THE ROAD SAFETY RISK MANAGER SOFTWARE TOOL: BACKGROUND RESEARCH
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The Road Safety Risk Manager Software Tool: Background Research
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AUSTROADS PROFILE

Austroads is the association of Australian and New Zealand road transport and traffic authorities whose purpose is to contribute to the achievement of improved Australian and New Zealand transport related outcomes by:

♦ developing and promoting best practice for the safe and effective management and use of the road system
♦ providing professional support and advice to member organisations and national and international bodies
♦ acting as a common vehicle for national and international action
♦ fulfilling the role of the Australian Transport Council’s Road Modal Group
♦ undertaking performance assessment and development of Australian and New Zealand standards
♦ developing and managing the National Strategic Research Program for roads and their use.

Within this ambit, Austroads aims to provide strategic direction for the integrated development, management and operation of the Australian and New Zealand road system — through the promotion of national uniformity and harmony, elimination of unnecessary duplication, and the identification and application of world best practice.

AUSTROADS MEMBERSHIP

Austroads membership comprises the six State and two Territory road transport and traffic authorities and the Commonwealth Department of Transport and Regional Services in Australia, the Australian Local Government Association and Transit New Zealand. It is governed by a council consisting of the chief executive officer (or an alternative senior executive officer) of each of its eleven member organisations:

♦ Roads and Traffic Authority New South Wales
♦ Roads Corporation Victoria
♦ Department of Main Roads Queensland
♦ Main Roads Western Australia
♦ Transport South Australia
♦ Department of Infrastructure, Energy and Resources Tasmania
♦ Department of Infrastructure, Planning and Environment Northern Territory
♦ Department of Urban Services Australian Capital Territory
♦ Commonwealth Department of Transport and Regional Services
♦ Australian Local Government Association
♦ Transit New Zealand

The success of Austroads is derived from the synergies of interest and participation of member organisations and others in the road industry.
Executive Summary

Managing road safety risk is now, more than ever, a critical function of road asset owners. The ARRB Transport Research and Austroads developed Road Safety Risk Manager will provide authorities with a powerful tool to manage, prioritise and track the status of road safety issues on their networks.

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, road safety audits at the design stage or for reviews on existing road sections.

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. The primary outcome of the research is the Road Safety Risk Manager software1.

In 1998 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, and provides users with the ability to analyse the hazard risk and the treatment risk reduction for 57 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.

To facilitate a trial of the process a spreadsheet based prototype was developed and provided to Australian and New Zealand road authorities. This early version of the software provided a quick and simple means of applying the methodology to a particular road safety hazard or treatment. This version was trialed for a period of 18 months to ensure the risk based approach was appropriate for the issues being considered. Feedback from these trials was incorporated into the methodology and the comments on the prototype software used to form the basis of the functional specification for the Road Safety Risk Manager software.

The current software provides a user friendly computer based system that can be used by auditors, investigators, project managers and asset owners. After appropriate training and site information, the tool allows the assessment of individual hazards and treatments in under 10 minutes. With reporting and budget analysis tools the software can meet the specific needs of risk identification, risk management and the development of remedial treatment programs. Exporting and importing functions also allow the development of local area programs at the regional level, which can be easily incorporated into a state-wide or federal program such as the ‘black-spot’ initiatives. This allows the comparison and prioritisation of actions in a consistent manner across the program, providing a targeted approach to funding those engineering treatments most likely to maximise the reduction in road trauma.

This report provides details of the research undertaken, the method developed and an introduction to the final product of the research – the Road Safety Risk Manager.

The Road Safety Risk Manager represents a new and innovative approach to prioritising a wide range of road safety treatments. As road safety practitioners gain a better understanding of the road safety problem from a risk perspective, the models and methods within the Road Safety Risk Manager can be constantly improved over time.

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1 For further information on the Road Safety Risk Manager contact ARRB Transport Research at rsrm@arrb.com.au.
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1 INTRODUCTION

Significant levels of expenditure are dedicated to improving the safety of road infrastructure using engineering countermeasures. The allocation of these funds to the most appropriate sites and issues has always been a challenge for road authorities. Austroads originally commissioned ARRB Transport Research to investigate and develop a method to prioritise the findings emanating from road safety audits on existing roads. Following development of the method it was found it could be applied to all audit types and non-audit road safety investigations. The final output of this research and development was the Road Safety Risk Manager software.

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 important issue for State and Local road authorities to address. To maximise the return on investment, road authorities can benefit from a systematic process that ranks potential road safety remedial treatments.

Road safety audits involve the assessment of a project or road section by an independent auditor with a 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 there will be no history of crashes.

Implementing audit recommendations typically requires some level of investment by the road authority. The question they face upon receiving a completed audit is which recommendation should be implemented first, or if limited funds are available for pro-active treatments, which recommendations should be included in the implementation program.

The treatment of a non-audit related safety project is often related to crash history at a site. For many sites the total crash numbers are quantified and an expected reduction in crashes as a result of a treatment estimated. Relying on crash records however limits the ability of an authority to proactively address sites that may still have a high crash potential.

In the completion of mass action programs (e.g., guard rail), the road authority will often need to prioritise between different sites and circumstances without a crash history to guide them.

The Road Safety Risk Manager tool will provide practitioners with a positive way to review the road safety performance of their road network and target interventions that contribute towards a safer road environment.
2 PROJECT BACKGROUND

The aim of the initial Austroads project (N.RS.9707/RS.SS.C.007) was to develop a practical and rational mechanism for prioritising (ranking) works and actions arising from existing road safety audits that accounted for crash risk, crash severities, potential benefits and costs. Road safety treatments on existing road networks have generally used crash histories as a means to prioritise sites, identify deficiencies and determine suitable treatments. With road safety audits representing a proactive approach to the treatment of sites, prior to crashes occurring, a different approach to evaluating the projects benefits, and prioritising projects was required.

2.1 Research Undertaken

Given the factors that influence a crash and crash outcome, how can the relative benefits of one treatment over the other be assessed? In researching an answer to this question, and developing the Road Safety Risk Manager the following tasks were undertaken:

- A review of current methods for prioritising works resulting from road safety audits within Australia and New Zealand.

- A review of road safety audit literature from around the world. Consideration of the risk management approaches utilised in non-road industries such as health, defence and nuclear power generation.

- The analysis of completed audits from around Australasia to determine the range of deficiencies identified in the road safety audit process.

- Investigation and analysis of the various methods and approaches to estimating risk, based on the range of deficiencies identified.

- Development and testing of a theoretical framework for prioritising works.

- Completion of two workshops with Australasian road safety experts to refine and confirm the theoretical process developed.

- An extensive literature review of road safety related crash countermeasures and their effect on crash reductions. This information was used to develop the risk profile for each deficiency type.

- Investigation of state and national crash rates and valuations of crash costs to enable an appreciation of base-line crash risk and typical crash severity.

- Finalisation of the theoretical process, and calibration of the models developed.

- Development of a spreadsheet based computer program to enable a trial of the developed process by Australasian road authorities. The 18-month trial included aspects of training, program analysis and theoretical review.

- A detailed review following completion of the trial to determine any aspects requiring further attention, or additional research required.

- Development of the final Road Safety Risk Manager software which included user testing through the development phase, and comprehensive testing of the pre-release version of the software.

- Development and completion of a training program to accompany the software distribution.
2.2 The key challenges

The concept of risk analysis within the road safety arena is not new. A number of models have considered a measure of exposure, probability and severity (e.g. Schnerring 1998; Viner and English, 1995). Models of risk assessment are also common in the occupational health and safety environment and defence industries.

The assessment of risk within these models is generally based on subjective judgements. Whether a particular event (generally defined as a loss of control of damaging energy) is almost certain through to highly unlikely to occur, whether the exposure is continuous or frequent through to very rare, and whether or not the consequences are catastrophic through to minor. Some examples of the typical definitions used are provided below.

**Exposure or Probability**
- Very rare, rare, infrequent, occasional, frequent, continuous;
- Rare, unlikely, moderate, likely, almost certain;
- Practically impossible, conceivable, remotely possible, unusual but possible, quite possible, almost certain.
- one in a million, remote, unexpected, likely, probable, imminent, certain; and
- As a Probability ➔ 0.000001, 0.00001, 0.0001, 0.001, 0.01, 0.1, 1

**Degree of hazard or severity**
- insignificant, minor, moderate, major, catastrophic;
- noticeable, important, serious, disaster, catastrophe; and
- monetary values.

Although these models allow an assessment of risk to be made the framework described above can leave wide scope for variations in assessments by different people. The wide range of road safety hazards also make it difficult to maintain relativity between different risk assessments. The concept of a one in one thousand event versus a one in a million event is difficult to use from a road safety perspective. Equally so, considering the hazard in relation to a bus may be viewed as more severe than in relation to a single occupant in a standard vehicle. For this reason the procedure developed needed to ensure that there would be consistency in interpretation and implementation between different users, different hazards and different locations. This required an understanding of the causal factors of crashes.

Given that there is a random nature in any crash recognising the risk of any particular hazard is complex. For example consider a horizontal curve and the potential risk elements:
- How is the likelihood of a horizontal curve contributing to a crash determined?
- 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?
Cherry and Fishburn (1996) suggest the need for care when assessing a project as an individual.

“You do NOT represent the average road user. Always resist making judgements based on a sample of one (you)!”

An important consideration throughout the development of the ranking procedure was the need to keep the process simple and quick. For the purpose of this project the aim was to limit the time required for the assessment of each recommendation to a maximum of 10 minutes. Given the number of recommendations that often eventuate from an audit, and resource availability within the controlling road authorities it was considered a more rigorous approach may not be practical or useful.

A further challenge was to restrict the data needs of the procedure to those variables readily available to road authorities. Extensive data requirements would limit the applicability of the process in practice, and therefore its usefulness to road safety professionals.
3 DEFINING THE PROBLEM

To enable an understanding of the range of road safety issues being identified in road safety audits and road safety programs a range of reports were sourced from Australian and New Zealand road authorities. Over 850 identified hazards and proposed recommendations were compiled to enable the ‘problem’ to be defined. Examples of typical recommendations are provided below to reflect the range of deficiencies and treatments identified.

- Install roundabout
- Re grade 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
- Install street lighting
- Consider relocating rigid objects on departure side of roundabout
- Install edgelines
- Re grade inlet and outlet channels to culverts
- Repaint linemarking

The deficiencies were then grouped into common issue types, with 57 different categories identified. The challenge of the research was to develop a method that would allow the relative merits of each issue type to be assessed on an equitable basis. The Road Safety Risk Manager is the result of that research.
4 THE ROAD SAFETY RISK MANAGER PROCESS

The Road Safety Risk Manager is focused on a risk management approach to identifying the value of a project. The process introduces the concept of a risk score, which is a function of exposure, likelihood and severity. The individual components are:

**Exposure**
- the number of vehicles that are exposed to the hazard,

**Likelihood**
- an assessment of how hazardous the road / location is,
- 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

**Severity**
- the severity of a crash if it does occur.

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

The process developed provides a means of assessing the risk of the hazards before and after treatment thus providing a RISK SCORE prior to treatment and a RISK SCORE after treatment.

In essence, the desirable treatment for a road authority to undertake is that which will provide the greatest reduction in risk for each dollar spent. 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.

4.1 Exposure

The exposure to a hazard is measured by the number of vehicles that pass the hazard, or those that may be affected by the hazard. The assessment of exposure needed to use a readily available measure that accounted for the following issues:

- The AADT (annual average daily traffic) on a road is generally available or a reasonable estimation can be made.
- Individual volumes making certain movements are not readily available. Turning volumes at intersections are generally not available,
- Pedestrian volumes are not generally available,
- Cyclist volumes are not generally available,
- Hourly flows of traffic (for example peak volumes) although relevant to the consideration of a hazard are generally taken as a constant percentage of AADT.
A range of different methods to account for exposure (including non-linear relationships between AADT and
crash rate) were investigated as part of the research undertaken. The increase in accuracy of these models
was found to be limited, and with the allowance for the varying crash rates on different road environments
as part of the likelihood analysis (refer 4.2.1), a relatively simple relationship for exposure was adopted.

In summary, the exposure for mid block road sections is considered in terms of the proportion of the AADT
subject to the hazard and for intersections or junctions, exposure is considered as the proportion of the sum
of entering flows relevant for the issue being considered.

EXPOSURE = Appropriate proportion of AADT for mid-block sections
EXPOSURE = Appropriate proportion of Σ(daily entering flows) for intersections

4.2 Likelihood

Existing likelihood models are generally based on the characterisation of risk or probability of an event
expressed as a fraction, restricting the ability to maintain a consistent approach when dealing with road
safety audit recommendations.

Typical assessments relate to the likelihood of a crash occurring. For example:

| Likelihood  | Probability | Equivalent
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Certain</td>
<td>$10^0$</td>
<td>$1$</td>
</tr>
<tr>
<td>Imminent</td>
<td>$10^{-1}$</td>
<td>$0.1$</td>
</tr>
<tr>
<td>Probable</td>
<td>$10^{-2}$</td>
<td>$0.01$</td>
</tr>
<tr>
<td>Likely</td>
<td>$10^{-3}$</td>
<td>$0.001$</td>
</tr>
<tr>
<td>Unexpected</td>
<td>$10^{-4}$</td>
<td>$0.0001$</td>
</tr>
<tr>
<td>Remote</td>
<td>$10^{-5}$</td>
<td>$0.00001$</td>
</tr>
<tr>
<td>One in a million</td>
<td>$10^{-6}$</td>
<td>$0.000001$</td>
</tr>
</tbody>
</table>

For the majority of road safety hazards the probability of the hazard being responsible for a crash is likely to
be less than $10^{-6}$.

The likelihood approach adopted aims to provide assessors with a logical method of viewing the safety
performance of various road features on a scale that can be easily related to. It is easier to comprehend that a
site with a hazard is twice as dangerous as a site without that hazard, than if the risk needed to be expressed
as a two in ten million, or a one in ten million chance.

The risk model developed needed to include the provision of direct guidance on the individual risk of
hazards and treatments on the road network. The methodology developed for the Road Safety Risk Manager
includes the assessment and estimation of:

- The crash rate for different road environments;
- The relative risk of the hazard itself;
- The contribution of other road factors, that may increase the risk of the hazard being considered; and
- The length of the hazard.

More detail on each component of the relative risk analysis is discussed in the following sections.
4.2.1 General Crash 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 ‘+’ intersections, 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.

4.2.2 Relative Risk

The Road Safety Risk Manager considers the safety performance of a particular issue from a perspective of ‘relative risk’. By considering a wide range of relevant crash studies the effect of a treatment can be measured which also provides an indication of the degree of hazard or risk posed by the original problem. That is a study that finds a large significant crash reduction for a certain treatment, also indicates that the original hazard had a large negative impact on safety. The ready availability of these types of analyses made the consideration of a relative risk possible. The concept of relative risk considers the risk of a particular hazard relative to some safer form of the road feature.

The major assumption, when adopting a relative risk approach, is that the treatment selected for evaluation is appropriate. The relative risk approach is not designed for assessing whether a treatment is appropriate, but rather provides a means of ranking appropriate treatments. That is the user is interested in the change in risk as a result of completing a treatment.

The basic process undertaken in the development of the relative risk concept was as follows:

- From the 850 recommendations sourced from actual audits the deficiencies and recommended treatments were grouped into common issue types (refer Appendix A).
- For each issue type identified, an extensive review of available literature was undertaken to identify various crash reductions evident from treatments related to those issue types.
- From the review of crash reductions, a risk profile of various issues on the road network was compiled and relative risk values assigned.

The relative risk approach essentially considers the deficiencies 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?

For example, given that the installation of edge lines is found to provide an average crash reduction of 17% from a series of studies, for every 100 crashes prior to the installation of edgelines, it can be anticipated that there will be only 83 crashes following the installation of edgelines. This can then be viewed from a risk perspective and the hazard of a road without edge lines calculated by considering the following formula.

\[
\text{Hazard Relative Risk} = \frac{\text{Expected Crashes before}}{\text{Expected Crashes after}}
\]

For the example being considered \[ = \frac{100}{83} = 1.20 \]
That is a road without edge lines is 1.20 times more likely to have a crash than a road with edge lines. The relative risk approach also allows an experienced road safety professional to make judgements on the effectiveness of actual or proposed conditions. That is, if the current edge lines were assessed as being 25% effective in operation (or 75% deficient) then a relative risk value of 1.15 may be deemed appropriate. With a considerable range of in-field conditions likely to be encountered by end users, the discretion for final selection of relative risk is left with the assessor.

This process was completed for all issues where data on crash reductions were available. A risk profile for each issue type is available within the Road Safety Risk Manager, providing guidance on appropriate relative risk to be selected for individual hazard and treatment assessments. For some issues such as access control and hazards in the clear zone additional site details are required to provide an indication of relative risk.

4.2.3 Influencing Factors

To account for the influence of other road features in making a site more hazardous, the Road Safety Risk Manager process requires the user to assess the relative risk posed by other road environment features at the site. The following question was asked in relation to all deficiency types.

*Given that the deficiency is identical in two different locations, what factors would influence the choice to select one site over the other?*

This question was asked for each deficiency grouping, with a maximum of five influencing factors set to ensure the task does not become too onerous. With all influencing factors essentially derived on the same basis (the concept of relative risk), they provide a consistent approach to considering other road factors at a site. With the road section known to the auditor or the assessor, the influencing factors can be rated quickly.

Background research and expert opinion was used to determine the degree of impact each influencing factor has in relation to the hazard being considered. For example:

No edgelining may be less of an issue where there is a 3.5m sealed lane width (good skid resistance), 2.5m unsealed shoulder, and 15m clear zone, on a straight section of road. The lack of edgelining is somewhat more hazardous if it is a 2.4m lane width, 0.2 m unsealed shoulder, at the edge of which is a 8m cliff (with a premium winery at the base of the cliff!), on the back edge of a curve and the pavement has poor skid resistance.

The influencing factors and relative weightings adopted for edge-lining are:

<table>
<thead>
<tr>
<th>Influencing Factors (edge-lining)</th>
<th>Surface Condition (skid resistance)</th>
<th>Lane width</th>
<th>Shoulder width</th>
<th>Horizontal alignment</th>
<th>Weather</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>20%</td>
<td>20%</td>
<td>20%</td>
<td>30%</td>
<td>10%</td>
</tr>
</tbody>
</table>

A similar approach has been adopted for all the primary issues investigated, with the influencing factor analysis incorporated as part of the hazard and treatment assessment in the Road Safety Risk Manager.
4.3 Severity

To complete the assessment of risk a judgement on the severity of crashes related to a certain hazard or treatment is required. 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 severe outcome, 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.

The severity calculation includes consideration of crash types, in either built-up or open road environments. Where a hazard is likely to contribute to a vehicle leaving the road, a further assessment of the clear zone conditions and likely impact on severity is required. When assessing a hazard within the clear zone the type of hazard (e.g., tree, bridge wall, guard rail, frangible post) is also considered from a severity perspective. Research into the severity implications of these issues is incorporated into the Road Safety Risk Manager to provide guidance on appropriate values.

4.4 Risk Score

The 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 exposure to the hazard determined, relative risk of the hazard and likely severity of a crash estimated, a risk score for the hazard or deficiency is available. A reassessment of the site based on the expected conditions following any planned treatment can then be undertaken. With the hazard risk score and the proposed treatment risk score calculated, the expected annual risk reduction is as follows:

\[
\text{Risk Reduction / year} = \text{Risk Score}_{\text{before}} - \text{Risk Score}_{\text{after}}.
\]

With the change in risk calculated the treatment cost and life are considered.

4.5 Treatment Life and Cost

The assessment of the treatment cost includes an estimation of the initial costs of the project including design and construction costs, the likely impact on maintenance costs on an annual basis, and any salvage value that the project may have at the end of the treatment life.

The treatment life reflects the expected period of time over which the treatment will remain effective. The life of the treatment is an important consideration when assessing the value of a proposed project.
4.6 Risk Cost Ratio

The primary output of the Road Safety Risk Manager is the Risk Cost Ratio, which forms the basis of the prioritisation process. That is projects are ranked from the highest risk cost ratio (or highest value project) to the lowest risk cost ratio (or lowest value project), where:

\[
\text{Risk Cost Ratio} = \frac{\text{Discounted Risk Reduction}}{\text{Discounted Costs}}
\]

The value can be expressed as "units of risk reduction per dollar spent".
5 THE ROAD SAFETY RISK MANAGER SOFTWARE

Following completion of the research and development of the prioritisation process, ARRB Transport Research developed a simple base-level computer package to assist road authorities to test the procedure over an 18 month period.

The in-field testing of the Road Safety Risk Manager occurred to varying degrees within each transport authority. All locations investigated the process, with some authorities undertaking detailed trials of actual audits and road safety investigations. Transfund New Zealand commissioned a detailed review of the process theory and software requirements, with Main Roads Western Australia actively supporting the trial through evaluation of their blackspot / road safety audit submissions for 2000 and 2001. The appropriateness of the underlying theory behind the Road Safety Risk Manager was confirmed during these reviews where the process was found “to be intuitively sound”, and a “significant advancement on previous subjective ranking methods”. The procedure was seen to have potential in providing “uniformity in the ranking of improvements” and uses in the ranking of “detailed safety audits, minor safety improvement projects, crash reduction studies, etc” (Brodie & Koorey, 2000).

Following completion of the trials, feedback was investigated and additional research was undertaken to refine the approach, or investigate the risk profile for issues that had not been addressed in the first version. A key finding from the trial process was the need for a detailed and comprehensive software application to facilitate the process and ensure a high level of user support and guidance through the assessment process. The comments received during this process formed the basis of the functional capabilities available in the Road Safety Risk Manager.

The following sections provide an introduction to the Road Safety Risk Manager software and the key functions available.

5.1 The Main Menu

The main menu of the Road Safety Risk Manager provides users with access to all the key elements of the software.

- User Manual: The software has been developed with an in-built user manual and help system
- New Investigation: When commencing an investigation a wizard helps the user record key information about the study being completed, and commence assessment of hazards or treatments related to that study.
- Add or analyse previous: The user can review or edit investigations, hazard and treatment assessments conducted previously.
- Report Options: A series of standard reports are available to users including the ability to rank the assessments undertaken.
- Import and Export: The import and export function allows the transfer of studies and assessments from one user to another. This is particularly relevant when compiling a state-wide or national program from a number of different assessors.
5.2 Investigation Details

A wizard steps the user through the entry of key background information about the site being investigated. Information includes details on the client, study area, road names and traffic volumes, the type of investigation being completed, the date of the investigation, the investigation team, project reference details and other information relevant to the study. Sample screens are detailed below.
5.3 Hazard Assessment

Following entry of the background details of the study, the individual hazards can be assessed. A wizard steps the user through the process from determination of the exposure at the site, the likelihood assessment including detailed assistance and provision of guidance on risk values for the various issues being investigated, analysis of the severity of a crash if it does occur, and calculation of the hazard risk score. Sample screens are detailed below.
The Road Safety Risk Manager Software Tool: Background Research

Figure 5: Hazard Wizard 3 of 7 – The general crash risk at the site

Figure 6: From Hazard Wizard 4 of 7 – Example of relative risk assessment
Figure 7: Hazard Wizard 5 of 7 – Assessment of other factors at the site. (Weather details are provided for all locations in Australia and New Zealand)

Figure 8: Hazard Wizard 6 of 7 – Determination of relative severity
5.4 Treatment Assessment

With the Hazard Risk Score assessed, the user can then reassess the risk of the site based on the conditions that will exist after the treatment has been implemented using the treatment wizard. The process is similar to the hazard assessment considering the expected treatment exposure, treatment likelihood and treatment severity. Sample screens are detailed below.
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Figure 11: Treatment Wizard 1 of 8 – Describing the proposed treatment

Figure 12: Treatment Wizard 7 of 8 - Summary of details and calculation of treatment risk score
5.5 Hazard and Treatment Summary

Following the assessment of the hazard and treatment, a summary of all values is provided on the Individual Hazard and Treatment summary form. The user can then easily review all assumptions, valuations and judgements made as part of the assessment. Access to the summary form for any hazard or treatment assessed is possible from the “Add or analyse previous” button on the main menu.

The user is also provided with the opportunity to track the status of a particular hazard and provide updates as to works planned or completed and the date of any action taken. This allows an authority to manage any outstanding safety issues and provide regular summary reports on the status and priority of defects on their network.
5.6 Reporting and Ranking

A number of standard functions are provided to allow users to prioritise and sort records as required. A series of standard reports have been designed that are suitable for detailed technical review, funding submissions, summary reports or management overview of the status of outstanding issues. Budget analysis tools are also provided to allow users to assess the impact sub-optimal project orders will have on the risk reduction achievable for a given budget. Example reports are provided on the following pages.
Reporting and Ranking (continued)

Figure 15: Individual Hazard and Treatment Report
Reporting and Ranking (continued)

Figure 16: Executive Summary Report detailing project priority and status

Figure 17: Budget Analysis Chart
6 CONCLUSIONS

The Road Safety Risk Manager represents a new and innovative approach to prioritising a wide range of road safety treatments. As road safety practitioners gain a better understanding of the road safety problem from a risk perspective, the models and methods within the Road Safety Risk Manager can be constantly improved over time.

Introducing the concepts of relative risk and risk assessment will encourage a new way of tackling road safety issues, and help in understanding the risk profile for road users on a road network. The project, while initially designed for existing road audits, has applications across the full range of audits (design etc.) and more widely in consideration of any project with safety implications.

The process has great potential to enable road asset managers to better identify locations of high risk where treatments will provide the greater returns. This will help focus the work of road asset managers to improve safety and ensure that the maximum reduction in road trauma is achieved from the investment in road infrastructure.

Formal analysis of road safety hazards and potential treatments may also reduce the risk of potential legal implications resulting from a proactive identification of hazards and ensure the road authority demonstrates their required duty of care.

The Road Safety Risk Manager\(^1\) provides a tool to assist decision making and a common basis for road safety treatment prioritisation. The challenge will be to expand knowledge of risk on the road network, refine the models within the process and continually improve the safety performance of road networks.

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\(^1\) The Road Safety Risk Manager is distributed by ARRB Transport Research. Further details on the software can be obtained from the ARRB Transport Research, Melbourne office or via e-mail at rsrm@arrb.com.au.
7 REFERENCES


APPENDIX A

The *Road Safety Risk Manager* provides guidance on the relative risk of 57 different road safety issues that may be encountered on the road network. They are:

- Access Control
- Access Points: individual accesses
- Bridge Width
- Clear Zone (roadside objects)
- Cycling Issues: Intersection
- Cycling Issues: Mid-Block
- Delineation: Combination of treatments
- Delineation: Chevrons
- Delineation: Guideposts
- Delineation: RRPM's Intersection
- Delineation: RRPM's Mid-block
- Horizontal Alignment (curve radius)
- Intersection: Advance Warning
- Intersection: Left Turn Provision
- Intersection: Linked signals
- Intersection: Red Light Cameras
- Intersection: Right turn phase/lane
- Intersection: Signal Timing
- Intersection: Signal Visibility
- Intersection: Y junction [Open]
- Lane Width
- Line Marking: Centreline
- Line Marking: Edgeline / lane line
- Line Marking: Profile or Raised edge line
- Line Marking: Transverse Lines stop etc.
- Line Marking: Words and Symbols
- Mid-block Turning Provision
- Overtaking Opportunities [Open]
- Parking
- Parking [Minor Streets]
- Pedestrian Issues: Intersection
- Pedestrian Issues: Mid-block
- Railway Crossing
Issues addressed by the *Road Safety Risk Manager* - (continued)

- Road Condition: Edge Breaks
- Road Condition: Roughness [Divided Road]
- Road Condition: Roughness [Undivided Road]
- Road Section Type
- Shoulder Width
- Shoulder: Textured Surface
- Sight Distance: Intersection
- Sight Distance: Mid-block
- Signs - Advisory: Curves
- Signs - Advisory: Intersection [Built-up]
- Signs - Advisory: Intersection [Open]
- Signs - Advisory: midblk(non-curve) [Built-up]
- Signs - Advisory: midblk(non-curve) [Open]
- Signs - Regulatory: Intersection
- Signs - Regulatory: Mid-block
- Skid Resistance (surface): Intersection
- Skid Resistance (surface): Mid-Block
- Speed Limit/Environment
- Street Lighting: Intersections
- Street Lighting: Mid-block
- Super-Elevation (camber)
- Traffic Calming
- Vertical Grade
- Work Zones

Guidance is also provided on the relative risk of issues that influence the safety performance of a site. They are:

- Intersecting Road Type
- Intersection Type
- Pedestrian Type
- Terrain
- Weather
INFORMATION RETRIEVAL

Austroads (2003), The Road Safety Risk Manager Software Tool: Background Research, Sydney, A4, 35pp, AP-R222/03

KEYWORDS:
road safety, risk management, prioritise, rank, crash countermeasure, software, track, hazard, treatment, evaluation

ABSTRACT:
Managing road safety risk is now, more than ever, a critical function of road asset owners. The ARRB Transport Research and Austroads developed Road Safety Risk Manager will provide authorities with a powerful tool to manage, prioritise and track the status of road safety issues on their networks.

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, road safety audits at the design stage or for reviews on existing road sections.

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. The primary outcome of the research is the Road Safety Risk Manager software.

1 For further information on the Road Safety Risk Manager contact ARRB Transport Research at rsrm@arrb.com.au.
Austroads publishes a large number of guides and reports. Some of its publications are:

AP-1/89 Rural Road Design
Guide to Traffic Engineering Practice

AP-11.1/88 Arterial Road Traffic Management
AP-11.9/88 Local Area Traffic Management
AP-11.10/88 Parking
AP-11.12/88 Roadway Lighting
AP-11.13/95 Pedestrians
AP-11.14/99 Bicycles
AP-11.3/88 Traffic Signals
AP-11.11/99 Motorcycle Safety

AP-11.8/88 Traffic Control Devices
AP-12/91 Road Maintenance Practice
AP-13/91 Bridge Management Practice
AP-14/91 Guide to Bridge Construction Practice
AP-15/96 Australian Bridge Design Code
AP-17/92 Pavement Design
AP-18/00 RoadFacts 2000
AP-22/02 Austroads Pavement Strategy 2001–2004
AP-26/94 Strategy for Structures Research and Development
AP-28/02 Road Safety Audit – 2nd Edition
AP-34/95 Design Vehicles and Turning Path Templates
AP-36/95 Adoptions and Innovations in Road & Pavement Engineering
AP-38/95 Guide to Field Surveillance of Quality Assurance Contracts
AP-40/95 Strategy for Ecologically Sustainable Development
AP-41/96 Bitumen Sealing Safety Guide
AP-42/96 Benefit Cost Analysis Manual
AP-44/97 Asphalt Recycling Guide
AP-45/97 Strategy for Productivity Improvements for the Road Transport Industry
AP-46/97 Strategy for Concrete Research and Development
AP-47/97 Strategy for Road User Costs
AP-48/97 Australia at the Crossroads, Roads in the Community — A Summary
AP-49/97 Roads in the Community — Part 1: Are they doing their job?
AP-50/97 Roads in the Community — Part 2: Towards better practice
AP-51/98 Electronic Toll Collection Standards Study
AP-52/97 Strategy for Traffic Management Research and Development
AP-53/97 Strategy for Improving Asset Management Practice
AP-54/97 Austroads 1997 Bridge Conference Proceedings — Bridging the Millennia
AP-55/98 Principles for Strategic Planning
AP-56/01 Assessing Fitness to Drive — 2nd edition
AP-59/98 Cities for Tomorrow — CD
AP-60/98 Guide to Stabilisation in Roadworks
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AP-64/00 Austroads 4th Bridge Conference Proceedings — Bridges for the New Millennium
AP-65/01 Road Condition Monitoring Guidelines: Part 1 — Pavement Roughness
AP-66/02 Asphalt Guide
AP-67/02 Travel Demand Management: A Resource Book
AP-68/01 Guide to Heritage Bridge Management
AP-69/02 Urban Road Design: A Guide to the Design of Major Urban Roads
AP-69/02 Austroads Guidelines for Environmental Reporting
AP-70/02 A Guide for Traffic Engineers — Roads-Based Public Transport and High Occupancy Vehicles
AP-71/02 Telecommunications in Road Reserves: Operational Guidelines for Installations
AP-73/02 Guide to the Selection and Use of Bitumen Emulsions

These and other Austroads publications may be obtained from:
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or from road authorities, or their agent in all States and Territories; Standards New Zealand; Standards Australia & Bicycle New South Wales.