

The Road Safety Risk Manager: Maximising Road Trauma Reductions from Engineering Countermeasures

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Abstract

Road safety practitioners have expressed a need to have more confidence in prioritising road safety engineering treatments. These treatments can be generated through standard road safety programs, black-spot assessments, community initiation or from design and existing road safety audits.

The Road Safety Risk Manager process has been developed to provide road safety professionals with a tool to proactively assess road safety hazards and treatments for the purpose of prioritising actions. The tool adopts a risk management approach, with the ultimate aim of maximising the risk reduction on the road network for a given budget.

AUSTROADS commissioned ARRB Transport Research to develop a procedure to rank the recommendations emanating from the road safety audit of existing roads. Based on the findings of this project the risk management approach to prioritising road safety treatments was developed. The process is based on the measurement of risk as a function of exposure, likelihood and severity. Background research provides users with the ability to analyse the hazard risk and the treatment risk reduction for over 70 different types of deficiencies, across a variety of different road types and severity outcomes. Following inclusion of treatment costs, the derived risk-cost ratio forms the basis of prioritising the proposed works. During initial testing it became evident that the process could be applied to all road safety treatments and not just those emanating from road safety audits.

Current developments are focussed on the development of a user friendly computer based system that can be used by auditors, investigators, project managers and asset owners to meet their specific needs of risk identification, risk management and the development of remedial treatment programs. With a targeted approach to engineering treatments those works most likely to maximise the reduction in road trauma can be completed.

Introduction

Significant levels of expenditure are dedicated to improving the safety of our road infrastructure through engineering countermeasures. The allocation of these funds to the most appropriate sites and issues has always been a challenging task, especially where crash histories are not present. Through appropriate prioritisation of road safety countermeasures we can not only regain the momentum but maximise the reduction in road trauma achieved from available budgets.

In addition to reactive programs based on crash histories, the conduct of road safety audits by road authorities has become an important tool in pro-actively identifying the crash potential and safety performance of a planned project or an existing network. Capital expenditure is generally required to address the safety issues raised and reduce the crash potential at the site. The prioritisation of these works is an issue state and local road authorities are currently coming to terms with. To maximise the return on investment, road authorities can benefit from a systematic process that ranks potential remedial treatments identified by road safety audits.

The AUSTROADS Project was set the challenge of developing a practical and rational mechanism for prioritising works and actions arising from Road Safety Audits.

The audit process involves the assessment of the project or road section by an independent auditor with a pure focus on aspects that are detrimental to road safety. As the audit concentrates on the physical elements of the road and road environment as they relate to driver and vehicle interactions, road safety audit recommendations generally relate to physical features. In many cases, especially design audits, crash histories are not available.

Audit recommendations typically require some level of investment by the road authority. The question they face upon receiving a completed audit is which recommendation do they undertake first, or if limited funds are available for proactive treatments, which recommendations are acted upon.

The completion and formal analysis of road safety audit recommendations may also reduce the risk of potential legal implications and ensure the road authority demonstrates their required duty of care.

The Road Safety Risk Manager tool discussed herein will provide practitioners with a positive way to review the road safety performance of their road network and target interventions that contribute to a road environment that does not injure its users.

Scoping the Problem

To enable an understanding of the range of road safety issues being identified in road safety audits a range of reports were sourced from Australian and New Zealand road authorities. Over 850 recommendations were compiled to enable the 'problem' to be defined. A brief example of some typical audit recommendations is provided below to reflect the range of deficiencies and treatments identified.

- ?? 'Regrade embankments to remove vegetation and any jagged obstacles'
- ?? 'Ban parking on service road'
- ?? 'Consider sealing apron to improve turns in/out of property and minimising gravel spillage'
- ?? 'Realign left turn lane, so traffic does not block view for other motorists'
- ?? 'Construct deceleration lanes'
- ?? 'Examine pedestrian behaviour - if warranted remove median trees (sight distance) and install ramps'
- ?? 'Replace hazard marker'
- ?? 'Consider relocating rigid objects on departure side of roundabout'
- ?? 'Install edge-lines'
- ?? 'Regrade inlet and outlet channels to culverts'
- ?? 'Repaint line marking'

The challenge facing the project team was to develop a methodology that would allow the relative merits of each deficiency and related treatment to be assessed on an even basis.

Background to the Process

Given that there is a random nature to some degree in any crash, the adoption of a risk management approach to identifying and treating potential crash locations was deemed appropriate. Quantifying the level of risk particular hazards or road environments play in road crashes posed the greatest challenge. For example how do we determine the likelihood of a horizontal curve contributing to a crash? How many vehicles are exposed to the hazard? What is the probability that the curve will be a causal factor in a crash? What will be the outcome of such a crash?

To maintain a nationally consistent approach to any process many issues need to be taken into account. An important consideration throughout the project was the need to keep the process simple and quick. For the purpose of this project the aim was to limit the assessment of each recommendation to a maximum of 10 minutes each. Given the number of recommendations that often eventuate from an audit, and resource availability within the controlling road authorities it was considered a more arduous approach may not be utilised to its full potential.

The Road Safety Risk Manager

Risk management techniques and models from a wide variety of industries such as the health, defence and nuclear industries were investigated for potential solution methods. Following investigation of these methods it

was determined that the base concepts underlying risk analysis would be suitable, however significant work would be needed to provide users with appropriate guidance to making judgements on likelihood and severity.

The centrepiece of the Road Safety Risk Manager is the development of a risk score. That is a hazard will have a certain level of risk, which will be a function of:

- ?? the number of vehicles (or pedestrians etc) that are exposed to the hazard,
- ?? an assessment of the how hazardous the deficiency is,
- ?? an assessment of what other factors at the site increase the level of risk drivers are subjected to as a result of the hazard, and
- ?? the severity of a crash if it does occur.

The road authority is then interested in minimising the effects of the hazard by a range of methods including a reduction in the exposure, removing or protecting the hazard itself, or reducing the severity of the crash if it occurs. The cost of treatment is an important consideration.

The process developed provides a means of assessing the risk of the hazards (and the treatment thereof) thus providing a RISK LEVEL prior to treatment and a RISK LEVEL after treatment.

In other words, the desirable treatment for a road authority to undertake is that which will provide the greatest reduction in risk for the road users. It considers the road user exposure, the risk or likelihood of a crash and the severity of that crash. Ultimately projects are ranked from those that provide the greatest reduction in risk per dollar spent, to those where the risk reduction per dollar spent is minimal.

Exposure

In general, the annual average daily traffic (AADT) is known for the majority of roads. For mid block road sections, exposure is considered in terms of the proportion of the AADT subject to the hazard and for intersections or junctions, exposure is considered as the sum of entering flows relevant for the issue being considered.

Relative Risk

Different road types generally have different levels of risk. Crash rates for various driving environments were calculated from actual historical crash data to provide a base-line crash risk for a range of different driving environments. These included divided and undivided rural and urban roads, signalised and unsignalised 'T' and '+' roads, roundabouts and a range of other typical environments. The user is asked to identify the appropriate road environment and base-line risk for the site being investigated.

A difficult part of existing risk models, and a potential source of wide variation between different users is the assessment of likelihood or the degree to which a hazard contributes to overall risk. These models generally focus on events from a predictive methodology such as 'a one in a million chance', or a 'one in 10 million chance'. When different users are asked to assess risk from this perspective the ability to discern between what is a one in a million chance, and a one in 10 million chance can be very difficult.

To overcome this difficulty the project team developed a concept referred to as the relative risk of the hazard or deficiencies. Essentially the deficiencies are viewed relative to the safest form of that particular part of the road environment. For example:

- ?? How much more hazardous is a road with no street lighting compared to one with a high standard of lighting?
- ?? How much more hazardous is an intersection with no turn control, compared to an intersection with full control?

From the initial collection of road safety audits, deficiencies were grouped into approximately 70 different categories. An extensive literature review was then undertaken to investigate typical crash reductions achieved from interventions related to those hazards. Based on these results the relative risks for the whole range of typical issues identified in road safety audits were calculated. The user then utilises this research background to determine a suitable value of relative risk for the particular hazard and treatment being considered.

For example a road with no edge-lines is 1.20 times more likely to have a crash than a road with well maintained, appropriate edge-lines. The range of relative risk is continuous thereby allowing the user to assess the appropriate relative risk at the site. That is, if the edge-line is badly deteriorated and is deemed to be 40% effective an appropriate relative risk may be 1.12. In this way the user can make appropriate judgements based on the conditions at the site, with background guidance from actual research results.

To account for the influence accompanying road features may have in making a site more hazardous, the user is also required to make judgements on the relative risk posed by other road environment features at the site. For example a lack of edge lines may not be as likely to contribute to a crash occurrence where there are wide lanes, good shoulders, and a wide clear zone. Influencing factors generally remain the same for the before and after treatment scenarios however they influence the magnitude of the 'risk score'.

Severity

The severity of a particular crash is also included in the analysis. While one project may reduce the risk of a crash significantly, the crash type may be a rear-end or relatively low severity crash. Another project may only slightly reduce the risk of a crash but the crash type is quite severe, such as a roll-over or head-on crash. Considering the likely crash types associated with a deficiency (and clear zone condition if relevant) these influences can be taken into account. Relative severity values have been estimated for the various crash types based on crash cost valuations.

Risk Score

With the exposure to the hazard determined, relative risk of the deficiency and likely severity of a crash estimated, a risk score for the hazard or deficiency can be determined.

This risk score is the product of the exposure, the base-line risk for the road being considered, the relative risk (of the hazard and influencing factors) and the severity. With the risk score of the hazard determined, a reassessment of the site following any planned treatment can be undertaken. This provides both a risk score before treatment and a risk score after. The magnitude of the risk score provides the assessor with an indication of how hazardous the site is. The risk reduction or difference between the risk score before, and the risk score after, provides the value of the project in terms of reduced risk.

Over the life of the treatment, the total discounted risk reduction, which when divided by the discounted cost of the treatment provides an indicator of the number of units of risk reduction per dollar spent. The projects can then be prioritised from the maximum reduction in risk per dollar spent, through to those projects where the reduction in risk per dollar spent is minimal. This program can then be implemented to ensure the potential for crash reduction across the network is maximised given the available budget.

The Ranking Procedure in Use

Following completion of the research and development of the ranking procedure, ARRB Transport Research developed an interim computer package to assist testing of the procedure.

Main Roads Western Australia, supported the trial through evaluation of their blackspot / road safety audit submissions for 2000. The results of this assessment were encouraging, and have provided a means to evaluate the project worth of many proposals that previously have been subject to solely 'engineering judgement'. Subsequent reviews and trials in other locations has also confirmed the potential value of the Road Safety Risk Manager.

An example of the summary outputs from initial assessments is shown below. An important consideration throughout the use of the process is that a number of judgments have been made by the users, and many assumptions are utilised within the process. The process also assumes that the treatments selected are appropriate and suitable for the location and problem identified. With this knowledge the ranked list can provide a useful basis on which to prompt discussion of economic, qualitative and political aspects that may influence the importance and or need for a project, and ultimately lead to a well planned works program that will maximise positive road safety outcomes.

Table 1

**Data Sorted by Risk Cost Ratio
(Edited Sample Only)**

Nominee	Road Name	Proposed Treatment	Initial Cost	RISK COST RATIO
Geraldton	Bayly Street and George Road	Install roundabout	\$60,000	3.99
Geraldton	Place Road / Flores Road	Channelise better with LT lanes introduced	\$5,000	3.09
Perth	Adelaide Terrace / Bennett Street	Install larger aspects and improve intersection delineation	\$3,100	2.68
Geraldton	Flores Road / Webberton Road	Install right turn lanes - imp channelisation / lane definition	\$10,000	1.63
Mandurah	Pinjarra Road / Anstruther Road	Skid resistant surfacing	\$12,000	1.29
Busselton	Tuart Drive Layman / Wonnerup South Road	Offset I/S and channelise / islands, Imp Sight distance, (Construct RT lane for Tuart RT Layman)	\$18,000	1.27
Roebourne	Balmoral Road / Warambie Road	Install roundabout	\$70,000	0.74

Where to From Here

Following feedback received during the 18 month trial of the process, development of a fully user friendly software application is nearing completion. This software package is currently undergoing Beta testing and is expected to be available for wider release early in 2002.

The refinement and improvement of the Road Safety Risk Manager will be an ongoing process. Introducing the concept of relative risk, and risk assessment will encourage a new way of tackling road safety issues, and help us to understand the risk profile of driving on a road network. The project, while initially designed around existing road audits, has applications across the full range of audits (design etc.) and more widely in consideration of any project or mass-action program with safety implications.

As demonstrated in the Main Roads Western Australia testing, the process has great potential to enable road asset managers to better identify locations of high risk, and where treatments will provide the greater return on investment. In this way we can expand on the extensive work of road asset managers to improve the safety performance of their road networks and ensure that the maximum momentum to reduce road trauma is gained from the investment in road infrastructure.

More information on the Road Safety Risk Manager, or details regarding release of the software can be obtained from rsm@arrb.com.au.

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