A REVIEW OF ROAD SAFETY AUDIT PROCEDURES

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ABSTRACT

Roads occupy a place of importance in any economy because of their unique characteristics and distinctive features of connecting interior places, with its network for carrying persons and goods. The increase in traffic brings out problems of road traffic accidents. It has been estimated that over 3 lakh persons die and 100 to 150 lakh persons are injured every year in road accidents through out the world. The aspect of road safety though aimed at in any design process however does not cover all the requirements to ensure accident free sections in any road network. ROAD SAFETY AUDIT (RSA) is a process in which experts attempt to identify potentially dangerous features in the highway environment. "It is a formal examination of an existing or future road or traffic project, in which an independent, qualified team reports on the project's accident potential and safety performance" (***Austroads* 2001**). Road safety audits are an efficient, cost effective and proactive approach to improving transportation safety. It is proved that RSA has the potential to save lives and ultimately money. Initiated in Great Britain (1980) RSA is well developed in countries like Australia, New Zealand, Canada, Denmark, Malaysia and Singapore. It is at varying stages of implementation in other nations like Thailand, India South Africa and Bangladesh.

Many countries had developed the road safety audit procedures. Even though the main methodology adopted is almost same in all countries, they had developed their own checklists for RSA according to the local conditions. It is a question why all road authorities around the world are not practicing this process. Therefore there is every need to develop its own RSA methodology in a country like India where road traffic accidents are assuming epidemic proportions. This paper aims to promote RSA by briefly describing it and outlining some RSA procedures followed worldwide.

1. INTRODUCTION

1.1 Global Road Accident Fatalities

Roads occupy a place of importance in any economy because of their unique characteristics and distinctive features of connecting interior places, with its network for carrying persons and goods. Increase in traffic brings out problems of road traffic accidents. It has been estimated that over 300000 persons die and 10

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to 15 million persons are injured every single year in road accidents through out the world. India has the distinction of having more than 22 lakh kilometer of well spread road network on which more than 400 lakh vehicles are moving daily. At the same time Indian transport system is rated one of the most accident-prone system with more than 14 accidents per thousand vehicles every year, compared to only 6 to 8 accidents per thousand vehicles in developed countries.

The problem of deaths and injury as a result of road accidents is now acknowledged to be a global phenomenon with authorities in virtually all countries of the world concerned about the growth in the number of people killed and seriously injured on their roads. In recent years there have been two major studies of causes of death worldwide, which have been published in the 'Global Burden of Disease' (1996. World Health Organisation, World Bank and Harvard University) and in the 'World Health Report – Making a Difference' (WHO 1999).

These publications show that in 1990 road accidents as a cause of death or disability were by no means insignificant, lying in ninth place out of a total of over 100 separately identified causes. However, by the year 2020 forecasts suggest that as a cause of death, road accidents will move up to sixth place and in terms of years of life lost (YLL) and 'disability-adjusted life years' (DALYs) will be in second and third place respectively.

1.2 Need for Road Safety Audit

Although the aspect of road safety is the aim of any design process, it does not cover all the requirements to ensure accident free sections in any road network. Road safety audit is a formal procedure for assessing accident potential and safety performance in the provision of new schemes, the improvement and the rehabilitation of existing roads and in the maintenance of existing roads. Road safety audit should form an integral part of highway planning, design, construction and maintenance and it requires an objective approach to the assessment of accident risk. This is to evaluate the degree of safety of road sections on a road network. There is a need to prepare a road safety audit manual for field engineers to enable them to carryout safety audit on existing roads, major rehabilitation works and also on new road schemes. The road safety audit, when used for applications on existing roads, is more appropriately termed a road safety audit review (RSAR) (Wilson, Eugene, 1999). RSA is a proven and highly cost effective process that assists with the production of safer roads. It is a part of road design process in most of the road authorities in countries as far apart and as diverse as Britain, Australia, New Zealand, Malaysia, Singapore, Canada and Denmark. In addition RSA is at varying stages of implementation in other nations including South Africa, Thailand, India and Bangladesh as well as parts of Middle East. The safety audit process has produced dramatic improvements in road safety in Australia, Canada, New Zealand and the United Kingdom. It is designed to help project directors and designers anticipate potential safety problems and provide them with recommendations to address them. The Federal Highway Administration (FHWA)

considers safety audits so valuable it partnered with fourteen States and two local agencies to test their effectiveness. The Pennsylvania Department of Transportation (Penn DOT) began "road testing" the safety audit process on a wide range of projects in April 1997, even before the FHWA pilot program started.

Introduced in England in the 1980s, the road safety audit originally was designed to identify traffic safety deficiencies on projects primarily still in the planning or construction stages. In Australia the Federal Office of Road Safety (FORS) is the agency within the Department of Transport and Regional Development (DTRD) responsible for road safety. FORS has identified the road safety audit as one of the national "best practices" that could be implemented to meet safety objectives.

In spite of many benefits of the road safety audit process, it is amazing why all road agencies around the world are not practicing this process. The reason may be that some authorities have not yet learnt about the process/ benefits or some road authorities suspect that they don't need road safety audit as they have 'world class' designers. Some may think that they have higher priorities than audits such as treating high frequency crash locations. The above views are incorrect and each in their way is handicapping the advancement of road safety engineering in those nations. With the rapid growth of new road infrastructure in many motorising nations, the need for RSA in these countries is not only great but it is urgent (Phillip Jordan, 2002).

2. ROAD SAFETY AUDIT

2.1 Definition

Austroads (1994) *defines* Road Safety Audit as: "A formal examination of an existing or future road or traffic project, or any projects which interacts with road users in which an independent, qualified examiner looks at the project's accident potential and safety performance". This definition was further revised in 2001 as "a formal examination of an existing or future road or traffic project, in which an independent, qualified team reports on the project's accident potential and safety performance". The ***European*** Transport Safety Council **(ETSC, 1993)**, which is an international nongovernmental organisation defines Road safety audit as "a formal procedure for independent assessment of the accident potential and likely safety performance of a specific design for a road or traffic scheme - whether new construction or an alteration to an existing road". Manual of Road Safety Audit, ***Denmark*** **(1997)** defines Road Safety Audit as "a systematic and independent assessment of the safety aspects of road projects. Its purpose is to make new and reconstructed roads as safe as possible – before construction is started and before accident occur". Road Safety Audit Manual, ***Vietnam*** defines Road Safety Audit as a formal process in which the planning, design, construction, operation and maintenance of new or rehabilitated road project is examined by an independent, qualified team to identify the projects potential accident and safety performance.

Manual of Road Safety Audit, ***Nepal* (1997)** defines Road Safety Audit as "a systematic method of checking the safety aspects of new roads in order to detect potential safety hazards before the road is opened to traffic". Guidelines for The Safety Audit of Highways, ***U.K.*, (1996)** define Road Safety Audit as "advertising formal procedure for assessing accident potential and safety performance in the provision of new road schemes and schemes for the improvement and maintenance of existing roads". The road and Traffic authority, ***New South Wales (1991)***, defines Road Safety Audit as "a means of checking the design, implementation and operation of road projects against a set of safety principles as a means of accident prevention and treatment". Manual for Safety in Road Design, ***India* (1998)** defines Road Safety Audit as a formal procedure for assessing accident potential and safety performance in the provision of new road schemes, the improvement and the rehabilitation of existing roads and in the maintenance of existing roads.

From the above definitions, by seeing the commonality in features of RSA, *Road safety audit can be defined as a systematic approach/evaluation of existing/new roads or traffic projects, in stages of planning, design, construction, operation & maintenance to achieve accident free roads and safety performance."*

2.2 Aims and Nature of Road Safety Audit

In safety audits the main objective is to ensure that all new highway schemes operate as safely as is practicable. This means that safety should be considered throughout the whole preparation and construction of any project" (IHT, 1996). RSA takes the principles developed through accident remedial programs, which have found to be effective and apply them pro-actively. The aim of the safety audits is to identify what needs to be done to prevent the occurrence of accidents, or reduce their severity of their occurrence. An audit is intended to identify potential road safety problems by looking at the scheme as if through the eyes of the potential users of all kinds, and to make suggestions for solving these problems by applying the principles of road safety engineering (AUSTROADS, 1994; Danish Road Directorate, 1993; IHT, 1996).
More specific aims are:

- To minimise the number and severity of accidents that will occur on the new or modified road.
- To avoid the possibility of the scheme giving rise to accidents elsewhere in the road network and enable all kinds of users of the new or modified road to perceive clearly how to use it safely.

Accident costs can be a major component of total road costs over the whole economic life of the project if there is significant safety problem designed in to the road. Road safety audits allow a pencil line on a plan to be changed, rather than having to change lengths of concrete or asphalt on the road. Auditing existing roads allow action to be taken before accident statistics highlight a problem.

2.3 Partners in the AUDIT process

After a review of different countries Road safety audit processes it can be inferred that three parties will involve in this process –Designer, Auditor and Client. Designer is responsible for planning / designing the project. Designer bears the responsibility for ensuring that a road safety audit is conducted and that the necessary measures are agreed on the basis of the auditor's recommendations and / or the client's decisions. The designer is also responsible for ensuring that the audit input information is unambiguously defined and that all circumstances are described in an easily understood manner. The project engineer or design engineer should be responsible for initiating the safety audit process for each scheme, and responding to the audit. Auditor's responsibility is to carefully review the presented project details in the light of best road safety expertise and from the viewpoints of all relevant road users. Persons designated as Road Safety Auditors work with, and have experience of, road accident analyses and road accident reduction. Auditors must be familiar with road planning, design and construction work and must undertake to keep their exercise up-to-date. Auditors should work within the terms of reference. They should comment only on the safety implications of schemes and provide constructive recommendations as to how any potential difficulties can be resolved. Client is one who allots the project for the designer and owns the project. As the party responsible for the basic conditions of the project, it is the task of the client to arbitrate in cases where the designer and auditor disagree. Disagreements are presented to the client who sends its written decision to the designer and auditor. One fundamental idea is that disagreements between the designer and the auditor are decided not by the designer but by the client, who has ordered the project from the designer. So it is an interaction between different parties, whose roles are predefined at specific stages. The different parties are client, designer and auditor. The Road safety audit process is a relatively simple process. The RSA process is shown in Figure 1 as given by Werner Koppel, 2003. The flow chart is self-explanatory.

2.4 Auditor's Requirements

To be effective the audit needs to be carried out by specialists who are independent of the design process. The auditors in no way should be connected to the project and he should have a fresh look at it.
According to ***Austroads*** a person who has an understanding of road user behaviour and human perception is also likely to be able to develop road safety audit skills. Auditors will be successful when they are able to use their skills to see the road project from the point of view of the different types of customer or road user – those able to think and perceive like each user. According to ***University of New Brunswick, Canada***, the audit team should be independent of the project design team to ensure that those who are unbiased and those who may have different perspective are reviewing the project. The selection of an audit team depends on the size and type of the project, the stage of audit and available resources.

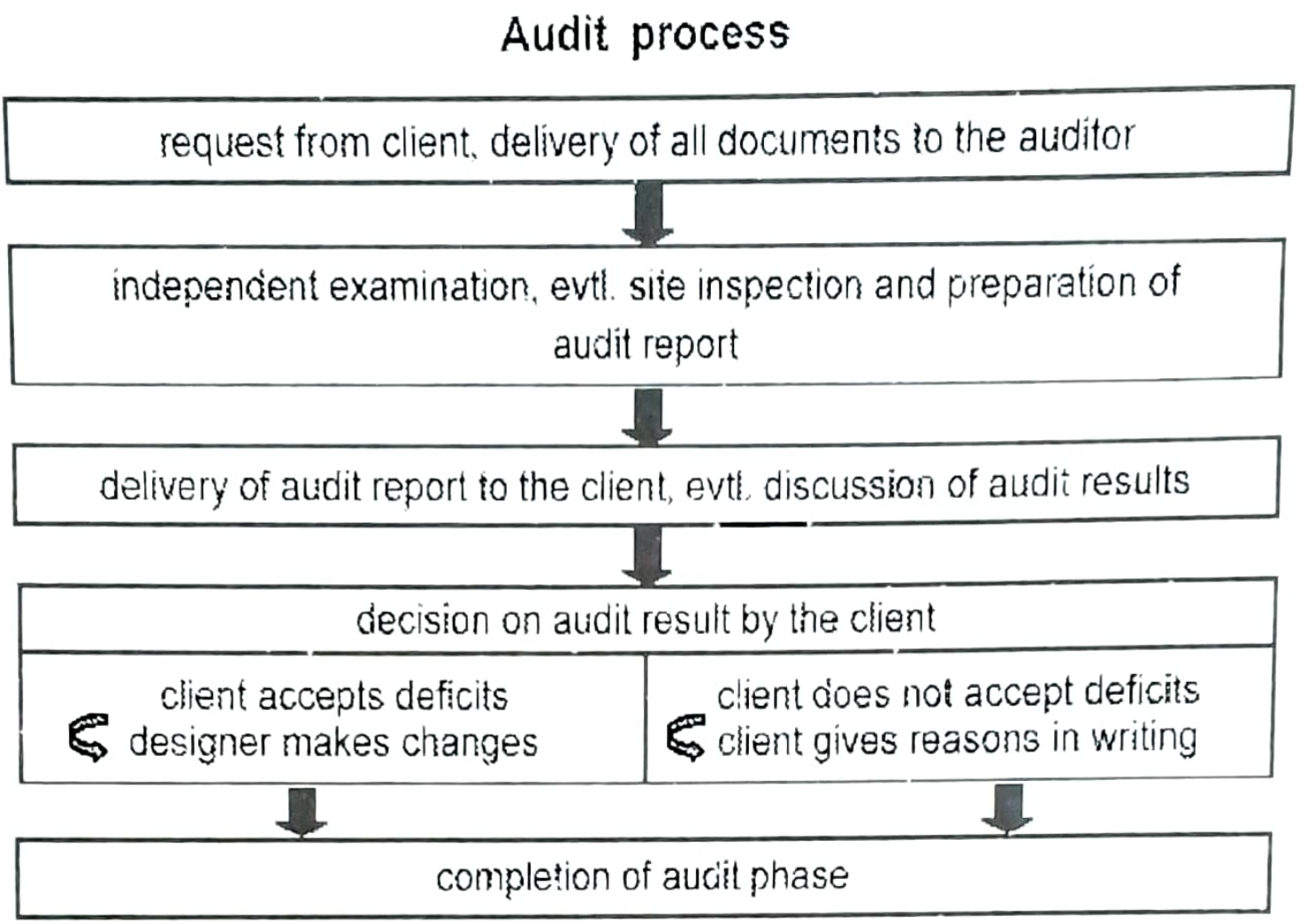

Figure 1: Safety Audit Process

In ***Germany (Koppel, 2003),*** the basic qualifications of an auditor are university education several years of road design experience or road related safety investigations, additional qualifications by training courses, recent safety know-how in design and operation. In ***Vietnam***, the auditor should have sound knowledge and experience in the field of road safety engineering, accident investigations and prevention, traffic management, road design and construction techniques and also have an understanding of road user behaviour and human perception are considered suitable to conduct road safety audit. According to ***U.K.***, audit should be undertaken by a team of people who have experience in the field of road safety engineering and accident investigation, linked to an understanding of traffic management and highway design. When necessary other fields such as enforcement and maintenance access to local knowledge also be relevant and also it should be independent of design team.

For conducting Road Safety Audit, it is difficult to find one person who is specialist in many areas. Therefore, different persons specialising in different areas are required. For example, Austroads says 2 to 4 persons are needed for large projects and one person is needed for smaller projects. Sometimes Highway authority itself can go for road safety audit, if it is a small project.

3 STAGES IN A ROAD SAFETY AUDIT

3.1 Road safety audit stages in different countries

Various stages in RSA adopted in different countries are briefly listed below.

Australia (Austroads guidelines, 2000)
There are 5 audit stages (6 stages post year 2000) as given below.
Stage 1- Feasibility Design
Stage 2 - Preliminary Design
Stage 3- Detailed Design
Stage 4a- During construction/traffic management (post 2000)
Stage 4b- Pre-opening
Stage 5- Post-opening and existing conditions
Design auditing (stage 1 to 3) requires a far great understanding of road design, traffic design, and road safety engineering than do later stages of auditing. There is also a need to be able to "visualise" future roadway conditions from design drawings.

Canada (UNB Transportation group 1999)
The following are stages of audits proposed by University of New Brunswick.
Stage1 Feasibility (planning)
Stage 2 Draft (preliminary/layout) design
Stage 3 Detailed designs
Stage 4 Pre-opening and
Stage 5 Post-opening (including existing or in-service facilities)
The complexity and level of effort of the audit process changes with each stage

USA (Institute of Transportation Engineers, Washington DC, 2000) has given the following stages.
Feasibility stage
Preliminary design stage
Detailed design stage
Construction –pre-opening stage
For existing roads

Germany (Werner Koppel, 2003)
Preliminary planning phase
Preliminary design phase
Execution design phase
Traffic authorization
Roads in use (local road safety inspection, since 1971).

After examination of different stages of RSA of different countries, different stages of safety audit are outlined below.

During Feasibility study	-	Stage 1 Audit
During Preliminary design	-	Stage 2 Audit
Completion of Detailed design	-	Stage 3 Audit
Completion of Construction	-	Stage 4 Audit
On Existing Roads (Monitoring)	-	Stage 5 Audit

3.2 Austroads Road safety audit stages

Austroads guidelines have been recognized as very easy to read document and recently described as "the definitive document on safety audit, for its messages and recommended procedures transcend hemispheres and are applicable anywhere in the developed world" (Bulpitt, 1999). So the various stages of Austroads (2000) RSA are described below.

Stage 1 Audit: During Feasibility Study

By providing a specific safety input at the feasibility stage of major schemes, particularly in urban areas, road safety audit can influence route choice, standards, impact on and continuity with the existing network, junction provision etc.

Review of initial project/planning study: Important subjects for assessment at this stage will include choice of route options, standard and cross-section, effects on existing network, number of junctions and their types etc.

Stage 2 Audit: Completion of Preliminary Design

On completion of preliminary design, to assess horizontal and vertical alignments, sight lines and layout of junctions including slip roads and lay-byes. After this stage, land acquisition and other associated legal matters become finalized.

Stage 3 Audit: Completion of Detailed Design

This audit occurs on completion of detailed design and before preparation of contract documents. Typical considerations include geometric layout, line markings, signals, lighting, signing, intersection details, clearances to roadside objects and provisions for vulnerable road users. Attention to detail at this design stage can do much to reduce the disturbances associated with last minute changes, which may otherwise be brought about with a pre opening audit. It is easier and cheaper to change some marks on a drawing than to later rebuild or rectify a road project that proves to be hazardous.

Stage 4 Audit: pre-opening stage audits

This stage is immediately prior to opening of scheme, involving the site staff and local traffic police. This should take the form of driving and when appropriate, walking or cycling the new route. This is checked during nighttime also to check signage delineation and other darkness-related issues.

Stage 5 Audit: safety reviews of existing roads

This audit aims to ensure that the safety features of a road are compatible with functional classification of the road and to identify any feature, which may develop over time into a safety concern. Regular audits of existing roads allow road safety hazards to be identified before they result in accidents.

4 MISCONCEPTIONS ABOUT ROAD SAFETY AUDIT

There has been some misuse of the term 'road safety audit' since its inception a decade ago. So the following guidelines provide advice about what a road safety audit is NOT (Morgan, Phillip Jordan, 2000).

- It is not a way of assessing or rating a project as good or poor.
- It is not a means of ranking or justifying one project against others in a works program.
- It is not a way of rating one option against another.
- It is not a check of compliance with standards.
- It is not an accident investigation.
- It is not a redesign of a project.
- It is not something to be applied only to high cost projects or only to projects involving safety problems.
- It is not the name you use to describe informal checks, inspections or consultations.

It is a commonly held view amongst engineers that complying with standards results in a safe design (Morgan, 1999). It is understandable that some practitioners think 'standards equal safety', given that they spend so much of their design time using standard values. Unfortunately this view is a fallacy, there is no single demarcation point in road design between what's 'safe' and what's 'unsafe' and it is no more true that a design which complies with all relevant standards is 'safe', than it is that a design which fails to meet a standard is necessarily 'unsafe' in the particular circumstances The achievement of appropriate levels of safety in road and traffic designs requires more than checking against standards. Rather than 'checking for compliance', we need to 'check a design's fitness for purpose' will the road or traffic treatment work safely for its expected users? This requires professional judgment by a person or people with road safety engineering skills. In short, it means a ***Road safety audit***.

5 COSTS AND BENEFITS

Audit costs were estimated to be in the range of from £ 100 to £ 6,000 (at 1993 prices) (IHT study 1995). In the UK, the 1994 value of preventing an injury accident was £55,650, so the actual cost of carrying out a relatively extensive audit is a fraction of the value of preventing a single injury accident (ETSC, 1997). In Australia, each stage of an audit of a scheme typically costs between AUS $ 1,000 to AUS $ 4,000 depending on the size of the scheme (ETSC, 1997).

According to Denmark, it is estimated that the in case of large projects cost of auditing including the time of auditors and designers amounts to nearly 1% of the construction costs. According to Vietnam, cost of auditing is estimated to be about 4 to 10% of the design cost. In U.K., benefit cost ratio has estimated 14:1, whereas New Zealand a potential benefit cost ratio of 20:1 has been estimated for consistent safety audit procedures.

Austroads recently commissioned a consultant to investigate, identify and measure the benefits achieved by road safety audit in Australia. The Austroads study has completed an international review of recent literature, which demonstrates the benefits of road safety audit. (Phillip Jordan, 2002).

A study in Great Britain that compared before and after crash statistics found that audited schemes achieved an average casualty saving per year of 1.25, compared to a saving of 0.26 for non audited schemes. Another study in Great Britain found that average savings from implementing changes at the design stage rather than after the project was constructed was approximately US$ 15,000 (Belcher, 1993). An evaluation study in Denmark, which involved a cost benefit analysis of 13 projects that had been subjected to road safety audit, gave a first year rate of return of 146%. A study in the Middle East concluded that a road safety audit would have provided a first year rate of return of 120% (Phillip Jordan, 2002).

In 1994 a study was undertaken in an English county in which two groups of matched schemes, one group having been audited and the other not, were compared (Surrey County Council, 1994). This study estimated that the audited schemes showed a saving of about 1 accident per site per year compared with the schemes, which were not audited, a saving which represents an accident cost saving per scheme well in excess of the cost of auditing the schemes.

The benefits of safety audits and safety impact assessment are in:

- Minimising the risk of accidents occurring in the future as a result of planning decisions on new transport infrastructure schemes;
- Reducing the risk of accidents occurring in the future as a result of unintended effects of the design of road schemes;
- Reducing the long-term costs associated with a planning decision or a road scheme;
- Enhancing the awareness of road safety needs among policy-makers and scheme designers.
- A better understanding and documentation of road safety engineering.

6 RECOMMENDATIONS

After thorough review of literature the following recommendations can be made to the countries where Road safety audit is in a developing stage or not yet practicing.

- In countries where Road Safety Audit is in a developing stage there is a need to examine their own procedures for the assessment of safety in road infrastructure projects to see how they can be made more effective in the light of practice in other countries.
- In countries where no formal procedure for safety audit exists, a mandatory requirement has to be introduced such that all major new road schemes are subjected to an independent safety audit.
- Formal procedures have to be extended to smaller schemes.
- Guidelines are to be prepared for use at national and local level laying down the terms of reference for safety audit including the roles and responsibilities of all concerned, with the help of experience in countries where safety audit is already practiced.
- A detailed RSA manual of good practice, which may be used in conjunction with the guidelines, is to be made essential.

7 SUMMARY

In the view of deaths and injuries as a result of road accidents virtually in all countries of the world there is an urgent need for implementation of road safety audit to minimize the fatalities due to road accidents. The purpose is to avoid the cost of any unnecessary future accident and casualty problems. At the strategic level, this entails assessment of the road safety implications of planning decisions that relate to modal choice, land use, the characteristics of city centers, transport infrastructure and services, and the interaction between public provision and private choice.

RSA can be used as powerful tool to minimize the risk of accidents on the road stretch, and to minimize the severity of accidents that do occur. By adopting a road safety audit procedure and by applying it within the design department of national, state and local authorities, RSA can start at minimum cost and with minimum disruption to existing programs. To ensure that the road safety audit process takes hold in a uniform manner, and to establish a process which is recognised formal and worthwhile, it is necessary to hold a number of road safety audit awareness/training programs at national and state level. Even the road safety audits for small cities and towns can be developed and promoted as is in use in some parts of America. Mandatory and cost-beneficial safety audit procedures programmed at well defined stages during the planning, design and construction of road schemes have to be carried out.

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