). A preliminary study of road user behaviour in developing countries. TRRL Supplementary Report 646. Crowthorne: Transport and Road Research Laboratory.

Jacobs GD and Sayer IA (1983). Road accidents in developing countries. TRRL Supplementary Report 807. Crowthorne: Transport and Road Research Laboratory.

Jacobs GD and Cutting CA (1986). Further research on accident rates in developing countries. Accident Analysis and Prevention, 18(2), 119-127.

Jacobs GD (1986). Road accident fatality rates in developing countries - A reappraisal. In: PTRC. Summer Annual Meeting. University of Sussex 14-17 July 1986, Proc of Seminar H. London: PTRC Education and Research Services, 107-120.

Kosasih D, Robinson R and Snell J (1987). A review of some recent geometric road standards and their application to developing countries. TRRL Research Report 114. Crowthorne: Transport and Road Research Laboratory.

Leburu FM (1990). Training the Children: Traffic Education in Botswana. Proceedings of the International Conference for Road Safety and Accidents in Developing Countries. Cairo: The Academy of Scientific Research and Technology.

Mackie et al (1990). Urban Safety Project 3. Overall evaluation of area wide schemes. TRRL Research Report 263. Crowthorne: Transport and Road Research Laboratory.

Mercer GW (1985). The relationships among driving while impaired charges, police drinking-driving roadcheck activity, media coverage and alcohol-related casualty traffic accidents. Accident Analysis and Prevention, 17 (6), 467-474.

Organisation for Economic Cooperation and Development (1974). Research on traffic law enforcement. Paris: OECD.

Organisation for Economic Cooperation and Development (1978). Chairman's report and report of sub group 11 and road safety education. Crowthorne: Transport and Road Research Laboratory.

Organisation for Economic Cooperation and Development (1979). Traffic Safety in residential areas. Paris: OECD.

Organisation for Economic Cooperation and Development (1986). Effectiveness of road safety education programmes. Paris: OECD.

Organisation for Economic Cooperation and Development (1990). Integrated safety management in urban area. Paris: OECD.

REAAA (1990). Sixth Conference. Proceedings of the Sixth Conference, March 1990. Kuala Lumpur: Road Engineering Association of Asia and Australasia.

Ross A (1984). Accident data recording systems/data linkages - the need in developing countries. Proceedings of conference "Transport Safety in Developing Countries", Amalfi, Italy.

Sabey BE and Staughton GG (1975). Interacting roles of road environment, vehicle and road-user in accidents. In: IAATM. 5th International Conference, London, September 1975. International Association for Accident and Traffic Medicine.

Sandwith A (1980). Traffic Safety in Zimbabwe. Zimbabwe Traffic Safety Board Report. Harare: Zimbabwe Traffic Safety Board.

Sayer IA and Downing AJ (1981). Driver knowledge of road safety factors in three developing countries. TRRL Supplementary Report 713. Crowthorne: Transport and Road Research Laboratory.

Simmons V (1990). Alcohol and Road Traffic Accidents. Proceedings of the First Caribbean Conference on Transportation and Traffic Planning. Trinidad: Caribbean Epidemiology Centre.

Spolander K (1977). Trafikoeverykning. NRTRI Rapport 139. Linköping, Sweden: National Road and Traffic Research Institute.

Tolley R (1990). Calming traffic in residential areas. Tregaron: Brefi Press.

Transport and Road Research Laboratory (1988). Overseas Road Note 6. A guide to geometric design. Crowthorne: Transport and Road Research Laboratory.

Transport and Road Research Laboratory (1995). Overseas Road Note 10. Costing Road Accidents in Developing Countries. Crowthorne: Transport and Road Research Laboratory.

Transport and Road Research Laboratory (1990). Blood alcohol levels in fatalities in Great Britain, 1988. TRRL Leaflet LF 2017. Crowthorne: Transport and Road Research Laboratory.

Transport and Road Research Laboratory (1990). A Guide for Drivers of Heavy Goods Vehicles. Crowthorne: Transport and Road Research Laboratory.

Transport and Road Research Laboratory (1991). Towards safer roads in developing countries. A Guide for Planners and Engineers. Crowthorne: Transport and Road Research Laboratory.

The World Bank (1990). Road Safety a Lethal Problem in the Third World. The Urban Edge, 14 (5), June 1990.

Yerrell JS (1991). Road safety in Africa - Background and Overview. Proceedings of the Second African Road Safety Congress. Oslo: Institute of Transport Economics (TOI).

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