

**A COST EFFECTIVENESS EVALUATION OF INTERVENTIONS
TO REDUCE TRAFFIC DEATHS AND INJURIES IN SOUTH
AFRICA
2005-12-01**



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Declaration

I hereby declare that the content of this dissertation is my own work, except where acknowledged in the text, and that it has not been submitted towards a qualification at any other university.

Signature:

A handwritten signature in black ink, appearing to read 'Pasana', written in a cursive style.

Date: 2005-12-01

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Abstract

The global burden of road traffic casualties is estimated at US\$518 billion in direct economic costs. Road traffic crashes are now preventable and predictable as demonstrated by the existence of many proven and cost effective intervention strategies, a result of three decades of research and development in high income countries. While remarkable progress has been made towards the provision of safe, sustainable and affordable means of transport in high income countries where road traffic deaths are on a declining trend, the global road traffic safety situation is however expected to get worse by 2020, in view of increasing deaths in the low to middle income countries, due to rapid motorization against the background of inadequate road infrastructure with poorly maintained roads, passive traffic law enforcement and corruption, inadequate health services, lack of funds, and inadequate data collection and research. These countries have thus experienced little or no success in resolving the problem of road traffic safety. Since South Africa falls into this latter category, this paper supports the thesis that the issue with road traffic deaths and injuries is a global problem requiring national capacity to be part of a global cooperation and responsibility. Given the recent institutionalized framework for planning, organizing and implementing the strategy for road safety management (the Road to Safety 2001-2005), the relatively high mortality rate of 27 per 100 000 population and the R13.8 billion in direct social costs to the economy, remains the challenge to build a strong political advocacy to enable the achievement of conditions for a sustainable national road safety capacity to manage road traffic safety. This calls for a comprehensive set of cost effective countermeasures. Most country successes have had a good political will complemented by a systems approach. Despite a good start with the Road to Safety 2001-2005, successes and mistakes made in high income countries as well as in low to middle income countries, can benefit South Africa in the design and implementation of a multisectoral national road safety strategy with the health sector playing a major role, in order to achieve significant reductions in road traffic deaths and injuries on our roads.

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Chapter 1:

INTRODUCTION

1.1 Background

Guided by the experiences from both the developed and less developed countries, the main objective of this study is to recommend the most cost effective interventions that could be used to reduce the number of traffic deaths and injuries on South African roads, in order to enable good resource allocation decisions in the public health and transport sectors.

It is estimated that road crashes contribute to 1.2 million deaths and around 50 million people are injured and / or disabled as a result. Without increased and concerted efforts of prevention and new initiatives, deaths and injuries will increase by 65% between 2000 and 2020, for the high income countries. Very critical, is the situation in low income countries, where the expected increase is around 80%. Around the world today, 85% of traffic deaths, 90% of the lost disability years and 96% of all children killed, occur in the low to middle income countries.

Over 50% of deaths are among young adults of between 15 – 44 years and among both children between 5 – 14 years and young people of between 15 – 29 years young (WHO, 2004, P, 3-4), and traffic injuries are the second behind HIV/AIDS, as a leading cause of premature death and ill health globally (FIA Foundation, 2005, p.1).

While in high income countries, occupants of cars form the majority of deaths, in low income countries of Africa, Asia, the Caribbean and Latin America, the majority of deaths is among pedestrians, passengers, cyclists, motorbike users and occupants of buses and minibuses.

Despite these regional differences, comparative fatality rates have shown that nearly everywhere, vulnerable road users are at a much higher risk of dying in a road crash than occupants of cars.

The direct economic costs of global road accidents is estimated at around US\$ 518 billion, and US\$ 65 billion for the low income countries (WHO, 2004, p. 3). In the US road traffic injuries cost US\$ 230 billion per year, the cost to the EU 15 is 180 billion euros per year and SA lost US\$ 2 billion in year 2000 (FIA Foundation, 2005, p. 2). This heavy burden is not only placed on national and regional economies but also affects households in terms of lost output. Against the background of these huge social and economic costs, little investment has been made in road safety research compared to other types of health loss. Today, many

proven, cost effective and publicly accepted interventions exist but funding has not met the severity of the problem (World Health Organisation, 2004, p. 5-6).

1.2 Contributory factors

Based on chapter 3 of the World Health Organization's report on road traffic injury prevention, the main risk factors can be classified into five elements;

- ❖ Factors influencing exposure to risk, such as rapid motorization, demographic factors, transport and road network planning, increased need for travel.
- ❖ Risk factors influencing involvement in a crash, e.g. inappropriate or excessive speed, presence of alcohol, being a young male, being vulnerable road user, travelling in darkness, vehicle factors, defects in road design environmental factors and poor road user eyesight.
- ❖ Risk factors influencing severity of a crash, e.g. human tolerance factors, inappropriate or excessive speed, non-use of seat belts and child restraints, non- use of crash helmets, non-crash protective roadside objects, insufficient vehicle crash protection for occupants and those hit by vehicles and presence of alcohol and other drugs.
- ❖ Risk factors influencing the severity of post-crash injuries, such as delay in detecting a crash, presence of fire as a result of collision, leakage of hazardous material, presence of alcohol and other drugs, difficulty in rescuing people from crashes, lack of appropriate pre hospital care and lack of appropriate care in emergency rooms.
- ❖ Human error within the traffic system, the size of kinetic energy of the impact to which people in the system are exposed, the tolerance of the individual to this impact, and the quality and availability of emergency services and acute trauma care, are among the various factors that contribute to the risk of traffic deaths and injuries.

This study is motivated by the urgency to minimize the burden of road traffic injuries, based on the following very strong social, health and economic reasons, making road safety one of the important priorities of public health policy;

- ❖ Road traffic deaths and injuries absorb massive financial resources, about 1% of the GDP in the developing countries, 1.5% in the transitional countries and 2% in highly motorized countries (WHO, 2004, p. 5).

- ❖ Casualties are predominately economically active persons, 'between' 1-40 year olds (WHO, 2004, P. 4-6), and this factor has a ripple effect on the affected dependents causing emotional suffering and poverty.
- ❖ Crash victims represent between 30% and 86% of all trauma admissions, who also tend to stay longer than average patients.
- ❖ Road traffic injuries have on the one hand equity implications, disproportionately affecting the poor in the developing world, where the majority of victims are vulnerable road users (pedestrians, cyclists, children and passengers). In the developed countries on the other hand, children from lower socio-economic backgrounds are more likely to die in road collisions involving pedestrians as against their more affluent counterparts (FEVR News Letter 40, 2003, p. 4-5).
- ❖ Current and projected data from many countries indicate a positive relationship between increasing motorization levels with the number of road traffic deaths. Solutions to the road safety carnage are likely not to keep pace with the rapid motorization rates in the low to middle income countries (FEVR News Letter 40, 2003, p. 5).
- ❖ As said earlier, the situation is expected to get worse by 2020. Road accidents are focused to rise from the 9th. to the 2nd. place as a leading cause of lost disability adjusted life years in the developing world and the 3rd. in the industrialized world. Road traffic injuries are an escalating health, social and economic hazard, particularly in those countries with limited resources.
- ❖ The relative success in the industrialized countries to reduce the burden of road traffic injuries can play a big role not only in the selection of better targets on the part of the developing countries, but also in their endeavour to incorporate the concept of sustainability into public policy making process, here, the adoption of affordable and cost effective reduction methods is called for, given limited resources (World Bank, 2004, p. 1-2), with implications for technology transfer from high income to low and middle-income countries (WHO, 2004, P. 11-12).

1.3 Overall objective and specific aims

The overall objective is to use cost effectiveness analysis in the evaluation of intervention strategies that can be used to reduce the high number of road traffic casualties in South Africa, when designing a comprehensive strategic mix of cost effective interventions, some

which could be selected from lessons drawn from what has been proven and cost effective in high income countries as well as in low to middle income countries and/or alternatively, those that could be weaved into local aspirations in terms of innovative content relevant to the selection of cost effective intervention strategies, with the allocation problem in mind.

Thus, central to this study is the cost effectiveness methodology which is explained in the next chapter, a technique that is applied to identify the most effective use of limited resources (Shepard & Thompson, 1979, p.1).

1.4 Overview

After introducing the methodology of cost effectiveness analysis in chapter 2, we move on to examine its use in road safety, first (in chapter 3) in high income countries and then (in chapter 4) in low to middle income countries. Chapter 5 is devoted specifically to application implications for South Africa.

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Chapter 2

COST EFFECTIVENESS ANALYSIS

2.1 Introduction

Before identifying the most cost effective interventions to reduce road traffic casualties in high income countries as well as in low to middle income countries, in order to learn from their experiences and perhaps make innovative recommendations for South Africa, it is necessary to explain the cost effectiveness methodology and justify its application in this study.

The economic problem of allocation involves choice among competing uses of scarce resources, so various evaluation procedures have been developed to determine the best proposed use of scarce resources in both public as well as private sector activities. As far as society is concerned, “best” is here defined both in terms of allocative and productive efficiency. It refers to the use of resources to produce a mix of goods and services which would be most highly valued by a society, recognizing the fact that there will always be alternative ways of reaching any given goal, and thus provides a way of determining which of the alternative strategies would realize the goal more effectively given resource expenditure (Evans & Van Duong, 2004, P.1). This requires an explicit or implicit comparison between alternatives and the most frequently used techniques in the public health sector are, the benefit cost analysis (BCA), cost effectiveness analysis (CEA), and cost utility analysis (CUA).

2.1.1 Explanation of technical concepts

Appraisals generally require the calculation of input resources or costs used in an intervention and output resources or benefits. In its concern with allocative efficiency, BCA attempts to place monetary values on the respective inputs and outputs. Theoretically, the costs are foregone benefits which could have been earned, if the inputs were used in the best alternative way. If the benefits of the proposed alternative are greater than the costs, or exceed the benefits that could have been earned by alternative resource usage, the proposed choice is allocatively efficient and the investment should be carried out. Attempts to apply BCA to health interventions have been

accompanied by major problems over the years, particularly the monetization of health improvements/benefits of an intervention (Evans&VanDuong, 2004, P.1).

Regardless of the method of economic valuation, there is an inherent bias which favours interventions that improve the health status of the rich over the poor. This is probably the reason why CEA and CUA have found popularity with public health sector interventions.

In a CEA, costs are measured in the same way as in a BCA however, benefits are measured in natural units designed to capture the status of health improvements. CEA sets a goal in a form of a physical target, social indicator, a health standard, or an environmental standard and then finds the least cost way of achieving it, without specifying the benefits thereof in economic terms (James, 1994, P.86-90). Any commensurate measure of benefits can be chosen such as lives saved, complications averted or illness prevented. Two outcome indicators can be identified, the final outcome indicator which represents the actual improvement in health (the number of lives or years of lives saved), while the intermediate outcome indicator reflects a stage in the process, and is assumed to be directly proportional to the final outcome e.g. the number of children fully immunized reflects the success of the program, since the subsequent overall health improvement in the population is directly proportional to the number of children immunized. Using the final outcome indicator such as the cost of a year of life saved by two programs, or the cost per child immunized by two strategies, comparisons are made to satisfy the requirement of explicit comparison of alternatives mentioned earlier. While the final outcome indicator can be used to explore both allocative and productive efficiencies, intermediate outcome indicators can be used to explore production efficiency only, whereby, ways of achieving, and a more specified goal are compared e.g. the cost effectiveness of mass treatment of children against some infection, without first seeking their individual infection status, can be compared using the cost effectiveness analysis of a program where children were first screened and only those infected would be treated (Drummond et al., 1997, in (Evans&Vanduong, 2004, P.1). The alternative with a lower cost per unit of outcome is then the more efficient.

The commonly used final outcome indicators limit the analysis to reflect improvements in the duration of life only, although health interventions can also improve the quality of life, making it difficult to incorporate both duration and improvement in one indicator. The recent developments of the healthy year equivalents have been so developed to bring both quantity and quality into one indicator, e.g. the CEA based on the QALY bring mortality and morbidity into one impact of an intervention and has become to be known as the cost utility analysis. The QALY is an algebraic

difference between the number of healthy years an intervention beneficiary expects to live because of the existence of the intervention being evaluated and the number of healthy years he would have expected had there been no intervention. On the other hand, the DALY is given by the sum of years of life lost (YLL) and years lived with disease (YLD) (Gruninger, 2004, P.10).

So the CEA is an approach that determines which program accomplishes a given objective at a minimum cost, derived from a more general formulation, the analysis of trade-offs between monetary and non-monetary (in this case health) effects (Shepard & Thompson, 1979, P.536). The foregoing definitional formulation now serves as an introduction to the major steps of a cost effectiveness analysis process.

2.2 Five major steps of CEA

Shepard and Thompson suggest a straightforward CE methodology applicable to a broad range of health programs, although variation in detail can be expected depending on different practitioners and circumstances and with certain problems still needing to be resolved.

2.2.1 Definition of the program

A precise definition of the program in terms of its focus, processes and limits is of critical importance, since minor differences in the definition can have great impact on costs and effects e.g. high risk persons as a target.

Any problem may be resolved through several approaches. Formulation of innovative programs is possible using the CEA in conjunction with health expertise. It could be used first to compare unlike programs, such as immunization or treatment to minimize deaths from influenza. If immunization is identified as the best general approach, CEA may then be used to refine variants of an immunization strategy and design it according to the specific situation. CEA is all about comparison of alternatives, such that clarity on the nature of the alternatives, types of beneficiaries, the current status quo and the precise organization of an intervention is required (Evans, 2004, P.2).

2.2.2 Identification and measurement of costs

Once identified, the net monetary costs for an intervention are compared with the status quo generally from the point of view of a society as a whole even though computing costs on a per participant basis is easier. This second step is in turn divided into the following four components;

- ❖ Computation of annual operational gross costs
- ❖ Calculation of monetary savings as a result of the program
- ❖ Discounting of the net monetary costs to the present value, following the principle that future costs are less expensive than the present costs e.g. an intervention program that saves one QALY 40 years has a cost effectiveness ratio of \$10 000/QALY without discounting, and with discounting at 5%/year, the present value of the future QALY is reduced to around 0.14QALY $(1/1.05)^{40}$, and the cost effectiveness ratio becomes \$70 000 $(\$10\ 000/0.14)$ (Gruninger, 2004, P.9).
- ❖ Then the net costs are found by subtracting savings from the gross costs, both in the present value terms which could either be positive or negative or even zero.

2.2.3 Identification and measurement of health effects

As mentioned earlier, while cost benefit analysis requires that benefits be expressed in monetary terms, cost effectiveness analysis allows the use of any commensurate measure of benefits, such as lives saved, complications averted or illnesses prevented. More general and preferable measures are the additional healthy year of life and additional year of disease (the QALY and the DALY) (Gruninger, 2004, P.10). Benefits should be calculated from the same perspective as costs (societal or governmental, total or per individual). The following are some of the valued effects;

- ❖ Additional years of healthy life
- ❖ Additional years free of disease
- ❖ Improvement of health without affecting survival

- ❖ And the negative effect resulting from an inconvenient health intervention

The number of lives saved or the number of years saved are measures/indicators used to achieve allocative efficiency but do not permit comparisons of the interventions that extend life with those that improve the quality of life, which led to the development of the above mentioned measures/indicators (Evans, 2004, P.3). Like the costs, the health effects/benefits should also be discounted to their present values in line with the society's time preferences, as benefits are more likely to be preferred now than in some remote time in the future. The present values of individual effects can then be summed up into net present effects/benefits.

2.2.4 Application of decision in the rules

There are four scenarios from which a decision rule may be determined;

- ❖ If the net effects and the net costs are both positive, the health of the recipients can be said to be better with the intervention program than without however, the resources are being used. A cost effectiveness ratio is found by dividing the net costs of the intervention by changes in health status or the improvement in years of healthy life, giving a measure of efficiency expressed in dollars per year of healthy life. $CE\ ratio = \frac{Cost\ 2 - Cost\ 1}{QALY\ 2 - QALY\ 1}$. The lower this number, the more efficient is the intervention (Gruniger, 2004, P.7). If the proposed intervention improves or at least does not impair health, and reduces costs at the same time, an intervention is also deemed desirable.
- ❖ If the net costs are negative or zero and the effects are positive, a proposed intervention will without doubt be desirable as it improves both health and reduces costs. Health interventions under this scenario tend to be inexpensive, highly effective, and prevent illness that would otherwise require expensive treatment, immunization against common diseases for instance.
- ❖ If the net effects are negative and the net costs are positive i.e. the morbidity and inconvenience associated with interventions exceed the outcomes/benefits, there is a societal loss from the intervention.

- ❖ The last case refers to the situation where both net effects and the net costs are negative. An intervention under this scenario retrains costs but at the expense of health e.g. from the closure of a facility. To measure cost containment, a cost effectiveness ratio can be calculated, to select the program with the largest ratio. As a decision rule however, the best program will always be the one that does not compromise health at all (See Table.1).

Table.1

Decision rules in cost effectiveness analysis

Net effects	Net costs positive	Net costs zero or negative
positive	Case1. $CE = \text{net costs} / \text{net health effects}$. Select most efficient programs improving health	Case 2. Program economically valuable. Should generally be implemented.
zero or negative	Case 3. Program benefits offset by morbidity and inconvenience. Program generally should not be implemented	Case 4. $CE = \text{net costs}/\text{net health effects}$. Select most efficient programs for containing costs (highest ratio)

Adopted from Shepard and Thompson, 1979, P.538

2.2.5 Sensitivity analysis

To take care of uncertainties, a sensitivity analysis forms the last step of a CEA, the main objective being to test the robustness of the results to changes in the critical parameter values. Through the use of computer programs, multivariable sensitivity analysis is carried out to show the range of values a cost effectiveness ratio can take when many parameters vary at the same time, even though studies have traditionally considered changes in each critical parameter separately. This deliberate effort can help to examine the effect of these uncertain factors on the decision rules (Evans, 2004, P.4).

2.3 Cost effectiveness analysis and road safety

This section is devoted to the justification of cost effectiveness use in the study on methods of reducing road traffic deaths and injuries in South Africa. The enormous burden of direct and indirect socio-economic costs associated with road crashes and subsequent deaths and injuries has turned road safety into a major problem, not only for the public sector but for the economy, particularly in resource poor countries (WHO, 2004, P.3-14). When resources are limited, a reliable knowledge about the effectiveness of and the efficiency of potential road safety interventions is needed to help the selection of those interventions that promise to achieve effective reduction in road crashes (Vahidnia & Walsh, 2002, P.7). In addition to the cost burden mentioned above, there is no question that resources are and will be needed to improve road safety standards. A more efficient use of the safety measures would reduce deaths and improve health and save expenditures. Thus in order to justify decisions on which policy measures to take, decision makers need instruments to assess the benefits and costs, or the cost effectiveness of road safety measures. The economic evaluation of road safety measures using cost benefit analysis is based on costs incurred as a result of crashes. Avoiding such costs represents the economic benefit of the interventions and the benefit cost ratio represents the economic advantage of the interventions. In contrast, in cost effectiveness analysis, the costs of an intervention are set against the effects, and these effects are not expressed in monetary terms.

In order to improve total economic welfare in the face of limited resources, the policy maker is faced with resource allocation problem involving trade-offs, given that some interventions are more or less cost effective than others. Making trade-offs calls for a comparison requiring techniques appropriate to non-marketable goods like safety. The problem is further compounded by the difficulty to place a price on safety. While the conventional cost and benefit analysis relies heavily on monetary values on both costs and benefits, it is a necessary but not a sufficient instrument of valuation in the case of health and safety. Cost effectiveness then becomes a useful approach because it assigns monetary values to costs only and circumvents the problem of monetizing health effects and benefits by expressing them in natural units or standards e.g. a count of adverse effects avoided, such as the number of lives saved, the number of life years gained and

the like. To this end, reference is made to a research study by Tengs et al., 1995, on five hundred life saving interventions and their cost effectiveness.

2.4 Limitations

Tengs et al., 1995, analyze the cost effectiveness of 185 life-saving interventions for which, \$21.4 billion as cost estimates of interventions per year averted 56 700 premature deaths and saved 592 000 years of life per year, but there was no relationship between the cost-effectiveness of the interventions and their implementation. They further allege that if the \$21.4 billion per year were to be spent solely on the most cost-effective interventions, twice as many lives and years of life could be saved. That is the nation could avert 56 700 deaths and save \$31.1 billion over the status quo, because of the unused investment opportunities that could save both lives and money. Not only would the current \$21.4 billion be saved but so would an additional \$10 billion, while still maintaining the current level of survival (Blodgett, 1999, P.3-4). Such policy performance can be achieved provided policymakers reallocate resources towards the most cost-effective environmental, health and safety regulatory programs. Blodgett suggests that the main reasons for the lack of implementation derive from policymakers, as being the unresolved methodological concerns, statutory limitations and political choices (Blodgett, 1999, P.3-4).

Another obvious limitation relates to the fact that cost effectiveness analysis cannot be used to compare programs with different outcomes, Tengs et al. seem to do it because costs and benefits are measured in different units of account however, it is amenable to comparing interventions with identical health and or benefit outcomes which yield the greatest health/benefit outcome per dollar.

2.5 Appropriate method

To highlight the use of CE methodology in a comparative, global framework, a generalized cost effectiveness analysis and its implementation via the WHO work program brings a societal perspective to the valuation of costs and effects, intended for policymakers, through identification of personal and non-personal interventions that are very cost effective, those that are not and those that are in between.

Using a state transition population model (sub-regional population development considering births, deaths and the specified risk factor),, this approach is applied to interventions aimed at reducing

the global burden of hazardous alcohol use, with the key transition rates, incidence of use in the population, case-fatality and remission and in addition, a health state valuation is specified for the time spent as a heavy drinker.

Two epidemiological scenarios were modeled over a lifetime (100years) analytical horizon;

- ❖ No interventions available to reduce hazardous alcohol use (natural history), and
- ❖ The population-level impact of each specified intervention implemented over a period of 10 years (after which rates and health state valuations return to their natural history values).

The difference is the population-level health gain expressed in DALYs averted as a result of the intervention, DALYs were then discounted at 3% and age weighted, with the sensitivity analyses performed on the omission of these weights. Evidence on four types of interventions; Brief interventions; Law enforcement (random breath taking of drivers); Policy and legislative interventions (taxes on alcohol sales); Drink-driving laws, restricted licensing outlets and advertising control; and Mass-media/awareness campaigns. Following an estimation of intervention effects and costs, and uncertainty analysis, the analysis found that in those sub-regions with high prevalence of hazardous drinking, the most cost effective single interventions were taxation and brief interventions, averting between 500-2 000 DALYs per one million population. Reduced hours of sale and a comprehensive advertising ban produced effects in the range 10-400 DALYs. Further, this sectoral CEA has application implications for specific country circumstances with different epidemiological characteristics, treatment costs and coverage which may not match the estimates of the sub-region as a whole. It can best be used as a framework of reference from which countries can start to bring their respective socio-cultural settings into proper perspective (Journal of studies on alcohol, 2005, P.1-20).

2.6 Conclusion

The methodology of cost effectiveness analysis then brings us to the next chapter on cost effective interventions in high income countries.

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Chapter 3

COST EFFECTIVE INTERVENTIONS IN HIGH INCOME COUNTRIES

3.1 Introduction

Since the risk of incurring injury in a road crash is easily predictable, the prevention of traffic deaths and injuries is possible and there are now interventions that have been proven to be effective. Thus, road traffic injuries should also be considered a preventable public health problem alongside heart disease, stroke, cancer and HIV/AIDS.

In high income countries, the fundamental objective is to provide safe, sustainable, and affordable means of transport. In order to achieve this, it is estimated that a comprehensive approach with complementary cost effective set of measures is needed. This in turn requires a firm political will and multi-sectoral collaboration, in which the health sector is expected to play a leading role. Progress with such plans around the world, has led to incremental reductions in deaths and injuries as a result of the road safety problem.

A range of interventions and accompanying strategies are categorized in line with the five factors of risk in road traffic, i.e. factors influencing exposure to risk, risk factors influencing crash involvement, risk factors influencing crash severity, factors influencing post-crash injuries (WHO, 2004, P.109). These are summarized in Table 3.1. Despite the importance of all interventions and strategies to the problem of road safety, this chapter on high income countries will focus mainly on those intervention strategies associated with the setting and compliance with key road safety rules, with specific reference to speed management, alcohol restraint and occupant protection.

Traffic law contributes to the reduction of casualties through the provision of safe road use and laying down standards for driver and rider behaviour. Its existence also deters road users from breaching those standards. To be effective, the law must be reasonable, appropriate and communicated to and understood by all road users. Without adequate detection and enforcement, appropriate penalties and a driving public who appreciate the risk and the consequences of offending and therefore comply, the benefits of road traffic law will tend to fall short of their potential (PACTS, 1999, p.4).

Table.3.1

Interventions to reduce traffic deaths and injuries

Management of Exposure to risk	Shaping the road network for road injury prevention	Appropriate vehicle technology	Setting and securing compliance with key road safety rules	Delivering post-crash care
Reduction of motor vehicle traffic	Safety-awareness in planning	Improving visibility	Setting and enforcing speed limits	Chain of help for the injured
Encouraging the use of safer modes of transport	Incorporation of safety features into road design	Crash-protective vehicle design	Setting and enforcing alcohol impairment laws	Pre-hospital care
Minimizing exposure to high risk scenarios	Remedial action at high-risk crash sites	“Intelligent vehicles”	Medicinal and recreational drugs	The hospital setting
			Drivers’ hours of work	
			Cameras at traffic lights	
			Setting and enforcing seat-belt and child restraint use	
			mandatory crash helmets	

Source: (WHO, 2004, chapter. 4)

3.2 Speed management

Speeding is a third leading cause of traffic-related deaths in the US, at a societal cost of around \$40 billion per year, occurring more on local and collector roads than on interstate motorways (Runge, 2004, P. 5). Speed is very central to the problem of road safety because the higher the speed, the shorter the time available to avoid collision and the more severe the impact when collision occurs. Further, fuel consumption, damaging exhaust emissions and traffic noise all become greater at higher speeds. Since shorter journey times as a result of higher speeds must be balanced against the above disadvantages, a need for speed management is implied. The individual driver's choice of speed is influenced by factors related to road and vehicle, traffic and environment and the driver (European Traffic Safety Council, 1995, P.11-16). According to Runge, a multi-disciplinary approach involving engineering, enforcement and education is necessary. However, education is not featured in this review since it has not established itself as a cost effective measure on its own but in combination with other strategies.

3.2.1 Road infrastructure design

Incorporation of safety features into road design encourages drivers to choose to comply with the speed limit (WHO, 2004, P. 114).

Road engineering strategies that reduce vehicle speeds and volumes are usually referred to as 'traffic calming'. Projects range from few minor alterations to neighbourhood streets to major reconstruction of a street network. Impacts range from moderate speed reductions on residential roads, to arterial design changes (Litman, 1995, P. 1-2).

At speeds higher than 30km/h, coexistence between pedestrian and motor vehicle is no longer relatively safe, hence the need for traffic calming to discourage entry into certain areas and the incorporation of physical speed reducing measures, such as mini-circles, road narrowings, chicanes and road humps, often complemented by a speed limit of 30km/h. (WHO Report, 2004, P.116-117).

- ❖ Seattle's traffic program in the US found that while traffic circles are an attractive addition in landscaping language, accident reduction is their greatest benefit. A total of 119 traffic circles were constructed between 1991 and 1994. There were 187 accidents in the year before construction compared to 11 accidents in the year after, a 94% decrease in one year and injuries fell 153 to 1 in the year following the construction.

Source: (Trafficcalming. Traffic circles have proven to be the most cost effective in solving speeding and traffic accidents problem with minimal controversy and over 600 circles have been constructed since 1973 and current funding permits the construction of 30 a year (US Roads, 1998, P.1-6).

- ❖ Another example is arterial traffic calming. Bridgeport Way W. is a main arterial, carrying 25,000 vehicles a day. The road has two travel lanes in each direction with a middle two-way-left-turn lane. There were 160 accidents less than a mile long section of the road for a three year period, before improvements. After the introduction of a curb, gutter, sidewalk, bike lanes, street lights, pedestrian crosswalks, landscape median and planter strips, the two-way left turn lane with a landscaped median was eliminated and capabilities for U-turn were provided at intersections for passenger vehicle only. Both the number of accidents and speed fell on the improved roadway, reducing accidents by 70% (Litman, 1999, P.11).
- ❖ Speed humps are another important aspect of road engineering, good for locations where very low speeds are desired and reasonable. They have proven very effective since they are relatively very cheap to construct and capable of reducing speeds. Table 3.2 reflects the effectiveness of speed humps (TrafficCalming.org. P.1);

Table 3.2

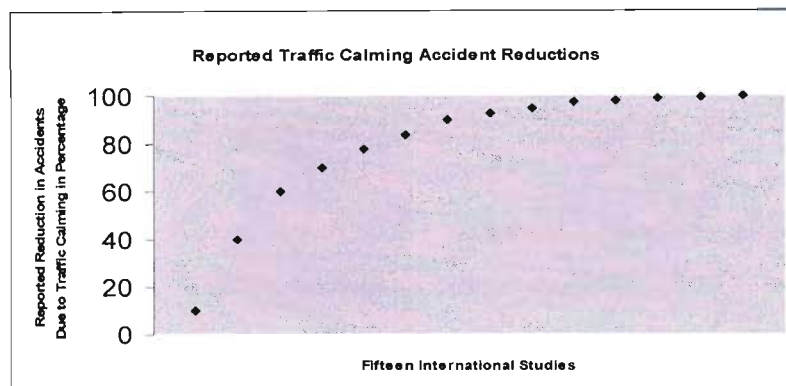
Effectiveness of speed limits

Type of hump	A 12- foot hump	A 14- foot hump
Decrease in speeds	A decrease of 22% in the 85 th percentile travel speeds or from an average of 35.0 to 27.4 miles per hr., using a sample of 179 sites	A decrease of 23% in the 85 th percentile travel speeds or from an average of 33.3 to 25.6 miles per hr., using a sample of 15 sites
Decrease in accidents	11% decrease or from an average of 2.7 to 2.4 accidents per year, using a sample of 49 sites	23% decrease or from an average of 4.4 to 2.6 accidents per year, using a sample of 5 sites

Source: (Trafficcalming.Org, 2005-09-08, P.1).

Below is also a graph showing changes in vehicle accidents rates from traffic calming measures in fifteen international studies, indicating significant reductions.

Fig. 3.1



Source: (Litman, 1999, P. 9).

3.2.2 Setting of speed limits

The multifunctional use of roads serving different types of vehicles and pedestrians, with large differences in speed, mass and degree of protection, requires roads to be classified and speed limits set by their function - the 'road hierarchy' e.g., 100-120km/h for flow roads, 80km/h for distributor roads and 30km/h for residential roads (WHO, 2004, p.113-115). Speed is explicit in the design of higher speed roads through the concept of design speed and its implications for alignment, while design for lower speed urban roads is more a matter of detailed layout within an alignment determined by other considerations, "The general speed limit for cars on urban roads is effectively harmonised at 50km/h throughout the EU." (European Transport Safety Council, 1995, p.17).

The following table 3.3 shows design and general speed limits for inter-urban roads;

Table 3.3

Design & General speed limits for inter-urban roads

	Design speed limit	General speed limit
Motorway	100-140km/h	90-130km/h
Expressway	80-120km/h	90-120km/h
Single carriage rural road	50-100km/h	70-100km/h

Source: (European Transport Safety Council, 1995, P.17).

Speed management measures according to road function could include;

- ❖ High speed - high quality roads are provided by the construction of multilane motorways, designed for longer distances and to provide acceptability for shorter travel times for all vehicles. European countries with the exception of Germany have general speed limits set between 90 and 130km/h on these motorways.
- ❖ The use of single carriageway on rural roads tends to result in more casualties than the use of motorways. For many such roads, the general speed limits of 70-100km/h cannot be seen to be adequate to the extent that lower speeds or re-design are required to increase safety.
- ❖ Transition from high speed to low speed roads, such as leaving a motorway demands that measures in the transition zone be complemented by measures along the through route within the urban area and result in a cumulative effect culminating in a gateway to the town or village, which marks the entry and coincides with the start of the town and or the village speed limit. The gateway has to be the most prominent element in the zone and visible over the stopping distance for the 85th percentile of the approach.
- ❖ With regard to local distributor and access roads, speed limits of 30km/h often complement speed management and traffic calming measures.
- ❖ Local rural roads serve locally-based traffic in rural areas, but may include access roads for local residents particularly around large urban areas. The common large number of losses of control that usually characterize these roads indicate inappropriate speed. Alignments should, where possible be homogenous, with a specified minimum visibility on bends, and shoulders provided to enable drivers to rectify losses of control. (European Transport Safety Council, 1995, P. 20-24).

The setting of speed limits is closely associated with the function and design of roads, to the extent that physical measures related to the road and the vehicles, supported by law enforcement by the police, do ensure that maximum posted speed limits are complied with, and appropriate speed is chosen for the prevailing conditions (WHO, 2004, p.127).

Speed limits can only address part of the problem of inappropriately high speed, since there will always be conditions under which the appropriate speed is lower than the general or local limit, and exceeding speed limits, at least by a small margin is widespread.

Where the infrastructure design has little influence, international experience with speed limits indicates that they nevertheless play an important role. The imposition or lowering of speed limits usually reduces the frequency and severity of road accidents and vice versa. It is not

easy to offer a precise rule about setting of speed limits, however research has shown that the drivers' choice of speed is dependent on the relationship between design speed on the road and the posted speed limit, as there is a consensus that drivers are more inclined to keep to the posted speed limit when they perceive the speed limit to be realistic.

The use of variable message signs that indicate different speed limits at different times on the same stretch of road is yet another way offered by modern technology to keep speed limits realistic under changing conditions. E.g. special circumstances, such as roadworks, bad weather, darkness and so forth (European Transport Safety Council, 1995, p. 24). Such a system on a motorway near Frankfurt reduced casualties by 40%, over a period in which they increased on other comparable stretches. The speed reducing capacity of variable speed limits appeared to be largest if the reason for current speed limit is indicated in the form of warning or advice. Table 3.4 shows the effects of changes in speed;

Table 3.4

Effects of changes in speed

Date	country	type of road	Limit change	Speed effect	fatalities
1985	Switzerland	motorways	130-120km/h	-5km/h in mean speeds	12% reduction
1985	Switzerland	Rural road	100-80km/h	-10km/h in mean speeds	6% reduction
1985	Denmark	built up areas	60-50km/h	-3 to 4km/h in mean speeds	24% reduction
1987	US	Interstate highways	55-65mph	+2 to 4m/h	19-34% increase
1989	Sweden	motorways	110km/h to 90km/h	-14.4km/h in mean speeds	21% reduction

Source: (European Transport Safety Council, 1995, p. 26).

3.2.3 Enforcement of speed limits

Speeding offences are the most common type of motoring offence regularly committed by many drivers with very small perceived or actual chance of being caught. Legislation and police enforcement is a vital way of encouraging compliance with speed limits, by increasing perceived chance of being caught. (European Transport Safety Council, 1995, p. 28).

Today, several techniques to enforce speed limits do exist, from car-following and radar measurement to speed cameras, laser devices and measurement from helicopters. On rural roads, a combination of radar measured vehicle speeds between two points or stationary speed enforcement with uniformed police officers and police cars attending check points has the capacity to reduce deaths by 14% and injuries by 6% (WHO, 2004, P.127). In most countries, a first speeding offence carries a penalty of a modest fixed fine, however courts can still impose higher fines. Most EU member states use penalty point systems under which repeated proven speeding offences result in driver disqualification. (European Transport Safety Council, 1995, p.18). Scandinavian studies conclude that an acceptable level of compliance could only be achieved if half the staff time spent on traffic enforcement were to be focused on speed, which is just not practicable. Thus, conventional traffic enforcement tactics alone are inadequate to achieve sustainable compliance with speed limits. Recent advances in technology offer new more effective ways, such as, speed cameras, automatic policing system, vehicle speed limiters and variable message signs. (ETSC, 1995, p.9).

- ❖ Camera technology is currently in use in many countries. In high-income countries, experience tells us that a speed camera that records photographic evidence of a speeding offence, admissible in a court of law is a highly effective means of speed enforcement. Substantial reductions in crashes have been achieved through the well-publicized use in places where there is low compliance with speed limits and the consequent risk of a crash. An independent review which analysed the effects of cameras in 24 Safety camera partnership areas in over a period of three years found that cameras are very effective in cutting speeds, saving lives, and preventing crashes, e.g. A 32% reduction in the number of vehicles breaking the speed limit, a 40% reduction in deaths or injuries at camera sites, and a 33% reduction in crashes involving personal injury at camera

sights. Earlier studies found that in 1992, after three years of the installation in the UK, the number of fatalities was reduced by 70% , the injured by 27% and the slightly injured by 8%. Thus, cameras are an effective method to persuade drivers not to speed, thereby reducing the number of people killed and injured (RoSPA, 2004, p. 4-5). As most crashes occur at junctions, cameras at junctions with traffic lights do complement improvement in junction layout and design and can at the same time be effective in reducing collisions including those caused by red light-running (WHO, 2004, P. 132). A meta analysis of the effectiveness of cameras at traffic lights has shown that they have a 12% reduction potential of injury crashes and a cost benefit analysis in the UK concluded that the return was nearly twice the investment after one year and 12 times after five years (GHSA News and Media, 2005, p. 1).

- ❖ Speed limiters in heavy goods and public transport vehicles, govern the maximum speed. These devices are in use in many countries and estimates of 1997 claim that they could contribute to a 2% fall in the number of injury collisions. (WHO, 2004, p.126-128).
- ❖ Social and political acceptability is very essential for the success of above measures, complemented by education, training and publicity (European Transport Safety Council, 1995, p. 29-31).

3.3 Alcohol restraint

According to a WHO comparative risk assessment study in 2002, alcohol is ranked No.1 risk factor for burden of disease in the Americas, representing over 10% of the total burden of disease (Monteiro, 2004, P.1). Around the world today, progress has without doubt been made in the prevention of alcohol-impaired driving, although, alcohol remains a significant and widespread factor in road traffic crashes. During 1997-2002, out of 9,622 child passengers who died in vehicle crashes, 24% were driven by alcohol-impaired drivers. Of the 2,061 alcohol-related crashes involving children, 79% involved at least one driver with BAC limit higher than 0.08g/dl and 60% of these crashes occurring between 6 a.m.-9 p.m. (Shults, 2004, P. 78). It is generally agreed by both research and road safety programmes that the reduction of alcohol-related crashes and injuries require traffic legislation-based effective set of measures (WHO, 2004, p.128). We start this section by reviewing the setting of alcohol

impairment laws and then examine well known enforcement measures of those laws, which have been proven cost effective in reducing fatal and nonfatal injury crashes.

3.3.1 Setting alcohol impairment laws

Blood alcohol concentration limits; many countries globally have legislation governing maximum permissible BAC Limits as a means to detect and prosecute alcohol-impaired drivers (see Table. 3.5 below).

Table.3.5

Standard BAC Limits

Country	BAC Limits	Country	BAC Limits
Albania	0.1	Luxembourg	0.8
Argentina	0.5	Malta	0.8
Australia	0.5	Moldova	0.3
Belgium	0.5	The Netherlands	0.5
Bulgaria	0.5	New Zealand	0.8
Canada	0.8	Norway	0.2
Croatia (Republic of)	0.5	Peru	0.5
Denmark	0.5	Poland	0.5
Estonia	0	Portugal	0.5
Finland	0.5	Romania	0
Denmark	0.5	Russia	“drunkenness”
Estonia	0	Singapore	0.8
Finland	0.5	South Africa	0.5
France	0.5	South Korea	0.5
Georgia	0.3	Spain	0.5
Germany	0.5	Sweden	0.2
Greece	0.5	Switzerland	0.8
Hungary	0	Thailand	0.5
Ireland	0.8	Turkey	0.5
Israel	0.5	United Kingdom	0.8
Italy	0.5	United States	.8/1.0

Source: ICAP (2002, P. 3).

- ❖ The current best practice is the upper limits of 0.05g/dl for the general public and 0.02 for young and inexperienced drivers and motor cycle riders. Based on effectiveness of such legislation in reducing alcohol related fatal traffic accidents, 0.08% BAC laws are strongly recommended (Task force, 2001, P. 20). In the US, strict alcohol-impaired driving laws reduced related deaths by 32% during the period 1987-1997, even though around 15,935 lives were lost in 1998. However there was a 1.6% decrease in fatalities from their 1997 level of 16,189 (Melissa, 1999, P. 17).
- ❖ In Australia, New Zealand, Canada and the US, the lower BAC laws (0.02g/dl) apply to drivers under the minimum legal drinking age of 21 years, while in other countries they are intended for newly licensed drivers or the newly licensed under a specific age (Shults, 2001, P. 71). Various studies on fatal crash outcomes found a reduction range of 4-24% (Guide to community preventive services, 2005, P.1).
- ❖ Minimum legal drinking-age laws which specify the age below which the purchase or consumption of alcohol becomes illegal have been enacted in most high income countries, e.g. since 1987, all American states have a set minimum of 21 years (Shultz et al., 2001, P. 72). A systematic review of published studies which assessed the effects of changing the MLDA from 18-21 and vice versa resulted in changes from 10% to 16% in alcohol-related crash outcomes, declining when the MLDA is increased and raised when it is lowered (Guide to community preventive services, 2005, P.1).

3.3.2 Enforcement

Any meaningful legislation will have little or no impact at all on alcohol-impaired driving without robust police enforcement. Well-known cost effective measures include among others; police operations, random breath testing and sobriety checkpoints in conjunction with penalties, mass media campaigns, and interventions for high-risk offenders. Thus, according to the world health report good enforcement is an integral part of road safety (WHO, 2004, P. 126).

To prevent alcohol impaired-driving, many high-income countries use evidential breath testing devices, whose success depends directly on the governing legislation and police operations against impaired-driving. Police power vary considerably between countries and

may assume one of the of the several levels, inter alia; checking obviously impaired drivers, drivers at roadblocks or sobriety check points, and breath testing of drivers at random (Zaal, 1994, P. 36). Successful enforcement can only be achieved if a high proportion of people are tested per year, unpredictable checkpoints covering the whole road network, and highly visible police operations (WHO, 2004, P. 130).

- ❖ Random breadth testing and sobriety checkpoints; roadblocks and sobriety checkpoints are intended to create a perception among the driving public that anyone found driving under the influence of alcohol will be arrested anywhere at any time. Many countries use roadblocks and sobriety check points, such as Australia, France, South Africa and others. The sustained and intensive use of the random breath testing is very effective in reducing injuries caused by alcohol impaired driving. In Australia for instance, since 1993, South Wales reduced alcohol-related deaths by 36% (with a frequency of one in three drivers tested), 42% in Tasmania (three out of four drivers tested), 40% reduction in Victoria (one out of two drivers tested) (Zaal, 1994, P. 39).. The goal of sobriety checkpoints is to deter alcohol-impaired driving by increasing the drivers' perceived risk of arrest. Based on systematic research of 23 scientifically-sound studies, it has been indicated that sobriety checkpoints have a consistent reduction potential of about 20% regardless of whether they were conducted on a short term basis "blitzes" or on a continuous basis for several years (WHO, 2004, P.130).
- ❖ Mass media campaigns generally enhance the effectiveness of enforcement of alcohol-impaired laws through increase in the fear of detection, arrest and its consequences, stigmatizing drinking and driving and promoting acceptability of enforcement activities (Elder et al., 2004, p.57-58). From a systematic review of studies that evaluated mass media campaigns, seven studies found a 13% (6-14%) decrease in total alcohol-related crashes. Six studies reported a 10%(6-14%) decrease in alcohol-related crashes and two studies found net decreases of 30% and 158% in the proportion of drivers who consume alcohol (guide to community preventive services, 2005, P.1).
- ❖ Other interventions especially for hard core drinkers could include increased taxation for alcohol beverages, driver disqualification, brief interventions such as alcohol interlocks and driver rehabilitation courses, training programs for the servers of alcoholic beverages, reducing BAC limits and blood alcohol tests

whenever crashes occur. Further, the issue of medicinal and other recreation drugs and the element of driver fatigue as a result of lack of sleep especially in commercial and public transport, are both associated with the problem of impaired driving (WHO, 2004, P.131-132).

3.4. Occupant protection

In the US, 31,811 occupants were killed in passenger vehicles, 77% of 41,471 traffic deaths in 1998. In order to bring down this death tall, not only in the US but around the world, legislation is needed to promote strong seat-belt use, efficient child restraint devices, airbag adoption and passenger restrictions especially in cargo areas of pick-up trucks (Melissa, 1999, P.5).

3.4.1. Seat belts

“The use of safety belts is the single most effective means of reducing fatal and nonfatal injuries in motor vehicle crashes” (Dinh-Zarr et al., 2001, p.48). Safety belt use is alleged to have saved 123,000 lives between 1975 and 1999, and in 1999 alone an estimated additional 9553 deaths could have been averted, if all motor vehicle occupants used seat-belts. Seat-belts have the reduction potential of 45-60% and 50-83% for serious injuries to the head, chest and extremities. Safety belt laws, primary enforcement of safety belt laws, and enhanced enforcement programs are some of the intervention measures that have been proven effective (Task Force, 2001, P.19).

- ❖ Mandatory seat-belt use laws; while on the one hand, occupants are required by law to wear seat-belts based on their effectiveness in increasing use and reducing fatal and nonfatal injuries, these laws have on the other hand an extended benefit of increasing the use of children safety belts (Task force, 2001, P. 19). A 1984 US amendment to Motor Vehicle Safety Standards no. 208 required the installation of restraint systems (airbag or automatic seat belts), unless two thirds of the nations population were covered by safety belts). This amendment led to 49 states enacting adult safety belts, typical for front seat occupants. Wide-spread knowledge of such laws accompanied by a perceived risk of detection and punishment is said to increase use. According to 1999 estimates, seat-belt use in high-income ranged between 90-99% for front-seat occupants and 80-89% for the rear-seat passengers. Mandatory seat-belt laws are

effective in reducing fatal and nonfatal injuries. Although various state legislations may differ in their specific requirements and enforcement provisions, 33 qualifying studies conducted on behalf of the task force on community preventive services found consistent reductions in fatal and nonfatal injuries and consistent increases in safety belt use. Results from 33 studies suggest a median 9% decrease in fatal injuries, a median 2% for nonfatal injuries and a median of 33% rise in observed safety-belt use (Guide to Community preventive services, 2005-09-21, P.1). Governing legislation will only have temporary effect on user rates if it is not accompanied by penalties, publicity campaigns and stringent enforcement (WHO, 2004, P. 132-133).

- ❖ With regard to enforcement of safety belt laws; primary enforcement refers to a situation where a driver is stopped mainly for seat-belt use violation whereas under secondary enforcement a driver can only be stopped given that another offence had already been committed. In view of the superior effectiveness, primary enforcement is strongly recommended over and above secondary enforcement in an attempt to increase safety-belt use (Task Force, 2001, P. 19). In the US, states with primary enforcement laws are on the average 15 points higher than those with secondary seat-belt laws (Melissa et al., 1999, P. 5).
- ❖ In addition to normal enforcement, enhanced enforcement programs supported by campaigns to promote compliance with the laws call for the increase in the number of officers on patrol, citations for violations, use of safety-belt checkpoints, or a combination of these measures. They are aimed at increasing public awareness of enforcement of safety-belt use laws. From various studies, effectiveness of enhanced enforcement in reducing fatal and nonfatal injuries combined, range from 7-15% reduction and 8-24% increase in observed safety-belt use (Dinh-Zarr, 2001, P. 55).

3.4.4 Child passenger restraint

Child safety seats can be extremely effective when properly installed and used. They are capable of reducing the risk of death by 70% for infants and by 47% to 54 % for 1-4 Year-olds and reduce the need for hospitalization by 69% for the 4 year olds and younger. (Task Force, 2001, P.17). In the US, almost 600 child passengers who died in vehicle crashes were younger than 4 years. Some of the main intervention measures include; mandatory child safety laws, public information and enhanced enforcement, and distribution and education programs (Zaza, 2001, P. 31).

Table. 3.6 below show existing and internationally accepted child restraints.

Table. 3.6

Child restraints

Type	Weight range	Approx. age range
Rearward-facing baby seat	Up to 10kg	Birth to 6-9 months
	Up to 13kg	Birth to 12-15 months
Forward-facing baby seat	9-18kg	9 months-4 years
Booster seat	15-25kg	4-6 years
Booster cushion	22-36kg	6-11 years

Source: RoSPA, 2002, P.1

- ❖ Mandatory child safety legislation on the use of child restraints is mainly aimed at encouraging a safe and secure ride for children under a certain age or weight, in state-approved child restraint devices, child safety seats (Task force, 2001, P. 18). A review of US studies on the impact of mandatory child safety laws suggests that they have on average a reduction potential of 35% in fatal injuries, 17% in all injuries and 13% increase in child restraint use. Incorrect installation and use presents a significant problem to the extent that potential benefits could be reduced (WHO, 2004, P.135).
- ❖ Information and enhanced enforcement campaigns attempt to reach entire communities towards the promotion of child safety seats through mass-media and special enforcement strategies such as checkpoints and stringent police operations (Task Force, P. 18). A review of four qualifying studies on the effectiveness of enhanced enforcement campaigns concluded that they are capable of increasing child safety seat use by a median of 12% (Guide to community preventive services, 2005-09-22, P.1).
- ❖ Distribution and education programs involve giving out approved child safety seats, lending or putting them out for rent at low cost to parents, in conjunction with educational components targeted at parents and caregivers with limited financial resources (Task Force, 2001 P. 18). Child safety distribution and education programs were found to increase both possession of and use of safety seats by 23% on the average, especially in hospitals and clinics and when provided by motor insurance companies (Guide to community preventive services 2005-09-22, P.1).

3.4.5 Mandatory crash helmets

In order to reduce fatalities among motorcyclists and bicyclists due to sometimes severe head, brain and neck injuries, effective strategies in high income countries include, setting of helmets performance standards, laws mandating their use, police enforcement and penalties for non-use, and information and enhanced enforcement campaigns. There is strong evidence that the use of bicycle helmet is capable of reducing head and brain injury risk from 63% and of loss of consciousness by 86% (Thomas S et al., 1994, P. 1).

In the US, there were 242 motorcycle fatalities and an additional 7 000 were injured in 2001. Motorcycle helmets have a fatality reduction potential of 29%. NHTSA estimates that helmets saved 674 lives of all ages in 2001, while an additional 444 lives could have been saved if all cyclists had worn helmets (NHTSA, 2001, P.3).

3.5 Conclusion

In order for a road safety system to achieve the objective of providing a less costly means of transport and yet be safe and sustainable, the foregoing review has shown that; Speed can be managed through engineering, traffic law enforcement and education strategies; Impaired driving prevented through legislation complemented by police enforcement; and occupants can be protected by appropriate vehicle technology and high performance restraints. Complementing by a strong political will and multi-sectoral collaboration including ongoing research have led to road safety progress in high income countries.

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Chapter 4

COST EFFECTIVE INTERVENTIONS IN LOW AND MIDDLE INCOME COUNTRIES

4.1 Introduction

As mentioned in chapter 1, the problem of road traffic deaths and injuries is seen as a major global public health concern in terms of economic, social and human costs, representing a heavy financial burden on national and regional economies, especially in low and middle income countries with limited resources. Expectations are that, the global burden will move from the 9th position in 1990 as a cause of premature death, to the 3rd position in 2020 mainly due to increasing incidence of crashes in low and middle income countries (Mohan, 2002, P.2). In recent times, some of these countries have limited success in finding sustainable solutions whereas high income countries have made significant progress as a result of a combination of interventions, strategies and policies developed in high income settings in the past few decades, given high health budgets, adequate research resources, high levels of health and safety awareness and near universal literacy (Forjuoh, 2003, P.1).

The road safety problem in low and middle income countries is even made more complex by the fact that the majority of deaths and injuries occur in low and middle income countries. Although rates of road traffic deaths vary widely between regions and between countries, higher rates are prevalent in low and middle income countries. These countries account for 85% of deaths and 90% of the DALYs lost annually because of road traffic crashes. South East Asia and western Pacific region make up more than half of the global total of traffic deaths (Peden, 2005, P. 4).

While the most vulnerable road users in these countries, pedestrians (particularly productive age group and children), cyclists and motorized two-wheeler and three-wheeler riders, represent the highest proportion of road traffic and hence the majority of road traffic related deaths, the majority of road users in high income countries are car owners and drivers and consequently are the majority of deaths (Peden, 2005, P.5).

The problem of road safety is growing at a fast rate in low and middle income countries due to rapid motorization against the background of inadequate road infrastructure with poorly

maintained roads, the high number of people killed or injured per crash, inadequate enforcement of traffic safety regulations because of limited resources, poor administration and corruption, less than desired public health infrastructure to provide treatment for the injured and poor access to health services by vulnerable population groups, pedestrians, cyclists and passengers of minibuses and buses often with questionable roadworthiness, and belonging to the lower socioeconomic groups (Nantulya et al., 2002, P.1-5). Globally poorer population groups bear a disproportionate burden of avoidable road traffic deaths and injuries, influenced by socioeconomic factors. Poor countries bear a disproportionate burden of injury and fatalities and within countries, poor people account for a disproportionate portion of ill health due to road traffic injuries indicating global inequities in health.

The problems can be addressed through policies that focus on the road safety of vulnerable population groups (Nantulya / Reich, 2002, P.13). Although there are many approaches that can be used, a few interventions that are known to be effective in most settings do exist, inter alia, legislation, enforcement and education, related to speed, alcohol, seat-belts and helmets as well as visibility (Peden, 2005, P.8). From the distinction between crash prevention and crashworthiness interventions, traffic law seems to be the driving force and very effective in road safety, as it aims at the prevention of occurrence of crashes whereas crashworthiness interventions such as costly airbags only reduce the resultant harm (For the US in 2003, there was a net annual benefit of \$1.14 billion from airbags that cost original purchasers \$30 billion (Evans, 2003, P.8-9)). A 10% decrease in prevention through traffic law provides more benefit than crashworthiness interventions that reduce fatality risk by 10% as these would convert deaths into serious injuries, while prevented crashes amount to the avoidance of all harm (Evans, 2004, P.17).

A lot can be learned from intervention strategies that were developed and have been proven successful in high income countries, which are generally feasible and could be applicable in low and middle income countries. While many can easily be transferred, country specific factors such as costs, feasibility and several barriers play a major role in the assessment of effectiveness in certain low and middle income country settings. Thus, the need for improvisation and innovation should be highly emphasized in the transfer of road safety technology to these countries (Forjuoh, 2003, P.1).

Based on the framework used in the previous chapter, the main focus here will likewise be, on those intervention strategies associated with the setting and compliance with the key road safety rules, with specific reference to speed management, alcohol restraint and occupant protection.

4.2 Speed management

Speed management has central relevance in traffic safety law in order to harmonise coexistence between the most vulnerable road users and vehicles in low and middle income countries. Although traffic patterns in these countries are not the same as in high income countries, the risk of death in a crash presented by inappropriate and excessive speed in particular, is much higher for vulnerable road users than car occupants as said earlier on in chapter 1. Due to inadequate research and other economic developmental problems in low and middle income countries and what has been developed and proven successful in high income countries, many of the intervention strategies are finding their way into the traffic safety programs of many low and middle income countries. According to Forjough, cost effective proven interventions have to be re-evaluated and enforcement measures need to be taken very seriously to guarantee any success (Forjough, 2002, P.1).

In high income countries speed management comprises engineering approaches or traffic calming measures particularly designed to protect vulnerable road users through speed reduction, as opposed to the traditional aim of increasing mobility in highly motorised settings and permitting higher speeds with fewer interruptions and delays (NHTSA, 1999, P.37), the setting and enforcement of speed limits and , complemented by an educational component, which needs distinct emphasis for low and middle income countries. Forjuoh places the blame on problems of low literacy levels, traditional beliefs regarding fatalism of injuries and the like, as obstacles to the proper understanding and visualisation of the reasons behind the high burden of traffic safety problem. The next subsection reviews measures related to road infrastructure design, followed by the setting of speed limits and enforcement of speed limits, education and publicity campaigns, in that order.

4.2.1 Road infrastructure design

Traffic engineering approaches or traffic calming measures have been designed to address the damage done to the traffic environment for non-motorists and the unacceptably high numbers of crashes, injuries and deaths. Without being elaborate on detail, common measures in high income settings include, road humps, horizontal traffic deflections, roundabouts, gateways and entries, and other approaches that emphasize design of pedestrian and cyclists friendly street systems, such as narrow streets with on-street parking, alleys for parking access and utility corridors, and short curb radii at intersections (NHTSA, 1999, P.38-44).

The above-mentioned measures have been proven effective in the reduction of vehicle speeds with the resultant safety and convenience for vulnerable pedestrians and cyclists. These measures are very important and urgent for low and middle income countries, in view of their high fatality rates pertaining to vulnerable road users. Forjuoh on the other hand makes reference to the following interventions and strategies with proven and promising effectiveness in increasing safety for pedestrians both in high income as well as in low and middle income countries; sidewalks, roadway barriers, pedestrian crossing signs, education and conspicuity-enhancement measures and roadway lighting. Roadway barriers have been evaluated in low and middle income countries (Forjuoh, 2002, P.111).

In the context of road safety in less-motorized environments, Mohan gives priority to countermeasures such as country-specific motor vehicle standards, analysis and treatment of black-spots, traffic separation and vulnerable road user friendly road infrastructures including intercity highways and of course relevant speed control measures (Mohan, 2002, P.6-10).

Some successes in low and middle income countries deserve to be mentioned. In Ghana, excessive speed alone accounted for more than 50% of all traffic crashes in the period, 1998-2000. Cost-effective rumble strips and speed humps which are easy to install have been found to be effective on roads in Ghana, which are now a common feature particularly in built up areas where excessive vehicle speeds contribute to high fatality rates among vulnerable road users. Their installation on the main Accra-Kumasi highway reduced crashes by 35% and fatalities by about 55% over a short period of 16 months (Afukar, 2002, P.77-81).

In 1995, road traffic injuries cost the lives of almost 1 400 people in Bogotá, Colombia. To reduce this toll, the government through its Transport Ministry and the Road Accident Prevention National Fund, adopted a comprehensive and creative approach. The reduction of traffic flows was fostered through the promotion of cycling and setting restrictions on times and places, when and where private vehicles may be driven. Bicycle paths were created and sidewalks which had been taken over by vendors and parked cars, were also reclaimed to separate cyclists and pedestrians from motorized traffic, and safe behaviour was promoted through public education campaigns, such as the use of zebra striped crossings. Corrupt city traffic police were eliminated, handing over responsibility of traffic enforcement to the national police as part of legal reforms, and bar and pub closing times were changed from 4.00am to 1.00am, to build respect for moderate alcohol consumption. In 2002, the 1995 created independent epidemiological supervisory committee responsible for monitoring external injuries as well as data on road traffic injuries reported around 50% reduction in traffic deaths (Giles et al, 2005-10-23, P.6-7).

Yet another success story has been documented in Costa Rica, where data on road crashes are being monitored, compiled systematically and made available to the public via the website of the National road safety council. Studies are underway on topics such as risk factors, crash victims and the economic impact of road traffic injuries. According to recent data, an 11% decrease in the number of crashes and a 16% reduction in related deaths have been recorded since 2003. This followed the setting of a goal of 19% reduction of road traffic deaths in the period 2001 -2005, to counter the annual fatality rate of 600 lives at a cost of around 2.3% of the GDP. The Costa Rican government sought the assistance of the Swedish government, the FIA foundation and the Global Road Safety Partnership in the implementation of their road safety plan (Giles Et al., 2005-10-23, P.5-6).

Lastly, safety audits (ETSC, 1995, P.24) represent another important aspect of road infrastructure design to ensure that planned or new roads do not have adverse effects on safety. In Korea, road safety inspection system was introduced to assess roads constructed after 2001 for the purpose of road design improvements. All new roads had to be inspected for safety from the planning stage to their completion, including existing roads and frequent crash spots, by a joint team involving the Police and the Road Maintenance Bureau to undertake redesign measures if necessary. After the reshaping of 232 roads in the first half of 2001, crashes, fatalities, and injuries fell by 38%, 65% and 36% respectively compared to the first half of 2000 figures, saving lives and averting high social costs that could have otherwise been incurred (Bong-Min, 2002, P.93-94).

4.2.2 Setting of speed limits

The concepts of road hierarchy, 100-120 km/h for flow roads, 80km/h for distributor roads and 30km/h for residential roads mentioned earlier in subsection 3.2.2 and the design and general speeds shown in table.3 in subsection 3.2.2, are feasible and applicable to low and middle income country road infrastructures because of their international acceptability, along with speed management measures which may be varied dependent on country specific circumstances.

Closely associated with the above concepts is the setting of speed limits supported by stringent police enforcement.

The setting of speed limits has proved to be an effective intervention in reducing traffic deaths and injuries of pedestrians as well as car occupants and has been evaluated in low and middle income countries. According to a study in Colombia, 2000, 34% of traffic related fatalities were caused by speeding, alcohol consumption or both, while an over 20% reduction in traffic

crashes and deaths in Brazil is partly the result of speed limits set on several roads since 1998 (Forjuoh, 2002, P.114).

4.2.3 Enforcement of speed limits

Anywhere around the world, the setting of speed limits is a very vital intervention in the reduction of speed to drive down the rate of road traffic casualties, however without rigorous traffic law enforcement, investment funds would be wasted. This should imply a strong recommendation for the strengthening of enforcement of speed limits in low and middle income countries with inefficient traffic law enforcement to detect violators due to limited resources and under trained police, bribery and corruption, shortcomings in transport policies, weak political support for prevention and control of road traffic casualties and low public awareness and support for speed management measures (Afukaar, 2002, P.78).

Measures to enforce speed limits developed and proven effective in high income countries are feasible and can be applied to various settings in low and middle income countries. These include among others;

- ❖ The lowering of urban speed limits is an effective way of achieving reduced speeds and casualty crashes. A 20km/h decrease in speed on Swedish motorways is said to have led to a 21% decline in road traffic deaths (Giles, 2005, P.4) (see also Table.3.4).
- ❖ Continuous police enforcement is one of the main countermeasures, given that driver expectation that enforcement will occur is ongoing and the fear of being apprehended exists (NHTSA, 1999, P.29-30).
- ❖ Automatic speed cameras used in many countries around the world are well known to be highly effective in the enforcement of speed and reduction of red light running. Mozambique seems to have a serious problem with red light running, where automatic speed cameras are feasible and should be strongly recommended to improve road safety there. In 1999, police reported 29 747 such cases in Maputo alone, where one out of every third driver has at least once crossed an intersection under red traffic lights. Further, passenger-ferrying buses and trucks take the lead in breaking the code, often leading to the deaths of many passengers aboard and consequent high social cost (Romao, 2002, P.65).
- ❖ Imposition of appropriate fines for violators to encourage compliance and the use of the revenue to fund more speed cameras. In the UK, revenue from court fines and fixed penalties goes to the consolidated fund of the Exchequer. However in

April 2000, a pilot project of a new system to enable fines from speed and red light cameras to pay for the costs of camera enforcement activities (known as Netting off) began in eight localities. The results were so positive that after one year, the government decided to extend the scheme and introduced the necessary legislation in section 38 of the Vehicle (crime) Act 2001. The income raised from speeding fines is not just spent on enforcement activities. The department of transport has published guidelines on how the revenue can be spent effectively to help improve road safety activities in the local area. Safety Camera Partnerships do this by closely working with the local authorities, the media and other organisations to highlight the dangers of speeding and increase awareness and acceptance of the safety camera program (RoSPA, 2004, P.2-3).

- ❖ Speed limiters for buses, minibuses and trucks, as an improvement to road safety, could be very valuable in low and middle income countries, given their high representation in road casualty crashes (Afukaar et al., 2002, P.75).

As an example of successful enforcement in low and middle income countries, the 1997 installation and publicity of speed monitoring cameras in the Korean high risk crash areas led to the placement of more cameras in 1998-1999, which resulted in a 28% fall in crashes and 60% fall in fatalities within a diameter of 1km from the high risk spots, within a year in both instances (Yang, 2002, P.93).

Again, in April 2001, the Korean government introduced a financial reward system for evidence of traffic violations, photographed or videotaped at the site of violation. In the same month 25 000 cases per day were submitted and 99% of those initially submitted were rewarded. In August the same year figures fell to 7 000 cases per day, suggesting that more drivers began abiding by the rules. The net effect was a 35.7% reduction in traffic crashes during the five-month period (Yang, 2002, P.93).

4.2.4 Education and publicity campaigns

Despite the fact that the effects of traffic education have not undergone evaluation, knowledge, attitudes and risk perceptions related to alcohol are included in secondary school curricula in some European countries and public opinion about alcohol in traffic has become positive in recent years. It is a well-known anti-social behaviour and the consequences thereof are well understood and hence there is little need to enhance awareness.

Publicity campaigns through the mass media, on their own without additional speed control measures has been shown to be hardly effective on speed choice. Environmental benefits of

appropriate speed should receive more enhanced emphasis than positive publicity given to new high speed road (ETSC, 1995, P.30, in Rooijers et al., 1992, see also Clayton, 1990).

The UK experience with road safety education has shown that using real streets with real traffic has the greatest potential for training young children, who seem to benefit most from the behavioural approach to road safety (Sayer, 1997, P.5). To improve conditions for vulnerable road users (adult pedestrians and children), an integral approach is required, an essential part thereof, being pedestrian education in schools. The provision of appropriate educational material, teaching approaches and generally increasing awareness of the relevant stakeholders, education ministries, teachers and pupils, will go a long way in addressing the problem in low and middle income countries. Results from a controlled study by the Transport research laboratory, UK, found that children exposed to the 'Safe Ways' material had improved their road safety knowledge and attitudes over children who had not been exposed to the resource, statistically significant at the 5% level (Sayer, 1997, P.10).

4.3 Alcohol restraint

The negative role played by alcohol impaired driving in road traffic safety and alcohol as a factor among pedestrian casualties, both in high income countries as well as in low and middle income countries are well known and many countries agree on the need for traffic law enforcement to prohibit alcohol impaired driving as evidenced by blood alcohol limits around the world (see Table 3.3.1).

4.3.1 Setting of alcohol impairment laws

Regulatory arrangements in high income countries include;

- ❖ The license suspension law, which is known to have a statistically significant reduction potential of fatal traffic crashes. The arresting officer is empowered to seize the licence of a driver who refuses to test for alcohol or fails the test. The intervention is feasible, affordable, and sustainable in low and middle income countries (Forjuoh, 2002, P.115).
- ❖ The .08 blood alcohol concentration (BAC) restriction for adults (Shults, 2001, P.69).
- ❖ Zero tolerance laws for drivers under the age of 21 (Shults, 2001, P.71).
- ❖ The minimum drinking age of 21 years for the youth (Shults, 2001, P.72).

Once the laws have been enacted, and then follow the most important part of alcohol restraint, the enforcement of those laws.

4.3.2 Enforcement

Several effective enforcement measures do exist, which could be feasible and applicable in low and middle income settings for example;

- ❖ Lowering the legal limit to 0.5g/L and a lower limit of 0.2g/L for inexperienced drivers, drivers in public service and heavy goods, with greater potential for road safety improvement especially where road infrastructures are inadequate and vehicles are less likely to be fitted with the latest technology (The Globe, 2003, P. 1-2).
- ❖ Random breadth testing and compulsory intensive sobriety checkpoint programs (see 3.3.2).
- ❖ Punishments in form of fines, driver disqualification (see 3.3.2) and vehicle impoundment (The Globe, 2003, P.3) are in order, to deter repeat offenders. Vehicle impoundment is applied in South Africa, even though evaluation of its effectiveness is not yet available.
- ❖ Increased taxation to effect price increases to moderate the intake of alcoholic beverages (see 3.3.2).
- ❖ Compulsory blood alcohol testing when crashes result in casualties, not only for prosecution purposes but also for the monitoring and collection of data needed for research (see 3.3.2).
- ❖ Comprehensive community based approaches that combine publicity and educational campaigns, and responsible alcohol serving practices (The Globe, 2003, P.2).
- ❖ The ignition interlock device relevant for hard core drinkers can be affordable and sustainable in low and middle income countries, however their feasibility and enforceability is controversial in view of current technological problems, installation in old cars and the possibility of tampering with the device without the availability of effective inspection, enforcement and funding (Forjuoh, 2002, P.115).

4.4 Occupant Protection

Road traffic safety laws are designed for occupant protection to address interventions aimed at keeping drivers and passengers of vehicles safe, with specific reference to the use of seat belts, airbags, child restraints and helmets to protect motorcyclists and bicyclists (Forjuoh, 2002, P.111). To derive maximum benefit from the use of the above devices, legislative measures are required, which include, mandatory seat belt use laws, child passenger restraint

laws, publicity campaigns and education and legislation governing the availability of functional seat belt in vehicles, which are well known cost effective and proven intervention strategies.

4.4.1 Seatbelts and mandatory seatbelt use laws

Seatbelts have the potential to reduce fatalities by 50% and serious injuries by 55%. Because of their affordability and feasibility, they can be used in low and middle income countries. However, enforcement would be difficult without legislation. High income countries have enough resources to undertake primary enforcement while some low and middle income countries can only afford secondary enforcement which is less effective, leading to passive enforcement and low compliance (see subsection 3.4.1). In Ghana, 16 445 traffic officers with 145 vehicles are expected to operate in a country with more than 18 million people, which clearly indicates that the inadequacy of traffic officers cannot guarantee effective enforcement of seatbelt laws. In the US, annual inspection of vehicles includes evidence of availability of functional seat belt as a prerequisite for the issue of roadworthy certificates. In low and middle income countries more than half of the imported vehicles lack functional seat belts and neither do the relevant government agencies have the capacity to undertake the inspections, leaving the banning of such vehicles as the next best alternative (Forjuoh, 2002, P.112). Airbags are an additional occupant protection device, capable of reducing the drivers' fatality risk. Although they are suspect of being less cost effective, they are anyway feasible and applicable in low and middle income countries because most of the latest car models imported from high income countries would have already been fitted with airbags directly from the manufactures.

4.4.2 Child restraints and child restraint laws

From the background information related to child protection in high income countries, as given in subsection 3.4.4, it is evident that child passenger seats are extremely effective in the reduction of infant and children road traffic casualties. They are capable of reducing the risk of death by around 70%. In low and middle income countries, children form part of the most vulnerable road users as pedestrians, as well as passengers in private cars, school buses and other modes of public transportation often involved in crashes, such as buses and minibuses. Since the seat belt usage is very low in these countries, the same can be expected of child safety seats.

The only way to protect these infants and children is to improve usage rates by borrowing affordable and feasible legislative intervention strategies from high income countries, for example,

- ❖ Controlled importation and manufacturing of appropriate child passenger restraints with acceptable international standards.
- ❖ Comprehensive and intensive police enforcement, coupled with fines without corrupt practices.
- ❖ Community-based approaches towards the promotion of increased usage of the child safety seats supported by education and information campaigns about the consequences of non-use and to mobilize public support for law enforcement efforts (ETSC, 2005-10-28, P.1-2).

4.4.4 Mandatory helmet use

The helmet use legislation is meant to protect motorcyclists as well as bicyclists against road traffic casualties, in terms of reducing incidences of severe head and neck injuries. Because of their affordability and effectiveness in reducing cyclists' casualties (see subsection 3.4.5), helmets are highly feasible in low to middle income countries, particularly in those countries where cyclists are a common feature on the roads, such as Indonesia, Malaysia, Taiwan, Thailand and the like.

Helmet use legislation should be complemented by measures such as setting helmet performance standards, police enforcement and appropriate fines for non-use, daylight running lights for motorcyclists and conspicuity enhancement measures for bicycles, skills training programs, safety programs, bicycle paths and lanes (Forjuoh, 2002, P. 112-113).

The development and local manufacture of low-cost helmets is also feasible in low and middle income countries, following the example of the Asia Injury prevention Foundation which has developed a light weight tropical helmet for Vietnam and has drawn up helmet performance standards (WHO, 2004, P. 137).

4.5 Cost effective injury interventions

Selected cost effective injury interventions are summarized in Table 4.1 according to country, type of intervention, outcome of the intervention, the respective cost and a comparable cost effectiveness measure of the intervention:

Table. 4.1

Cost effectiveness of injury interventions in LIMC

Country	Intervention	Outcome	Cost	Cost/life-year
Colombia	Better police enforcement + media	50% decrease in deaths	\$ 225 513	\$ 322
Costa Rica	Media	11% decrease in crashes & 16% decrease in deaths	\$ 15 800	\$ 164
Ghana	Rumble strips	35% decline in crashes & 55% in deaths	\$ 20 900	\$ 27.6
Korea	Reshaping of old roads	38% decrease in crashes, 65% in fatalities & 36% in injuries	\$ 53 600	\$ 696
Brazil	Setting of speed limits	20% decrease in crashes & deaths	\$ 225 513	\$ 7 047
Korea	Speed cameras	28% decrease in crashes & 60% in fatalities	\$ 53 600	\$ 48
Korea	Financial reward system	35.7% decrease in traffic crashes	\$17 866.6	\$ 16

4.6 Conclusion

A common pattern is evident in low and middle income countries, where pedestrians, children, cyclists and passengers in multi-passenger buses, minibuses and trucks, represent the majority road traffic related deaths and injuries, with significant economic impact on households and the national economies. In high income countries on the other hand car owners and drivers form the majority of casualties.

In Asia, pedestrians and motorcyclists are exposed to the highest risk of injury and pedestrians and passengers in mass transportation are the main concern in Africa, while the urban pedestrian is the biggest concern in Latin America and the Caribbean, reflecting distinct regional patterns and differences.

Again, multi-disparities exist, in terms of socioeconomic status, gender, age, place of residence, geographic location, education, exposure to risk, morbidity and mortality rates, social consequences of ill health as well as access to treatment, as emphasized by Nantulya and Reich.

The concern about the vulnerability of people living along highways is well documented. However, roads are often built through areas where the potential for economic activity exists, thus creating conflict over space between road users and the local population. People also tend to settle near roads because of the consequent increased economic activity. This is a dynamic process of changing populations, settlements, migration patterns and needs. And yet these changing conditions are never considered in the design and construction of new roads (Nantulya et al., 2002, P.4-5).

Many crashes involving pedestrians and cyclists can be attributed to the intense competition for space on multipurpose roads and streets, especially the role of fast-moving motor vehicles. The conflict is most severe on streets passing through crowded low-income urban residential areas and in settlements along major roads passing through rural areas.

To reduce the crash and injury risks experienced by vulnerable population groups, key stakeholders need to be mobilized to support the development and implementation of comprehensive policies that protect these groups. There is therefore a need for a paradigm shift in global road safety and transport planning to take into consideration the needs of all road users so that roads and streets do not produce an unfair burden of injury and death for lower income groups (Nantulya / Reich, 2002, P.19).

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-Chapter 5

COST EFFECTIVE INTERVENTIONS: IMPLICATIONS FOR SOUTH AFRICA

5.1 Introduction

After the foregoing reviews of the most cost effective interventions in high income countries and in low to middle income countries, we now focus our attention to the road safety problem in South Africa, its magnitude, current efforts being undertaken to resolve associated issues, and taking into consideration experiences from high income and low to middle income countries, attempt to recommend what could still be done in order to close the gap between what is known to be cost effective and the actual practice of the South African public policy.

5.1.1 Background to the road safety problem

According to the recent World Health Organization report on road traffic fatalities, Africa had the world's highest road traffic mortality rate of 28,3 per 100 000 population in 2002, followed by the Mediterranean region, South East Asia and the Americas, with death rates of (26, 4), (18, 6), and (16, 2) per 100 000 respectively. This shocking fact is attributable to the South African road traffic mortality rate of (27), which is just a few points below the African average (Jacobs et al., 2000, P.22). The fact that low to middle income countries carry most of the world's burden of road traffic casualties is herewith confirmed. Further, while casualties are expected to be on a declining trend in high income countries, they are expected to escalate in low to middle income countries over the next 20 years and beyond (WHO, 2004, P.34-35).). In 1998, there were 28 000 fatal crashes resulting in the loss of around 9 000 lives, 36 000 serious injuries and 84 000 slight injuries (Department of Transport, 2001, P.6). Behind homicide, road traffic holds the second place as a leading cause of non-natural fatalities in South Africa. Though not the highest in the world, our road traffic death rate is 11.7 per 100 million kilometers of travel and ranks among the top ten. A very high pedestrian component is obscured by the above summary statistics. Approximately 45% of our road traffic deaths involve

pedestrians (i.e. about 4 500 pedestrians are killed and 26 000 are injured every year). However, concerted preventative efforts since early 1990 have decreased the proportion from 47% in 1987 to 37% in 1996 (Peden, 1999, P.337). Thus, pedestrians are still the most vulnerable population group.

In South Africa, there are 6 million licensed drivers, 6 730 000 million licensed and registered vehicles and around half a million road traffic crashes occur annually, with a road fatality rate of 13.8 per 10 000 motor vehicles (Department of Transport, 2001, P.6). South Africa's experience has been quite different from other large African countries (Nigeria, Kenya, Ethiopia, Tanzania, and Zambia), over the past several years, as shown in Fig 17 (1987-1995). On the one hand, their road fatality toll per 10 000 motor vehicles grew by over a quarter and South Africa on the other hand, experienced a boom in both motorization and population, while its road fatalities appear to have stabilized at approximately 10 000 annually. The relative personal safety risk doubled for many African countries whereas it decreased for South Africa (although by comparison it is still very high) (Jacobs et al., 2000, P.21-23). According to the Department of Transport, the South African economy lost an estimated R13, 8 billion to road traffic crashes in year 2000, excluding indirect social costs (Department of Transport, 2001, P.6). Kwazulu-Natal province with relatively high number of annual road traffic deaths is believed to incur a cost equivalent to 5% of the Gross National Product. In order to assist decision making, road crash costs expressed as percentage of the GNP range from 0.3% in Vietnam to almost 5% in the US, Malawi and Kwazulu-Natal. Apart from the humanitarian aspect of reducing deaths and injuries in South Africa, a strong case can be made on economic grounds alone as they consume massive financial resources that a country can ill afford to lose. Even in the transport sector, hard allocation decisions have to be taken over the resources that have to be devoted to road safety (Jacobs et al., P.9-10).

5.1.2 Contributory factors

According to the Department of Transport, some of the factors contributing to the magnitude of the road safety problem include;

- ❖ Inappropriate and excessive speed, with 30% and 50% of all road traffic crashes involving private vehicles and, freight and passenger vehicles respectively.
- ❖ Alcohol-impaired driving and drug use, driver fatigue and driver incompetence (untrained or those with fraudulent licenses, estimated to make up 50% of registered licenses).
- ❖ Inadequate road infrastructure (especially with poor road signs and markings, untreated road-railway crossings and other black spots), stray domestic animals (donkeys, cows and horses) and poor maintenance of roads.
- ❖ High pedestrian road use (a product of hybrid first-third world infrastructure and economy), is reflected in the high rate of vehicle-pedestrian collisions and casualties, 40-50% occur in the urban areas and 30-40% in rural areas.
- ❖ The problem of roadworthiness, widespread disregard for the use of safety devices (seat belts, child restraints and helmets) and the problem of overloading passenger and commercial vehicles (Department of Transport, 2001, P.11-15).

5.2 Road safety management

5.2.1 The strategic objective

After abolishing the National Road Safety Council in the early 1990s, South Africa's road safety management became the responsibility of the Directorate of Traffic Safety within the Department of Transport, to coordinate activities. The legal framework for the Department is the 1996 White Paper on transport policy.

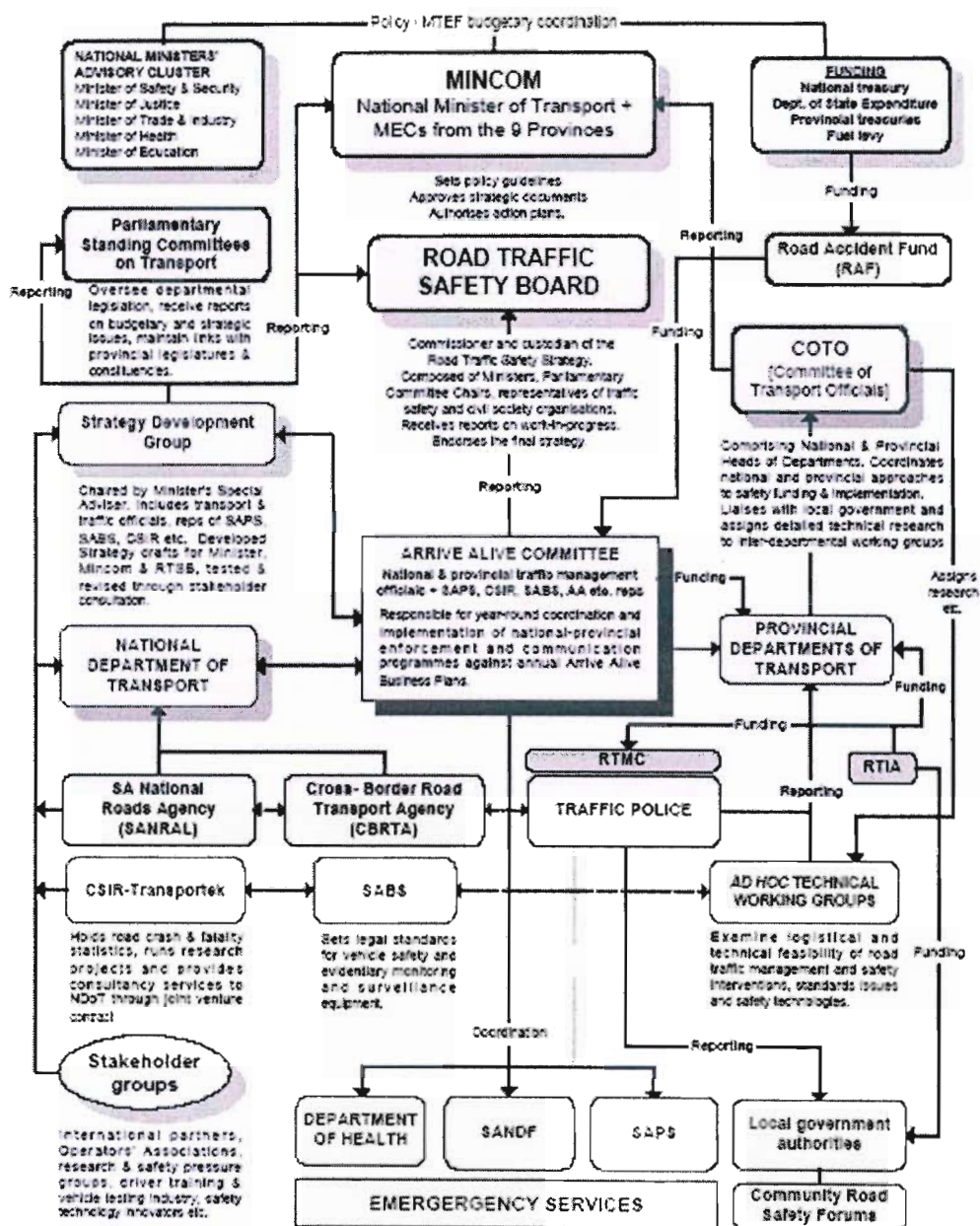
The main strategic objective of The Road to Safety 2001-2005, is to ensure an acceptable quality in road traffic with the main emphasis on road safety on all urban and rural roads in the country. In order to achieve this, the Department has set a strategic target of a 5% annual reduction in road traffic crashes and casualties until 2005, with R770 million saving to the economy per year and, reliant on strengthened institutional capacity and improved statistical trends, hope to realize at least a 10% annual reduction until the year 2009. The main focus of the strategy 2001-2005 to reduce road traffic casualties on urban and rural roads is on the following key areas;

- ❖ Enforcement and compliance with traffic law
- ❖ Vehicle and driver-related factors
- ❖ Road infrastructure, management and information systems
- ❖ Communication, education and community participation (Department of Transport, 2001, P.16).

The current impetus of the Road to Safety can be attributed to the revision of the 1996 Road Traffic Management Strategy that brought with it the Administrative Adjudication of the Road Traffic Offences (AARTO) Act and the establishment of the Road Traffic Infringement Agency (RTIA), and the establishment of the Road Traffic Management Corporation (RTMC). Around 1999, following several serious crashes in the public passenger transport, an urgent need to analyze associated safety issues was given. This provoked the development of a comprehensive monitoring and enforcement regime to deal with all aspects of passenger and road freight transport safety. It also became necessary to formalize the proper role of Arrive Alive, not as an all-purpose strategic and operational tool but as a delimited rolling tactical program designed to achieve effective and practical intergovernmental cooperation in ongoing road traffic safety management, coordination and implementation of strategy (Department of Transport, 2001, P.3-4).

Although it is acknowledged that the strategic targets of 5-10% reduction in road traffic casualties have been set too low to match the current magnitude of the road safety problem, this is however in full recognition of the fact that the Road to Safety involves a qualitative process of institutional restructuring and the realization of benefits thereof can at times take longer than anticipated, in view of the mammoth task of transforming the road user tradition of our country, and the problem of under-reporting of crash data (Department of Transport, 2001, P.19). Any comprehensive strategy therefore, demands a continuous identification and assessment of acute problem areas, prioritization of these areas and the setting of targets, and the choice of cost effective intervention strategies to ensure efficient resource allocation. Short, medium or long term proposed interventions when used in combination should enable the setting of standards and rules, appropriate institutional reforms and compliance encouraged and enhanced through education and promotional publicity campaigns. (See the diagrammatic illustration of the management structure on the next page).

THE ROAD TO SAFETY Managing and Coordinating the Strategy



FINAL DRAFT

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In summary, managing a strategy in the context of road safety in South Africa, involves the need for intergovernmental and cross-sectoral coordination and the implementation of proven cost effective interventions, supported by sustained private sector and community participation. In line with the demands of a comprehensive strategy, outcome oriented interventions should necessarily address the main elements of any road traffic system, the road environment, the road user and the vehicle, in terms of identifying acute problems, the setting of priority targets and the monitoring of outputs and outcomes to check progress towards the achievement of overall strategic objective (Department of Transport, 2001, P.17). This brings us to the main elements of the management of strategy, the intermediate outcomes and the user-group outcomes.

5.2.2 Intermediate outcomes

As seen from the diagrammatic illustration of The Road to Safety managing and coordinating the strategy, it should be noted that the Strategy Development Group was temporarily operational until the strategy document had been published, leaving the Arrive Alive Committee responsible for the day to day coordination and implementation of the national-provincial enforcement and communication programs. In the interim, Arrive Alive is expected to achieve the following expected intermediate outcomes leading to the final outcomes of reduced road crashes and casualties as set out in the strategic objective;

- ❖ Lower average traffic speeds in urban and rural areas
- ❖ Further reductions in impaired driving on our roads
- ❖ Increased seatbelt wearing rates
- ❖ Increased compliance with road traffic rules and regulations

5.2.3 User-group outcomes

The proposed strategic interventions in the Road to Safety are expected to;

- ❖ To stamp out fraud in driver licensing and vehicle testing to improve driver skills, attitudes and keep danger off our roads.

- ❖ To maintain high proportion of high caliber drivers.
- ❖ To achieve a well organized, preferably self-regulated and closely monitored commercial and passenger transport industry.
- ❖ To achieve marked reductions in casualty rates for passengers, pedestrians and cyclists (Department of Transport, 2001, P.19-20).

5.2.4 Proposed Road Safety interventions;

a) Development of Forensic Auditing Capabilities.

In addition to increasing the number of driver licensing and vehicle testing inspectorates, the creation of a strong forensic auditing capacity is vital in order to keep out corruption and malpractice in these sectors, such as the proposed Drug Recognition Expert (DRE) program and definition of appropriate sentences. In the interim, while further research into (DRE) is being undertaken, Road to Safety will work in close collaboration with the National Directorate of Public Prosecutions and /or the Scorpions to secure the services of a team of forensic auditors to support the inspectorates. Where violations are proven, withdrawal of the individual's registration or license centre or test station will follow and criminal prosecutions will be initiated.

b) License Fleet Safety Management/Code of practice.

An informal consultation process is already underway with the freight and public transport employers' associations and trade unions, to be followed by formal negotiations to built consensus around self-regulatory measures, legislative and regulatory changes deemed necessary for tighter fleet safety management. International models currently being explored emphasize the need for a formal Safety Fitness Rating Methodology.

❖ Protection of Vulnerable road users.

In order to protect pedestrians, children and cyclists, Road to Safety will;

- a) Ensure full provincial and local implementation of the new Pedestrian Facility Guidelines and the new SA Road Safety and speed limits manuals;

- b) Support the commitment by provinces to carry out planned, continuous, multi-disciplinary upgrades of identified urban and rural hazardous locations, with community participation via democratically structured Safety forums;
- c) And expand rural road upgrade/maintenance programs nationwide, supported by systematic funding of emergent construction SMMEs, while at the same time integrating safety training into the process of improving road quality and visibility.

❖ Communication, education and public participation

To lend support to the above road safety interventions, the minister of transport took the initiative by convening a series of national consultative workshops inviting participation, input and commitment from government, industry and civil society. The Minister also encouraged the extension of the consultative process to the provincial and local government level hosted by the respective MECs for transport and Metropolitan Mayors, to introduce the national strategic framework, clarify the most effective forms of cooperation between provincial and local government and identify the necessary mechanisms and funding resources for local community involvement in road safety programs. Under consideration is the following key focal areas; pedestrian safety, cyclist safety, understanding and observance of road signs, and commuter vigilance, reporting and preventative action. In parallel, the Minister also opened up a process of continuous interaction with the major industry role players – minibus taxi, bus, coach and freight and transport trade unions-aimed at developing a culture of joint responsibility for the improvement of safety in all areas of operation.

Further, progress is being made to integrate road safety awareness education into the mainstream school curriculum, as basic life skills. As from 2001, all learners from pre-school level through to grade 9 will be exposed to systematic, practical road safety education within the framework of the “life skills” component of Curriculum 21 (Department of Transport, 2001, P.22-26).

5.3 Intervention strategies

Irrespective of the motorization level, everywhere around the world, there is a need to improve safety of the traffic system for all its users, and to reduce current inequalities in the risk of being injured in a road crash (WHO, 2004, P.12-13). With reference to page 15 of chapter 3, successes in high income countries in the reduction of crashes and injuries suggest a multisectoral approach with the public health sector playing a leading role. With that in mind, we restrict our focus of attention on those intervention strategies associated with the setting and compliance with the key road traffic rules and regulations, with specific reference to speed management, alcohol restraint and occupant protection, notwithstanding the importance of several other strategies aimed at improving road safety. This is in line with the framework adopted in the two preceding chapters.

5.3.1 Speed management

Lowering of vehicle speed is a major priority in the prevention of road traffic crashes. A 1% decrease in speed reduces the risk of injury by 2-3% and the risk of fatal injury by twice as much. Vehicle speed greatly impacts on pedestrian injury. As the speed increases from 30-50 km/h, the risk of pedestrian death increases eightfold (UN General Assembly, 2003, P.5). Excessive and inappropriate speed is factor in 75% of road traffic collisions on South African roads. Desired lower and safer speeds can be achieved through appropriate infrastructure design, the setting and enforcement of speed limits;

- ❖ Road infrastructure design

Traffic calming or road engineering interventions to reshape old roads and the incorporation of safety features into the design of new roads can be very cost effective in the long run not only in lowering speeds and calming traffic volumes, but also to improve pedestrian facilities in order to prevent road traffic crashes and subsequent casualties.

The Ethekeweni Transport Authority identified the city's most notorious roads, with Umgeni Road and Edwin swales V C Drive topping the list. According to the head of Strategic Planning, reengineering road works are already under way to widen Edwin Swales to three lanes in each direction, from the South Coast Road to help

reduce traffic levels and fatalities (Goldstone, 2005-04-28, The Mercury, News/Books).

Implementation requirements of New Road Safety, Road signs and Pedestrian safety Manuals became law on the 31st. December 2000. Provinces mandated to guarantee required funds in MTEF budgetary process.

In tandem with provincial/local government/community participation processes, ensure that a continuous provincial level program of hazardous location audits is in place and that appropriate technical, engineering and administrative resources are made available to support community initiatives; resources of SANRAL to be used wherever appropriate-Continues through life of strategy.

Create coordinating structure to link NDoT participation in integrated rural development programs with provincial road building, upgrade and maintenance programs and with SANRAL corridor/SDI development activities. Key theme: "Access-with-safety"-to be realized through rural road transport and road safety forums and the provision of training, skills transfer and SMME empowerment programs-created in 2001 and continues through life of strategy. National government to apply pressure on PDoTs, local government and SANRAL to ensure that speed limit audits complement hazardous location upgrade programs, throughout the life of the strategy. Maintain regular liaison with SANRAL on the development of formalized coordination procedures to link and streamline the actions of traffic officers, SAOS officers, ambulance services and tow-trucks at crash scenes.

Engineering approaches to improve pedestrian safety are not new to South Africa as documented by a comprehensive research program conducted since 1980 to upgrade all pedestrian facilities through warrants for the provisions and guidelines for the correct layout and siting of the various types of pedestrian facilities. Two broad engineering approaches are in use in South Africa;

- a) Pedestrians are integrated with road traffic and managed through temporal separation (pedestrian crossings, school crossings, traffic lights) or soft separation (traffic calming); or

- b) Pedestrians are segregated from road traffic through horizontal separation (pedestrian malls, sidewalks, township layout providing for separate walkway systems) and vertical separation (foot bridges and subways) (Ribbens, 1996, P.10-11).

❖ Setting of speed limits

In terms of the National Road Traffic Act, 1989, general speed limits are set at 60km/h on public roads within an urban area, 100km/h outside an urban area, 120km/h on a freeway and a maximum speed limit of 80km/h for a commercial vehicle. The law also contains certain provisions for minibus taxis, buses commercial vehicles, and tractors.

Top limiters have been introduced in a number of countries worldwide and have been mandatory in the EU since 1995. Following on the British experience with speed limiters, a British standard was prepared (BS AU 217 Part 1a:1987) for speed limiters, which was then used by the Ministry of Transport to introduce these devices onto both trucks and coaches starting in 1989/90 through to 1995. The largest percentage reduction in road deaths has taken place over the same period as the introduction of the speed limiters onto trucks and coaches (Department of Transport, 2005, P.6).

5.3.2 Alcohol impaired driving

According to the South African national injury mortality surveillance system, there were 25 361 fatal injuries registered at 32 state mortuaries in 2001, approximately 35% of all non-natural mortality in South Africa. Transport-related accounted for 27% of all fatal injuries. Pedestrians, a road user group that is mostly killed accounted for 37%, followed by passengers of vehicles with a 17.4%, drivers (14%) and cyclists (3.1%).

Alcohol is a major risk factor for all fatal road traffic injury in South Africa. In one study, alcohol was found to be a factor in around 29% of non-fatally-injured drivers and in over 47% of fatally-injured drivers (Peden, 1996, P.). In another study, out of BAC tests conducted on 2372 (34.6%) of the 6859 transport-related deaths, more than half (51.9%) of all transport-related deaths had an elevated BAC, and of these positive cases 91% recorded BAC levels of 0.05 g/dl or higher. Pedestrians, followed by drivers were most

likely to be BAC positive (Peden et al, 2000, P.) To support the above findings, a mortality researcher of the Medical research council and the University of South Africa blame lax enforcement of alcohol impairment laws, following a 2003 report by the National Injury Surveillance System that more than 50% of drivers killed were over the legal limit (Kahn, 2005-03-23, P.3).

❖ Alcohol impairment laws

The current legislation applicable to all drivers sets the BAC limit of 0.08gm/100ml of blood, and the new legislation has lowered it to 0.05 for all drivers and 0.02gm/100ml for professional driver (driver of a commercial vehicle exceeding a mass of 3.5 tones or driver of a vehicle carrying passengers for reward) (Department of Transport, 2000, p.1).

❖ Traffic law enforcement

As mentioned earlier, the Arrive Alive committee (See P.53) is responsible for the enforcement of traffic laws and communication/awareness programs to deal with violators of speed control, alcohol, seatbelts, and vehicle/driver factors. The core targets are speed and alcohol, the main contributory factors particularly on weekends when the lethal cocktail (speed and alcohol) accounts for more than 60% of the total number of crashes, while speed alone contributes 75% of all crashes on our roads. There are 7 000 people involved in Arrive Alive 98% being traffic officers. A serious setback for effective law enforcement is the fact that normal working week for a traffic officer is from Monday to Friday, 8am-5pm whereas 65% of crashes occur at night and over weekends, demanding an overtime arrangement which represent more than 17% of budgetary allocations (Department of Transport-Arrive Alive, What is it all about?, P.1-3). Some of the enforcement measures which have been integrated into Arrive Alive programs include;

- a) Enforcement of road signs compliance.
- b) Extended deployment of static and mobile speed cameras.
- c) Enforcement of new alcohol limits.
- d) Enforcement of seatbelt usage and moving violations.
- e) Multi-purpose road-blocks.

5.4 Concluding remarks

The underlying strategic objective is to apply the most cost effective intervention strategy mix to reduce road traffic deaths and injuries, based on lessons from both high income countries and low to middle income countries, with due consideration to the South African circumstances.

In line with the recommendations of the World Report on road traffic injury prevention, the Road Traffic Safety Board within the Ministry of Transport is the commissioner and custodian of the Road Traffic Safety strategy. In this capacity, it is able to assess the magnitude of the problem and deal with it through the final endorsement of the national strategy and plan of action. The problem of resource allocation demands proper assessment of costs and benefits of specific interventions, vital in the setting of priorities and targets, in view of limited financial and human resources. And international collaboration in terms of exchange of knowledge and expertise, establishment of alliances and partnerships tend to strengthen local capacity.

In order to understand the entire road traffic crash prevention effort, it is necessary to understand and view the traffic system, the road user, the vehicle, and the road environment, as a dynamic system which can either produce or prevent crashes (Giles, 2005, P.2). There is no standard package of interventions that works in all contexts, however good practice would comprise legislation, traffic law enforcement and education with specific reference to speed management, fight against alcohol and drug impaired driving and occupant protection. At the same time, three to four decades of experiences in high income countries provide examples of mistakes made while attempting to improve road safety (Peden, 2004, P.723). It is now generally accepted that road safety is a global problem and requires national capacity to be part of a global cooperation and responsibility (WHO, 2004, P.160-164).

5.5 Recommendations

- ❖ Without being prescriptive, there are valid reasons why the Public Health Sector should play a leading role in road safety, currently the responsibility of the Transport Sector. Apart from the given potential to benefit directly from improved road traffic injury prevention, in terms of sustainable health care provision, the health sector is at the receiving end of the damage done and has several important roles to play such as;
 - a) Data collection through surveillance and surveys.
 - b) Research on causes of road traffic crashes and casualties.
 - c) Exploring ways of prevention and reduction of the severity of injuries.
 - d) Lending support in the implementation of interventions.
 - e) Working to persuade policy- and decision-makers of the necessity to address injuries in general as a major public health issue.
 - f) Translating effective science –based information into policies and practices.
 - g) The promotion of capacity building (Peden, 2005, P.7-12).
- ❖ Speed is the number one killer on South African roads and experiences from high and low to middle income countries tell us that the strengthening of traffic law enforcement on speed limits to lower speeds is the most cost effective way of reducing road traffic deaths and injuries. The same applies to the prevention of alcohol impaired driving.
- ❖ The apparent non-use of seatbelts and child restraints is a serious setback for the protection of vehicle occupants, little is known about the user rates statistics and there are few studies on the effectiveness of seatbelts in less developed countries and none for South Africa. The cost of a one year enhanced seatbelt enforcement program would be around US\$300 000 and the benefits in terms of saved lives and injuries are estimated at \$1.7 million (Harris et al., 2005, P.103-104). Although the use of seatbelts and child restraints has been proven cost effective both in high income and low to middle income countries, it has received relatively little attention in South Africa, despite the existence of seatbelt laws and their primary enforcement. In view of their effectiveness, it is strongly recommended

that South Africa should enhance the seatbelt and child restraint use through increased police enforcement and punishment.

- ❖ Notwithstanding the importance of other factors influencing road traffic collisions, the road user factors (human error within the road traffic system) are more important than engineering factors and among engineering factors, the improvements in road infrastructure bring forth larger changes in risk than those associated with vehicle engineering changes. The human factor that dominates is the driver behavior to the extent that it holds the key to changes in road traffic safety. “Behavior-change theories may offer some guidance that could contribute to harm reduction.” (Science Serving Society, 2004, P.4).

In the South African context, negative driver behavior refers to deeply entrenched and pervasive disregard for law compliance, the tradition of widespread aggression towards other road users and irresponsible disregard for basic rules of safe road usage. (Department of Transport, 2001, P.5). The Minister of Transport also recognizes human behavior as the most prevalent contributor of collisions in his forward remarks to the Road to Safety 2001-2005 document (Department of Transport, 2001, P.3). In high income countries, legislative countermeasures have achieved the largest changes in behavior e.g. random breath testing in Australia achieved a 19% change, speed limit change in the US (34%), seatbelt-wearing in the UK (20%) and 35% of those who received a ticket were less likely to be involved in a fatal crash within the month following the ticket. These reductions simply overwhelm crashworthiness improvements. A vehicle change that reduced driver fatality risk by 10%, would reduce fatalities by only 0.6% in the first year as most vehicles date from before the change and not all victims are drivers. A lesson for South Africa is that the largest reductions in road traffic deaths and injuries are achievable from a more effective traffic law enforcement which includes new technologies such as photo radar and red light cameras.

- ❖ Research into the adequacy of 7 000 traffic officers against 7 000 000 drivers in the country need to be undertaken, with reference to their numbers, funding and training in order to strengthen traffic law enforcement. Much as there is the need to close the gap between what is known to be effective and what is actually

practiced, not only in South Africa but elsewhere around the world, there is also the need for the development of new research-based policies, which will require more investment in research. Non-governmental organizations can also play an important role in this regard by;

- a) Creating awareness of the dimensions of the casualty problem and articulating the need for research-based action to the communities and policy-makers.
 - b) Identifying and actively promoting demonstrably effective solutions with due consideration to practicality, cost and public acceptability (Breen, 2004. P.30).
- ❖ South Africa urgently needs a strong political advocacy to facilitate the achievement of conditions for a sustainable national road safety capacity (US Department of Transport, 2004, P.1). This is in view of the very high mortality rate of 27/100 000 population, the massive social cost of R13.8 billion and the 2010 soccer world cup. A marked reduction in road traffic casualties in the next five years, leading to the hosting of the big event, would improve South Africa's international image (Yang B, 2002, P.1-2).

5.6 Conclusion

The most successful countries are those that have a good political will and have embraced a systems approach in the sense of an interaction between the road user, the vehicle and the road environment, in order to identify the potential for interventions. Further, a systems approach recognizes that humans do make mistakes, and therefore a safe road system is one that accommodates their weaknesses. The Swedish Vision Zero and the Dutch Sustainable Safety (WHO, 2004, P.19-22) are very good examples of a systems approach to road safety. The problem of road safety may be likened to that of the prevention of HIV and AIDS. Without the promotion of positive driver behavior change, intervention strategies are likely not to be effective in view of the fact that one of the major risk factors that influence the road traffic casualties lies with the human error within the road traffic system. South Africa is therefore no exception in this regard.

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