Road safety audit – what we have learnt?

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Abstract. The traffic accident problem in Malaysia is one of the most serious problems facing the nation. In the effort to reduce traffic accidents, ‘Re-Active’ initiatives, such as the ‘Accident Blackspot’ Program, ‘Pro-Active’ measures such as Road Safety Auditing and improved road design practices is implemented. In early 1997, Road Safety Audit (RSA) was started in JKR and a manual was produced as the primary guide for Road Safety Auditing by JKR and its Consultants engaged in this work. Since then, the implementation of RSA has revealed issues on poor RSA management, common repetitive mistakes by designers and the absence of warrant application. This paper discusses these issues and relates them to the study carried out. This study attempts to compare local RSA practices with other countries in finding the solutions to the above problems. It has been shown that having a policy, clear roles & responsibility and proper RSA management is vital in ensuring road safety is adequately catered for. Furthermore, frequent updating of design guidelines and building up of competency of road designers can substantially reduce the issue on quality of road design.

1. Introduction

Road Safety Audit (RSA) is an engineering technique aimed at identifying potential safety problems during planning and design of projects. RSA can identify potential safety hazards before they become accident prone locations [2]. The RSA definitions may differ from one country to another.

Road safety audit is a formal procedure for assessing accident potential and safety performance in the provision of new road schemes, and schemes for the improvements and maintenance of existing roads – United Kingdom (UK) [4].

A RSA is a formal safety performance examination of an existing or future road or intersection by an independent audit team. It qualitatively estimates and reports on potential road safety issues and identifies opportunities for improvements in safety for all road users - United State of America (USA) [4].

The definition of Road Safety Audit (RSA) in Malaysia is different from that of other countries. Road Safety Audit for a road project may be defined as the formal examination of its planning, design and construction stage and also of the characteristics and operation of an existing road, by independent and qualified examiners, to identify any potentially unsafe feature or operational arrangement that may adversely affect the safety of any road user - Malaysia [4].

The traffic accident problem in Malaysia is one of the most serious problems facing the nation. The implementation of RSA faces many challenges, amongst which are poor RSA management, common repetitive mistakes by designers and the inconsistent application and implementation of RSA. This paper
attempts to compare local RSA practices with other countries in finding viable solutions to the above problem. The countries which have been selected are due to their advanced practices in implementation of Road Safety Audit (RSA).

2. Literature review

2.1 Road Safety Audit Practices in Other Countries

2.1.1 United Kingdom. The concept of road safety audits originated in the United Kingdom during the 1980s. In 1987, the United Kingdom (UK) Department of Transport formulated strategies directed towards achieving a one-third reduction in the number of annual highway casualties by the year 2000. In 1988, the UK passed a legislation requiring all road authorities in mainland Britain to take necessary steps to reduce crashes on new roads. This requirement led to the development of two key publications: A Road Safety Code of Good Practice (Local Authorities Association, 1989) and Guidelines for the Safety Audit of Highways (Institution of Highways and Transportation, 1990, revised 1996) [2].

In 1991, the UK Department of Transport made road safety audits mandatory for all national trunk roads and freeways. It currently remains the responsibility of the individual highway organizations to determine what to audit and when, as a function of their highway programs, design procedures, and type of project [2].

2.1.2 Australia. In Australia, the National Association of Road Transport and Traffic Authorities is known as AUSTROADS. In 1994, AUSTROADS released a publication entitled, Road Safety Audit. This publication establishes a broad set of guidelines for a national road safety audit program. It includes widely adopted checklists, developed through close interaction with Transit New Zealand, which are used to ensure all areas of safety are considered when conducting a road safety audit. Individual states are incorporating road safety audits at different rates throughout Australia [2].

The state of Victoria’s road agency, Victoria Roads Corporation (VicRoads), considers the road safety audit to be an integral component of the quality management process. Road safety audits are carried out from project conception to construction completion on all projects costing in excess of A$5 million (CDN $4.8 million). Furthermore, VicRoads randomly audits 20 percent of other construction projects at one or more stages and 10 percent of maintenance work [2].

The Roads and Traffic Authority (RTA) is responsible for road safety in New South Wales. RTA published a road safety audit manual as part of the New South Wales quality management approach in 1991. Twenty percent of existing roadways within all regions are to be audited to “identify deficiencies in existing roads and identify priorities for action” (Roads and Traffic Authority, 1991). Furthermore, twenty construction projects, varying in project size and stages, are to be audited every year within each region [2].

2.1.3 New Zealand. Transit New Zealand (TNZ) is the national road agency responsible for the maintenance and improvements to the New Zealand highway network. In 1989, TNZ created an Authority whose main objective is the provision of an integrated and safe highway network. After reviewing the practices and procedures of road safety audits developed by the UK and Australia, TNZ published a document entitled, Safety Audit Policy and Procedures [2]. This publication states that all projects costing more than NZ$5 million (CDN$4.2 million) would be audited from project conception to construction completion. TNZ mandated that road safety audits would be conducted on a 20 percent sample of state highway projects, however, there are no guidelines for the identification of projects to be included in the sample [2].

2.2 Road Safety Auditor

The Road Safety Auditor must be independent, so that the design is viewed with ‘fresh eyes’. Nonetheless, good communication between the parties must be established and maintained if the audit is to be done effectively and without wasted time and effort. Further, the sensitivity associated with having design work ‘judged’ should be recognised. Auditors need to be objective in their assessments,
yet sensitive to the fact that no one likes criticism. Designers and clients need to consider audit recommendations objectively and gain from the experience [6].

2.2.1 Qualifications. Road safety audits should be conducted by an individual or team with adequate knowledge of road safety engineering principles and practices, experienced in accident investigation and recommending preventive measures, traffic engineering and road design. Consequently, members with experience in enforcement, maintenance, and human factors can be added to the team on a project by project basis and at different audit stages. Human factor expertise may, in selected areas, contribute to a road safety audit by providing an understanding of the interactive nature of user behavior with the road environment [2].

2.2.2 Experience. It is imperative that the audit team has substantial collective experience in the key areas noted in the previous section. While audit checklists serve to identify critical items/areas to be considered, they should only be considered memory aides for individuals with a wealth of experience and not an exhaustive listing of issues [2].

2.3 Problems and Issues
2.3.1 Inadequate Information About the Scheme. Sometimes the Designer does not provide sufficient information to enable the Auditors to properly understand what is to be built. This can largely be avoided by requiring Designers to provide full section drawings (vertical and horizontal alignment) and large-scale drawings of all junctions, bridges, etc., as well as an explanation of what standards have been used, and how safety issues have been addressed. Drawings of standard cross-sections and standard junction layouts are unacceptable on their own. Designers should also be encouraged to show the location of traffic signs, safety barrier and other roadside furniture [9].

Lack of appropriate information to carry out Road Safety Audit is a common issue within the questionnaire responses, highlighting the need for a clear Road Safety Audit Brief and well defined commissioning process [1].

2.3.2 Lack of Time for Auditing. The scheme preparation programed must allow sufficient time for audits to be done at the appropriate stages. The time between design completion and issue of invitations to tender is particularly critical. This is frequently too short a time to enable a proper audit and follow-up to be done [9].

There are a number of issues on details for a Road Safety Auditor dealing with some development schemes. Some of these are related to the quality of the design. As there is often pressure to complete these audits within a short period of time, the Road Safety Audit Team Leader is then faced with a choice – whether to reject the commission due to insufficient information or to work on the information provided and point out the deficiencies [1].

2.3.3 Misunderstanding of Roles and Responsibility
2.3.3.1 Road Safety Audits Is Being Used As A Design Checks and Other Informal Reviews. Deficiencies should only be identified by the audit team. It is not within an audit’s mandate for a redesign or recommendation to be made to mitigate a deficiency. This responsibility will rest with the project owners or their design staff. Auditors may suggest plausible options, but it is not their responsibility to make specific recommendations nor to promote a particular solution. The primary task should be for auditors to ‘describe the problem and what it entails’ and let the project owners/designers make the decision. Informal reviews should be a part of the normal design process, separate from the scope of services which RSA provides [2].
2.3.3.2 Road Safety Audits Is Viewed as A Check Of Compliance Design Standards. Compliance to standard alone does not guarantee a road to be safe because the standard gives minimum values which do not allow rooms for errors among drivers. Furthermore, the standard itself may out dated. [2].

3. JKR’s experiences
In early 1997, Road Safety Audit (RSA) was started in JKR and a manual was produced as the primary guide for Road Safety Auditing by JKR and its Consultants engaged in this work.

Since then, the implementation of RSA faces many challenges due to poor RSA management, such as late appointment of RSA Auditor and subsequently leading to inappropriate timing for auditing in each stage of audit. Furthermore, the appointment of the Auditor is by the consultant responsible for the design and the consultant may hesitate to expedite the appointment because the audit will be another checking process on the result of their works. From the consultant’s perspective, more checking will only result in more amendments to be done and will delay the completion of the design works. The time between design completion and tender stage is particularly critical. This is frequently too short to enable a proper audit and follow up to be done.

Moreover, there is no specific warrant to identify project criteria and type for choosing the relevant Road Safety stages involved in the project. In most cases, project managers normally assume that the requirement of all stages of RSA is mandatory for all project. As a result, over dependence on the services of Auditors by the designers occurs and this sometimes causes confusion on the roles and responsibilities between designers and Auditors.

3.1 Result of Study
A desk study was carried out on the road safety deficiencies highlighted by Road Safety Auditors involving 32 projects comprising of RSA stages 1, 2 and 3 for each project. The sampling involves equal numbers of internal and external audit reports. Furthermore, the desk study involves 13 nos. (41%) upgrading of roads and 19 nos. (59%) new roads as per figure 1 below.

![Figure 1. New and upgrading road projects](image)

Based on the observation carried out, there were 29 numbers of road safety deficiencies highlighted by road safety auditors. Road network effect, provision for road users with special needs and general geometric standards were found to be the most frequent deficiencies found in RSA Stage 1, which is 20 nos. (69%), 5 nos. (17%) and 4 nos. (14%) respectively as per figure 2.
Figure 2. Deficiencies audit item in stage 1

A closer observation on road network effect issues above found that inappropriate placement of project terminals constitutes 9 nos. (45%) of the deficiencies found in the road network effect. This is clearly shown in the figure 3.

Figure 3. Deficiencies found in the road network effect

As for RSA Stage 2, a total of 58 numbers deficiencies were highlighted in the sample reports. It was observed that issues involving horizontal and vertical alignment constitute the highest number of safety deficiencies, i.e. 37 nos. (64%). This is followed by cross-section 15 nos. (26%), interchanges and intersections 4 nos. (7%), and design criteria 2 nos. (3%) as shown in figure 4.
Based on detailed observation it was found issues involving sub-standard horizontal curves and vertical gradients constitute 28 nos. (76%) of the deficiencies found in the horizontal and vertical alignment category. This is clearly shown in figure 5.

The study has also indicated that 92 number of safety deficiencies were found in Road Safety Audit Report Stage 3 involving various issues. It was found that issues involving traffic signing and road marking are 30 nos. (33%) and road side safety provision 20 nos. (22%) contributed to 50 nos. (55%) of the total deficiencies as shown in figure 6.
Figure 6. Deficiencies Audit Item in Stage 3

Figure 7 shows that issues involving inadequate numbers of signage and inappropriate usage of road markings 15 nos. (50%) were the main concerns highlighted in auditing of signage and road markings. This is followed by inadequate detailing of barriers in auditing of road side safety provisions 13 nos. (65%) as figure 8.

Figure 7. Deficiencies Found in Traffic Signing & Road Marking
Most of the deficiencies that were found in RSA 1, 2 and 3 involved 54% in-house design and the remaining 46% those designed by Consultants. Meanwhile, 57% of the deficiencies involved new road projects.

3.2 Discussion and Recommendation

Result of the study above shows that most of the RSA Stage 1 issues involve terminals of road project. This type of safety deficiency is typical of both roads designed by in-house designers and those involving new road projects. This is possibly due to the current practice of limiting the design of the road works within the specified project limit only. This is further aggravated by inadequate transition at the interfacing of new and existing road.

The issue of substandard road curve is a common road safety deficiency especially in RSA Stage 2, as shown in figure 9. The RSA Guidelines (1997) states that a substandard road curve is a curve with a speed difference of more than 10-15km/hr from its approaches [3]. It normally occurs on the first curve after a long straight section. In addition, sometimes the horizontal curve length is also inadequate for the vehicle to maneuver the curve safely.

Meanwhile in RSA Stage 3, road safety deficiencies commonly involve issues of traffic signing and road marking and road side safety provision, as per figure 10, figure 11 and figure 12 respectively.

**Figure 8.** Deficiencies Found in Roadside Safety Provision
Figure 9. Inadequate Length Curve (Lc)

Figure 10. Inadequate Type and Traffic Signing Location

Figure 11. Inadequate Type of Road Marking
The issues on safety deficiencies which are repeatedly reported in RSA reports need to be looked into to minimize further occurrences. Hence, JKR has embarked on a policy to review the design guidelines every 5 years to ensure it is being updated to the current best practices. Furthermore, JKR has established its own training facility, known as Center of Excellence in Engineering and Technology for JKR’s staff (CREaTE) and started to introduce training modules in road design. This is part of the effort to increase the competency in road design among JKR engineers and its technical staffs.

Currently JKR has its own design verification processes, however there is a need to improvise so that issues involving design discrepancy and shortcomings are addressed early before the road safety audit processes. This is crucial because the roles and responsibility between designer and road safety auditor is often unclear. This problem also happens in other countries, where the road safety auditor is also considered as a road designer [2]. It is important to note that road safety audits are not informal design checks or inspections and do not replace the duties of a road designer. Informal reviews should be a part of the normal design process separate from the services a RSA provides.

Obviously, the implementation of RSA in Malaysia has revealed issues on poor RSA management which also occurs in other countries [9]. The practice of late appointment of RSA Auditor, leads to late execution of the audits or inappropriate timing of auditing. Recognizing this as an issue, JKR has introduced RSA as part of additional services of the Consultants. This means the appointment is carried out early during the planning phase and carried through during construction to ensure continuity. In addition, to facilitate tracking the RSA processes throughout the project duration, RSA activity is also included as a part of milestone in the project’s work program.

Besides that, the existence of an objective criteria/warrant helps to optimise the usage of resources and also avoid over dependence on road safety auditor. In other countries, criteria/warrant are used to identify those schemes or projects that should be audited to optimize the resources involved [2] and when to audit [5]. Subsequently, the absence of warrant in the existing procedure may result in poor RSA management. Therefore, the development of warrants is a necessity to improve the overall execution of RSA.

JKR has also carried out many other initiatives to improve the implementation of RSA. Among them are RSA training, an accreditation system for the selection of qualified auditors, production of Guidelines for The Safety Audit of Roads and Road Project in Malaysia and guideline on reporting. However, there is a need to improvise further especially in establishing a hierarchy ranking of safety deficiencies to enable quicker decision making, improved documentation system to facilitate traceability and retrieval of RSA decisions.
4. Conclusion
This paper has discussed the implementation of Road Safety Audit in Malaysia in comparison with other countries. Some examples of road safety deficiencies are commonly highlighted in RSA reports. Among them are; inappropriate placement of project terminals, issues involving horizontal and vertical alignment and also issues involving inadequate numbers of signages and inappropriate usage of road markings. This issue is certainly unique in Malaysia compared to other developed countries. Hence, the RSA processes should be tailored to the need of the country. To solve these issues, we need to improve the competency of our designers, improvise our design verification processes, review design guidelines and standards every 5 years to ensure it is being updated to the current best practices. In addition, poor RSA management, warrants and recommendations were also discussed.

5. References
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