IPENZ Transportation Group Technical Conference 2003

Technical Note - Safety Audits of Existing Roads Database

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Abstract

Transfund New Zealand commissioned Opus International Consultants to develop a system for recording and analysing findings from Safety Audits of Existing Roads, undertaken by Transfund within various Road Controlling Authorities. The resulting database has been used for some years to identify common safety issues found in audits and to highlight these to practitioners. The relative safety performance of different road features, RCA groups, and audits within these groups can also be compared using the database. This paper summarises the development of the database to date, the key findings from the audits recorded, and possible future initiatives.

1. Introduction

In New Zealand, formal assessment of the safety of existing road corridors has been developed largely over the past decade or so. As part of its (then) national audit and review role, Transit NZ began trialling procedures for undertaking audits of existing road networks in 1995[1], using a method developed by the (NSW) Roads and Traffic Authority as starting point. Subsequently Transfund NZ continued developing the process here, culminating in the current procedures used for *Safety Audits of Existing Roads* (SAER)[2]. To date, Transfund has undertaken 33 SAER audits within various Road Controlling Authorities (RCAs) around New Zealand.

Transfund commissioned Opus International Consultants in 1998 to develop a system for recording and analysing findings from SAER audits. The resulting database has been used for some years to identify common safety issues found in audits and to highlight these to practitioners. It has also been helpful in considering the ongoing refinement of SAER. This technical note summarises the development of the database to date, the key findings from the audits recorded, and possible future initiatives. Further details can be obtained by contacting Ian Appleton at Transfund.

2. SAER Performance Measures

For the database to provide comparative information, some performance measurement system had to be developed. The system developed[3], is an empirical measure of safety issues identified in a SAER audit. Audit items are normally ranked in a report according to a subjective "low/medium/ high/urgent" scale, depending on the relative hazard frequency and the likely crash severity. The SAER database assigns numerical *Risk Weightings* (RW) to these ratings, as described in Table 1.

Table 1: Risk Weightings to be assigned to different Audit Item Risk Levels

Risk Level	Null*	Low	Medium	High	Urgent
Risk Weighting	0.1	1	10	100	1,000

* This is used for national policy items or general items that are not under the control of the RCA

The weightings can then be combined to produce a "Total Risk Weighting" or an "Average Risk Weighting" for the entire audit. The Average RW for different hazard types can also be compared.

Another proposed measurement tool was to monitor the progress of RCAs in implementing the audit recommendations. A series of *Implementation Weightings* (IW) were developed to scale the previous RWs up or down, depending on the level of subsequent attention paid to the hazards identified. Table 2 lists the weightings used in the database. This requires a persistent programme of follow-ups later to determine RCA's progress.

Table 2: Implementation Weightings (IW) for carrying out SAER Recommendations

Category	IW
Fully implemented	0.1
Project underway	0.5
Awaiting funding/policy change	1
Not started – but agree	5
No action to date	10
Disagree with recommendation	5

In theory, the resulting safety performance measures could be used to enable an RCA to compare its performance against other RCAs, or against successive audits. Some caution is needed at the moment with the former comparison (and Transfund have certainly not used it for any formal assessment), partly because of the vagaries of the existing SAER process, the unproven nature of the weightings, and the limited number of audits completed to date. In time however, the latter

[1] Transit NZ, *Safety Audits of Existing Roads: Review of Process Development and Initial Implementation*, Report No. 95/434S, Wellington, Feb 1996.

[2] Transfund NZ, *Safety Audit Procedures for Existing Roads*, Report No. RA97/623S, Wellington, Dec 1998.

[3] E. Chadfield, *Transfund Safety Audit on Existing Roads Discussion Document: Performance Measures*, Opus International Consultants Report 5PC418.00, Palmerston North, Jun 1999 (unpublished).

comparison could allow RCAs to track their relative self-improvement, perhaps as part of a wider Safety Management System.

3. Database Development

The original SAER monitoring system was developed in a Microsoft Access 97 database. General information about each audit (e.g. location, date, auditor names, network type) was entered along with details about each key audit item listed in the report (e.g. hazard type, problem, recommended treatment, implementation to date). A reference is also provided for each item, allowing users to refer back to the original report for more information. Note that the database only includes the safety issues identified in the report as being common or significant; the individual hazards identified on each route audited (usually listed in appendices to the report) are not included.

The original database allowed for basic data entry and various reporting and graphing options. There were some concerns however about its "user-friendliness" and there was also a need to introduce some security to prevent users from corrupting the existing data. The database also suffered from inconsistencies in the terminology used for safety deficiencies and their recommended treatments (partly as a consequence of inconsistencies between reports), so a means of providing more commonly used terms for selection was also desired.

A new Access 2000 database has now been developed to store information from all the previous SAER audits. The database is in fact two linked database files; a "front-end" that holds the forms, reports and other processing tools, and a "back-end" that holds the actual data. This allows the features of the database to be updated (and tested) without affecting the actual real data. The database presents a series of simple menu screens to select tools for entering and editing audit report information and subsequently interrogating the data. Common Windows features like drop-down boxes and push-buttons have been used to provide a familiar interface for users. Various text and graphical reports can be viewed and printed, although some further functionality is still required. The new database has also been designed with some "future-proofing", to allow for the inclusion of more quantifiable information from future SAER audits (see Section 5 below).

4. Findings to Date

The 33 audits to date have encompassed RCAs including large cities to Transit NZ networks to small districts, auditing a range of urban and rural roading networks (and one motorway network). Over 570 audit items have been recorded, with items per audit ranging from 7 to 29 in number.

Table 3 summarises the ten audits to date with the highest and lowest Total Risk Weightings; in practice they also tend to be the ones with highest and lowest Average RWs.

Table 3: SAER Audits with the Highest/Lowest Total Risk Weightings

RCA	Audit Date	No. Items	Total RW	Average RW
Large North Island City	6/1996	18	1512	84.0
Urban Fringe Nth Is. District	8/1996	11	1154	104.9
Large North Island City	5/1997	17	1070	62.9
Urban/Rural Nth Is. District	6/1999	27	854	31.6
Large North Island City	4/1998	12	822	68.5
: : :	:	:	:	:
Rural North Island District	7/2002	12	84	7.0
Rural North Island District	9/2002	15	69	4.6
Urban/Rural Nth Is. District	5/2001	10	46	4.6
Rural North Island District	6/2000	10	46	4.6
Rural South Island District	6/2002	7	34	4.9

Note that it is unwise at this stage to draw any conclusions regarding the relative "safety" of different RCAs, hence only general descriptions of each RCA are given. Inspection of the list suggests that there is a bias towards larger urban areas at the top end; the earlier audits also seem to generally be ranked higher than the more recent ones. These findings may indicate methodological issues still remaining within the current SAER audit process. It may simply reflect the increased

relative risk in urban areas because of greater traffic volumes and/or a general improvement over time in the safety of all RCAs.

Audit hazards are grouped into categories as outlined in Transfund's SAER procedures, and this enables a comparison of different hazards to be made. Table 4 summarises those items that have been reported the most and least to date in SAER reports.

Table 4: Audit Item Categories with the Highest/Lowest Occurrence

Group Description	No. Items	Total RW	Average RW
3.1: Warning Signs	42	1023	24.4
10.1: Surface Condition	25	349	14.0
6.4: Poles / Objects	25	1132	45.3
8.1: Pedestrians	23	518	22.5
7.3: Intersection Control	20	335	16.8
4.5: Edge Marker Posts	20	236	11.8
: : :	:	:	:
2.4: Shoulder Slopes	2	110	55.0
10.4: Drains (maintenance)	2	20	10.0
10.5: Guard-rail (maintenance)	2	11	5.5
5.1: Overtaking Opportunities	1	10	10.0
5.2: Passing Lanes	1	0.1	0.1
1.1: Horizontal Alignment	1	0.1	0.1

While some of the most frequently featured hazards may come as no surprise, it is interesting to consider the implications of issues like horizontal alignment and passing opportunities barely rating a mention. Clearly these features have a significant impact on our crash numbers overall, yet the existing SAER process appears to be accepting that they are a "hazard of the territory" in many cases (e.g. winding mountainous environment) that are difficult to improve. This finding from the audits to date was a key catalyst to developing the current process changes, discussed below.

In comparing urban and rural networks, pedestrian facilities are easily the most significant urban safety issue identified (double that of the next item, edge line markings), with warning signs somewhat more frequent than edge marker posts at the top of the rural list. Items with the highest average RWs (i.e. the most severe problems) were hazard markings, road works, and bridges, although a number of "other items" that could not be categorised elsewhere also ranked highly.

The implementation data is the least developed within the database; to date, only 5% of audit items are listed as being "fully implemented" (another 5% had a "project underway"). However this reflects the fact that currently 60% of items have not been followed up on their status with the RCAs concerned since the original audit, and many others have not been updated subsequent to initial RCA feedback. It is hoped to undertake some further implementation follow-up in the near future with RCAs that have been previously audited.

The findings from interrogating the database have helped to identify common safety issues to raise within the industry. For example, *TranSafe* (Transfund's regular road safety newsletter) has featured articles on roadside hazards, curve warning signage, pedestrian facilities, and edge delineation.

5. Future SAER Developments

There has been increasing interest in SAER as many RCAs seek to monitor and improve safety performance. However, to date, the commissioning and funding of the audits has remained solely with Transfund. With the resources currently available it is only possible for Transfund to undertake a limited number of SAER audits each year and at the current rate it could take 15 years or more before an audit has been undertaken in every RCA. Clearly this situation is less than adequate and does not realise the full potential of this safety management tool.

Having demonstrated that SAER is a sound and workable tool that has attracted widespread support, it is reasonable now to develop the process so that the industry as a whole can "take ownership" and be responsible for applying SAER for its own benefit. However, experience over

the years has highlighted a number of issues related to the subjective nature of the process and its consistency, including:

- The adequacy of the simple "low/medium/high/urgent" ratings to accurately measure a network's safety. The weightings used in the SAER database for performance measures could also be questioned about their appropriateness.
- The consistency of safety issues identified. For example, a review of two independent SAER audits of the same RCA (within a few weeks of each other) found that only about half of the issues identified by each team were common to both parties[4]. One team also typically rated items at higher levels of risk, resulting in a five-fold difference in the SAER database risk weightings.
- The relationship between safety issues identified and the actual crash problems evident. A comparison of SAER audit ratings with LTSA crash costs found a wide variation between them in the relative danger of different road deficiencies[5].
- The effects of "exposure" on the relative ratings. This is particularly relevant when comparing the safety performance of a (say) longer high-volume road with a shorter low-volume road. Simply because of the additional traffic and road length, you would expect the former to have a greater likelihood of crashes (all other things being equal).

To date, Transfund has been able to "moderate" these effects somewhat by the teams selected, but the process should ideally be robust enough using any team of appropriately trained auditors.

In Australia, ARRB Transport Research has been developing a more objective procedure to rank the recommendations derived from SAER. This has now produced the Road Safety Risk Manager (RSRM) program[6], recently introduced in New Zealand. RSRM's methodology is based on the measurement of crash risk as a function of exposure, likelihood and severity, and provides users with the ability to calculate the relative risk of a hazard and its proposed treatment. More than 50 different types of deficiencies have been quantified to date, derived from worldwide safety research.

Following reviews of the RSRM methodology and the existing SAER process, Transfund has started to develop a less subjective SAER audit procedure[7]. The safety performance of each road section is compared against a "standard" road type, appropriate to that section. Deficiencies or improvements are identified relative to the selected standard. The resulting road "risk score" provides a measure of safety performance for that road, whilst acknowledging the underlying effects of traffic volume, terrain and road type.

The existing SAER database has been used to identify the range of deficiencies (or improvements) that may be encountered. Relative risk factors for each deficiency/improvement have then been determined on the basis of existing research literature. The emphasis has been on providing a system that does not require field data collection that is excessive or difficult to measure quickly. Field-testing has refined the process to produce a workable audit method, and it is hoped to be able to introduce the revised system (dubbed *RISA*: "Road Infrastructure Safety Assessment") in the near future. Further information about RISA is detailed elsewhere[8], or contact Transfund.

6. Acknowledgements

In presenting this technical note, the authors would like to thank Opus International Consultants Ltd and Transfund New Zealand for their support.

[4] M. Noone, *A Review of two independent Safety Audits of the Existing Road Network in Manawatu District*, Transfund Report OG/0901/4S, May 2001.

[5] C. Brodie, *Safety Audit of Existing Roads: Safety Performance Measures; Validation of Risk Rating System*, Transfund Report OG/1001/5S, Beca Carter Hollings & Ferner Ltd, Tauranga, Nov 2000.

[6] R. McInerney, *The Road Safety Risk Manager Software Tool: Background Research*, Research Report AP-R222/03, Austroads, Sydney, Mar 2003, 35pp.

[7] S. Wilkie & F. Tate, *Transfund New Zealand Safety Audit of Existing Roads: Developing a less Subjective Assessment*, Opus Central Laboratories Report 02-529562.00, Lower Hutt, Jun 2002.

[8] M. Noone & J. Hannah, *Safety Performance of Low Volume Roads: Introducing Road Infrastructure Safety Assessment*, presented at Low Volume Roads Conference, Christchurch, Jul 2003.