CHAPTER 1: INTRODUCTION

1.1 BACKGROUND

Road traffic safety improvement interventions[1] are planned and executed with two basic objectives in mind, namely reducing the number and severity of road traffic accidents. Road traffic safety improvement interventions normally include three elements: engineering, education and enforcement. Large amounts of money are used for these interventions. The evaluation thereof is essential to ensure that the public receives the full benefit of the limited available budget. Evaluation of improvement interventions are normally done through an objective analysis of one or more of the dimensions of the road safety problem. This involves statistical analysis of accidents or critical offence monitoring.

Behavioural science offers a wide range of opportunities to increase an understanding in the field of road safety. Among others, Glendon (1987) lists three main areas:

- mental processes/ cognition – e.g. risk perception, learning and development, hazard perception and labelling, attributing responsibility, cause and blame;
- behaviour – e.g. accident causation, responding to hazards, making and correcting errors;
- environment – e.g. valid indicators of risk exposure, training, education, communication, responding to hazards.

1.2 OBJECTIVES OF THE STUDY

The study was aimed at providing a framework for the evaluation of road safety improvement interventions. It investigated the various elements that should be included in the evaluation of a road safety improvement intervention. The framework provides a discussion of the various elements and methodologies that can be followed in the evaluation of a road safety improvement intervention.

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[1] A road safety improvement intervention includes road safety campaigns, changes in legislation, or for example, the AARTO Bill.

The study also includes an evaluation of aspects of the Arrive Alive 1 to illustrate the different elements in the evaluation of a road safety improvement intervention.

The objectives of the study are:

- a literature study on the evaluation of elements of road safety improvement interventions;
- a contextualisation of the road safety status of South Africa in the international scene;
- a framework for the evaluation of road safety improvement interventions;
- an evaluation of certain elements of the Arrive Alive 1 road safety improvement intervention to illustrate the proposed framework.

1.3 SCOPE OF THE STUDY

The study is limited to the preparation of a framework for the macro-level evaluation of road safety interventions and a preliminary evaluation of some of the elements of the ARRIVE ALIVE 1 campaign (1 October 1997 to 31 January 1998), by taking accident history (where available) from as early as 1994 into consideration. Macro-level evaluation refers to the evaluation of an intervention in an area, i.e. not at a location or on a specific route. Road safety improvement intervention refers to any action (campaign, legislation, programs etc) that is aimed at improving road traffic safety in an area. The area can, for example, be a country, a province or a metropolitan area.

On a national level, the accident history from as early as 1938 is utilised. Monthly data for 1999 is not included in the study as the delay period for obtaining reasonable accident data is at least one year, measured from January of the following year.

Data from Statistics SA (formerly the Central Statistical Service) is utilised for the evaluation on national and provincial levels. An evaluation on metropolitan level including a selection of worst routes and worst locations is based on data from the Durban Metro. The Durban Metro expends significant amounts of

manpower and resources on checking the accuracy of accident reports and provides more accurate data than normal accident databases that only capture data as provided on the SAPS 352 accident reports.

Law enforcement data for the ARRIVE ALIVE 1 period was found not appropriate to evaluate offence levels. The extent of law enforcement actions during the Arrive Alive 1 campaign was obtained from an official report on the Arrive Alive 1 road safety campaign included in the literature study on the campaign.

1.4 METHODOLOGY

A literature study was done on the development of road safety approaches, road safety improvement interventions and the evaluation of elements of road safety improvement interventions.

A framework was then developed for the evaluation of road safety improvement interventions.

Monthly and annual accident data were analysed at national level, for Gauteng, Western Cape, KwaZulu-Natal, for the Durban Metro area, for a selection of intersections in Durban and for a number of major routes in the Durban Metro area. Certain elements of the ARRIVE ALIVE 1 campaign were evaluated to illustrate outcomes of the campaign and the result of different evaluation methodologies.

1.5 PROBLEM STATEMENT

Road traffic safety is an important health and society issue. The costs of road traffic accidents are high and the public demands improvement. The evaluation of the efficiency of road safety improvement interventions are difficult due to a number of factors like poor data and complex techniques – some questionable. A framework for the evaluation of road safety improvement interventions is required to enable the evaluation of the different dimensions. The framework for such an evaluation process includes the evaluation of existing methods and perceptions. Such a framework will enable the monitoring of interventions for improvement in the design of the intervention and also the data requirements for the evaluation process.

1.6 ORGANISATION OF THE REPORT

Chapter 1 is an introduction to the study.

Chapter 2 discusses the road safety problem and illustrates the need for road traffic safety improvement interventions.

Chapter 3 describes the principles of road safety improvement interventions.

Chapter 4 discusses the international approaches to road safety.

Chapter 5 discusses the ARRIVE ALIVE 1 campaign.

Chapter 6 introduces the evaluation of road traffic safety improvement interventions.

Chapter 7 introduces accident analysis as a measure in the evaluation of road traffic safety improvement interventions.

Chapter 8 describes the statistical analysis of road traffic accident data.

Chapter 9 illustrates the use of accident data analysis with annual data using the annual accident statistics of South Africa.

Chapter 10 illustrates the use of monthly accident data series to evaluate the Arrive Alive 1 road safety campaign.

Chapter 11 introduces and discusses the evaluation of other factors, like human responses, in road traffic safety improvement interventions.

Chapter 12 provides the framework for the evaluation of the human factor in road safety interventions and also illustrates the use of the framework by providing a preliminary evaluation of Arrive Alive 1.

Chapter 13 describes the conclusions and recommendations of the study.

The references and a bibliography are included at the end of the report.

Appendix A: The regression analysis of number of accidents and fuel sales.

Appendix B: The regression analysis of number of accidents and number of registered vehicles.

Appendix C: The graphic representation of monthly accident data series for South Africa, Gauteng, KwaZulu-Natal, Western Cape, the Durban Metro, a selection of worst locations in Durban Metro and a selection of major routes in the Durban Metro area.

Appendix D: The graphical representation of the distribution of driver and passenger ages involved in accidents in the Durban Metro area.

CHAPTER 2: THE ROAD SAFETY PROBLEM

2.1 INTRODUCTION

700 000 people die annually in road traffic accidents around the world (World Highways, January/February 1999). In the USA road traffic accidents is the fifth top leading cause of death (NCHS website 2000).

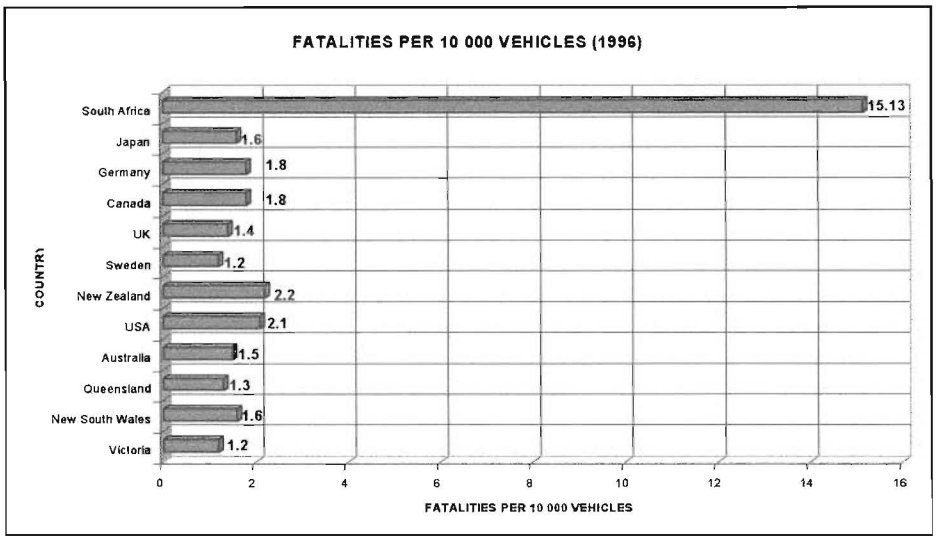
This chapter will highlight the road traffic safety problem in South Africa. Road safety improvement interventions that contribute to the reduction of accidents and/or the severity of accidents can be justified in terms of both human suffering and economic benefits. The chapter shows some of the gains for South Africa to be derived from a reduction in the accident rate and severity.

2.2 THE ROAD SAFETY PROBLEM IN CONTEXT

During 1998, 512 605 accidents were reported on South African roads, resulting in 129 672 people being injured and a further 9 068 dying. Apart from the traumatic social cost of these accidents, the burden on the economy amounted to R 13,5 billion (1998 Rand) (CSS 1999).

2.3 SOUTH AFRICA'S ROAD SAFETY RECORD COMPARED TO OTHER COUNTRIES

Graph 2.1 shows the fatality rates per 10 000 registered vehicles for South Africa compared to other countries in the world. Note that the definitions of fatalities differ from country to country and that this can influence the results. Unfortunately statistics from other African countries or transitional countries in the world are not readily available and are therefore not included in this report.



Graph 2.1: Comparative fatality rate per 10 000 registered vehicles in 1996 (after CSS 1999)

2.4 THE COST OF ROAD ACCIDENTS AND POTENTIAL SAVINGS

The total cost of road traffic accidents in South Africa amounted to R 13,5 billion in 1998 (1998 Rand) (CSS 1999). This cost is based on the severity of accidents:

- fatal degree of injury accident = R 340 337
- serious degree of injury accident = R 89 332
- slight degree of injury accident = R 25 434
- damage only degree of injury accident = R 17 983.

The saving will be proportional to the percentage reduction in accident severity or fatalities (the sum of the individual savings per injury category).

2.5 ATTITUDE TOWARDS ROAD SAFETY

The attitudes towards road safety can be divided into three main categories, namely:

- the public: the level of road safety on the roads is not acceptable and it is dangerous to travel;
- technical - special task teams are set up after bombing attacks while road traffic deaths generally only receives attention during peak holiday periods or after a series of fatal accidents. Although the associated costs and number of

accidents are high, the probability of death or injury during a trip is as small as 1 in one million per trip (Lay, 1986). It is, however, twenty times less than the chance of death caused by an act of terrorism (Shubik, 1991). The reason for the unwillingness of society to appreciate this is not clear. Wilson (1975) suggested in a study that the number of individuals involved in a single incident is used by society to quantify the risk of an event.

- the public sector

  - national level – Minister Mac Maharaj stated that *we are aware of the critical situation on our roads in which more than 10 000 people are currently killed per annum and close to 50 000 seriously injured of which 40% are pedestrians* (RTMS 1997)

  - the main purpose of the Road Traffic Management Strategy that was accepted by all levels of government *was to reduce road traffic accident fatalities by 10 percent by the year 2000*

  - in the preparation of Moving South Africa (a vision for 2020) the effect of road traffic accidents were seen as a threat to the sustainability of transport: *road safety (is rated) at or near the top of customer needs... road safety imposes enormous costs on society, making the transport system inherently unsustainable... This destabilises the long-term sustainability of transport and depresses usage levels through fear of road safety* (Moving South Africa 1998).

2.6 CONCLUSIONS

The road safety problem in South Africa is serious in terms of cost and suffering. Public sentiment demands attention to the problem and government accepted a Road Traffic Management Strategy geared towards improving road traffic safety in South Africa.

CHAPTER 3: APPROACHES TOWARDS IMPROVING THE ROAD SAFETY PROBLEM

3.1 INTRODUCTION

The purpose of this chapter will describe the views on, approaches to and stages of developments to improve road safety.

3.2 VIEWS ON ROAD TRAFFIC SAFETY IMPROVEMENTS

During the past century, views on addressing the road safety problem have changed significantly. Eight basic views were identified by Haight (1983). In addressing the problem it is important that these views be taken into consideration:

- The Road Safety problem is not curable. A road traffic accident is a consequence of mobility. It is therefore important to keep in mind that accidents cannot be eliminated. We can, however, reduce the consequences thereof. It affects the approach to road safety because it changes the focus: from a problem to be eliminated to a problem that should be managed. This in turn places a responsibility on professionals to develop scientifically sound techniques to ensure that resources spent on safety are effectively and well-spent. The target for road safety problems should therefore be a reduction to acceptable and manageable levels (Evans, 1994).

- The *Blame* or *Causal* approach should be abandoned. It is generally agreed that there are contributing factors in any accident. It is important to realise that the human factor should be closely studied, observing that a human being has limited capabilities, needs information to make decisions, requires time to receive and act upon the information/ make the necessary decision and can make incorrect decisions. In the causal approach the road safety specialist fails to recognise the responsibility of designing the road system for the human being. Provision should be made by designing for the human being and not forcing the human being to fit into the design.

- A road traffic accident is a consequence, not an accident. The concept of blaming an accident on human error gives rise to the thought that a road safety specialist should change the human to prevent the accident. A road

safety specialist should rather focus on controlling the consequences of the three phases of an accident: pre-crash (e.g. accident prevention), during-crash (e.g. seatbelts) and post-crash phases (e.g. emergency services). It is also important to realise that a countermeasure normally either reduces the number of accidents or the severity thereof (Ogden, 1996).

- Exposure reduction. By managing the mobility, i.e. the exposure of high risk groups, accident losses can be reduced. This approach is specifically successful with novice drivers.

- Statistical analysis. Scientifically sound analysis - using a sound database and skill in the analysis and interpretation thereof - is required to evaluate whether a program or system is rendering the required benefit or has the necessary effect. The road safety specialist should therefore be aware of the following when attempting statistical analysis:

  - accident databases have limits and shortcomings (e.g. different definitions of fatalities, inaccurate reporting, missing data);

  - the isolation of a single factor from others is problematic as the other factors may also affect the safety;

  - the danger of *regression to the mean*.

- The probability of counter-intuitive outcomes. A road safety improvement intervention based on logical and sensible ideas may not have the effect it was designed to have.

- Evaluation of proposals. Proposals for the improvement of road safety should be evaluated to ensure the selection of only the proposals most likely to be effective.

- Setting intelligent priorities. Road safety projects compete with other programs for already limited budgets. Evaluations should therefore enable authorities to set priorities to select only projects that will reduce the number and severity of accidents and be the most cost-effective (Ogden, 1996).

3.3 STAGES IN THE HISTORICAL DEVELOPMENT OF ROAD SAFETY IMPROVEMENT INTERVENTIONS

Over the past years, various approaches to road safety were taken. Six basic stages in the historical development of road safety improvement interventions can be identified (Organisation for Economic Cooperation and Development, 1984), namely:

- the Mono-Causal Casuistic Approach;
- the Mono-Causal Accident Proneness Approach;
- the Mono-Causal Chance Phenomenon Approach;
- the Multi-Causal Chance Phenomena Approach;
- the Multi-Causal Static Systems Approach;
- the Multi-Causal Dynamic Systems Approach.

3.4 THE MONO-CAUSAL CASUISTIC APPROACH

In the mono-causal casuistic approach, every accident is seen as unique and one too many. It is believed that by taking away the cause of the accident, the problem can be solved. This approach does not consider the following:

- by taking away one problem, one may create another;
- there may be more than one solution, i.e. there is not a unique and separate solution to every single accident;
- this approach leads to the attitude of *blaming the victim*.

The main reason for the failure of this approach is the fact that it ignores the interaction between the components of the road system.

3.5 THE MONO-CAUSAL ACCIDENT PRONENESS APPROACH

The mono-causal accident proneness approach refers to the approach where accident-prone drivers are identified and then either kept away from traffic or forced to improve themselves by training and punishment. All previous attempts to identify these accident-prone drivers have failed. A US Department of Transport report (Hulbert 1982) states that *the negligence law usually treats driver error as both avoidable and unreasonable, and imposes liability pursuant to an objective standard to which all drivers are held ... but .. a significant gap exists between the standard of behaviour required by the negligence law and the average behaviour normally exhibited by most drivers*. Hulbert (1982) therefore concludes: *the old concept of the accident prone driver is not supported by the facts*.

3.6 THE MONO-CAUSAL CHANCE PHENOMENON APPROACH

This approach regards accidents as being purely a matter of chance. Accidents can therefore not be prevented, as fate cannot be changed. This approach leads to the development of mechanisms to reduce the severity of accidents, e.g. crashworthy vehicles, break-away supports etc.

3.7 THE MULTI-CAUSAL CHANCE PHENOMENA APPROACH

The multi-causal chance phenomena approach started in the early 1970's. The approach assumes that accidents are the result of a combination of factors or the outcome of a chain of events. The interactions of these factors (human-vehicle-road) are partly random and partly deterministic (i.e. controllable). This gives rise to the development of extensive database systems and statistical techniques to identify the interaction among the portion of factors that are deterministic. This is in essence the current approach followed in road safety.

The biggest drawback of this approach is the fact that the amount of accident related information that can be collected is limited and that the ability to evaluate and model the interaction of all the relevant factors is limited.

The multi-causal static and dynamic systems approaches are refinements of this approach.

3.8 THE MULTI-CAUSAL STATIC SYSTEMS APPROACH

The multi-causal static systems approach is a problem-oriented strategy that focuses on the nature of the problem. It singles out the specific part of the problem and attempts to examine it more closely. The approach led to a number of *in-depth studies* where as much data as possible is collected at the site, about the circumstances of the accident, as well as information from the early stages of the chain of events that led to the accident itself.

This approach fails as it does not take cognisance of the fact that transport and accident processes are dynamic. The data collected is purely *snapshots* and not a *movie*. In every accident, the probability of failure is partly the result of circumstances or actions that preceded it.

3.9 THE MULTI-CAUSAL DYNAMIC SYSTEMS APPROACH

The multi-causal dynamic systems approach attempts to search for *critical lines or sequences through all the processes leading to road trauma* (OECD 1984). It is the most appropriate approach as it is not only problem-oriented and directed at effectiveness like the other multi-causal approaches, but it is also aimed at optimisation, i.e. achieving specific goals and integration, while considering all phases and countermeasures.

The OECD (1984) identified a number of key links that require investigation to operationalise this approach. They are:

- travel needs that create the demand for mobility;
- predisposition, i.e. the factors that increase the risk of travel;
- road user factors such as urgency, fatigue, use of alcohol and/or drugs etc.;
- modal factors such as comfort and access;
- environmental factors such as traffic volumes, characteristics of the road, traffic and weather;
- encounters, i.e. the potentially risky traffic situations of travellers - the outcome of these encounters is determined by:

  - road user characteristics such as experience, skills, motivation, risk-taking, etc;
  - vehicle characteristics such as manoeuvrability, braking, stability, etc.;
  - traffic factors such as volume, stability of flow, intersecting traffic, conflicting manoeuvres, etc.

- incidents, i.e. encounters that require extreme responses by road users (heavy braking, swerving etc.) or those that result in undesirable vehicle behaviour (jack-knifing, skidding, etc.);
- accidents, i.e. incidents that involve a collision. In this case, little discretion is left to the road user at this stage and the outcome of this incident is the result of already established conditions and actions (during the preceeding phases);
- injury and damage, i.e. the consequences of the energy exchange in the accident;
- recuperation, i.e. the attempts to save the life of the accident victim, the physiological and physical recuperation of survivors and the disposal or repair of damaged property.

The systems-oriented approaches lead to significant progress in road safety as they incorporate the essential interactions between the road user, the vehicle and the road system.

3.10 CONCLUSIONS

The views on road safety improvement interventions and the historical development of these interventions form an essential part of the strategic planning of road safety improvement interventions. The multi-causal dynamic systems approach provides opportunity to address the contribution of the road environment, the vehicle and the road user to road traffic accidents in a holistic manner.