Guide to Road Safety Part 7

Road Safety Strategy and Management

Austroads

Guide to Road Safety Part 7:
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Abstract

The *Guide to Road Safety Part 7: Road Safety Strategy and Management* is intended as a guide to the process of road safety strategy development, management, evaluation and risk assessment. It outlines options for strategy development and details the value of a 'vision' in driving strategy development. It covers the stages of a strategy lifecycle, including problem analysis, countermeasure selection, target setting and safety performance indicators, development and implementation. It also details the importance of, and methods for, monitoring and evaluation.

The joint Australia and New Zealand Standard on risk management (AS/NZS ISO 31000:2018) is used as the basis and structure for an overview of risk assessment and management in the road safety network context. The issues of communication and consultation, establishing the context, identifying risks, analysing risks, evaluating risks, treating risks, and monitoring and review are discussed. Examples of risk in the road safety context are provided, including those relating to road trauma, legal risk, and risk from adverse public opinion. Case studies are provided to assist practitioners in the assessment and management of risks on their networks.

This guide also provides specific road safety management context sections for local government and regional and remote areas.

Keywords
road safety, strategy, road safety management, governance, strategic planning, target, modelling, evaluation, road safety countermeasure, cost effectiveness, performance indicators, risk assessment, risk management, local government, regional and remote areas

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About Austroads

Austroads is the peak organisation of Australasian road transport and traffic agencies.

Austroads' purpose is to support our member organisations to deliver an improved Australasian road transport network. To succeed in this task, we undertake leading-edge road and transport research which underpins our input to policy development and published guidance on the design, construction and management of the road network and its associated infrastructure.

Austroads provides a collective approach that delivers value for money, encourages shared knowledge and drives consistency for road users.

Austroads is governed by a Board consisting of senior executive representatives from each of its eleven member organisations:

- Transport for NSW
- Department of Transport Victoria
- Queensland Department of Transport and Main Roads
- Main Roads Western Australia
- Department for Infrastructure and Transport South Australia
- Department of State Growth Tasmania
- Department of Infrastructure, Planning and Logistics Northern Territory
- Transport Canberra and City Services Directorate, Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development and Communications
- Australian Local Government Association
- New Zealand Transport Agency.

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1. Introduction

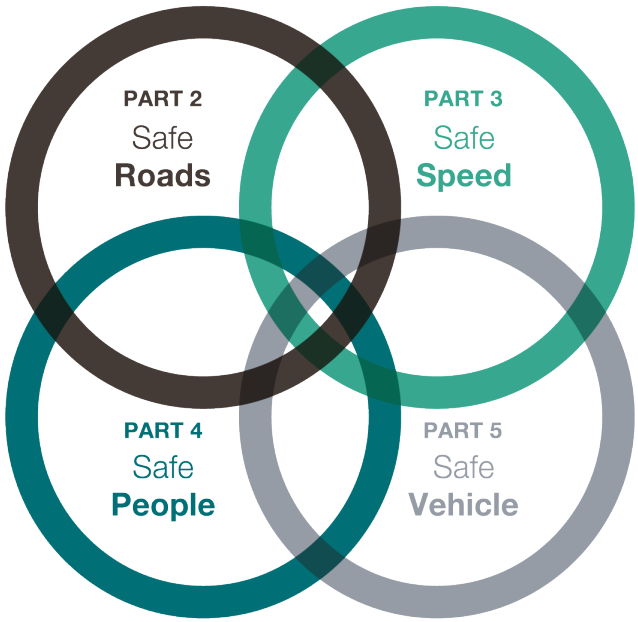
This *Guide to Road Safety* has been structured to reflect the Safe System which has been adopted by Australia and New Zealand as part of their overall road safety strategy. The Guide consists of the parts as documented in Table 1.1.

Table 1.1: Parts of the Guide to Road Safety

Part	Title	Content
Part 1	Introduction and the Safe System	An overview of the Guide to Road Safety and the Safe System philosophy.
Part 2	Safe Roads	Guidance on safe road design.
Part 3	Safe Speed	Guidance on the application of safe speeds.
Part 4	Safe People	Information on safe people and communities.
Part 5	Safe Vehicles	Information on safe vehicles and vehicle safety features.
Part 6	Managing Road Safety Audits	Guidance on the procurement, management and conduct of road safety audits.
Part 6A	Road Safety Auditing	Guides practitioners through the practical implementation of road safety audits. (Part 6 and 6A will be consolidated)
Part 7	**Road Safety Strategy and Management**	**Guidance on road safety strategies and road safety management.**

The four pillars of the Safe System are reflected in this Guide through the aforementioned structure and also through the contents of the Guide. It is noted that each pillar does not stand on its own but, rather, interlink with other pillars to form the Safe System (Figure 1.1). As such, readers of this Guide are encouraged to refer to multiple pillars when reading this Guide.

Figure 1.1: AGRS Part 2 to Part 5 interlink with each other



1.1 Purpose of the Guide

The *Guide to* Road *Safety*, in association with other key Austroads publications, provides road safety practitioners with knowledge and techniques that enable the application of Safe System principles.

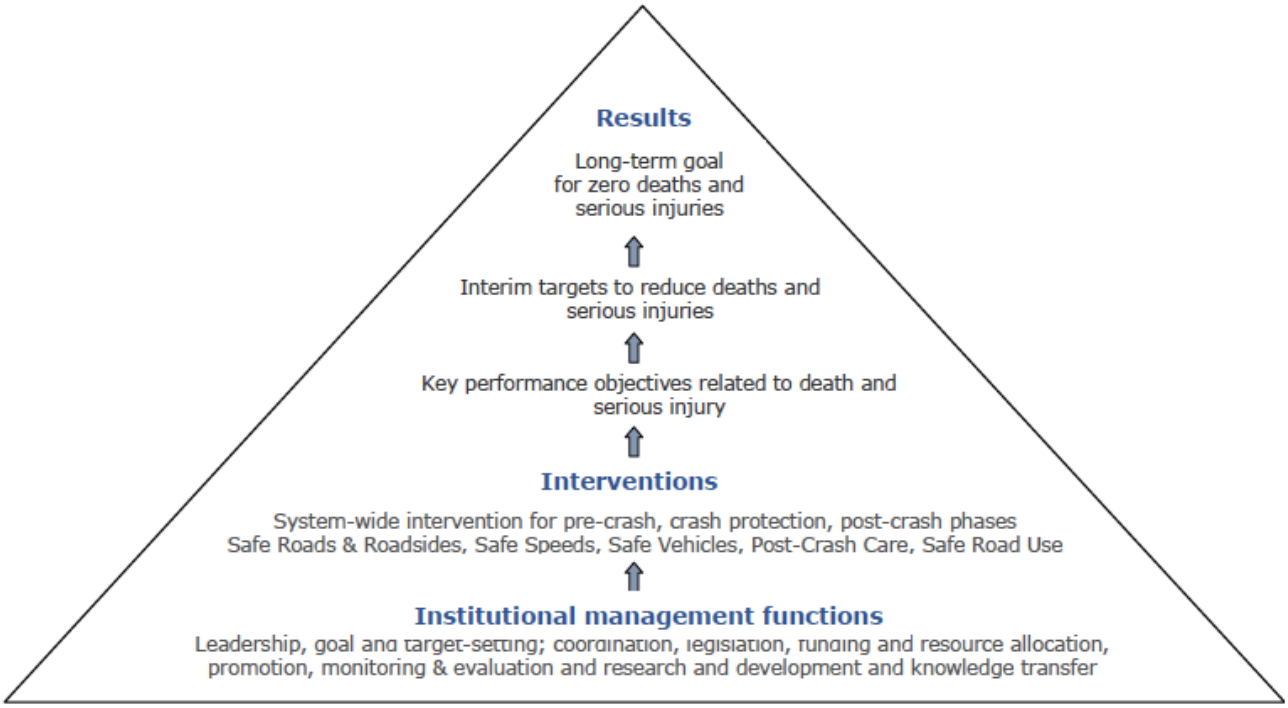
This Part of the Guide is intended as a comprehensive introduction to the road safety strategy development process, based on best practice as it is currently understood. It is aimed primarily at staff in lead agencies, including local government, and other stakeholder agencies who are new to the road safety strategy development process. More experienced staff may also find it useful as an overview of the strategy development processes they are engaged in. It draws on experience in Australia, New Zealand, and overseas. It contains sufficient guidance for an individual to contribute to strategy development at national, state, or local level. However, readers who have a major commitment to this area are encouraged to also examine some of the key texts cited in the report as this will enrich their appreciation and understanding of the issues.

1.2 Road Safety Strategies

In common with other developed countries, all jurisdictions in Australia and New Zealand have a formal road safety strategy which guides the efforts to reduce road deaths and injuries. By setting the level of ambition and priorities, these strategies provide the mandate for action on road safety.

The organisational setting in which strategy work occurs is fundamental to the process and its success. Effective strategies mobilise the organisation of effort via the safety management system. Success hinges on having the appropriate organisational structures, governance, resources, skills and relationships (Woolley et al. 2018). There must be a holistic specification of roles across agencies reflecting a single, coordinated effort. This starts with a capacity for collective attention to strategy. In this way, road safety strategy extends beyond its purpose of setting out how lives will be saved and into the realms of organisational culture and management. Safe System represents a significant change in the way in which the road safety problem is perceived and therefore managed and a significant cultural shift is required before this approach becomes normalised practice (Austroads 2018). The relationship between road safety outcomes, the state of the road system and the organisations' responsible for roads is illustrated in Figure 1.2.

Figure 1.2: Safe System results, intervention and delivery framework



Source: European Commission (2018)

This discussion is based on four terms, vision, strategy, plan and target. The meanings attached to those terms in this document are:

- Vision: 'an innovative description of the future traffic system, or a desired direction of road safety development' (Organisation for Economic Co-operation and Development 2002, p. 20).
- Strategy: a coordinated set of actions designed to achieve a specific result or set of results in a specified period.
- Plan: an expression of the strategy over a shorter period, so that the fulfilment of successive plans, modified in the light of changing circumstances and outcomes achieved or not achieved, achieves the desired result of the strategy.
- Target: an outcome expressed in quantitative terms, e.g. number of fatalities, percentage reduction in fatalities, or fatality rate per population or per distance travelled.
- Safety Performance Indicator: A quantifiable measure of a road transport system that is logically linked to a reduction in the number of fatalities and serious injuries (Swedish Transport Administration 2012).

A common first response by road practitioners to the Safe System philosophy is an overwhelming sense that it is impossible to eliminate death and injury from the road system. Due to the complexity of the road system and its interacting components, a Safe System may take several decades with multiple strategies and shorter-term action plans to accomplish (Austroads 2018b). To be fully effective, the new strategies and plans must re-assess priorities in the light of what has been achieved in the previous strategies, changes in the population, economy and traffic system in the intervening years, and new developments in knowledge and practice. To assist this process, it is important that the persons devising the strategies and action plans in Australia and New Zealand are aware of and are guided by best practice in this area.

1.3 Strategies for Different Levels of Government

Both Australia and New Zealand have national road safety strategies. In New Zealand, the national government has primary responsibility for road safety. The national road safety strategy is therefore the document which determines the pattern of road safety investment and activity. In Australia, which is a federation of states and territories rather than a unitary state, the states and territories retain primary responsibility for roads and road safety. The National Road Safety Strategy states principles and documents an agreed set of priorities, and the action plans which flow from it identify the directions for the different levels of government and their agencies in the shorter term. The state and territory strategies and related action plans spell out the specific goals and actions for each jurisdiction.

Links to the web sites for each of the Australian national and state and territory strategies, and New Zealand's national strategy, are shown in Text Box 4 of Section 6.

In both countries, road safety strategies have been developed at some local government levels. A detailed account of the particular challenges faced by local government in developing road safety strategies and sustaining effective road programs may be found in Section 18 and further information in an Austroads review of community road safety programs (Austroads 2002). New Zealand has a long tradition of decision-making in relation to roads at the local level, including decisions affecting road safety activity, and a well-developed system of road safety coordinators in local authorities. Most local authorities have developed road safety strategies or road safety action plans. In Australia, progress varies considerably from jurisdiction to jurisdiction. In some states, most local authorities now have a road safety strategy. Many of these are fully integrated into local government processes and are being actively pursued. In other states, local government programs are still in the early stages or have been taken up by fewer local governments, so that fewer local governments have action plans. As a general observation, local government has limited capacity to address road safety issues without support from Federal and State governments (Woolley et al. 2018).

Some jurisdictions include a fourth level of planning in the form of regional action plans. In New Zealand, the Regional Authorities (an intermediate level of government) develop their own road safety plans. In Queensland, the regional offices of the Department of Transport and Main Roads, Queensland develop regional plans which adapt the state strategy to fit regional circumstances.

1.4 Character and Benefits of a Road Safety Strategy

The strategies now being developed locally and internationally represent the latest evolution in road safety thinking as a means to further improve safety outcomes. These strategies have some distinctive characteristics in that all:

- aim to eliminate all fatalities and serious trauma from road crashes in the long term
- recognise that road users will remain fallible and crashes will occur
- stress that those involved in the design of the system are responsible for ensuring that no deaths or serious injuries occur from its use, and those that use the system need to accept responsibility for complying with the rules and constraints of the system
- aim to reduce crash energy through managing the interaction of all components of the transport system
- rely upon comprehensive management structures incorporating all relevant government agencies
- align safety management decisions with broader transport and planning decisions
- re-orient their interventions to focus on the inherent safety quality of the road infrastructure, and align travel speed with that infrastructure
- make comprehensive use of technology to improve the safety of the road transport system
- address road safety as a measure of organisational performance (Organisation for Economic Co-operation and Development 2008).

There are many benefits to be gained from following a sound process of road safety strategy development. While the benefits of the strategy itself are difficult to quantify, the benefits of many of the specific actions called for in the strategy will be quantifiable. The costs of developing the strategy are likely to be very small in comparison to delivering the road safety program over the life of the strategy. Some of the benefits to be anticipated from developing a strategy are:

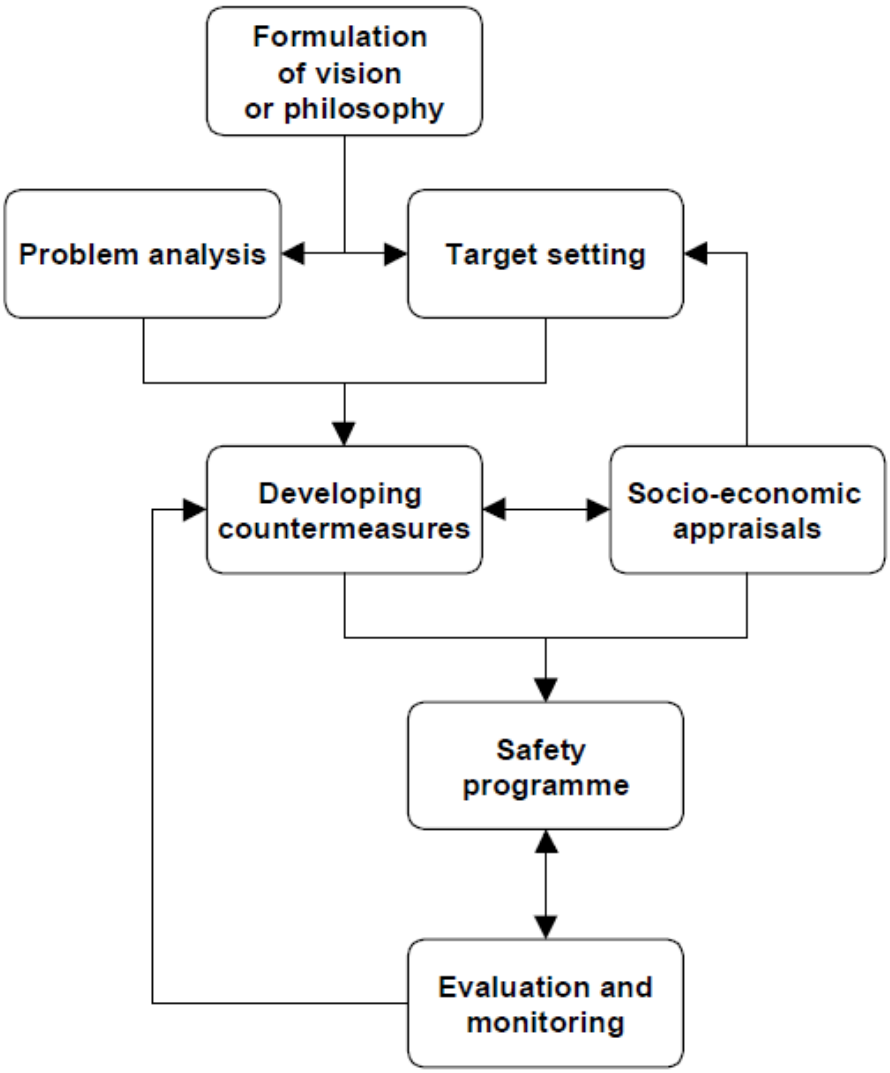
- a comprehensive examination of road safety issues across the jurisdiction, in terms of both fatality and injury outcomes and public perceptions of major issues
- commitment of stakeholders in road safety to a coordinated set of actions – this should include the highest decision-making levels in the jurisdiction
- prioritisation of effort with available resources
- a public commitment to action which the community can understand and support
- commitment to a program of countermeasures which is based on current understanding of best practice, and which is the best that can be provided in view of the available resources and skills, and public acceptance of measures
- efficient allocation of resources to road safety goals, and coordinated action to tackle road safety issues
- an appropriate balance between road safety and other societal goals affecting transport such as mobility, health, environmental protection and equity
- accountability for investments and actions to improve road safety, especially those measures which involve controlling driver behaviour
- monitoring and evaluation of programs to enable on-going improvement
- a clear statement of the problem, a clear commitment to tackle it and a clear goal or goals to work towards
- as experience is accumulated, building capacity to tackle road safety issues
- engaging the public and building support for road safety interventions and expenditure.

1.5 Developing a Road Safety Strategy

There is no single ‘recipe’ for developing a road safety strategy. The way in which a strategy is developed will inevitably depend on the jurisdiction’s progress in terms of safe mobility and road infrastructure, its previous history of road safety activity, the relations between the major stakeholder groups and between the individuals in leadership roles in different organisations.

However, there are a number of different processes that must be progressed in developing a soundly-based strategy. Figure 1.3 is taken from an OECD report on road safety strategies and may be used to illustrate the process. The figure illustrates a ‘top down’ approach, starting with a vision or philosophy. An alternative approach is to proceed ‘bottom up’, starting with an analysis of what can be achieved, discussed later.

Figure 1.3: OECD strategy development process



Source: Organisation for Economic Co-operation and Development (2002).

The 'vision' is a statement of what the jurisdiction should strive to achieve. The Organisation for Economic Co-operation and Development (2008) recommends that the vision for a strategy should include long term goals to eliminate death and serious injury on the road transport network. This ambitious vision is expressed in the Netherlands' Sustainable Safety strategy and Sweden's Vision Zero strategy. Austroads member jurisdictions are increasingly moving towards adopting similarly ambitious road safety visions. For example: Western Australia's Towards Zero Road Safety Strategy aims to achieve 'a road transport system where crashes resulting in death or serious injury are virtually eliminated' (Office of Road Safety 2009); and New Zealand's Road Safety Strategy, Safer Journeys, sets its vision to achieve 'a safe road system increasingly free of death and serious injury' (Ministry of Transport 2010). This approach to setting a vision for road safety is based upon the idea that death and serious injury should not be accepted as inevitable and mirrors the safety approach taken in other transport modes such as aviation, rail and shipping (Organisation for Economic Co-operation and Development 2008).

The long term vision of eliminating deaths and serious injuries from the road transport network needs to be balanced with firm and achievable interim targets. It is very difficult to achieve ambitious targets that seek very large reductions in road trauma by specific dates without links to specific interventions and achievable interim targets. Targets that fail to be achieved often undermine the credibility of target setting and road safety programs in general (Organisation for Economic Co-operation and Development 2008). As such targets based on expected outcomes from specified interventions should be set, as a means to move systematically towards achieving an ambitious vision (see Section 4 and Section 5 for detailed descriptions of countermeasure selection and target setting).

The Organisation for Economic Co-operation and Development (2008) states:

> *The only effective use of aspirational targets is in establishing a long term vision for achieving rates of deaths and serious injuries close to zero coupled to a twin track approach to make the vision operational: interim targets for quantified improvements over specific periods along the way, through interventions that are part of the road safety strategy; and research into more effective and new interventions to push the performance frontier.*

In Sweden this 'twin track approach' involves expressing the vision in terms of an end state for the road system which would result in the agreed trauma levels. Backcasting techniques are then used to identify the interventions and their timeframes needed over the life of the strategy to transform the road system and hence meet the trauma targets. Packages of countermeasures are then produced as scenarios to inform funding and policy considerations. This approach is designed specifically for long term strategies aimed at eliminating road trauma (Swedish Transport Administration 2012).

After the vision has been stated, the next steps in strategy development are the detailed work of problem analysis, countermeasure development, countermeasure appraisal, and target setting. Socio-economic appraisal includes economic analysis of the costs and benefits of the countermeasures, an assessment of their acceptability on the part of the public, and a consideration whether the trained personnel or other specialised resources are available to deliver particular countermeasures.

Once targets are set and countermeasures agreed, the specific details of the safety program can be planned and delivered. Ongoing monitoring and evaluation is an essential part of the process to discover what impact the safety program is having and whether the targets set out in the strategy are likely to be met. The results of monitoring and evaluation enable adjustments to the program to bring it closer to meeting the targets specified in the strategy. The various steps are described in Section 3 to 8 of this report. Communicating the results of monitoring to road users is essential in building support for the strategy and may help encourage behaviour change.

As mentioned above, an alternative approach is to work 'bottom up' starting at the level of problem analysis and countermeasure development. By identifying the number and type of road crashes (e.g. in terms of crashes, deaths and injuries, or aggregate estimated economic losses), and by identifying the impact countermeasures are likely to have (e.g. reducing the incidence of crashes, or reducing the probability of injury if a crash does occur), it is possible to estimate the crash reductions likely to result from certain types of countermeasures. The aggregate number or value of all crashes prevented is an estimate of the overall benefits of the program. While this approach may appear less challenging than the top down approach, it is more likely to give a realistic estimate of what can be achieved. In reality, target setting is likely to involve elements of 'top down' and 'bottom up'. It is also likely to commence with a consideration of what is currently being achieved and what are the simplest, quickest and least expensive ways to achieve more.

1.6 Guiding Principles

Both Australia's *National Road Safety Strategy 2011–2020* (Australian Transport Council 2011) and New Zealand's Road Safety Strategy, *Safer Journeys 2010–2020* (Ministry of Transport 2010) adopt the Safe System approach as their guiding principle. The Safe System differs from traditional approaches to road safety. Rather than always blaming the road user for causing a crash, it acknowledges that even responsible people sometimes make mistakes in their use of the roads.

Australia's *National Road Safety Strategy 2011–2020* states the Safe System takes 'a holistic view of the road transport system and the interactions among roads and roadsides, travel speeds, vehicles and road users. This is an inclusive approach that caters for all groups using the road system, including drivers, motorcyclists, passengers, pedestrians, bicyclists, and commercial and heavy vehicle drivers' (Australian Transport Council 2011).

The Safe System approach is detailed in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021a).

A final point on technology. Of increasing importance is the ability of road infrastructure to be compatible with vehicle capabilities to maximise the benefits from the most effective technologies (e.g. edgelines that are readable by cars). For large parts of the road network where large investment in infrastructure upgrades are unlikely, such as low volume roads, vehicle technologies may play a crucial role in preventing road departure crashes and intersection collisions and compensating for the many errors that may lead to severe crashes (Austroads 2018c). Practitioners who are developing road safety strategies must keep a keen eye on the convergence of technologies across the Safe System pillars.

1.7 Critical Success Factors

Experience in many countries has shown that the development and delivery of successful road safety strategies depends on a number of critical success factors relating to political leadership and institutional arrangements. The critical success factors for effective road safety management listed in the Organisation for Economic Co-operation and Development report *Safety on roads: what's the vision?* (OECD 2002) are shown in Text Box 1.

Text Box 1: Critical factors for effective road safety strategy development and implementation (adapted from Organisation for Economic Co-operation and Development 2002)

- Political commitment: road safety has to be placed high on the road safety agenda to achieve effective outcomes.
- Co-ordination: is essential among all stakeholders, government, community and private, to ensure integration of road safety issues and solutions.
- Leadership: program development and implementation, communication and co-ordination require a focal point.
- Safety planning: short and long term plans with specific goals and funding arrangements are an essential part of the process.
- Data sharing and data quality: collection, analysis, linkage and use of all aspects of road safety data, including enforcement activity and outcomes of judicial processes for drivers are essential at all stages of the strategy development process.
- Evaluation: specific programs should be evaluated, and the whole process of strategy development and outcomes should be assessed periodically.
- Accountability: organisational structures, requirements and practices should be evaluated where there are identified safety responsibilities.
- Marketing, outreach and public education: these are essential elements for engaging the public.
- Staffing: staff must have the skills, resources and training required to implement road safety programs and to act as expert technical advisors to road safety decision makers.

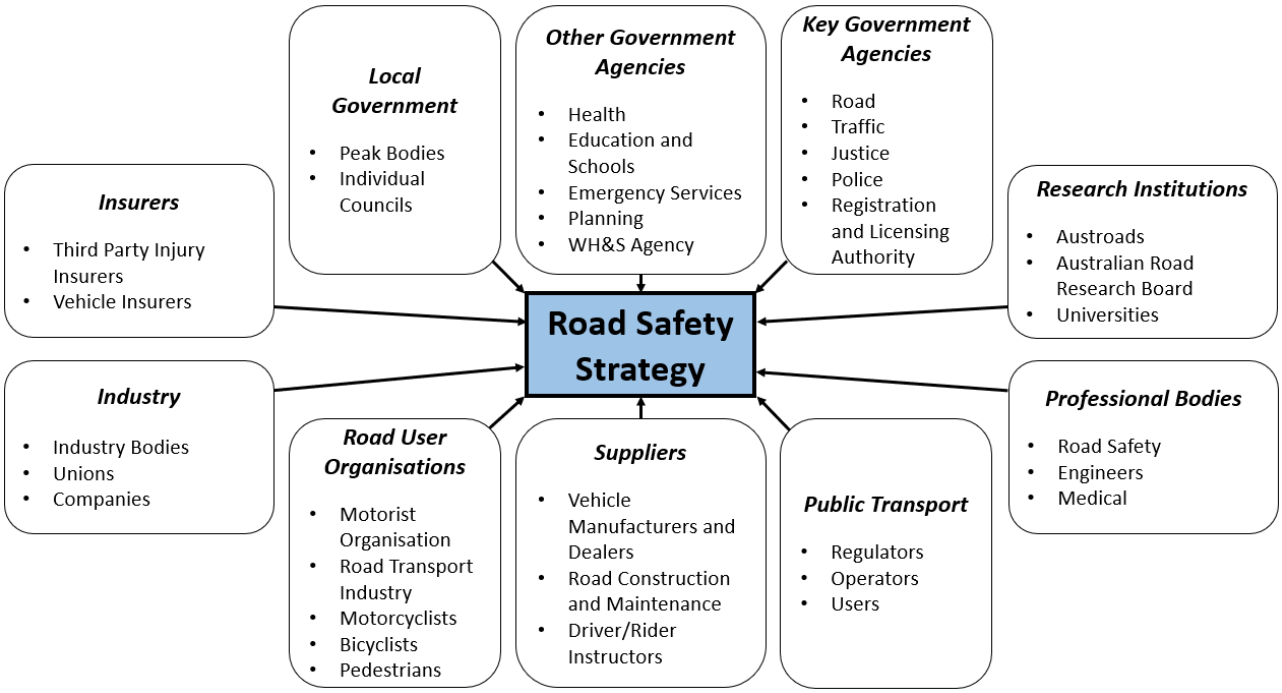
2. Partnerships and Consultation

In Australia the road safety strategy at the national level is agreed at the Infrastructure and Transport Ministers' Meeting (ITMM). Reporting to the Council of Australian Governments (COAG), the Infrastructure and Transport Ministers' Meeting brings together Commonwealth, State, Territory and New Zealand Ministers with responsibility for transport and infrastructure issues, as well as the Australian Local Government Association. In New Zealand, the lead agency responsible for the delivery of the road safety strategy is the New Zealand Transport Agency, part of the Ministry of Transport. Each Australian jurisdiction also has a lead agency responsible for administering their own individual strategies; see Text Box 4 in Section 6 for examples of national, state and territory strategies.

Despite a lead agency taking responsibility for the safety of the transport system, successful attainment of ambitious goals lies in a collaborative approach by national, regional and local agencies and authorities involved in transportation and community well-being. At the state level, the lead authority may be a road agency with wide-ranging responsibilities, a transport authority, or an office of road safety. The emphasis is on arriving at agreement among the key agencies relating to priorities and actions. In local authorities, arrangements are also diverse, with technical services departments, community development departments or dedicated road safety coordinators being among the usual groups or individuals with responsibility for the carriage of the strategy.

Besides the lead agency, many organisations have a role to play in the delivery of a safe road transport system. Figure 2.1 indicates the range of organisations likely to be involved in the process. It is not an exhaustive list; other organisations may be involved in the process in some jurisdictions.

Figure 2.1: Stakeholder contribution to road safety strategies



The reasons for making them part of the process include:

- they have closely related goals, some of which may overlap with the objectives of the road safety strategy (e.g. both health and police have a commitment to reducing traffic injuries)
- they have primary responsibility for activities which are critical for road safety outcomes (e.g. traffic law enforcement, trauma care and workplace safety policies)
- they have information and insights not generally available to the lead agency (e.g. health sector's understanding of contemporary drug issues)
- they have the capacity to deliver road safety interventions (e.g. motoring organisations, insurers)
- involving other key stakeholders in the planning process encourages a sense of ownership and commitment to the strategy
- the Safe System approach requires inputs from a wider range of organisations than just the road or traffic agencies.

As well as engaging key stakeholders, it is essential that a road safety strategy has the support of other interest groups and the public at large. This is best achieved through consultative exercises, which can take a variety of forms e.g. regular meetings of stakeholders involved in particular areas, such as cycling, motorcycling or heavy vehicles, or through invitations to make submissions when strategies are being revised. Regular meetings and communication have the advantages of establishing on-going contacts, establishing a sense of mutual responsibility between organisations and acting as a source of advice in response to monitoring reports.

It is preferable that people who are most affected by legislation give their support to that legislation. Interest groups may be able to deploy more resources to examining particular issues than road authorities, and their representatives may have had more experience in considering particular issues than road authorities or their advisers. The best interest group representation consists of a core of capable people with technical skills, a passionate commitment to their interest, and many years of practical experience. With the wide availability of scientific, technical and policy materials and the ability to communicate with similar organisations across the globe through the internet, these organisations are often a substantial source of expertise. These developments are welcome in that they raise the level of debate and are likely to encourage support for well-founded measures. On the other hand, these developments mean that road safety proposals are likely to receive increasing scrutiny from user groups, and to be rejected unless they can be shown to have definite advantages. Since many interest groups are adept at using the media, proposals which do not win their support may be difficult to implement and to find wider public support. Consultation is therefore an essential part of the strategy development process.

Interest groups can be very useful channels for delivering information. For example, motoring organisations have been a key participant in the Australasian New Car Assessment Program (ANCAP). They have been particularly effective as a way of disseminating the information which comes out of the program by publicising it directly in their magazines, referring to it in reviews of motor vehicles, distributing leaflets, and advising members on vehicle purchases. Mother and baby clinics and other organisations devoted to the health and welfare of young children have been effective in explaining the benefits of and promoting baby capsules and child booster seats since these devices first became available. The WA Child Car Restraints Program is supported through agreements with other organisations such as RoadWise (the local government road safety program), Kidsafe (a child safety organisation) and the Meerilinga Playgroup Association which promote the program's fitting and checking service through their networks.

3. Problem Analysis

Whether the strategy development proceeds 'top-down' or 'bottom-up' (Section 1.4), problem analysis is a critical step. Problem analysis involves developing a detailed appreciation of the road safety issues in the area covered by the strategy. This appreciation should be based primarily on the road crash database, interpreted with caution due to: under-reporting of crashes (particularly those involving pedestrians or two-wheel vehicles); the fact that some information is frequently not reported (e.g. BAC information for drivers and riders); and the fact that some important information is generally not recorded at all (e.g. BACs for pedestrians). Other relevant information sources are hospital records, and public opinion regarding road safety issues. These issues are discussed in detail in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b).

3.1 Problem Definition

Traditionally, problem definition in road safety has centred on the road user behaviours associated with crashes. Safe System thinking, however, recognises human fallibility as a feature of road use rather than a bug in the system. Our understanding of what lies behind road user error is evolving but it is evident that many of the situations people are placed in when using the road system invite certain errors to be made. We now understand that many of these errors cannot be easily eliminated. Furthermore, system designers and managers have a responsibility to not only mitigate for predictable errors but also to protect those innocently caught up in crashes. The appropriate response to dealing with this issue is to ensure that the road network is forgiving of error and does not allow people to inadvertently cause harm (Austroads 2018b) At the same time there exist extreme behavioural violations that challenge Safe System design.

In this context, problem definition takes on two parts. Firstly, the problem of system design to accommodate human error and, secondly, the problem of de-coupling extreme behaviours from crash events.

For the purpose of strategy development, problem definition and problem analysis become linked in an iterative and converging practice aimed at harm elimination. The process generally consists of concurrently examining the crash database, the asset condition (including speed management) and the vehicle characteristics to determine:

- whether that particular type of crash is increasing or decreasing, both in terms of absolute numbers and in relation to other types of crashes
- whether crash casualty outcomes are improving or worsening, both as injury severity and ongoing disability
- whether there is a safety performance gap in the road system
- whether there is an effective intervention to prevent the resultant trauma and a plan for its implementation.

3.2 Deeper Understanding of the Issues

Effective understanding of a problem often requires deeper investigation than routine examination of the databases, drawing on theoretical understanding of social, economic, behavioural and medical issues and more detailed analysis which usually relies on additional data sources. The importance of this scientific appraisal lies both in the more precise definition of problems and the identification of appropriate solutions.

A good example is the way the problem of older drivers has been reformulated over time. The research of the 1960s indicated that older drivers had higher fatality and injury rates per distance driven and were over-represented in crashes at intersections. Since this was consistent with what was known about age-related changes in sensory and decision-making processes, particularly vision, this led to a focus on age-related decline in skilled performance and the search for appropriate screening methods to identify at-risk drivers (Hakamies-Blomqvist, Siren & Davidse 2004). Later research, however, showed that older drivers did a greater proportion of their driving in relatively high-conflict suburban environments rather than on relatively safe freeway-standard roads, so that crash rates per distance travelled gave an exaggerated picture of the risk related to age. This required additional research to establish the travel patterns of older drivers in relation to those of other age groups. Later work demonstrated that the greater physical frailty of older people explains much of their higher death and injury rate, and that the increase in the risk of crash involvement is a relatively minor issue. In recent years, the focus of concern has shifted from 'why do older drivers have crashes?' to 'which older drivers are at risk, and why?' The focus has also shifted from driving to a broader concern with the mobility of older persons (Hakamies-Blomqvist, Siren & Davidse 2004).

Building a deeper understanding of issues will often require bringing new thinking to the problem. Expert panels of review can be highly effective here. Such panels will often bring together experienced practitioners, researchers and theorists in related fields from both the home jurisdiction and elsewhere.

3.3 General Measures

Some of the most effective countermeasures are not targeted at one particular type of problem, but have benefits across a range of problems in terms of crash reductions and/or injury reductions when crashes do occur. One example is engineering and enforcement measures designed to reduce vehicle speeds, which both reduce the chance that a collision will occur, and reduce the injuries to road users when a collision does occur. Another example is restraint use by car occupants, which is unlikely to influence whether or not a crash occurs, but which has a major effect on the severity of the injuries to the occupants of vehicles involved in the crash.

In developing a road safety strategy, it is necessary to consider general measures from two points of view. For existing general measures, the questions are whether investments are at the appropriate level, and whether the detailed allocations of these investments are appropriate. For example, when considering speed management, it may be appropriate to consider whether sufficient speed camera hours are available to achieve the desired pattern of speed profiles and also to consider whether changing the proportion of deployments in rural areas is needed. Maintaining key safety-related behaviours at high levels is an essential component of a road safety strategy.

For new general measures, it is necessary to consider whether there are new types of countermeasure available which have the ability to affect a wide range of crashes or their outcomes. If promising new outcomes are available, the question to be considered is how best to advance this countermeasure. In turn, this depends on the state of development. The appropriate action may be to initiate a trial if there is not yet convincing evidence of the benefits. On the other hand, if there is already sufficient evidence of the benefits, appropriate action may be to change regulations or legislation, to lobby for changes at the state or federal level, to change practices or to start investing in the countermeasure.

The appropriate road safety strategy is developed in the light of this analysis. It may be apparent that some countermeasures are performing well and should be continued. In other cases, more effort or investment may be required to prevent crashes increasing in number or severity, or to improve on the situation. Alternatively, it may be evident that some countermeasures are failing and that a new approach is required.

It also needs to be recognised that not every problem can be covered by the strategy, and that decisions will have to be made about cut-off points either in terms of the size and public profile of the problem, or the value likely to be received from known countermeasures. It is important, particularly during the early years of road safety strategies, to focus on those key areas where progress can be measured and is visible to the community.

3.4 Changes in Population and Travel

In interpreting changes in crash numbers and their underlying patterns, it is necessary to take into account growth in population and travel. As pointed out in Part 1 of the Guide, crash numbers and crash rates in terms of population and travel are important perspectives on the problem. For example, an increase in crash numbers may be a reflection of population growth rather than an increase in overall travel. In Australia and New Zealand, the growth in the numbers of older people in future years is of particular concern. Increased traffic congestion, higher fuel prices and an increased focus on environmental factors, such as pollution, in the future could lead to more cycling and walking, and increased travel by public transport, with possible consequences for the relative proportions of different road user types who are killed or injured, as well as the overall total.

In assessing what the overall impact of individual countermeasures and the whole road safety program is likely to be, it is necessary to estimate population, vehicle fleet and travel over the life of the strategy, and to take this growth into account when calculating crash and/or trauma reductions as a result of the strategy. Vulcan and Corben (1998) demonstrate how this can be done and how, in some cases, the impacts of particular countermeasures can be estimated in the context of this background.

3.5 Additional Data Sources

Hospital records in particular are a useful supplement to the crash database. It is well-established that there is under-reporting of injuries resulting from road crashes, and that this is particularly severe for cyclist and pedestrian crashes. A second reason for considering hospital data is that a distinction between serious injuries and other injuries is not provided in the crash records for all jurisdictions. In jurisdictions where this distinction is made, there are doubts regarding its reliability. At present, it is not always possible to match hospital records with crash records, so the information available for planning purposes is likely to be a distribution of the seriousness of injuries resulting from traffic crashes.

Other useful sources of data are calls to ambulance and rescue services to attend crashes, and calls to tow-truck services. The latter is particularly useful where there are arrangements for a centralised call allocation system.

Other potential data requirements may also be considered. For example, it could be particularly useful to include data on road infrastructure. For example, information on the extent of the road network that has Safe System infrastructure (e.g. separation of traffic on high speed roads, grade separated intersections to eliminate intersection crashes, roadside barriers to shield trees, etc.).

3.6 Public Opinion

Public opinion is an important consideration at the problem analysis stage for three reasons.

First, it is important to recognise that the public may have concerns about issues which have little impact on actual road safety outcomes in terms of crash numbers, but which represent serious weaknesses in the system. For example, there are drivers who continue to drive with apparent impunity, despite repeated disqualifications, without actually crashing. While this represents a high risk situation, it does not result in significant numbers of road casualties. Unless road safety plans include means for dealing with issues such as these, they may lack credibility with the public.

Second, public opinion is sometimes well ahead of the decision makers on major road safety issues. For example, opinion surveys showed that a majority of the public was in favour of random breath testing long before it was introduced in most jurisdictions (Homel 1986). Similarly, there was majority support for lower speed limits on local streets in many states well before the lower limits were introduced (e.g. Austroads 1996).

Third, there may be a negative side to public opinion in that the public may have deeply-held views about the nature of road safety problems and the appropriate solutions which are at variance with the scientific understanding of issues. For example, many drivers believe that lack of skills or knowledge about traffic rules are a major issue, and are therefore prepared to support measures such as more rigorous testing of learner drivers and riders, licence re-testing and advanced vehicle handling training. Many drivers reject the idea that speeding a few kilometres above the limit substantially increases crash risk, and are therefore hostile to measures which would encourage them to change long established habits regarding speed choice, such as reduced tolerances.

Public endorsement or rejection of issues should, ideally, play little role in deciding which measures are adopted and developed in a road safety strategy. However, they might have a role in shaping priorities for action, and it is essential that they be taken into account when considering how to present or 'market' particular issues. It is particularly important that governments be able to resist public pressure for ineffective activities or facilities.

In Australia, the Department of Infrastructure, Transport, Regional Development and Communications. conducts periodic surveys of community attitudes to road safety issues. One of the main benefits of the survey is the ability to track how attitudes and beliefs have evolved. The latest survey at time of writing was conducted in 2017. The main purpose of the survey was to monitor attitudes to a variety of road safety issues, evaluate reactions to specific road safety countermeasures, suggest new areas for intervention and identify significant differences between jurisdictions. The survey involved telephone interviews with over 1700 individuals, aged 15 years and over, across Australia. The issues examined include: perceived causes of road crashes, exposure and attitudes to both random breath testing and roadside drug testing, attitudes to speed, perceptions of police enforcement, mobile phone use while driving, reported usage of seatbelts, involvement in road crashes, and experience of fatigue while driving.

In New Zealand, the Public Attitudes Survey has been undertaken periodically since 1974, and annually since 1994, to evaluate attitudes to road safety issues, primarily alcohol-impaired driving and speed. A representative sample of the New Zealand population is chosen including men and women aged 15 years and over from towns, cities and rural areas throughout New Zealand. In 2016, 1666 people were interviewed (Ministry of Transport 2016).

Some other jurisdictions run their own surveys, and others are at the start of establishing baseline surveys. A road safety strategy should take these surveys into account where they are available.

3.7 Societal and Technology Changes

A range of changes in society are likely to have a major impact on travel, mobility and life-style patterns, and should be considered when developing a strategy. These include:

- Economic growth – more business activity is likely to lead to increases in freight and work-related travel, while more wealth in the hands of consumers is likely to lead to increased travel and possibly an increased rate at which older vehicles are replaced
- Alcohol sales are likely to change in response to economic growth; and increased alcohol consumption may lead to increases in drink driving
- Drug use – both prescription and illicit drug use are constantly changing and evolving and understanding these could play a role identifying at-risk times and areas for impaired driving
- Demographic changes – changes to the numbers of young people aged 16–25 years and older people aged 75 years and over are likely to put upward pressure on crash rates
- Vehicle choice – increases in sales of four-wheel-drive vehicles and motorcycles have also been shown to have an impact on crash rates

- Cultural changes – for example, concern for the environment and climate change could shape road users' choices in the future over which mode of transport to use and lead to more walking, cycling and use of public transport.

A further consideration is changes in technology. These can impact across the entire road system with positive and negative effects on safety problems. For example, changing vehicle technologies demand compatible infrastructure to maximise the benefits from the most effective technologies (e.g. edgelines that are readable by cars). For extensive lengths of the road network where large investment in infrastructure upgrades are unlikely, such as low volume roads, vehicle technologies may play a crucial role in preventing road departure crashes and intersection collisions and compensating for the many errors that may lead to severe crashes (Austroads 2018c).

4. Countermeasure Selection

The consultation and problem analysis stage should identify the problems which the strategy is to address. The next stage is to select the actions needed to address each of these issues. Together these actions will combine to achieve the target identified by the strategy. In order to understand which actions or countermeasures are likely to be successful in a jurisdiction, it is essential to understand the nature of the problem in detail. This entails a continuation of the examination of the database, in many ways an extension of the problem analysis described in Section 3. In this case, the focus is on understanding the locations, circumstances and behaviours which relate to specific issues.

Countermeasures can be selected from a wide range of options in the areas of engineering (road and traffic based measures), vehicle design, driver training, public information and education, and enforcement and sanctions.

Selection of appropriate and effective countermeasures depends on a good understanding of the problems which they are intended to address. The essential points to understand are:

- What is the nature of the crash problem, for example in terms of the crash types involved? Has exposure been taken into account (in terms of population/distance travelled/vehicle registrations)?
- Where does the crash problem occur? Is it jurisdiction-wide, or is it confined to particular geographic areas or road types?
- Who is involved in the type of crash in question? What gender, and age and road user groups are involved?
- When does the crash problem occur? What time of day and day of the week? Is the problem seasonal? Is it related to the weather?
- What factors contribute to this type of crash? For example, did poor engineering or poor driving decision-making contribute?

When conducting longer term planning for the achievement of zero road trauma, countermeasure selection focusses on road system transformation. The aim is to close the gap between existing road system standards and those needed to eliminate harm in the event of crashes. Safety performance indicators are used to evaluate the effect of countermeasures and monitor progress towards the final Safe System (Swedish Transport Administration 2012).

4.1 Conceptual Frameworks for Countermeasure Selection

Two systematic approaches are particularly useful for considering how countermeasures relate to the problems that they are designed to address; the Safe System approach and the Haddon Matrix.

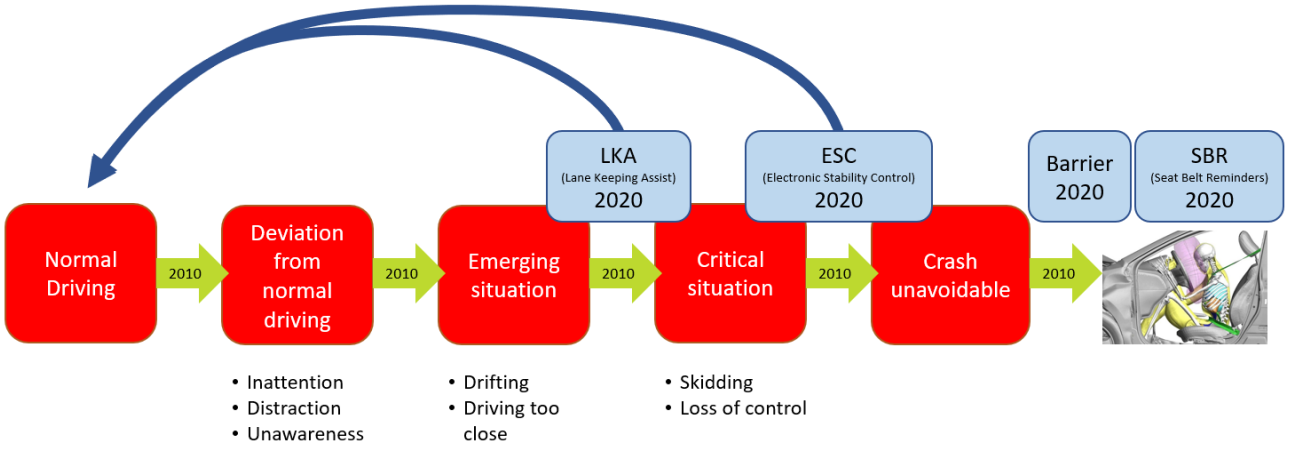
The Safe System approach is explained in detail in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021a) and, in short, the Haddon Matrix (see Appendix A) identifies events that contribute to crashes and injuries. Events are classified as relating to the human, vehicle or road, and as occurring pre-crash, during the crash, or after the crash. This gives rise to four broad classes of countermeasures for reducing crashes and minimising their impact on individuals:

- exposure control – e.g. provisions in graduated licensing to restrict the number of passengers and/or driving late at night
- reducing crash risk – e.g. improved braking, better signs and road markings
- improving road user protection – e.g. improved crashworthiness, restraints and laws to require their use, more forgiving road environment
- improving assistance to injured persons – e.g. faster emergency response times, better trauma care.

The Safe System approach is detailed in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021a). The Haddon Matrix is explained in Appendix A of this document.

In an extension to the thinking behind the Haddon Matrix, Swedish road safety planners have adopted the chain of events model shown in Figure 4.1. This approach identifies a series of opportunities, many only seconds in duration, in which interventions can take effect to reduce trauma outcomes. The result is a greatly expanded range of countermeasures available to road safety planners.

Figure 4.1: Chain of events leading to a crash



Source: Swedish Transport Administration (2012)

4.2 Selection of Countermeasures

The process of selecting countermeasures should involve answering the questions listed below, or an equivalent set of questions:

- Given the nature of a particular problem, what sort of countermeasures might be effective?
- What evidence is there to demonstrate that each countermeasure is effective? Detailed discussion on the evidence-based approach to road safety is available in Part 1 of the Guide. Have any evaluations been carried out in this or similar jurisdictions which show what a particular countermeasure can achieve? Systematic reviews (i.e. reviews which set out to answer a particular question, based on studies which meet specified criteria, in contrast to the usual narrative reviews are particularly useful).
- Which countermeasures appear to fit the problem in the jurisdiction in question? For example, alcohol prohibitions for young drivers in Australia would (in theory) have less relevance in the US, where young people cannot drink alcohol in bars and other public venues until they are aged 21 years. Conversely, it would be difficult to gain acceptance in Australia or New Zealand for prohibiting public consumption of alcohol until the age of 21 years.
- What return does each of the countermeasures offer on the investment involved? Elvik et al. (2009) provide comprehensive evaluations of a wide range of countermeasures, although caution needs to be exercised in assuming that the precise values they estimate would apply in Australia or New Zealand. For an evaluation of road safety countermeasures from an Australian perspective, consult the *Road Safety Engineering Risk Assessment Part 6: Crash Reduction Factors* (Austroads 2010). Also refer to Austroads (2012) *An Introductory Guide for Evaluating Effectiveness of Road Safety Treatments* for an overview of this topic.
- Does the jurisdiction have the capacity to implement a particular countermeasure? (e.g. the legislative framework, engineering standards, access to the technology, trained personnel).
- What mix of countermeasures offers an effective solution to a particular issue?

- Is a prospective evaluation for this particular countermeasure needed? If so, how extensive should the evaluation be?
- Over what time frame will the countermeasures apply? How soon can they be introduced? Do they call for a fixed investment? (e.g. an upgrade of crossing facilities) or an ongoing commitment? (e.g. commitment to an education or enforcement program).

In some cases, new developments arise that have a general effect on safety and are likely to affect many different types of crash. Because they are not solutions to a particular type of crash, they offer substantial reductions in crash or injury outcomes, and so must be considered for inclusion in the program. A current example is autonomous emergency braking (e.g. Fildes et al. 2015), which has resulted in large reductions in rear end crashes from a wide range of causes. It would therefore be appropriate to promote this new technology as part of the strategy, while monitoring its performance under Australian or New Zealand conditions. A comprehensive search for new developments should therefore be conducted whenever road safety strategies or shorter-term action plans are being considered.

Often new developments are likely to have insufficient evidence as yet for a full-scale roll-out. To address this, the best performing road safety jurisdictions conduct pilot studies and demonstration projects to assess a particular countermeasure's effectiveness. Well-designed pilot projects have proved to be an indispensable tool to secure further support for the wider implementation of road safety countermeasures. Pilot studies and demonstration projects are used to evaluate the actual effects of measures, address any problem areas, and inform advice on good practice. Demonstration projects must be of sufficient scale and intensity to contribute to the long-term process of building sustainable road safety, while demonstrating measurable road safety results in the short-term to provide evidence-based benchmarks for the further roll-out of similar initiatives. This latter objective can be achieved by targeting high-risk road corridors and urban areas with sufficient resources to make a measurable impact (Bliss & Breen 2009). In good practice research and development and knowledge transfer, the lead agency responsible for road safety needs to develop and fund demonstration projects in areas which offer large potential for road casualty reduction and, if successful, uses the results to roll-out the countermeasure on a larger scale.

As well as identifying new developments, the planning process will usually involve reviewing existing countermeasures, many of which may have been in place for many years, and which continue to be the main basis of road safety programs. In these cases, it is worth reviewing the countermeasures and their application to determine whether they are worth considering, and whether they could be better targeted or managed. For example, speed camera programs have generally been shown to be effective, but there may be scope for increasing their effectiveness by expanding the programs, reinforcing enforcement with vehicle-activated signs which provide feedback to the driver by displaying the vehicle speed, or reducing the enforcement tolerance. It is during this process that evaluations of both processes and outcomes are particularly useful (see Section 8).

A further consideration in countermeasure selection is the potential for double-counting countermeasure benefits. For example, where roadside barriers exist the additional benefits from lane departure management will be substantially reduced as errant vehicles will already have a high performing energy management system in place (Swedish Transport Administration 2012).

4.3 Legal Issues

The type of innovation required to pursue Safe System principles is often perceived by practitioners and managers as a corporate risk thus limiting the potential for non-standard countermeasures to be installed on the road network. This may lead to a 'do-nothing' approach unless a standards-compliant treatment is feasible. However, 'doing-nothing' ultimately leaves the identified hazard untreated and thus continuing to pose a safety risk to road users.

Some road authorities are exploring this issue further and many legal commentaries consistently point to the fact that doing something to manage risk for road users is better than doing nothing at all. That is, using innovative treatments is a realistic option which does not compromise the level of legal vulnerability carried by a road authority and should be used to encourage innovation rather than used as a deterrent. A common proviso is that documentation must justify the reasonable decisions made when selecting and implementing crash mitigation options (Austroads 2018b).

4.4 Social and Economic Appraisals

Successful road safety programs may not be socially acceptable without action to influence public perceptions. At times the best results in terms of road safety may be achieved by the least popular measures (e.g. speed limit reductions, which are known to dramatically reduce crash likelihood and severities); in these cases the onus is on the lead agency to convince the public of the efficacy of the countermeasure.

Progress in implementing new countermeasures is largely influenced by their acceptability to the public. A good example is seat belt wearing. Seat belts have been fitted to cars for over 40 years. Wearing rates by drivers and front seat passengers were gradually brought to a level of 40% through encouragement and publicity before it was made mandatory, when the percentage doubled ‘almost overnight’. Future examples are black box recorders of the motion of vehicles shortly before a crash and intelligent speed adaptation in vehicles, which may with a period of voluntary fitting create a climate of acceptance for mandatory implementation if they are not cost prohibitive (Ward et al. 2003).

A period of consultation before the road safety strategy is finalised, perhaps through release of a discussion paper, will help decide whether proposed countermeasures are acceptable to politicians, key stakeholders and the community. In addition, regular road safety market research surveys will also assist in providing information on acceptance or otherwise of countermeasures. Decisions will then need to be made as to whether particular countermeasures will be introduced or continued. This will involve consideration of the other issues discussed here (such as costs and benefits in terms of reduced road trauma) as well as the influence of the political party in office.

It may be possible to win over the public to accept something to which they are at first resistant, but this takes time, and is an uncertain process. Public perception of traffic law enforcement is particularly sensitive, as it has implications not only for road trauma, but for the costs borne by the public and wider relations between the public and the police. The media can play an important role in improving the public’s perception of the danger which compliance with the law is intended to reduce, and in heightening the risk of being caught if not complying (Ward et al. 2003).

Public acceptability of countermeasures is likely to be influenced by:

- perception of the seriousness of the risk against which the countermeasure is directed
- social acceptance of the behaviour being regulated
- perceived effectiveness of the countermeasure
- inconvenience caused by the countermeasure
- intrusiveness and impost of the measure into personal lifestyles (Ward et al. 2003).

Understanding the above issues of public acceptance, and the influence of interest/lobby groups and media coverage, is important in countermeasure selection.

In road safety it is common to undertake a benefit-cost analysis to determine if the benefits of a countermeasure outweigh the costs. In contrast, Safe System principles contend that life and severe injury should not be reduced simply to economic values. Where benefit-cost analysis is applied, in addition to the immediate safety benefits and the direct costs of the countermeasures, it may be appropriate to consider wider environmental and community impacts, benefits such as reduced crime and vandalism, or reduced emissions, and disbenefits such as increased travel times and congestion.

Commonly used indices used in benefit-cost analyses include the benefit-cost ratio (i.e. the ratio of the economic benefits of the crashes prevented to the costs of providing the measure plus ongoing maintenance), net present value (i.e. the net value of the benefits expected over the life of the project minus the costs of provision and ongoing maintenance), first year rate of return (i.e. the net benefits delivered in the first year of a project in relation to the annualised costs). Ranking the economic indices for a number of competing countermeasures can assist in prioritising countermeasures. For further information relating to crash risk, and details on how to conduct an economic appraisal, see the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b). For a more in-depth coverage of issues relating to economic appraisal, see the *Guide to Project Evaluation Part 1: Introduction to Project Evaluation* (Austroads 2009a).

Not all countermeasures will have clear benefits and costs. Some countermeasures, such as more extensive engineering schemes will also have traffic and environmental effects, for which no monetary value has been established. For countermeasures in the areas of education, training and publicity, and for some types of enforcement, the potential reduction in numbers killed and injured cannot be accurately estimated. Decisions about their implementation must be made by informed judgement and best estimates with sensitivity testing using benchmarks against better/worse performing comparisons (Ward et al. 2003).

4.5 Other Considerations

A number of steps may be necessary to give effect to the strategy. These include:

- changes to legislation, which generally require a long lead time in terms of convincing relevant stakeholders that the legislation is worthwhile, as well as the time required for the necessary parliamentary and government procedures
- communicating the strategy to stakeholders, and building their support for and commitment to the strategy
- promoting awareness of the strategy to the community at large, and public education programs to build its support for the strategy and the measures it contains.

The road safety strategy is an important element in demonstrating that the lead agency is fulfilling its essential role and exercising its duty of care towards the community.

Governments and road users have different perspectives on road safety issues, with governments having a strategic view based on harm reduction and trends which affect the community as a whole. Individuals, on the other hand, have a much more limited view of road safety, and are aware of issues and behaviours which affect them directly. Governments therefore face a major challenge in communicating this wider perspective to the community, and why it requires changes to behaviours which road users may not perceive as particularly risky.

Decisions about road safety legislation and policy at the government level are part of the normal political process, and are therefore subject to the same considerations as other actions and policies. Some key considerations are:

- Timing: Governments are in a much better position to impose changes which are likely to be unpopular in the short term when their popularity and credibility is high.
- Flexibility: Controversial road safety measures should be introduced and promoted on a trial basis, so that they can be modified if required without losing face.
- Community support: Road safety strategies are likely to attract more community support if there is community input during the consultation phase.

5. Target Setting and Safety Performance Indicators

This section provides guidance on setting of targets for the strategy. It defines what is meant by a target (and places this in contrast to a 'vision'), identifies the requirements for good safety targets, and then explains how safety performance indicators are used to monitor progress towards targets.

Visions and targets act together to motivate stakeholders to help achieve safety improvements.

A report by the Organisation for Economic Co-operation and Development (2008) on setting road safety targets under the Safe System model suggests jurisdictions should adopt highly ambitious visions that seek in the long term to eliminate death and serious injury from the road network. This builds on a previous report by the European Transport Safety Council (European Transport Safety Council 2003) that claims a good vision for road safety is capable of motivating opinion-formers and decision makers, convincing them of the need for change, and may also be a way of capturing public interest and raising the profile of the strategy in policy terms. The most ambitious visions have the potential to 'alter the community's view of the inevitability of road trauma, alter institutional and societal responsibilities and accountability and change the way in which road safety interventions are shaped' (Organisation for Economic Co-operation and Development 2008).

In contrast, targets relate to specific goals to be met within a set timeframe. Targets must be achievable, quantifiable and empirically derived to be motivating for stakeholders, particularly if they are closely related to the measures selected to bring about casualty reduction.

There is a need to carefully determine road safety targets so that they reflect the key aspirations of the vision, provide clear guidance to stakeholders regarding their contribution to the strategy, and are ambitious enough to motivate commitment but not so ambitious that there is no prospect of meeting them. The following section discusses some of the requirements for the setting of road safety targets.

5.1 Setting Road Safety Targets

Evidence suggests that the setting of quantified road safety targets produces greater success in improving safety (e.g. Organisation for Economic Co-operation and Development 2002; 2008) than not having such targets. The same research also indicates other benefits from the setting of quantified targets including an increased likelihood that safety policies will be implemented, greater integration of effort by various organisations, and a wider scope in the targets set.

Targets should be set based on analysis of available data sources and priorities (Section 3). Techniques for modelling trends and the effects of combinations of countermeasures are available, and should be used at the national and state level. A number of documents available provide a full discussion of the target setting process, including those used as the basis for the Western Australian (Corben et al. 2008) and New Zealand (Ministry of Transport 2009) strategies.

Modelling processes generally aim to determine current trends in crashes based on recent events. They also consider road use over time, and any potential changes to road use patterns (e.g. from changes in traffic volume or composition arising from economic growth) and make assumptions about likely future casualties given these forecasts. This enables the estimation of a baseline forecast, which shows the expected change in casualties if no further action was taken. This is often known as a business-as-usual case and is an important step in the modelling process. Without this business-as-usual estimate it would be impossible to predict the gains in road safety as a result of any planned initiatives. This baseline case allows for changes in population growth, increases in exposure on the road network as well as various economic factors. Often despite absolute increases in fatalities or injuries the countermeasures implemented have in fact been successful, because without them the increases would have been much greater. The effects of these forecasts on broader transport objectives need to be examined, particularly those relating to community health e.g. changes to travel mode, impacts on levels of activity, or environmental impacts (Racioppi et al. 2004). There may also be a need to link with other sectors, particularly health, to determine other policies that may impact on the baseline forecast.

The advantage of forecasting traffic is that it enables safety issues to be anticipated and their management to be planned. For example, a forecast increase in truck travel indicates that the two highest growth points will be larger vehicles, and increased truck movements in metropolitan areas. This allows agencies to plan for initiatives such as increased resources for truck regulation and inspection, engineering and traffic management improvements along truck routes, and developing advice for car drivers on how to interact safely with trucks.

Once a baseline forecast has been produced, it is possible to model the expected outcomes which would result from different mixes of policy and programs of countermeasures which might be included in the strategy. This process uses evidence-based estimates of the effectiveness of individual road safety initiatives. Such modelling can take into account both new initiatives and the expanded use of current measures. The mix of policies and countermeasures which gives the best outcomes can then be used as a guide to priorities and the measures to be included in the overall strategy. Often the modelling approach operates at the macro level and so only includes initiatives that are designed to have a large impact and a substantial reduction in road trauma. The final strategy must take into account the whole range of factors discussed in Section 4, especially those relating to acceptability and availability of specialist resources.

An example of the modelling process involved in setting targets for road safety strategies can be drawn from the approach used for the most recent Australian, Western Australian and Victorian road safety strategies. A Macro Estimates Target Setting (METS) modelling approach was employed. The main purpose of the modelling was to estimate the level of serious casualty reductions that could be achieved during the life of the strategy and to indicate at a very broad level what kind of action would be required to bring this about. The METS analyses allow different levels and combinations of initiatives to be easily compared. The savings as a result of these initiatives were estimated relative to the level of serious casualties that could be expected to occur in the absence of a significant road safety strategy or the baseline case as described earlier. See Appendix B for more detail about the process involved and outcomes of the METS modelling approach.

Advances in road trauma modelling have also been the focus of work by the Swedish Transport Administration. The Swedish management-by-objectives approach uses backcasting techniques to test road trauma reduction targets against business as usual and new investment scenarios. This approach has a focus on quantifying both trauma reduction targets and the road system needed to meet these. Key performance indicates are then used to track progress in the road system towards the desired Safe System state. Appendix C has more detail on the Swedish approach to road trauma modelling and target setting.

Target setting at the local or regional level requires an alternative approach as the data, resources and level of expertise are generally not available. National or state targets are often adopted sometimes with justifiable adjustment to accommodate local circumstances such as a regional transport policy. A further development for local and regional targets is the growing appetite for local authorities to adopt their own ambitious Vision Zero targets. An increasing number of cities in North America are taking this approach (Vision Zero Network 2019).

Strategies often provide an overall target in terms of casualty reduction, typically derived from analysis of trends and the cumulative effect of proposed actions. The most recent Australian strategy aims to reduce the absolute annual number of road crash fatalities and injuries by at least 30% by the end of 2020, compared to the average numbers of fatalities and serious injuries in a baseline period from 2008–2010. The previous Australian strategy employed a different approach, as it aimed to reduce the rate of road fatalities per 100 000 population. The most recent New Zealand strategy provides a number of specific targets as well as more general goals (Table 5.1). These targets focus on key at-risk groups within the driving population and specific road safety countermeasures. The targets in New Zealand's *Safer Journeys 2010–2020* (Ministry of Transport 2010) strategy are in line with best practice, although there are also a few specific numerical targets and more general calls for reductions.

Table 5.1: New Zealand's Safer Journeys 2010–2020 strategy – targets

Focus	Target reduction
Increase the safety of young drivers	Reduce the road fatality rate of young people from 21 per 100 000 population to a rate similar to that of young Australians of 13 per 100 000
Reduce alcohol/drug impaired driving	Reduce the level of fatalities caused by drink and/or drugged driving, currently 28 deaths per one million population, to a rate similar to that in Australia of 22 deaths per one million population
Achieve safer roads and roadsides	Significantly reduce the crash risk on New Zealand's high risk routes
Achieve safer speeds	Significantly reduce the impact of speed on crashes by reducing the number of crashes attributed to speeding and driving too fast for the conditions
Increase the safety of motorcycling	Reduce the road fatality rate of motorcycle and moped riders from 12 per 100 000 population to a rate similar to that of the best performing Australian state, Victoria, which is 8 per 100 000
Improve the safety of the light vehicle fleet	Have more new vehicles enter the country with the latest safety features. The average age of the New Zealand light vehicle fleet will also be reduced from over 12 years old to a level similar to that of Australia, which is 10 years
Achieve safer walking and cycling	Achieve a reduction in the crash risk for pedestrians and particularly cyclists, while at the same time encouraging an increase in use of these modes through safer road infrastructure
Improve the safety of heavy vehicles	Reduce the number of serious crashes involving heavy vehicles
Reduce the impact of fatigue and address distraction	Make New Zealanders' management of driver distraction and fatigue a habitual part of what it is to be a safe and competent driver
Reduce the impact of high risk drivers	Reduce the number of repeat alcohol and speed offenders and incidents of illegal street racing
Increase the level of restraint use	Achieve a correct use and fitting rate of 90 per cent for child restraints and make the use of booster seats the norm for children aged 5 to 10
Increase the safety of older New Zealanders	Reduce the road fatality rate of older New Zealanders from 15 per 100 000 population to a rate similar to that of older Australians of 11 per 100 000

Source: Ministry of Transport (2009)

In addition to overall targets, a number of strategies include intermediate targets and safety performance indicators. One option is to develop an 'outcome management' framework which directly links the outputs from the strategy (what will be done) with outcomes (what is to be achieved). This is a useful approach which focuses attention on key outcomes, and assists in the monitoring process. The following section discusses performance indicators that may be used in the road safety context. These include indicators that can be used as overall targets, or for intermediate targets (Bliss & Breen 2009).

5.2 Safety Performance Indicators

Safety performance indicators can be highly effective in determining road safety policies and interventions. They constitute an essential tool for diagnosing problematic areas, for understanding the processes leading to road crashes, and for helping stakeholders understand how they can contribute to improved road safety.

It is important that safety performance indicators focus not only on the final crash outcomes (fatal and serious injury) but also on intermediate outcome indicators that are thought to contribute and also measure the outputs being delivered to address the outcomes (Organisation for Economic Co-operation and Development 2016).

World Health Organisation (2017) advice to countries is that indicators should:

- Be strongly associated with the injury and/or fatality occurrence
- Be sensitive to changes brought about by road safety measures; and
- Have a clear operational definition, and have feasible monitoring mechanisms available
- Be feasible to collect, compile, analyse and communicate, with high quality data relating to these indicators on a regular/timely frequency.
- Be supported by data that can be collected through unambiguous data collection instruments with the potential to set a baseline and monitor changes over time.

5.2.1 Casualty based indicators

The ultimate aim of a road safety strategy is to reduce casualties. Most strategies include some casualty based measure as a key target. The most commonly used target is a reduction in the number of fatalities by the end of the strategy period. This is often specified as a percentage change over the baseline period. Alternatively, fatalities can be expressed as a rate per unit of traffic or population, and a percentage reduction over time calculated. Examples include fatalities per:

- 10 000 vehicles registered
- billion vehicle kilometres travelled
- 100 000 population.

The fatality rate per 100 000 population allows comparison with other health and social issues, and allows comparison across regions or demographic variables. The fatality rates per vehicle kilometres travel or per vehicles on register allow comparison across time or across different types of facilities. Rates need to be handled and interpreted with care. For example, a review of an earlier UK road safety strategy found that the targets set were not met due to a higher than expected increase in traffic volumes, even though crash rates had decreased (Allsop 2000).

There are problems in using fatalities as a target, especially at the regional or local level. At that level, fatalities usually constitute relatively small numbers and because of this there is often a great deal of statistical variation over time. It is therefore more difficult to determine overall effectiveness using this measure alone. This is likely to become an even greater issue over time, as the number of fatalities has been declining in both Australia and New Zealand. In order to address this, a number of strategies also include serious injuries in the targets (e.g. Australia and New Zealand). These are generally combined with fatalities to provide a total, or can be provided separately. Lower severity crashes are usually not included as targets as there are low reporting rates for these crash types, making them potentially unstable over time. While measuring what matters is the intention in setting injury targets, care should be exercised to ensure simplicity and ease of communication to the public (World Health Organisation 2017).

A change in crash cost (or social cost where this is calculated) can also be used to set targets, and this has the advantage of including different crash severities as one overall figure. These can be provided as totals or as rates that include measures of population or vehicle use.

The New Zealand strategy includes specific targets for different at risk groups, including among others, a 40% reduction in the fatality rate of young people and a 20% reduction in fatalities resulting from crashes involving a drug or alcohol impaired driver (Ministry of Transport 2010). Targets can potentially be derived for any road user group. By defining a target for such a group, increased emphasis is placed on addressing a particular crash problem.

In addition, targets may be specified for regional areas within a national or state strategy or even for local areas (although this is most likely to be beneficial in a regional strategy). As with all target setting, this would need to be conducted in close consultation with relevant stakeholders at regional or local level.

5.2.2 Intermediate goals

Along with casualty based indicators, it is also useful to provide intermediate goals. It is most useful to derive these based on the safety measures that will be implemented as part of the strategy. For instance, if there is a focus in the strategy on speed, indicators of speed reduction will be useful to ensure that this measure is being met. This is particularly useful for monitoring purposes (Section 8), but also acts to focus attention on this issue if specified as a quantified target.

In addition, some authors have highlighted problems when only using casualty reduction targets. Aeron-Thomas et al. (2002) provide advice for the production of road safety plans in developing countries, although the results from this work may be applied to some extent in Australia and New Zealand, particularly at local government level. They suggest that sole use of casualty based targets may be misleading due to under-reporting, and that many actions within a strategy relate to longer term development (e.g. skills and systems) which will not produce casualty reductions in the short term but are required for sustainable reductions in casualties. Although not specifically highlighted below, such capacity building measures could also be used as targets within a safety strategy. See Text Box 2 for a list of intermediate performance indicators proposed in the most recent Australian strategy from which intermediate goals could be drawn.

Text Box 2: Intermediate Key Performance Indicators (KPIs) from the Australian National Road Safety Strategy 2011-2020 (adapted from Australian Transport Council 2011)

Safe roads

- fatalities from head-on crashes
- fatalities from single-vehicle crashes
- fatalities from intersection crashes
- fatalities from crashes occurring on:
  - metropolitan roads
  - regional roads
  - remote roads.

Safe speed

- fatalities from crashes where vehicle speed was a contributory factor.

Safe vehicles

- average age of the Australian vehicle fleet
- percentage of new vehicles sold with a 5-star ANCAP rating
- percentage of new vehicles sold with key safety features (e.g. ABS, ESC).

Safe people

- young driver and motorcyclist fatalities
- older driver and motorcyclist fatalities
- motorcyclist fatalities
- bicyclist fatalities
- pedestrian fatalities
- fatalities from crashes involving a heavy vehicle
- number of drivers and motorcycle riders killed who had a BAC above the legal limit
- fatalities from crashes involving an unlicensed driver or motorcycle rider
- vehicle occupants killed who were not wearing a seatbelt.

Some other possible intermediate goals include: the rate of positive BAC tests per number of tests conducted; rates of helmet use (motorcycle and cycle); rates of traffic offences; and emergency response time to crashes. Caution is required when using enforcement based measures as intermediate goals, as over time, there may be changes in the level of enforcement or in enforcement strategy, and this may result in changes in the number of safety-related offences recorded. In addition, survey based measures may also be used, including: level of interest in road safety by the general public; and the level of understanding of road safety issues. Infrastructure based KPIs could also be considered, such as the percentage of high speed rural roads that are not divided.

Finally, the proportion of the general public trained in first aid has also been used as an intermediate goal (e.g. Sweden's 1995–2000 strategy, cited in Aeron-Thomas et al. (2002). This would be particularly relevant in areas where emergency response times to crashes are slow (for instance, in rural and remote areas).

Regardless of technique used, the targets and performance indicators that are selected should be 'SMARTER'. This acronym stands for targets that are specific, measurable, achievable, realistic, time-bound, extending and recorded (although there are various combinations of the wording for this acronym). Text Box 3 contains further information on the setting of SMARTER objectives. As an example, an 'unsmart' objective might be to 'reduce speeds on rural roads', while a smarter objective is to 'reduce the average rural speed from 104 km/h to 100 km/h by a certain year'.

Text Box 3: 'SMARTER' Targets

- **Specific** – Targets need to be specific so that they are clear and precise. It is important that all stakeholders know what is meant.
- **Measurable** – Targets need to be quantified so that stakeholders can determine whether targets have been met, and more importantly, how outcomes are tracking towards the target through the duration of the strategy.
- **Achievable** – In order to be motivating, targets need to be realistic. It is important that targets are objectively selected based on available data. If targets are over-ambitious, it is less likely that they will be met. It may be necessary to prioritise the most important targets within the available timeframe and resources.
- **Relevant** – The targets should add value, and the ultimate goal of a reduction in casualties should be kept in mind when determining targets.
- **Time-bound** – Given that most strategies are related to a set time period, targets are generally time-bound. Along with targets to reach by the end of the strategy, it is also possible to have interim targets (either formally as a target, or for tracking purposes). These also allow for programs to be adjusted as required.
- **Extending** – It is important that targets are challenging so that the opportunity to maximise casualty reduction is not missed. A balance is required between this and ensuring that targets are achievable.
- **Recorded** – It is important that details about targets are clearly recorded.

6. Strategy and Action Plan Development

The previous sections of this guide have discussed some of the preparation surrounding the production of a strategy. There is a need to document each step so that all of the relevant stakeholders are clear about what the problem is, what needs to be done (and by when), and who will be doing this. The strategy document is the focus of all of these elements, and the main guiding principles within this document need to be agreed to ensure commitment by all stakeholders.

Given the length of time over which most strategies apply (often around a 10 year period), there is need to constantly review the contents of a strategy, particularly in light of current trends and events. Some strategies do this through a formal review process while others utilise action or implementation plans with a shorter timeframe.

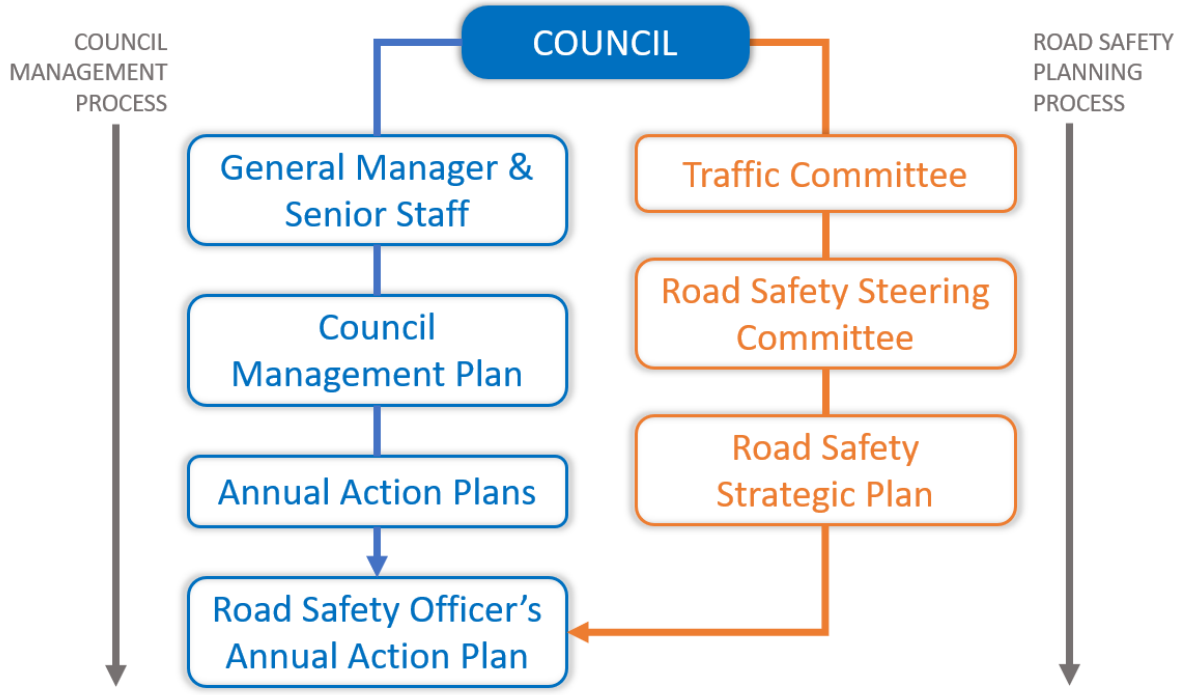
For examples of recent action plans see:

- South Australia: *Towards Zero Together: Road Safety Action Plan 2018-19* (Department of Planning, Transport and Infrastructure 2018)
- Victoria: *Towards Zero 2016-2020 Victoria's Road Safety Strategy and Action Plan* (Victoria State Government 2016).

The Australian strategy (Australian Transport Council 2011) sets overall targets for 2020 as well as a series of 'first steps' that will be completed within the first three years of the strategy. Past Australian strategies have provided for biennial action plans. The current Australian strategy was independently reviewed in 2018 as a precursor to development of the next national strategy.

The most recent New Zealand strategy (Ministry of Transport 2010) was released with overall targets to 2020, but also included 'first actions' which list the initial priority areas that require attention and the actions that will be taken to address these priority areas. Such priority areas include: young drivers; impaired driving; and motorcycles. The New Zealand *Safer Journeys 2010–2020* strategy will be implemented in three action plans and details the process many local councils use to form regular action plans derived from overarching road safety strategies. The process involves many branches of council and is often shaped by competing priorities.

Figure 6.1: An example of the process involved in creating a road safety action plan



Source: De Rome and Davies (2007)

As Section 5 points out, there is a need to consider future developments in the planning process and to anticipate developments that might lead to increases in crash rate. As Section 4 points out, it is also necessary to consider what new developments are becoming available which may deliver worthwhile benefits. The processes of planning and review should therefore have proactive elements, as well as reactive elements which are focussed on change in the light of experience with existing strategies.

Strategies differ on what is included in a strategy document, and what is included in action or implementation plans. One key point of difference is the level of detail on specific measures. Some include greater detail within the strategy, some leave detail to the action plans, while others provide detail for the initial period of the strategy (e.g. the first two years), but rely on action plans to supply detail for later stages of the strategy. There is no right answer as to which is the best approach on this issue. The important point is for strategy to allow enough flexibility to address any specific problems that arise: as the strategy unfolds (for instance in light of new information on potential problem groups); due to changes in the political environment (including changes in funding or priorities) or with new techniques with which to address risk.

Given the differences in the purpose of strategies, it is difficult to provide generic information about what should be included. However, some common features which are likely to be included within a strategy or action plan (and often both) include:

- the vision, and any guiding principles
- comparison with other jurisdictions, especially neighbouring and similar jurisdictions, and acknowledged best practice jurisdictions
- strategic context, including:
  - broader government strategy (especially transport policy)
  - a statement of current problems
- targets and key performance indicators
- countermeasures that will be used to address the problem

- key stakeholders who will be involved in delivering these countermeasures
- costs of implementing countermeasures, and who will meet these (note: depending on the political climate it may be difficult to get a commitment to funding a strategy many years into the future)
- information on how the strategy will be monitored and evaluated
- any research needs
- an implementation schedule.

As well as general road safety strategies, jurisdictions will often devise mode specific safety strategies that set targets and actions to improve the safety outcomes for high risk road users. For example it might be necessary to have motorcycle, heavy vehicle, pedestrian or bicycle strategies that allow for more specific and targeted actions to reduce serious injuries and fatalities to vulnerable road users. Text Box 4 provides links to examples of road safety strategies from different national, state and territory jurisdictions as well as mode specific strategies that could be used as a model for others.

Text Box 4: Links to road safety strategies (Current as at April 2019)

National strategies

- **Australia** – The National Road Safety Strategy, 2011–2020
  www.roadsafety.gov.au/
- **New Zealand** – Safer Journeys 2010–2020
  www.saferjourneys.govt.nz

State and territory strategies

- **New South Wales** –*Road Safety Strategy 2012–2021*
  www.roadsafety.transport.nsw.gov.au/aboutthecentre/strategies/nswroadsafetystrategy/index.html
- **Victoria** – Towards Zero 2016-2020 Road Safety Strategy
  www.roadsafety.vic.gov.au/strategy/victorias_road_safety_strategy.html
- **Queensland** – *Safer Roads, Safer Queensland: Queensland's Road Safety Strategy 2015-2021*
  www.tmr.qld.gov.au/Safety/Road-safety/Strategy-and-action-plans.aspx
- **Western Australia** – *Towards Zero: Road Safety Strategy 2008–2020*
  www.rsc.wa.gov.au/About/Role-of-the-Commission/Towards-Zero-Strategy
- **South Australia** – *Towards Zero Together: South Australia's Road Safety Strategy 2020*
  www.dpti.sa.gov.au/towardszerotogether/road_safety_strategies
- **Tasmania** – *Towards Zero – Tasmanian Road Safety Strategy 2017-2026*
  www.transport.tas.gov.au/roadsafety/towards_zero
- **Northern Territory** – *Towards Zero Road Safety Action Plan 2018-2022*
  https://roadsafety.nt.gov.au/about
- **Australian Capital Territory** – *ACT Road Safety Strategy 2011–2020*
  www.justice.act.gov.au/safety_and_emergency/road_safety/act_road_safety_strategy_and_action_plans

Mode specific strategies

- **Australia** – *National Heavy Vehicle Safety Strategy (Setting the Agenda 2016-2020)*
  www.nhvr.gov.au/about-us/corporate-documents
- **New South Wales** – *NSW Motorcycle Safety Strategy*
  https://roadsafety.transport.nsw.gov.au/aboutthecentre/strategies/nswmotorcyclesafetystrategy/index.html

7. Implementation

The organisational framework for implementation of road safety strategies is the safety management system (European Commission 2018; Organisation for Economic Co-operation and Development 2008). Australian and New Zealand jurisdictions use different safety management systems depending on historical practice and evolution. Useful guidance on safety management systems is provided in Bliss and Breen (2009).

Ensuring a road safety strategy is effective requires knowledge about implementation processes and how and where in other sectors of government and society road safety delivery can be mainstreamed and partnerships built. The following basic requirements have been identified for effective road safety strategy implementation:

- obtaining political commitment
- ensuring an agency takes a leadership role (a road safety champion)
- ensuring stakeholders are accountable for the actions allotted to them
- organisation and coordination of stakeholders
- establishing an organised relationship between actions, implementation plans, organisation and financing
- ensuring effective communication and knowledge transfer
- monitoring and evaluating the implementation plan (process evaluation)
- ensuring adequate resourcing
- ensuring an adequate skills and knowledge base
- including target groups in preparing and implementing policy – politicians, administrators, policy-makers, road safety practitioners and road users (Racioppi et al. 2004).

7.1 Stakeholders

A group of the key stakeholders typically form the main steering committee and oversee strategy implementation. This might include the lead agency that has overall responsibility for the strategy development, police, emergency services, road and transport agencies, registration and licensing agencies and the third party insurer. The composition of this group will depend on the division of responsibilities and working arrangements amongst agencies in each jurisdiction. For example, in Victoria, the Road Safety Executive Group consists of the chief executive officers from VicRoads and TAC, the Assistant Commissioner, Traffic and Operations Support, Victoria Police and Deputy Secretaries from the Department of Transport, the Department of Justice and Regulation and the Department of Health and Human Services. It suggests strategic directions for Victoria's road safety strategy and monitors and reports progress to the government.

As discussed above an implementation/action plan should be developed, and each agency may wish to develop its own plans, programs and actions. The business plans of involved agencies should incorporate the relevant actions contained within the road safety strategy. For example, the *National Road Safety Strategy 2011–2020* provides a framework which complements the road safety strategies of state, territory and local governments and has an associated action plan.

7.2 Financing the Road Safety Strategy

Securing sufficient funds to support the road safety strategy is generally the result of ongoing negotiation with government based on proven countermeasures with sufficient community acceptance. Gaining government support for the strategy is an essential step in securing government commitment and finance. Finance is unlikely to be forthcoming unless the road safety strategy and targets within it are seen as realistic. This applies particularly to any new and controversial elements in the strategy.

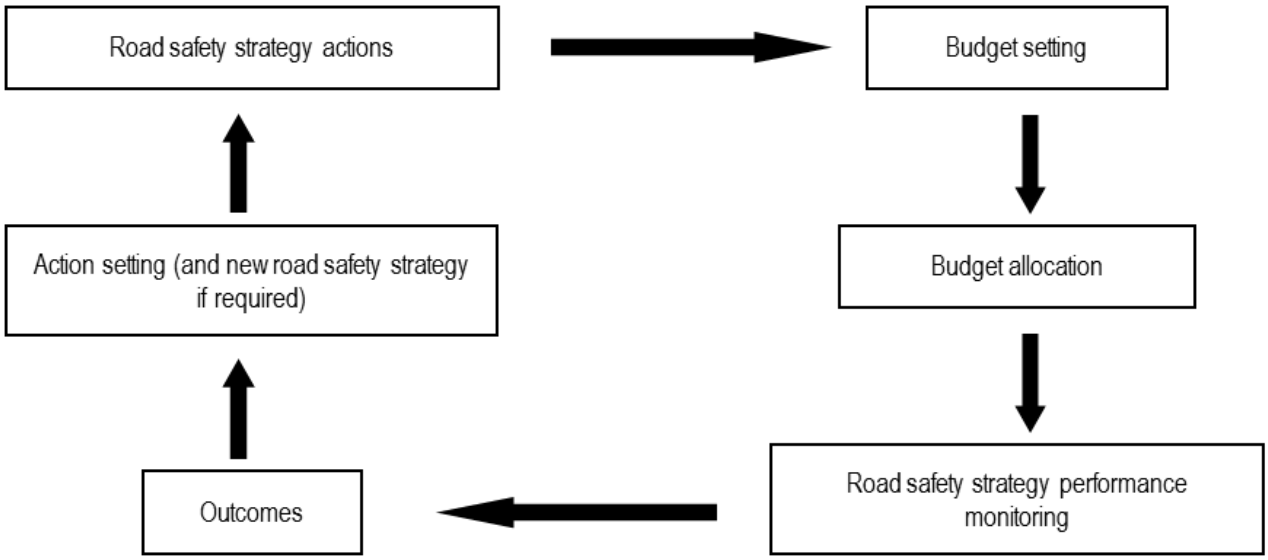
Detailed analysis of benefits and costs is needed to ensure the business case is robust. For example, an assessment of roads in Victoria undertaken as part of an impact investment case study demonstrated that infrastructure improvements would take the network from:

- 40% 4 star or better to 78% 4 star or better for vehicle occupants, and
- 54% 3 star or better to 87% 3 star or better for motorcyclists.

Based on the BITRE cost model, the combined private and social benefit of the above investment would be approximately AUD$323.8M and would have a benefit cost ratio of approximately 9.7 and an internal rate of return of 130% (Woolley et al. 2018).

Figure 7.1 shows the steps needed to be taken in ensuring sufficient financing is achieved in each agency. This would normally occur on a yearly basis, where budget is sought to address the actions in the strategy not yet addressed or achieved, or for any ongoing actions.

Figure 7.1: Financing the road safety strategy



Source: Adapted from Racioppi et al. (2004).

7.3 Implementation Plan

It is recommended that an implementation plan outlining the resources to support the road safety strategy be developed. The plan should identify the key focus areas, outline actions required to complete the deliverables and identify the responsible agency. Links to the relevant strategy and resources are also often useful (an example is provided in Table 7.1).

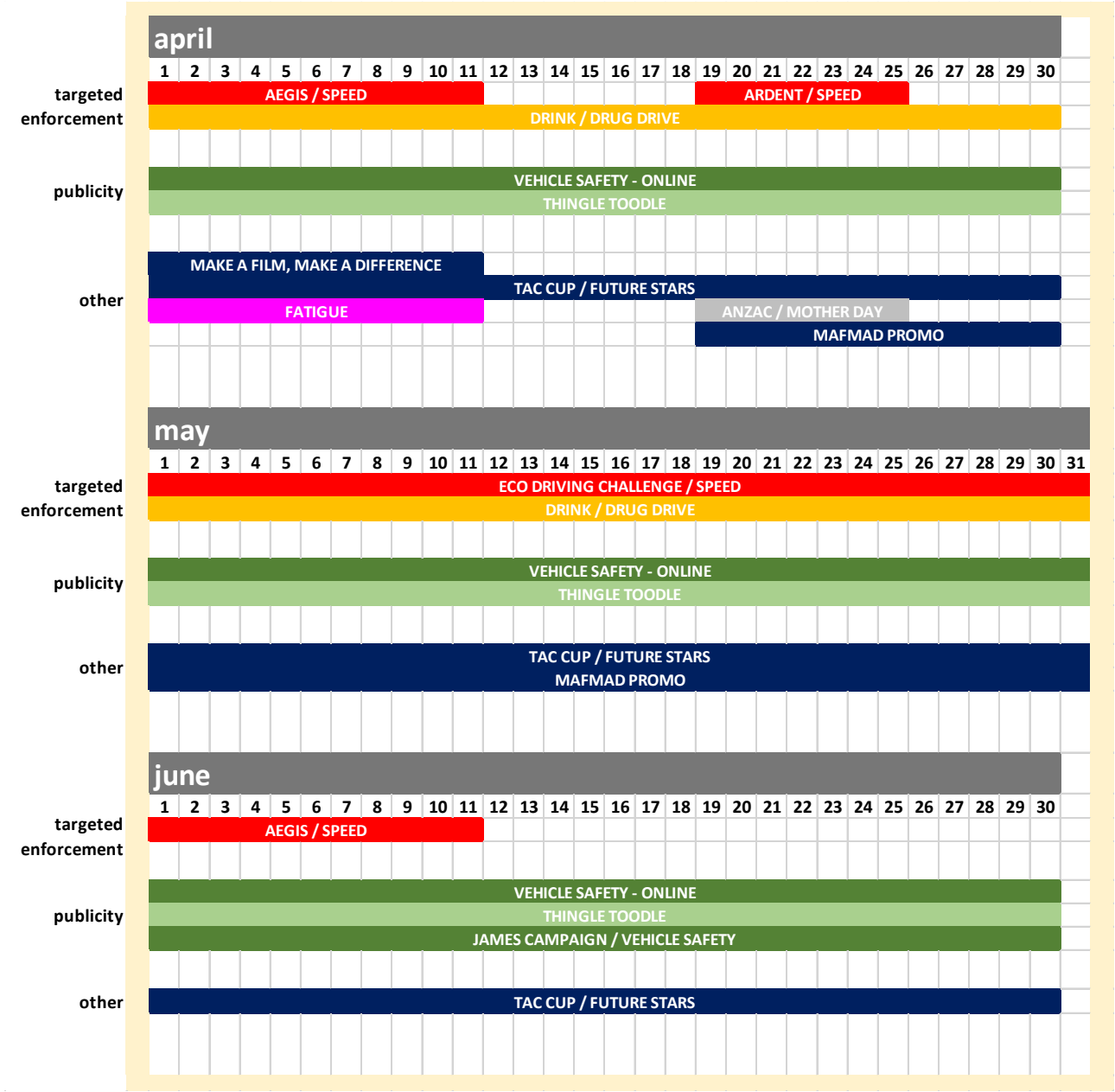
Table 7.1: An excerpt from the most recent New Zealand implementation plan

Focus Area	Specific Actions	Responsibility
1. Enable Smart and Safe Choices	Engage with the public on the value of new safety technologies and encourage them to adopt those technologies voluntarily.	Ministry of Transport
	Pilot in-vehicle technologies that offer better real-time information to road users about road risk, speed limits and current road conditions.	
2. Make Motorcycling Safer	Improve awareness of the benefits of Anti-lock Braking Systems (ABS) and vehicle safety features including conspicuity.	ACC + Ministry of Transport
	Investigate mandating ABS on all new motorcycles over 125cc (excluding off-road motorcycles).	
3. Ensure Roads and Roadsides Support Safer Travel	Develop and implement a national programme of safety improvements on specified highest risk local urban arterials that focuses on all modes and on vulnerable road users. The Programme will be developed by 2017 and implemented during the 2018-2021 National Land Transport Programme (NLTP) – or earlier where possible.	New Zealand Transport Agency, in conjunction with local government
	Develop and implement a national programme of lower cost safety improvements such as rumble strips, wide centrelines and pain treatments on high-risk local rural roads. The Programme will be developed by 2017 and implemented during the 2018-2021 NLTP – or earlier where possible.	
4. Encourage Safe Vehicles	Encourage, Implement and Mandate the following: • Electronic Stability Control (ESC) for heavy vehicles • Under-run protection on heavy vehicles • Anti-lock Braking System (ABS) for heavy vehicles and motorcycles • Side protection standards • Side-curtain airbags for light used vehicles • Autonomous Emergency Braking (AEB) for all vehicles except motorcycles.	Ministry of Transport

Source: Ministry of Transport (2016)

Many agencies produce a calendar of activities to support the implementation plan. It typically outlines the timing of each major activity, what the activity involves, and which agency is responsible. The Victorian road safety strategy calendar is shown as an example in Figure 7.2. This is typical of the documents that have been issued in the past, directed primarily at stakeholder organisations. Months are grouped according to which campaign is being run that month. For each group of months and its campaign there is a summary describing media campaigns, enforcement and other activities; a fact sheet outlining the extent and nature of the problem; advertising in the form of video clips of television advertisements; community resources, in the form of posters or leaflets; and a section on campaign evaluation which is added after the campaign and its evaluation have been completed. The disadvantage is that the details of the campaigns are not available until the month in which they start. However, it is a comprehensive resource for stakeholders and the public once the material is made available.

Figure 7.2: An excerpt from a Victorian road safety program calendar



7.4 Reporting

Progress should be reported at regular intervals, determined by the needs of the various stakeholders. Internal reporting needs to be frequent, to allow interventions on the part of stakeholders when required to ensure the plan stays on track. Reporting to parliament and the public can be less frequent. Progress towards targets should be a major focus of all reporting.

8. Monitoring and Evaluation

Ongoing monitoring and evaluation of a road safety strategy is required to:

- ensure that the road safety strategy actions are being carried out and assess the degree to which actions have been completed (progress made) and targets met
- determine how actions are being carried out and whether this process needs improvement or changing (process evaluation)
- determine if there are casualty and crash reductions, and/or behaviour changes (outcome evaluation) from the actions undertaken
- determine the impact on public acceptance, political environment, support of key stakeholders, remaining funds (cost effectiveness) etc., if required.

Monitoring and evaluation is an essential source of information which helps the lead agency ensure that goals are being met, and may assist other agencies in ensuring they are contributing effectively. Monitoring and evaluation are critical if continuation of the strategy is contingent upon the demonstration of ongoing benefits.

8.1 Monitoring Actions and Targets

Systematic recording of data and analysis of trends from which the performance measures can be calculated allows the most recent values of the measures and their trends to be compared with target levels. This task should be undertaken for a whole target area as well as those relevant to the strategy areas (e.g. road, vehicle, road user). Trends should take into account exposure measures such as population, vehicle, travel counts etc. Performance measures such as alcohol levels, seat belt wearing, speed choice will need to be done via periodic surveys (European Transport Safety Council 2003; Organisation for Economic Co-operation and Development 2008). Guidance on targets and performance indicators are provided in Section 5.

8.2 Process Evaluation

A process evaluation is concerned with how the delivery of actions was carried out and if the methods employed were effective. Thus a process evaluation is aimed at enhancing the current road safety program of actions by understanding them more fully and also determining how they are perceived by the target group.

It is important to determine if the program/actions were implemented as planned and if the objectives were met. If the program does not go to plan, resources could be wasted, in terms of staff time and other costs. In this event, there will be a need to determine which part of the process needs to be changed.

The type of information collected for a process evaluation depends on the nature of the program. Some items for consideration include:

- What was the time taken to implement the countermeasure (quantity of progress), and how were the resources and costs used? Did the process take the time and resources expected, and were process steps followed? Did the countermeasure implementation meet budget? These measurements can be ongoing, as effective management of countermeasure implementation requires regular comparison between actual and planned implementation. This allows for implementation plans to be adjusted as required (Austroads 2009a).
- Were any particular problems encountered during countermeasure implementation?

- Did delivery of the countermeasure meet requirements? (e.g. in terms of the number of countermeasure items developed and delivered to the target group, the numbers of people in the target groups attending events, receiving materials, or reading leaflets).
- What was the impact of the countermeasure? (e.g. in terms of media coverage and opinion of the target group).

8.3 Outcome Evaluation

Outcome evaluation involves making an assessment of whether and by how much a countermeasure has reduced crashes and injuries or changed behaviours. It measures countermeasure effectiveness.

Countermeasures should be effective and provide benefits in terms of injury and lives saved. The value of these benefits should outweigh the costs of providing the countermeasures. The techniques for making these assessments are discussed in Section 4.3. Where it is not possible to make an assessment in terms of injury or crash reduction, behavioural change in the desired direction is the next most satisfactory measure.

For details on the information to collect refer to Section 3 on issue identification and to Section 5 for information on targets and performance indicators.

Outcome evaluation at a whole of strategy level is a complex yet valuable endeavour. Best practice includes engagement of independent experts for strategy review. Sweden's approach includes an annual public review of overall road safety performance. Experience shows that Annual Results Conferences can provide an innovative way of encouraging appropriate focus on strategy goals, targets and objectives, declared contributions and exchange of best practice and accountability for results from key agencies and the wider road safety stakeholder partnership (European Commission 2018).

8.4 Responsibility for Monitoring and Evaluation

Monitoring and evaluation is usually the responsibility of several stakeholders involved in the strategy, under the leadership of the lead agency. There needs to be adequate resources allocated to these tasks. Resourcing should also provide for the prompt dissemination of results and any consequent adjustments to the targets, the strategy itself, actions and/or implementation plan (European Transport Safety Council 2003).

8.5 Relation to other Austroads Material Dealing with Evaluation

This report gives an introduction to the principles of road safety evaluation. For a more in-depth understanding it will be useful to consult other Austroads material dealing with evaluation.

Crash modification factors associated with particular engineering treatments may be found in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b). A comprehensive list of road safety engineering treatments is presented, together with the proportion by which each treatment is expected to reduce crashes. The *Introductory Guide for Evaluating Effectiveness of Road Safety Treatments* (Austroads 2012) details methodologies to estimate the true extent of changes in crash occurrence. It addresses evaluation quality, methods, assessment and reporting as well as providing case studies for various methodologies. This report is highly recommended to provide a practical understanding of the aspects of planning and conduct of studies to assess the effectiveness of actions to reduce crashes on the road system.

Australian Transport Assessment and Planning (ATAP) provides full details on conducting an evaluation, and should be consulted in relation to evaluation of strategies. This is eight part comprehensive guide to all forms of evaluation, extends well beyond evaluation in safety terms to include all types of decisions relating to public transport infrastructure projects, policies and programs which have implications for the positive or negative economic impacts of crashes.

9. Introduction to Risk Assessment and Risk Management

The following sections describe the processes for assessing and managing different types of road safety risks on a road network. A range of issues are covered in these sections, along with illustrative examples. However, the main focus is on risk assessment and management processes. The joint Australian and New Zealand Standard on risk management (AS/NZS ISO 31000:2018) is used as the basis for these sections and is recommended reading for those seeking further details on this issue.

Risk assessment at different management levels requires different tools. At a national or state level safety risks need to be determined globally, identifying broad trends and leading to national or state strategies. At the other end of the spectrum, at an operational level, site risks can be evaluated and managed in a significantly more detailed manner, including identification and management of specific features or hazards. These sections are primarily aimed at the management of risk at the operational level.

The examples used mostly relate to road trauma, but some coverage is made of legal risk, and risk relating to adverse public opinion. When discussing road trauma, examples from road safety engineering are mainly used, but the principles apply to all types of safety interventions.

Risk management in the road safety context should be considered as part of a 'Safe System' approach (e.g. Australian Transport Safety Bureau 2004a). This suggests that:

> *the prime task for transport designers, regulators and policy makers is to minimise the total risk in the system by:*
>
> - *determining the relevant risk factors in a given situation*
> - *determining which factors can be* effectively *manipulated*
> - *determining which countermeasures will produce the desired outcomes.*

9.1 Definitions

The terms 'risk' and 'risk management' are used fairly regularly in everyday English, and this makes the need to clarify what is meant by these terms in the context of this document more important. In general, risk management is often thought of as managing internal and external influences to maximise opportunities. In road authorities it could be seen as managing internal and external influences to maximise positive outcomes, including safety, legal liability, public opinion, and budgets. It could also include minimising the potential for damage (human, financial or image), loss, injury, or death.

Examples of risk in a road authority include the risk of:

- crashes on the road network
- public outcry
- road or bridge failure
- political influence
- unmarked services during construction (i.e. costs for relocation of services)
- legal action.

However, for the purpose of this document, the definitions used in the joint Australian and New Zealand Standard on risk management (AS/NZS ISO 31000:2018) have been adopted, where risk is defined as:

> *The effect of uncertainty on objectives.*

In addition, the Standard states that risk is usually expressed in terms of risk sources, potential events, their consequences and their likelihood.

The risk management process is defined as:

> *Coordinated activities to direct and control an organisation with regard to risk.*

9.2 Principles of Risk Assessment and Risk Management

AS/NZS ISO 31000:2018 provides details as to the stages of risk assessment and risk management. The stages are:

- communicate and consult
- establish the context
- identify risks
- analyse risks
- evaluate risks
- treat risks
- monitor and review.

9.3 Aims and Benefits of Risk Management

AS/NZS 4360:2004 previously highlighted 10 benefits of risk management. While they are not explicitly set out in AS/NZS ISO 31000:2018, all of these issues are relevant to some degree in the road safety context. These are:

- fewer surprises (including mitigating the effect of adverse events through forward planning)
- exploitation of opportunities (with a better understanding of risks, there is a greater confidence to seek opportunity)
- improved planning, performance and effectiveness
- economy and efficiency (especially important in the road safety environment where there are limited resources)
- improved stakeholder relationships (through identification of stakeholders and dialogue)
- improved information for decision making
- enhanced reputation
- director protection
- accountability, assurance and governance
- personal wellbeing.

9.4 Perception of Risk

There are often differences in the perceived level of risk, and the actual risk level. This difference is pronounced when comparing public perception of risk with actual risk, because the public and media perception of risk is often focused on isolated, high profile events. One child killed on the way to school, a school bus crash, a hazardous goods vehicle or a large truck or road train invokes outrage, with full media coverage and calls for immediate action. However, lower profile events that are far more numerous often receive little attention, despite the greater impact on overall trauma.

Individual perceptions of risk are also likely to differ, indicating a need for wide consultation when managing risk.

In addition, research (Transport Accident Commission 2016) shows that the public tends to overestimate the impact of human factors such as driver distraction, inattention, not wearing seat belts, using a mobile phone and drink driving in crash causation compared with simple mistakes. Under a Safe System approach, while drivers are expected to comply with road rules, the road environment should be forgiving enough that a crash caused by these factors will not result in death or serious injury.

9.5 Barriers to the Introduction of Risk Management

Risk management is an important part of the overall management process, and needs to be embedded in this process to have greatest effect. However, there are sometimes barriers to the successful implementation of risk management. Medbury (1995) suggests that these include:

- problems selecting who will drive the program (role conflict)
- financial and staff restraints
- no previous ‘loss’, so therefore no need for risk management
- complacency or resignation to the status quo
- risk management seen as a low priority issue
- cultural barriers to change.

Medbury indicates that most of these barriers relate to management, and therefore strong and genuine commitment is required to the risk management philosophy and methodology. Following from this, similar commitment is required from all relevant staff, and this can be achieved through effective education and communication.

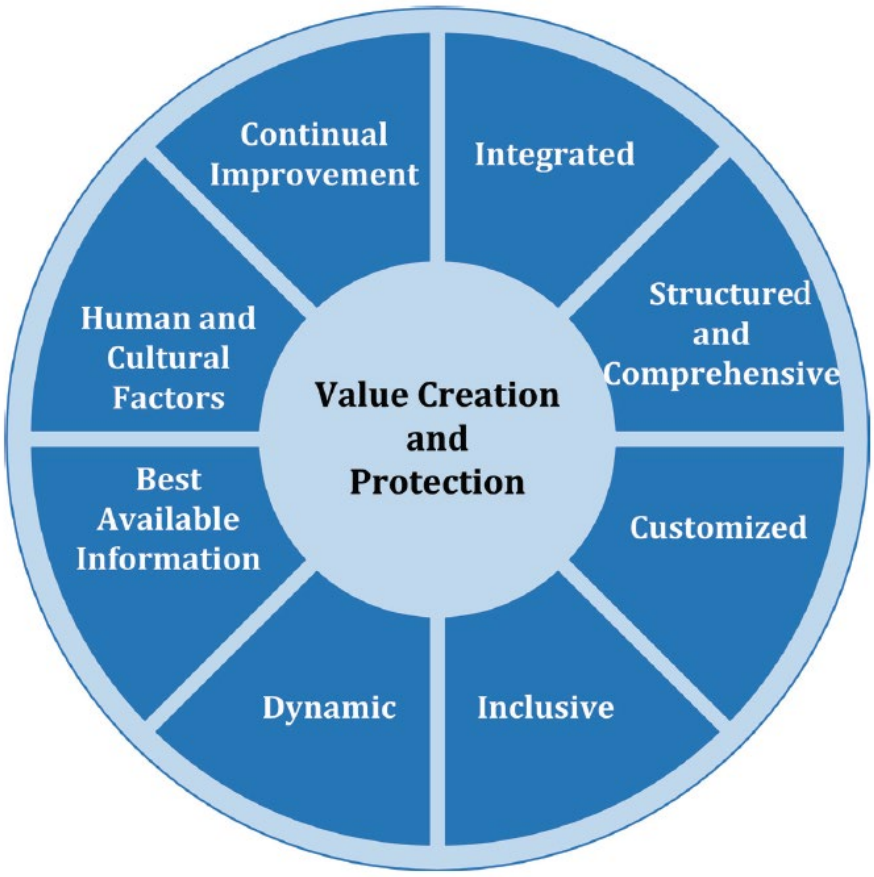
10. Principles of Risk Assessment and Risk Management

This section introduces the principles of risk assessment and management in the road safety context. The aims and benefits of risk assessment and risk management are discussed, including those in relation to the internal context (for example budgets, policy, internal stakeholders and capabilities) and external context (including external policy and public opinion) for risk management.

10.1 Principles

AS/NZS ISO 31000:2018 provides some general principles of risk management. The intention is that organisations apply these principles to their own operations when they are deciding how to manage risk. The general principles are shown in Figure 10.1 and centre around the overarching purpose of risk management, which is the creation and protection of value.

Figure 10.1: Principles of risk management



Source: AS/NZS ISO 31000:2018

How these principles apply in the road safety setting is presented in Table 10.1.

Table 10.1: Risk management principles in the road safety setting

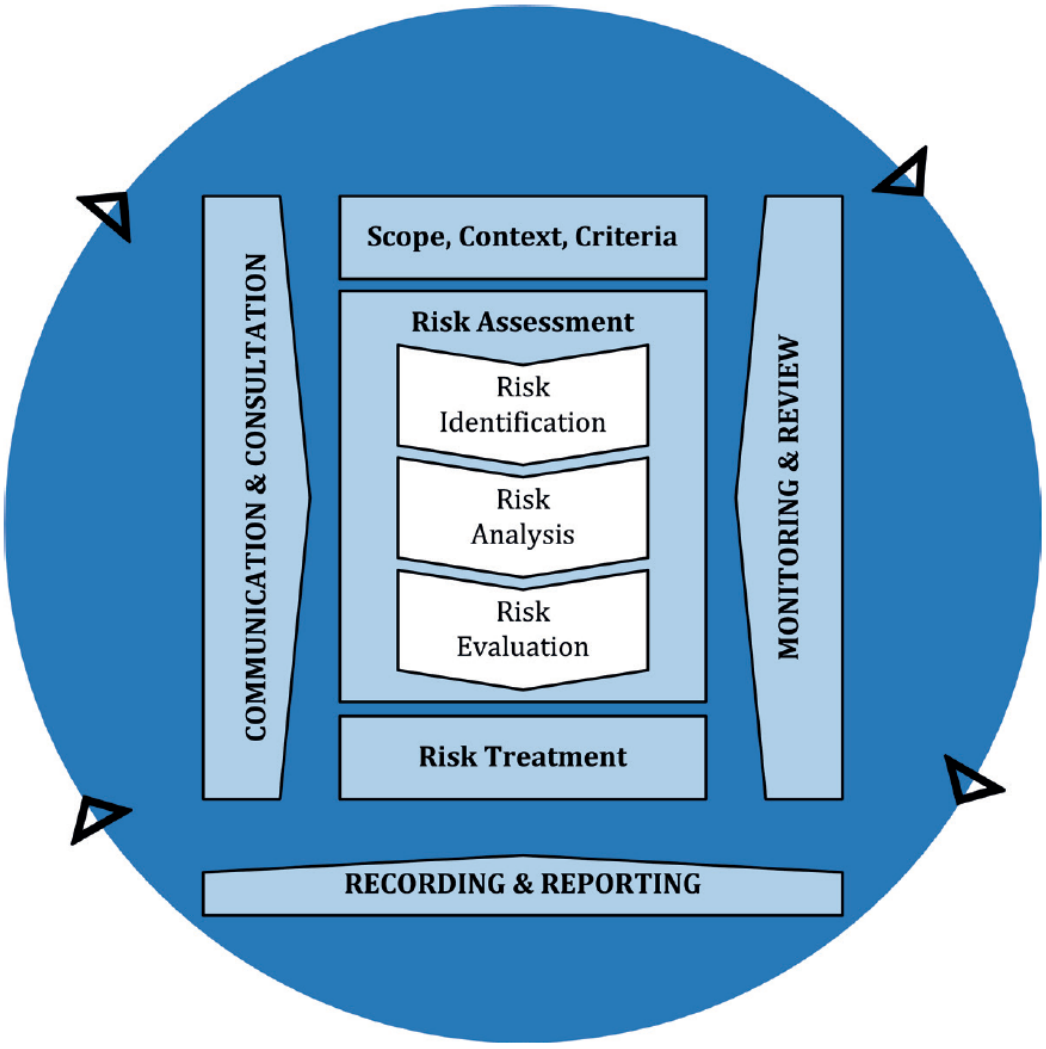
Principle	Description	How it relates to road safety
Integrated	Risk management is an integral part of all organisational activities.	Road authorities have a duty to provide a safe road environment, but not all departments or teams within the organisation are directly involved in providing road infrastructure or in managing road trauma. Those departments should not be exempt from having to think about the road safety implications of their work and should liaise with the road safety specialists in the organisation at the earliest opportunity.
Structured and comprehensive	A structured and comprehensive approach to risk management contributes to consistent and comparable results.	There are many ways of assessing road safety risk and not all are suitable on all parts of the road network. Regardless of the method used, the same method should be used on similar roads or on the same project to ensure that the risks calculated are comparable to each other. This is especially important in road safety programs where projects are being prioritised against each other and comparable methods of assessment are critical.
Customised	The risk management framework and process are customised and proportionate to the organisation's external and internal context related to its objectives.	While no part of the road network is immune to trauma, some parts experience more than others or to a greater level of severity. Methods used to assess risk on high speed rural roads may be excessive on low volume residential streets. The risk assessment framework should be flexible enough to consider different situations and the tools used to assess the risk should be suitable and proportionate to the task at hand.
Inclusive	Appropriate and timely involvement of stakeholders enables their knowledge, views and perceptions to be considered. This results in improved awareness and informed risk management.	Road safety practitioners should be involved in the earliest stages of a project's life. If their involvement is left to the design stage, key decisions about that project may have already been made and will be difficult to change.
Dynamic	Risks can emerge, change or disappear as an organisation's external and internal context changes. Risk management anticipates, detects, acknowledges and responds to those changes and events in an appropriate and timely manner.	Risk registers for programs and projects should be developed and maintained throughout the life of the program or project. Regular risk meetings should be held to ensure that new risks are being recorded and the status of existing risks is being monitored.
Best available information	The inputs to risk management are based on historical and current information, as well as on future expectations. Risk management explicitly takes into account any limitations and uncertainties associated with such information and expectations. Information should be timely, clear and available to relevant stakeholders.	Road crash data is an historical record of the safety performance of an intersection or section of road, but it can also be used as a way of predicting risk (future crashes) on that road. Analytical models such as ANRAM use crash data and other inputs to produce risk ratings, but these models rely entirely on the accuracy of their inputs to produce their forecasts.
Human and cultural factors	Human behaviour and culture significantly influence all aspects of risk management at each level and stage.	Road safety practitioners and the public generally have very different views on the relative risks of using the road network. They may also place different values on road safety, journey times, overtaking opportunities, parking opportunities, streetscape and many other aspects of the road environment. These issues will need to be worked through during the community consultation phase of a project and may have significant impacts on the level of road safety that can ultimately be provided.

Principle	Description	How it relates to road safety
Continual improvement	Risk management is continually improved through learning and experience.	Regardless of how risks are assessed (road safety audit vs analytical models, for example) the process should always be reviewed to identify ways to improve it. Models can be calibrated against observed data and refined to improve their accuracy. New techniques and contemporary thinking can be incorporated into best practice. In this way, the tools and methods used to predict risk will continually improve with the result that our ability to combat road trauma before it happens will also improve.

10.2 The Risk Management Process

AS/NZS ISO 31000:2018 is highly relevant to the road safety setting. The risk management process from that Standard is presented below:

Figure 10.2: Risk management process overview



Source: AS/NZS ISO 31000:2018

There are six key elements to the risk management process, discussed in brief below. Full details can be found in the joint standard. The tasks of identifying, analysing and evaluating risks are often referred to as risk assessment, while the whole process is considered as risk management.

10.2.1 Communication and consultation

At each stage of the process, there should be communication and consultation with relevant internal and external stakeholders. This should also occur for the process as a whole. Communication seeks to promote awareness and understanding of risk, whereas consultation involves obtaining feedback and information to support decision-making. It may be useful to develop a communication plan to help facilitate this process. Such communication is important to enable understanding of the decisions made, but also to identify the perceptions regarding risk by stakeholders.

Stakeholders will vary according to local circumstances, but should include:

- community groups
- road user groups
- police
- elected representatives
- automobile associations
- asset managers
- operation managers
- health care professionals
- relevant state and local government agencies
- funders for road safety
- local residents.

10.2.2 Scope, context and criteria

This step is important to gain appreciation of all factors which might influence the ability to meet the intended outcomes. It involves establishing the scope (strategic, operational, program, etc) and the external context, including identifying external stakeholders, relevant strategies, regulatory issues and the financial environment. It also involves establishing the internal context, including discussions with internal stakeholders, and reference to all relevant strategies and plans.

Establishing the context includes defining the goals and objectives, and the scope or range of activities which the management process should cover. These include (but are not limited to):

- road trauma levels/crash types/crash costs
- the legal context, and liability
- public opinion.

In addition, there is a need to develop some criteria against which the risk is to be evaluated. This includes assessing the needs for treatment based on financial, social, legal or other criteria.

Finally, it is suggested that the structure for the rest of the process be defined, including sub-dividing activities into a set of steps which provide a framework to assist with delivery and to ensure that risks are not overlooked.

10.2.3 Identify risks

This step involves the identification of risks to be managed, and a systematic approach is required to ensure that all relevant risks are identified for inclusion in later analysis. Risks that are under the control of the organisation should be identified, as well as those that are not. Consultation with internal and external stakeholders is important in identifying all relevant risks. Information on techniques that can be applied in the identification of risks is highlighted in Section 12.

10.2.4 Analyse risks

An analysis of risks requires an understanding of the level of risk so that decisions can be made about how or whether to treat the risk. This involves assessing issues such as the consequences and likelihood of an event, including the magnitude of consequences should the event occur. Analysis of events can be quantitative (including analysis of historical data), semi-quantitative or qualitative (including expert judgement). Communication and consultation with relevant stakeholders is required as part of this process. Further details on types of analysis including examples from the road safety context are provided in Section 13.

10.2.5 Evaluate risks

An evaluation of risks is required in order to select those risks that require treatment, and to prioritise these. Organisations are unable to treat all potential risks, given a finite level of resources, and this is also true in the road safety context. It is important to prioritise risks in order to produce the maximum benefit from the limited available resources. It is also important to communicate and consult with all relevant stakeholders during the prioritisation task. The issue of risk evaluation is dealt with in detail in Section 14.

10.2.6 Treat risks

Once an assessment of the risks has been undertaken, and those risks that need to be treated have been identified, it is then necessary to assess available options for the treatment of those risks. A treatment plan should be produced including details of how the risks will be treated, who will be responsible, and what are the expected outcomes. Close communication and consultation with stakeholders is required when treating risk. Details for this stage of the process are provided in Section 15.

10.2.7 Monitor and review

Ongoing monitoring and review is required throughout the risk management process. This is to ensure that progress is being made against the treatment plan, and that continual improvement can be made. As an example, it is important that the effectiveness of treatments is monitored so that this information can be included in future treatment plans. It is also important to evaluate the influence of changing internal and external factors in this process. The issues surrounding monitoring and review in the road safety context are presented in Section 16.

11. Establishing the Context

An appreciation is required of all factors that might influence the ability to meet the intended outcomes. To gain such an appreciation, there is need for the following:

- communication with internal and external stakeholders
- review of relevant internal and external strategies
- review of regulatory issues
- appreciation of the financial environment and funders, both internal and external
- definition of the goals and objectives.

Also important is an understanding of the Safe System framework, the details of which can be found in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021a). This considers the system (vehicles, roads, road users and their physical, social and economic environments) as a whole, including the interaction between the individual elements.

In the road safety context there are a number of risk types that can impact on authorities. Most familiar are those relating to the level of road trauma, including number of crashes, crash types and crash costs. However, there are other risks that need to be considered when setting the context, and when identifying issues that might impact on outcomes. The legal context is an increasingly important risk that needs to be managed by authorities, and public opinion should also be included in the risk management process. Each of these issues are discussed below, and used as the basis for discussion throughout the rest of this document.

11.1 Road Trauma

Road authorities in Australia currently manage a road system on which around 1200 people are killed, and approximately 36,000 people seriously injured every year (average per year between 2013 and 2015; prior years not compatible due to changes in injury classification, BITRE 2018). In New Zealand the figure is around 325 deaths a year, with 2,400 serious injuries (average per year between 2000 and 2016, Ministry of Transport 2019). Effective management of the road network is a key performance indicator for all road authorities, and as the key provider of road infrastructure there is an obligation to provide a safe road environment and to minimise this risk.

Road trauma, and the social and economic costs associated with it is an area of risk that needs to be managed by authorities. Authorities are in a leading position to reduce trauma levels on their roads through a variety of means, but particularly through road engineering. Examples are provided in later sections of this report on managing risks relating to road trauma.

11.2 Legal Context

There is more than a moral obligation on road authorities to provide a safe road environment, with legal obligation (particularly in Australia) also an issue. Given the differing legal situations in Australia and New Zealand, responsibilities for each are treated separately.

11.2.1 Australia

It is difficult to provide generic advice in this section given the differences across jurisdictions, and the fluid nature of the legal situation. Legal advice should be sought at the local level.

Traditionally, the non-feasance rule has provided authorities with immunity from liability for their failure to repair and maintain the roads in their jurisdiction. However, recent test cases (most notably *Brodie v Singleton Shire Council*) have changed this situation with the limitation of non-feasance immunity. This has implications for Australian authorities and may leave authorities open to legal liability when crashes occur. The non-feasance immunity has been replaced by a recognition that road authorities owe all road users a duty of care, and must do what is reasonable to be aware of deficiencies in the road system, to assess and prioritise them, and have a system for remedying them (Sarre 2003). This responsibility covers the full road reserve, and by implication, all road users (including pedestrians).

Road authorities are obliged to have in place reasonable programs of inspection to allow them to identify problems with their roads. This assessment should take into account the fact that road users might fail to take proper care of their own safety. The road authority should have in place arrangements to make sure that deficits which pose a risk to road users are dealt with in a reasonable time, having regard to available resources.

It should be noted that the requirement of duty of care does not demand that there be no deficiencies in the road system – only that a road authority will do what is reasonable to monitor and remedy problems. The court decisions recognise that the resources available to an authority, including the availability of material and skilled labour, may limit how quickly repairs can be made, and how work is to be prioritised. If this results in a delay to remedying a situation which is hazardous for road users, the road authority should consider other alternatives such as using signs to alert road users of the hazard or, in extreme cases, closing the road.

Different jurisdictions have responded to the recent test cases in different ways, with some jurisdictions reintroducing legislation. For instance in Queensland sections 35-37 of the *Civil Liability Act 2003* provide limited protection of a nature similar to non-feasance, although there are specified exceptions to its application within the Act itself so it is not a complete protection. Many jurisdictions have taken a more active role in managing risks. It is beyond the scope of this document to address the legal situation in each jurisdiction, and authorities are advised to seek local legal advice when addressing the legal context.

11.2.2 New Zealand

In New Zealand, road controlling authorities have no specific duty under law to consider and implement measures to address road safety risk. Instead, personal injury is considered a community responsibility and individuals who are injured are not entitled to sue whether the injury was caused by individuals or organisations.

11.3 Public Opinion

When considering the context, community needs and expectations need to be carefully considered. Communities are increasingly demanding safety on their road networks, and there has been increasing media interest in road safety issues. As discussed, there are differing perceptions as to levels of risk. A car hitting a train will often make front page news, whereas a single vehicle run-off-road crash will hardly rate a mention. The latter event is the far more common, and so carries a greater degree of risk in terms of overall trauma.

Conversely, individual road users often perceive the risk associated with individual journeys as being relatively minor. Therefore, it is often difficult to persuade individuals to change their behaviour in order to reduce risk. However, when aggregated, changes in behaviour can have a high cumulative effect on overall safety. Rumar (2002) suggests that the crash risk in every trip is microscopic, but that an individual may make many such trips over time, and that the sum of all of these risks is substantial over a longer period. Even greater is the collective risk over the whole community.

Levels of perception may not be based on the actual level of risk, and this is an issue that needs to be managed. Cherry and Fishburn (1996) suggests that as an individual:

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

It is important to avoid making judgements of acceptable risk from an individual point of view, and so consultation with key stakeholders is required when defining objectives.

Due to the public's perception of risk on the road network as being very low, they are often resistant to changes that will impact on them, such as reductions in speed limits that will increase journey times, particularly in rural areas where travel distances can be great. Research (Transport Accident Commission 2016) suggests that almost all drivers consider their skills to be better than average, and that they are therefore capable of driving at high speeds. Communicating the risks to the community as a whole will be key to overcoming these issues.

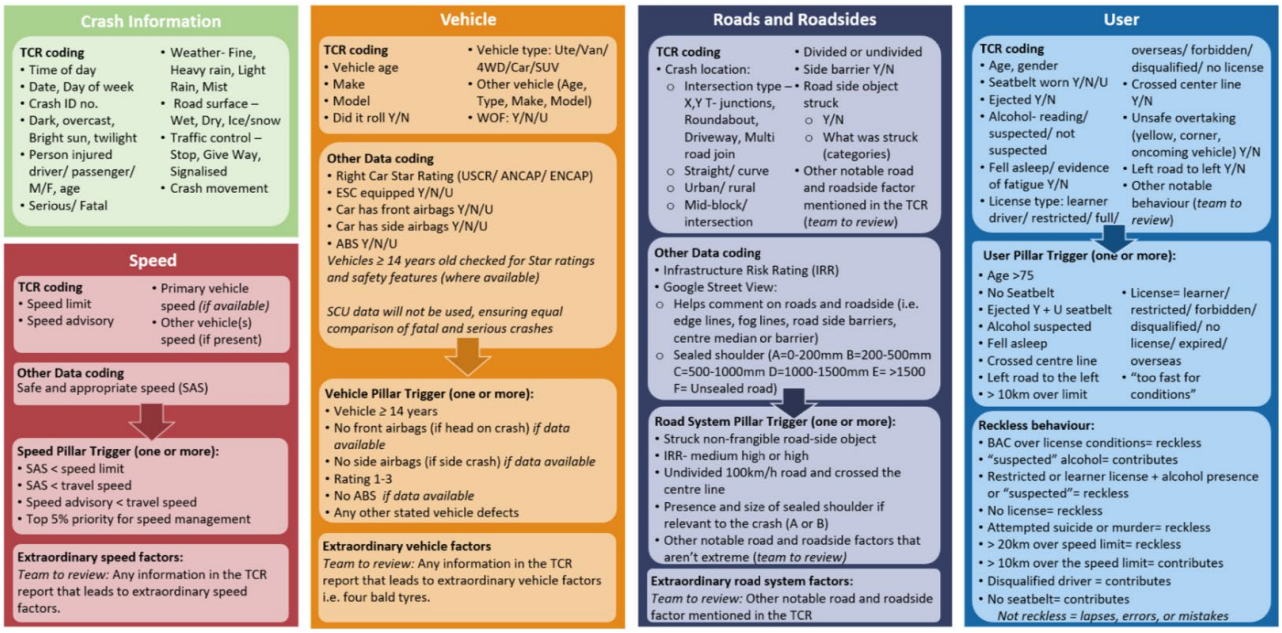
12. Identifying Risks

Once the context has been established, and goals and objectives have been set, the first step of a risk assessment involves the identification of risks to be managed. Consultation with internal and external stakeholders is important in this process, and this identification should be done in a systematic way. The examples of road trauma, legal and public opinion have been used as types of risks. These are the risks of most relevance in the road safety environment, but there are others that may be of importance, and it is up to the authority to identify all risks that may be of relevance.

12.1 Road Trauma

There is a large variety of factors that contribute to road crashes. In identifying risks at the network level there is a need to take a systematic approach to ensure inclusion of all of these relevant risks. Mackie et al. (2017) highlights a number of potential contributing factors to road crashes, in a table that aligns with the Safe System (see Figure 12.1), which should be taken into account when developing solutions to reduce fatal and serious injury crashes.

Figure 12.1: Factors contributing to road crashes



In the early 1980s Haddon developed a useful conceptual framework for considering the factors which contributed to road crashes. It consisted of a matrix of potential risks involving the human, vehicle and road, and how these can influence safety before, during and after a crash (see Appendix A for further information about the Haddon Matrix). The matrix can be used as a way of developing a comprehensive set of possible crash countermeasures. A number of the causes of road crashes are outside the influence of road authorities (especially at local level). However, it is useful to identify all risks to determine which of these can be addressed through the risk management process. Those risks relating to the road will be of greatest relevance to authorities, while those relating to the vehicle will be least susceptible to change (at state and local level). For this reason, examples used in this document relate mainly to road safety engineering measures, although the methods discussed could easily be applied to other areas of treatment.

Appendix D outlines some of the issues associated with risk assessment and management and road user issues, and concludes that a risk management approach should be applied to the 'human element'. However, such an application has not been conducted in any consistent way in the past, and this is an issue that needs to be addressed.

12.2 Legal Risk

Identification of legal risks will need to be based on discussions with legal advisors within each jurisdiction. The legal situation varies between jurisdictions, and it is beyond the scope of this document to address this issue in detail. However, identification of risks might include the following:

- review of the legislative position in the local jurisdiction
- review of relevant precedents and test cases
- assessment of insurances, including the appropriate level of liability
- review of systems, including network management and project level tools.

12.3 Risk from Adverse Public Opinion

In order to identify risks associated with public opinion in a systematic way, a community attitude survey can be undertaken. A representative sample should be selected, and a structured survey undertaken to gauge opinions on a range of safety issues. This can be repeated over time to assess changes in attitudes and opinions to key issues.

Given the influence of the media, and the degree of interest from the media in road safety related issues, media monitoring will also provide information from which potential risks can be identified.

13. Analysing Risks

Following the identification of risks, the next stage in a risk management process is analysis of these to help determine whether to treat the risk, and if so, how. Consideration should be made as to the causes of the risk, and the likelihood and consequences that the risk will occur. Similar risks can be combined for ease of assessment, and low impact risks excluded from further analysis. This screening process is often necessary, as given limited resources, it is usually not possible to thoroughly assess and evaluate all risks. In some circumstances, a qualitative approach (this could be defined as any method which uses descriptors rather than numerical values when classifying risks) can be used as an initial screening, and will help identify where the level of risk does not justify a more in-depth quantitative analysis. Alternatively, a more in-depth quantitative investigation may be necessary to provide appropriate details. In addition, adequate data may not be available to undertake a quantitative analysis, and so a qualitative approach will be required. Sometimes, a combination of techniques may provide greater insight, such as when dealing with highly uncertain events and particularly those with severe consequences.

This section highlights a number of issues relating to data and processes for risk analysis.

13.1 Sources of Data

Once all sources of risk have been identified, there is a need to collect information on each of these to determine the level of risk. There are a number of sources of information that can be used, although in some cases it will be difficult (if not impossible) to collect relevant information with which to make informed decisions. Sources of information include:

- crash databases
- hospital or insurance data
- pro-active assessments of safety, including road safety audit and Safe System assessment findings, and network level assessments such as computer modelling
- information from asset management and road maintenance
- road inventory data
- traffic volume, speed and vehicle classification data
- enforcement data
- monitoring data
- legal precedents
- public opinion surveys
- media monitoring.

A brief discussion on some of the key sources of data can be found in Appendix E.

13.2 Quantitative Approaches

When assessing the risks for road trauma, blackspot analysis is typically used to identify locations with high levels of risk. Blackspot sites, lengths of road or areas with crashes over a minimum number per year are selected for inclusion in the analysis (for instance, three casualty crashes over a five-year period may be used as a minimum for a site). A list of sites is produced, which forms a ‘short-list’ for more in-depth assessment and consideration for treatment.

However, a simple analysis of crash numbers gives no indication of the severity of the crashes involved, so often the crash or social cost is used (higher severities have a higher crash cost, and these costs can be aggregated by site, area or topic of interest). For example, Table 13.1 shows a list of intersections in the Victorian blackspot program ranked by crash cost.

Table 13.1: Example of sites by social cost

Intersection name	Fatal	Serious	Other	Crash cost
Mt Glen Drive x Kennys Road	1	3	1	$11,612,950
Cemetery Road x Princes Street	1	1	3	$10,497,750
Baillieu Street x King Street	1	1	1	$10,287,350
Rosanna Road x Yarra Street	0	4	18	$4,544,800
Forge Creek Road x Racecourse Road	0	3	1	$2,093,600
Lardners Road x Main South Road	0	2	4	$1,746,400
Buckley Street x Victoria Street	0	2	3	$1,641,200
Goold Street x Wallace Street	0	2	3	$1,641,200
Dunsmore Road x Settlement Road	0	1	2	$873,200
Short Street x MacRae Street	0	1	2	$873,200

In addition, crash risk analysis can be undertaken by including a measure of vehicle volume to crash information. This provides a level of crash risk by vehicle volume (for instance, crashes per million vehicle kilometres travelled or vkt) to identify routes, areas or crash types that fall above the average expected. Similarly, pattern analysis can be undertaken to identify common crash types for treatment (for instance drink drive, speed, fatigue, and run-off-road crashes). Crash costs can also be included in this type of analysis to indicate severity (for instance cents per vehicle kilometre, or dollars per kilometre of road. See Land Transport Safety Authority 1996).

It may be useful to determine risk by making comparisons with other similar groups or regions. This can also help identify issues to target for remedial action. Such comparisons are used internationally (e.g. Australian Transport Safety Bureau 2004b) to compare key performance figures (primarily deaths per population, deaths per registered vehicle, and deaths per vehicle kilometre travelled) for different jurisdictions. They are also used nationally, for example in New Zealand in the production of annual road safety reports, which highlight the safety of each authority. As an example, major cities form ‘Comparison Group A’, and each of these cities is compared to the all-group average. Comparisons made with similar authorities will have more relevance than data from the whole country. Differences between comparison groups can often be explained (e.g. high volumes of through traffic from outside the area will distort measures based on population), although in many cases these differences may help highlight issues that require attention.

Further percentage rates are calculated to consider factors such as road type (sealed/unsealed, divided/undivided etc), night time crashes (which relates to delineation), fatigue and speed (for further details see Kidd & Willett 2001).

Western Australia also produces road safety performance charts and maps across the network including road user type and crash type clustering. An internet based system called ‘Intersection Crash Ranking’ allows interactive reports to be produced for a single intersection, or a series of intersections by local government, region or state-wide, based on 5 years of crash data. Results can be ranked by crash frequency or crash cost (similar to Table 13.1 above) and detailed summary reports produced showing crash types and road users.

Further examples of network level approaches are provided in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b).

Simulation or modelling techniques can also be applied where information allows, and this technique is a powerful tool in assessing network risk. These types of models typically use a combination of historic crash data and road characteristics known to influence safety outcomes to produce a risk rating or score. This approach is much more in line with the Safe System approach of addressing risk proactively, rather than treating crash locations. For example, a cluster of run-off-road crashes on a stretch of road may highlight a genuinely risky location, or it may simply be a statistical anomaly that is not representative of the overall risk along the road. Similarly, a road with no crashes does not mean that the road is free from risk.

In considering the modelling of road safety indicators, Bergel (1998) produced a model to consider adjustments to be made to (monthly) crash data to enable comparison and evaluation of road safety initiatives. An example of the model is provided in Table 13.2 below.

Table 13.2: Bergel model of road safety indicators

Levels	Risk exposure	Risk	Severity
Modelled variables	Traffic	Number of crashes (non fatal, fatal)	Number of victims (deaths, seriously injured, lightly injured).
Explanatory variables	• Economic growth • Network length • Fuel price • Weather conditions	• Traffic • Economic growth • Network length • Fuel price • Weather conditions • Speed • Seat belt use	• Traffic • Number of crashes • Economic growth • Fuel price • Weather conditions • Speed • Seat belt use

Consideration of this modelling provides an indication of the variables that are likely to influence the exposure, probability and severity of crashes on the road network.

13.3 Qualitative and Semi-qualitative Analysis

In some situations, there may be a lack of objective data with which to make a quantitative assessment of risk. For example, in assessing the level of risk based on legal liability, there is little objective information on which to base any analysis. In these cases, more qualitative approaches may be used. There are various models of qualitative risk assessment that are of relevance to road safety. These include:

- risk classification
- fault and success trees
- cause-consequence diagrams.

Further details of these can be found in Appendix F.

13.4 Data Quality and Integration

Good quality information is important in order to make informed decisions about the current level of risk. However, there are often deficiencies in the available data due to factors such as constraints in data collection systems and errors in the database, including incorrect recording of the location where crashes occurred. Crash databases are comprehensive in the collection and recording of crashes involving fatalities, but those involving lower severities often go unreported or are inaccurate in terms of location and orientation of vehicle movements. In some instances, the data collected may be based on subjective judgement.

It is therefore important to know how much reliability can be placed on data to enable informed decision making, and to work towards improvement where deficiencies are identified. These limitations can have direct implications on the successful management of risk. As an example, crashes attributed to the wrong location may direct funds to the wrong site, and lead to the problem not being addressed. There is a need for active management of data quality to improve decision making.

13.5 Cost Effective Data Collection

There is obviously a wealth of data that could be collected to enable decision making about the level of risk. However, there are costs associated with data collection, both in financial and human resource terms. Therefore, there is a need to prioritise the data collected. The decision as to whether data are collected should be based on risk management. The question that needs to be asked is whether the availability of the data item could assist in analyses which could lead to preventing something from happening that would have an adverse impact on the objectives identified at the outset of the risk management process. If it will, then data collection will most likely be required.

14. Evaluating and Prioritising Risks

Once risk levels have been identified, there is a need to evaluate and prioritise these for treatment purposes, as there are usually limited resources available with which to reduce risk. This prioritisation needs to take place with reference to the internal and external context, and especially in relation to the available level of funding. It is also important to prioritise risks with reference to the original objectives and to consult with all relevant stakeholders about the prioritisation process, and the outcomes from it.

This section provides guidance and examples to enable practitioners to effectively evaluate and prioritise risks.

14.1 Prioritising Risks

One of the overall aims of risk management in the road safety context is to reduce trauma, and to do this in the most cost effective way. Given limitations on budgets, it is important to determine which interventions will produce the greatest savings in casualty numbers and severity. In many cases risks may be identified, the treatment of which would be at the expense of other more serious risks. As identified earlier, there are several sources of information relating to risk, including blackspot analysis, information from pro-active approaches (such as road safety audit), maintenance programs and public feedback. Each of these sources needs to be used in the process of prioritisation for later treatment.

Blackspots, routes and areas are perhaps the easiest of risks to prioritise, and there are well-established techniques available for this task. Other types of risk are more difficult to prioritise, although there is an array of location-specific and network-level tools available.

14.1.1 Evaluation based on historic data

The most commonly applied technique to evaluate existing crash locations is to assess historical trends in data (including blackspot analysis and other techniques described in the previous section). This involves comparison with existing crash numbers (or crash rates, or the social cost of these crashes) over the network. However, evaluation also requires knowledge of expected reductions at the locations if they are treated. Predicted reductions in crashes from proposed treatments are calculated to provide input to a benefit cost analysis at each site. Sites can then be compared, and the most economically advantageous set of sites and interventions programmed for remedial work. For further discussion on this issue, see Appendix G.

This process implies some knowledge about those sites that can be most effectively treated. Sites with high crash rates or social cost that have multiple causes of crashes may be more difficult to treat than sites with a lower social cost but greater commonality in crash types. Treating sites with a common crash cause where all the crashes are broadly similar may produce a higher reduction in social cost for the amount spent, although this will vary by site.

In addition to the cost benefit approach, intervention levels are sometimes used when prioritising sites for treatment. Intervention levels (along with levels of service) are mainly used in maintenance programs, but have relevance to road safety. As an example, surface condition, and the level of skid resistance may be subject to periodic assessment. Once the pavement condition deteriorates to a pre-determined level, remedial action is programmed. This level may vary as a result of geometric design elements (particularly horizontal and vertical alignment), traffic volume, rainfall, or road environment (including speed environment), and at hazardous locations such as intersections, or prior to pedestrian crossings. A lower intervention threshold is typically used in some environments as skid resistance is more important, and plays a greater role in safety at these locations than it does at others. Intervention levels help us to prioritise remedial treatments to get the maximum benefit from limited budgets.

One drawback with this approach is that it tends to ignore locations with a similar underlying risk because they happen to have no crashes. On low volume, high speed rural roads where crashes are often a result of random chance and do not necessarily point to a deficiency in geometry, assessment is more difficult. A series of cross intersections along a route may be virtually identical, and therefore have a similar underlying risk, but a crash history at one intersection does not always mean that it is riskier than another. The challenge is quantifying the underlying risk so that risky sites are not left untreated.

14.1.2 Evaluation where there is little historic data

In the case of risks identified through pro-active assessment (such as network level assessments of risk, or road safety audit), or with sites and treatments suggested by elected members or the public, there is often little crash data to help with prioritisation. Because of this, prediction about future crashes is difficult. However, given that the majority of crashes on the road network fall outside what would normally be defined as blackspots, there is a need to address such locations in order to reduce overall road trauma.

The Australian National Risk Assessment Model (ANRAM) is a tool that may be used in these circumstances to help assess risk and predict the number of crashes on a road network. These can then be used as a proxy for actual historical crashes and crash reduction factors can be applied as normal to determine crash savings.

Appendix H provides further details on such tools, while Section 17 includes practical examples where such tools have been used successfully.

14.1.3 Comparison between risk types

Although there are tools available to prioritise risks within each of these sources of information (i.e. comparing blackspots and prioritising for treatment), it is much more difficult to prioritise risks across a variety of data sources, for instance blackspot sites and recommendations from road safety audit. In Australia, the Department of Infrastructure, Regional Development and Cities (2018) suggests that recognition needs to be given to both blackspot and pro-active approaches, and suggests a proportion of safety treatments for each approach:

> *… the Black Spot Programme also recognises that there are road locations which could be considered as 'accidents waiting to happen'. Therefore, some programme funds may be used to treat sites where road traffic engineers have completed a Road Safety Audit and found that remedial work is necessary. This allows an opportunity for proactive safety works to be undertaken before casualties occur.*

In some locations there are fewer blackspots, and crashes are more scattered across the network (for instance on rural roads and in some local government areas). In such locations a higher proportion of funding on proactive safety works may be appropriate.

RSRM is an effective tool in prioritising pro-active approaches against more traditional blackspot treatments. As an example, this tool can be used by authorities to objectively assess public feedback (e.g. requests for installation of pedestrian crossing facilities) against other treatments highlighted from traditional blackspot programs. If the request for treatment falls short of risk reduction that may be gained from other expenditure, practitioners have a valid reason that is objective, transparent and documented with which to reject such requests.

14.2 Practical Examples

Practical examples of road network risk assessment tools are provided in Section 17. Some of these include:

- Victorian Safe System transformation of Top 20 roads
- Queensland RISC software tool
- Network crash rates
- AusRAP – Road Protection Score
- UK SafeNet
- Western Australia CRASHtool
- Australian ALCAM
- Australian ANRAM
- Safe System assessment framework.

15. The Treatment of Risk

Just as there are multiple causes of crashes, there are multiple ways in which these causes can be treated. Some of these treatments are more effective than others making availability of relevant information on risk reduction important. Selection of treatments should be based on sound evidence, as measures that may appear to be potentially effective to the casual observer may have little impact on safety or, in the worst case, may actually lead to increased risk.

When treating legal risk, relevant local advice needs to be sought. For treatment of risks associated with adverse public opinion, there is a need to formulate relevant strategies, and this can be done in association with public relations personnel.

When treating the risk associated with road trauma, there are a number of ways that authorities can decrease the level of risk. These include:

- reduction of exposure to the risk
- reduction in the likelihood of a crash (including the concept of a 'no surprises' environment)
- reduction in severity (e.g. creating a more forgiving road environment).

In terms of solutions to the risk related to exposure and consequences, remedial treatments could be viewed as:

- elimination - remove the hazard
- substitution - use a safer option
- engineering controls - in terms of design modifications
- isolation - where the hazard is removed from direct influence
- administrative controls - including educational initiatives, speed limits, licensing, drink driving laws, or
- personal protective equipment – for example vehicle improvements (air-bags, electronic stability control etc.).

Additionally, the Haddon Matrix and Safe System may be used to formulate countermeasures based on human, vehicle and road related issues (including speed), and how these can influence safety before, during and after a crash.

Of greatest relevance to most authorities is the effect on risk from changes to the road environment. Through the monitoring of engineering based measures, information exists on the level of reduction that can be expected from measures in different road environments (crash reduction/modification factors). Care must be taken when selecting treatments based on their crash reduction factors (CRFs) as these are typically measures of a treatment's ability to reduce crash likelihood. As Australia and New Zealand move towards embedding the Safe System, greater importance should be placed on treatments that reduce crash severity, whether in combination with likelihood or not. It may even be acceptable in some circumstances to accept an increase in crash likelihood if the treatment will eliminate (or virtually eliminate) death and serious injury.

A wide variety of engineering-based remedial measures are available to treat road safety risk. It is beyond the scope of this guide to discuss these and the reader is referred to Austroads (2019). In addition, the notes on administration for the federal black spot program have a treatment crash reduction matrix showing expected crash reductions for various treatments. Most state road authorities have similar and generally expanded crash reduction information for state blackspot programs.

Once treatments have been developed for each of the risks, a treatment plan should be produced. This should include details of how the risks will be treated, who will be responsible for treatment of each treatment type, and what the expected outcomes are.

16. Monitoring and Review

Ongoing monitoring and review at all stages of the risk management process are required to ensure that the treatment plan is being met when implementing treatments, and that lessons learned from the process are recorded and included in future risk management. Measures may have both positive and negative consequences, and it is important to assess these to help refine future treatment options, and to minimise any negative factors. Monitoring is not only a useful source of information within the authority for use at a later date, but is also potentially useful for other authorities.

In addition, it is important to recognise the impact of changes in an organisational context (either in relation to internal or external factors), for instance in levels of funding, legislation or overall strategic policy. Treatment plans will need to be reviewed and altered where appropriate as the result of such changes.

A number of authorities monitor the success of road safety treatments based on changes in crash numbers. This typically involves evaluation of crashes before and after the treatment, and attributing changes in crash numbers or rates to that treatment, although it may also involve monitoring changes in behaviour (such as compliance with speed limits). Statistical techniques are often applied to determine the effect of the treatment, and where possible appropriate control sites should be used to help counter any effects caused by external factors. Care also needs to be taken in ensuring that changes in traffic volumes are taken into account when evaluating some types of treatments. Further details on these issues can be found in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b).

As Australia and New Zealand move towards embedding the Safe System, treatments that reduce injury severity will become increasingly important. Crash severity should therefore be included in the list of things that should be monitored so that, in time, a database of FSI reduction factors can be created alongside crash reduction factors.

A number of authorities have created monitoring databases to assess the effectiveness of road engineering treatments. At the most basic level, a monitoring database should include records of what problem existed that prompted the need for action, the actions that have been taken, the location, and the date that the actions were started and completed. Ideally, this information should be linked to information on crashes both before and after treatment. Any other relevant information that has been collected should also be included (for instance, before and after speed data for a speed camera site).

Examples are given in Appendix H of the US CMF Clearinghouse database and the New Zealand Crash Analysis System (CAS).

17. Risk Assessment and Management Case Studies

A number of case studies are provided in this section to illustrate examples of risk assessment and management in the road safety context.

17.1 Victorian Safe System Transformation of Top 20 Roads

Run-off-road crashes represent a significant issue on Australasian roads. Recent research from Victoria (Victoria State Government 2016) highlighted the following:

- 44% of deaths and 20% of serious injuries occur on high speed rural roads
- 64% of fatal crashes on undivided high speed roads involve drivers crossing the centre line and either striking another vehicle head-on or running off the road
- 21% of fatal crashes on undivided high speed roads involve drivers running off the road to the left
- For every 100 km stretch of high speed, high volume rural road (such as freeways) 17 people are killed or seriously injured every year.

A key strategy of the Towards Zero Action Plan is the transformation of the 20 most dangerous rural roads in Victoria to full Safe System compliance. This is part of the Safe System Road Infrastructure Program (SSRIP), which is a partnership between VicRoads and the Transport Accident Commission (TAC). Unlike previous similar programs to treat roads with high run-off-road crash risk, the Top 20 program recognises that clusters of crashes do not necessarily represent areas of higher risk and that any area could be the site of a crash. Consequently, the strategy is to treat the entire road length by installing continuous flexible safety barrier, including in sections that would meet traditional clear zone requirements. Additionally, at-grade intersections are either being closed, replaced with grade separated interchanges (on freeways) or roundabouts (on highways) where possible.

This is an example of treating roads based on risk rather than crash history. While sections of those roads do have a crash history, there are also sections that do not, but there is usually nothing different about those sections to warrant lesser treatment.

17.2 Queensland RISC Software Tool

Queensland Department of Main Roads has developed a Roadside Impact Severity Calculator (RISC) software tool which is aimed at prioritising roadside hazards for removal (see Douglas & Spencer 1999). It specifically deals with roadside hazards, as run-off-the-road crashes account for greater than twenty per cent of all crashes in Queensland. A three step procedure is involved that includes:

17.2.1 Hazard identification

Hazard identification is used to evaluate the hazard potential of roadside objects. This considers variables such as clear zone, location of hazard and crash history. Clear zone rules of thumb or AASHTO (the American Association of State Highway and Transportation Officials) guides are used in the identification process.

17.2.2 Risk analysis

Risk analysis is performed to evaluate the risk posed by the hazard. This is based on AASHTO guidance and considers road environment variables, traffic volume and object attributes. These inputs are used to calculate an encroachment frequency (a base encroachment rate multiplied by traffic volume, curvature and grade factors). The object collision frequency is then calculated by considering lateral encroachment probability, encroachment angle, vehicle 'swath' width, encroachment frequency and object lateral offset and width.

17.2.3 Assessment of remedial measures

Appropriate treatment options are then identified. Benefit cost analysis is then used to rank treatments to get the best return for limited funds. Other factors, such as environmental or social issues, may also influence the order of ranking.

17.3 New South Wales Network Crash Rates

In New South Wales, the former RTA has calculated crash rates at a network level for various road stereotypes, focusing on rural roads. The project aims to determine the relative priority of road links by identifying current and potential problem locations for analysis. A spatial database was set up linking road crashes with other roadway attributes and parameters.

Crash data was collected and stored electronically and geo-referenced. Road attributes were collected through use of GispiCam imagery data collection.

Thirty-four roadway cross sections with similar design characteristics and layout (road stereotypes), were selected. These stereotypes covered single and dual carriageways according to number of lanes, ranges of lane width and ranges of shoulder width. Average historic crash rates were then calculated for each stereotype.

Within each stereotype, different sections have their own additional attributes. These attributes (e.g. centre line marking, horizontal curvature, speed zone, traffic volumes) were analysed to determine what effect individual attributes had on crash rates for each stereotype. For instance, the model calculated that for two lane divided sections with a painted median, the average crash rate is 9% lower than the average crash rate for two lane non-divided sections.

The model allows the identification of problems on a route basis and the effect of remedial treatments to be considered. Subsequent to identification and suggested solution, economic analysis and cost-benefit can be applied to prioritise treatments.

17.4 AusRAP – Road Protection Score

The RACV, on behalf of the Australian Automobile Association engaged ARRB to develop and pilot a methodology to assess the inherent safety of a road network based on the engineering features of that network. The network level road safety risk assessment process is designed to form part of the AusRAP (the Australian Road Assessment Program) initiative.

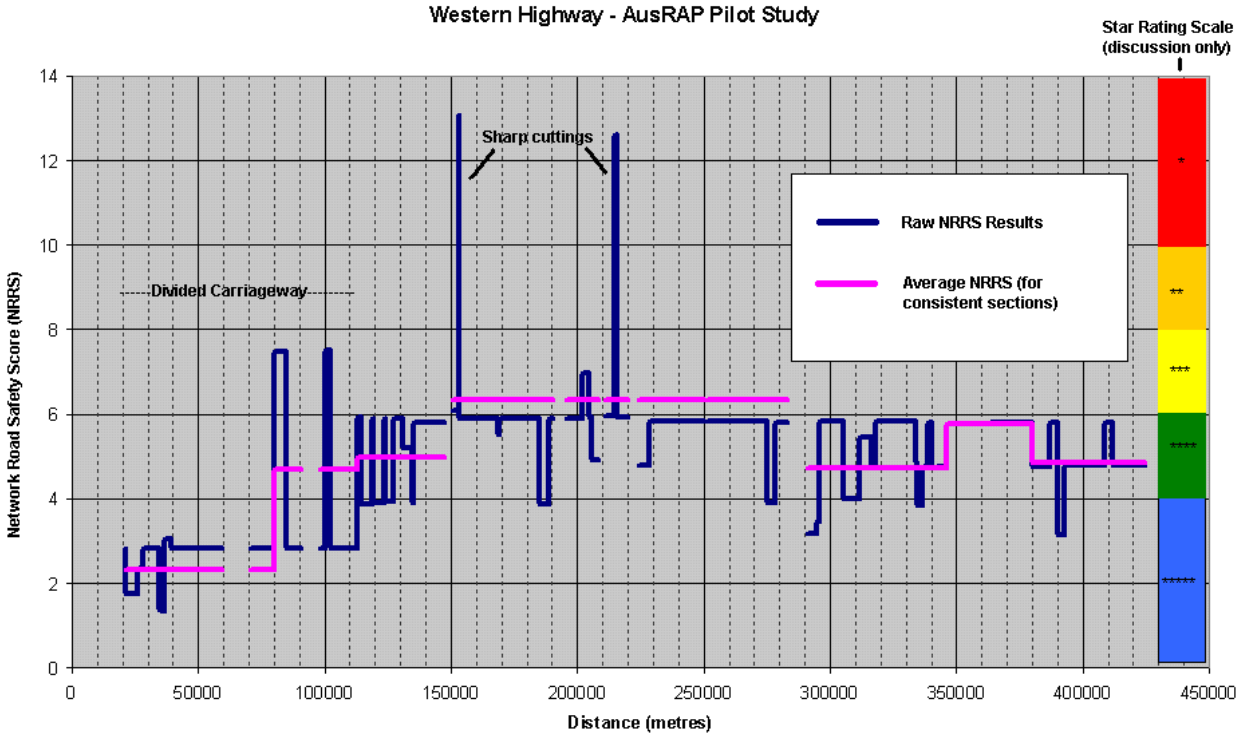
The pilot provides an initial working model for the key stakeholders to evaluate the feasibility, potential applications and presentation methods associated with the AusRAP models, and facilitate its communication to the public.

The project involved the development of a network level road safety assessment methodology, building on existing work completed by ARRB and Austroads as part of the Road Safety Risk Manager research.

The results of the pilot study are summarised in Figure 17.1. The key measure used to assess risk was the Network Road Safety Score (NRSS), based on the proactive assessment of a range of road engineering features. The lower the NRSS, the safer the road.

As an indication, the first 110 km of the Western Highway in Victoria is divided carriageway and as such scored a lower level of risk. The risk on the undivided sections increased, with fluctuations in risk evident along the entire road as road features (such as roadside hazards, alignment, cross-section, intersections etc) varied in condition.

Figure 17.1: AusRAP Pilot Study: Network Road Safety Scores



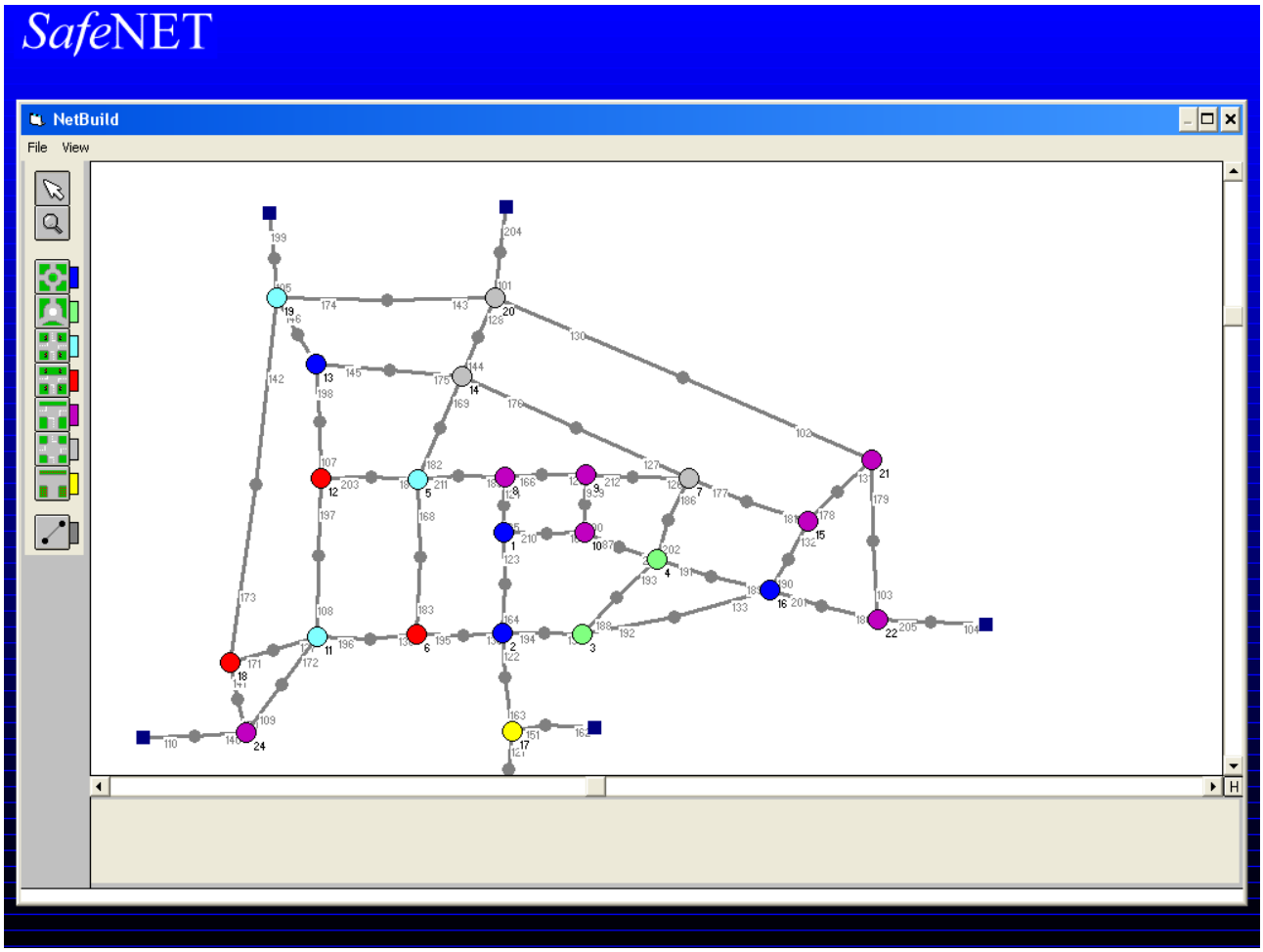
Following the completion of the pilot study the motoring associations have now publicly released the findings (see eg www.Ausrap.org), and further work is planned in the development of the Network Road Safety Scores in the near future. The extension of the AusRAP research has been identified as a priority action in the National Road Safety two-year Action Plan.

17.5 UK SafeNet

The Transport Research Laboratory (TRL) has developed *Safe*NET (Software for Accident Frequency Estimation for Networks), a software package to assist traffic engineers in the design of safer road networks. Research has been conducted to develop models to predict crashes, and to apply these models for an area-wide assessment. The *Safe*NET software is designed to provide a rapid assessment of the effects of potential network management changes and how changes in junction design, form of control and traffic assignment affect the crash frequency on the network.

The software allows users to build their network on the screen (Figure 17.2). Data can then be added for each network feature.

Figure 17.2: Screen representation of SafeNET road network



From this information, details of the predicted number of crashes can be obtained.

'Accident predictive models' have been developed for typical intersection types. The model estimates the number of crashes that can be expected on average, given information on traffic flow and the design of the intersection or link.

Total junction or road link crash frequencies can be obtained by entering information on vehicle flow, pedestrian flow and site characteristics. This software is designed to interface with assignment programs to combine predictions of how traffic will re-route, and estimates of resulting crash patterns (Department for Transport 1999). TRL has recently released version 2 of this software.

17.6 Main Roads WA CRASHtool

CRASHtool is a software tool that is designed to assist in the analysis of reported road crashes on the Western Australian public road network. It provides an interface with the WA crash data system (the Integrated Road Information System, or IRIS) and includes features that assist in the identification and diagnosis of hazardous locations. It also has the capability to analyse the safety effectiveness of multiple countermeasures at a location, and to rank and prioritise results from this analysis. CRASHtool is also integrated with black spot program nomination processes.

Development of CRASHtool began in October 2002, where it was initially intended as a tool to assist in fatal crash investigations. However, it is now used more widely including road network analysis and works program prioritisation. Reporting is intended to assist with crash analysis investigations, research and black spot submissions (Figure 17.3). The tool can be used to:

- diagnose performance problems at a location by comparing crash distribution with network average crash patterns
- prepare a collision diagram at intersections
- rank possible countermeasures in decreasing order of net present value of crash costs to enable treatment selection
- assess trends in crashes at a location using a crash factor matrix
- model up to four countermeasures simultaneously at a location and prepare cost benefit calculations.

Figure 17.3: Example of report output from CRASHtool

Network Average Crash Pattern Comparison

Project title: **Sample intersection**

Crash data from:	01/01/1998	To:	31/12/2002
IRIS extract file:	D :\Sample.txt		
Filter applied:	No filters applied		
Road Environment	Intersection at major road / major road in a built up area		
Last report run at:	26/11/2003 16:10		

Crash grouping		RUM codes	This study area	Network average	Flag
Crash Nature	Rear End	31, 32, 33, 55, 61, 62	31	55	**Significantly under-represented**
	Head On	21, 51	0	0	
	Sideswipe	23, 24, 25, 26, 34, 35, 36, 37, 38, 39, 42, 53, 54, 64	7	7	
	Right Angle	11, 12, 13, 14, 15, 16, 17, 18, 19, 10, 47, 48, 49	15	16	
	Right Turn Against	22, 27	44	15	**Significantly over-represented**

It is intended to continually refine CRASHtool with proposals to include information on traffic volume and composition, pavement geometry and condition, and speed zone information.

17.7 ALCAM

The Australian Level Crossing Assessment Model (ALCAM) is used to assess the level of risk at level crossings throughout Australia. The ALCAM model was initially developed by the Queensland Government and is now managed by a national reference group which continually monitors its relevance and reliability. ALCAM produces a risk score for a level crossing based on the physical characteristics of a level crossing and the existing warning and control devices that have been installed.

ALCAM provides a relative risk rating (comparative to other crossings) rather than assessing the safety of a crossing in a stand-alone manner. The model is also useful in the identification of the key characteristics that contribute to risk at level crossings.

A risk score is calculated based on the risk posed to each road vehicle driver that approaches the crossing, assuming that the driver exhibits appropriate behaviour, and is not an overall measure of the safety of the crossing. Scores are not used to determine whether a crossing is ‘safe’ or not, but rather as an indicator on how the risk score for a crossing would compare with the level of risk that may be acceptable at other crossings with a similar traffic and road environment profile.

The risk score is calculated by assessing the traffic level (average daily train movements multiplied by average daily road vehicles). This is then modified by an Environmental Factor, which acts as a multiplier to address the severity of the consequences of an incident based on factors such as the type of road/rail traffic, road approach alignment and road traffic speed.

Risk scores that fall below the ‘Installation Score’ indicate a level crossing risk is likely to be within acceptable limits and remedial work to address the identified risks is probably not required (although the condition and use of the crossing must be monitored). Risk scores that fall between the ‘Installation Score’ and ‘Intervention Score’ may have hazards that need to be managed, while those above the ‘Intervention Score’ are likely to require priority attention to reduce the level of risk.

18. Local Government Context

The preceding sections of this part to the Guide are relevant to local governments, however the purpose of this section is to further understand how local government and community road safety are managed in Australia and New Zealand, what types of activity they involve, and how they contribute to road safety outcomes. It is intended to assist persons involved with local road safety activities in carrying out their duties, including community members, local government employees and elected representatives, and public servants employed by other levels of government to support local programs. It outlines the conceptual basis for community road safety and its potential benefits, describes its objectives and the institutional arrangements necessary to sustain it, discusses the difficulties associated with evaluating programs at the community and local government level, and provides links to successful programs and available resources. It also suggests ways in which local government can work to improve road safety through road safety strategies and management.

18.1 Local Government Road Safety and Community

In Australia and New Zealand local government, community road safety has become established as an essential element in most jurisdictions' road safety programs. The role of Australian local government in delivering road safety and the importance of engaging the community are acknowledged in the *National Road Safety Strategy 2011-2020* (Australian Transport Council 2011) and the *National Road Safety Action Plan 2018 – 2020* (Transport and Infrastructure Council 2018). For New Zealand, the guiding documents are the *Government Policy Statement on Land Transport 2018/19 – 2027/28* (Ministry of Transport 2018), *Safer Journeys* (Ministry of Transport 2010) and the *National Land Transport Programme 2018-21* (New Zealand Transport Agency 2018). In Australia, the role of local government in delivering road safety is also recognised in the road safety strategies developed by the different state governments (see Text Box 4 of Section 6). Effective community road safety programs are based on the same general principles as other road safety activities managed at the national or state level, but they do pose some particular challenges.

Local government and community road safety programs cover a wide range of organisational and financial arrangements which vary considerably in their scope and activities. Precise definitions of the terms 'local government road safety' or 'community road safety' are unlikely to satisfy all contributors to these areas. It is sufficient to agree that the terms refer to road safety actions with a local focus, which are initiated, managed and delivered within a local community. State or national government agencies located within the community may be partners within this process.

Although precise definitions are elusive, it is worth making the distinction between 'local government' and 'community road safety'. 'Local government road safety' implies activities which are embedded in local government processes and operations, and where local government is the lead agency. 'Community road safety' is the more general term and is sometimes used to include local government road safety, but it also includes arrangements where the lead agency could be a community organisation not directly linked to council. Where such arrangements exist, local government is generally encouraging and assists with staff participation, use of facilities and financial support.

18.2 Strategic Role of Local Government

Local government is an integral partner in the governance of New Zealand and Australia. The Australian Local Government Association's *Strategic Plan 2017-2020* (ALGA 2017) identifies four core strategic priorities. Of relevance to local government and community road safety, these priorities include strengthened regions and cities, and infrastructure that meets the needs of local communities.

Building capacity and sustainability are key strategies in pursuit of these priorities. The ethos and practical steps which have evolved in community road safety therefore provide a good fit to the priorities of local government as defined by its peak body. The *Local Government Roads and Transport Agenda* (Australian Local Government Association 2019) describes local government's role in collaborating with federal and state/territory governments to manage transport networks and infrastructure, and advocates for increased partnerships for road safety programmes.

In most jurisdictions, local road safety programs are delivered through local government. Even in jurisdictions where they are not, local government is a key player in the steering committee and is a major contributor to its functioning by making available premises, funding, staff and other support.

A broadly similar situation applies in New Zealand, where Local Government New Zealand (LGNZ) is a partner and stakeholder with central government in governance matters applying to local jurisdictions < http://www.lgnz.co.nz/>. LGNZ represents the 78 local authorities on all matters that affect local government, including road safety strategy and direction. LGNZ's policy priorities include infrastructure and social issues (Local Government New Zealand 2017). These priorities have direct relevance for road safety outcomes, with transport networks and community safety specified as key issues.

Local government has responsibilities in a number of other areas where there may be possibilities for productive synergies. All councils have land use planning and regulation and the provision of roads as core functions. Although arrangements differ across jurisdictions, and differ among councils due to factors such as size, resources and priorities, councils are often active in the areas of transport and traffic planning, and health and community services, including youth services and services for older adults.

Local road safety programs and activities are likely to be more sustainable and receive better support from local government if there is a commitment to road safety in the council's general plan or strategic statement along with a reporting mechanism which puts road safety objectives and progress towards their achievement before council. This will require the support of elected representatives as well as council officers.

Local government has important roles to play in improving road safety, e.g.:

- it has primary responsibility for the safety of the roads it owns and manages
- as a planning authority, it has a duty to consider the road safety implications of decisions regarding land use and the form of developments on roads that it controls, and may have an advocacy and/or partnership role in other situations
- it has a role in lobbying higher levels of government for funding transport infrastructure and services which will benefit the community and for changes to legislation which may have a particular impact on its community, e.g. aspects of police traffic enforcement
- it has a role in engaging and empowering its community in relation to road safety issues, in encouraging safe road user behaviour, and in coordinating local resources for better road safety outcomes.

Local governments in different jurisdictions fulfil these roles in different ways. The obligations stemming from the first of these roles is discussed in Section 18.4 and the practical implications of the first and second of these roles are discussed in Section 18.5. The third and fourth roles are discussed in Sections 18.6 to 18.8.

18.3 Local Government's Duty of Care as a Road Authority

Road safety is a core responsibility for road authorities in Australia and New Zealand. The community expects a high level of road safety. Road crashes result in serious financial losses and emotional trauma which affect communities, particularly smaller communities where people killed or injured and their families or businesses are more likely to be known to other community members. Road safety is high on the political agenda, and road crashes attract wide media coverage.

In Australia, a series of court decisions have established that road authorities (including local governments) have a duty of care towards road users. In practice, this means that they must do what is reasonable to be aware of deficiencies in the road system, to assess and prioritise them, and have a system for remedying them (Sarre 2003).

Road authorities are obliged to have in place reasonable programs of inspection to allow them to identify problems with their roads. This assessment should take into account the fact that road users might fail to take proper care of their own safety. Road authorities should also have in place arrangements to make sure that deficiencies which pose a risk to road users are dealt with in a reasonable time, having regard to available resources. Note that the requirement of duty of care does not demand that there be no deficiencies in the road system – only that a road authority will do what is reasonable to monitor and remedy problems. The court decisions recognise that the resources available to an authority, including the availability of material, skilled labour and funding, may limit how quickly defects can be addressed. If this results in a delay to remedying a situation which is hazardous for road users, the road authority should consider other alternatives such as using signs to alert road users of the hazard or, in extreme cases, closing the road.

As planning authorities, they have a duty to ensure that road safety is not compromised by excessive demands on the road system posed by developments, and have the capacity to ensure developers address potential safety issues as part of their development proposal e.g. providing adequate road layouts (including lighting and footpaths) for new developments, providing traffic signals or intersection redesign for large new commercial developments.

In New Zealand, road controlling authorities (RCAs) have no specific duty under law to consider and implement measures to address road safety risk. Instead, personal injury is covered by a national injury insurance scheme. As in Australia, the community has a growing expectation that authorities will provide safe travel conditions.

Duty of care and its chief implications are that all local governments must take responsibility for the safe operation of the roads they manage. The minimum commitment to road safety is a process for identifying safety issues and prioritising them, a process for remedying these issues within a reasonable time frame and a process for managing unsafe situations until remedial works can be undertaken. Each of these processes must be defensible as ‘reasonable’. Most local authorities would seek to go beyond this minimum. As Section 18.6 shows, there are benefits for the community in going beyond road engineering and land use planning and developing a more comprehensive approach to road safety which engages local stakeholders and reaches widely into the community. Higher levels of government have been active in supporting these developments with staff and funding, and efforts have been well received by local governments’ constituencies.

18.4 Direct Actions to Improve Road Safety through Councils’ Operations

Local councils have opportunities to directly influence road safety outcomes through some of their core business activities. The principal ones are discussed in this section, but the list is far from comprehensive. Nevertheless, it can be seen that many aspects of councils’ activities are involved, embracing many different individuals. It is therefore essential to make the point very clearly that road safety is something that touches on all council officers’ responsibilities. The discussion about partnerships, capacity building and social capital in Section 18 applies to networks and relationships within council, as well as within the community at large.

18.4.1 Action as a road authority

In order to meet legal and/or community expectations, there are a number of things that a local council must do in terms of understanding the deficiencies of its road network, managing traffic and managing maintenance issues.

Local government is responsible for most of the roads in Australia and New Zealand. In Australia, local government manages approximately 75% of the length of all roads and it is estimated that 36% of all kilometres travelled are on local roads (Australian Local Government Association 2017). In New Zealand, local government is responsible for 88% of the national road network, which caters for approximately 50% of travel (Local Government New Zealand 2017a).

As a road authority, a local council is required to have a reasonable knowledge of the deficiencies in its road network and a long-term plan to remedy these as funds become available. This may be based on a number of information sources, such as a crash analysis carried out as part of developing a road safety plan, safe system assessments, road safety audits or inspections, or automated surveys of road geometry, cross-section and roadside clearances.

In many jurisdictions, crash data for local government areas can either be accessed via a website or provided by the organisation responsible for the state or national crash database. It is common for the crash data to be presented spatially, which simplifies interpretation and provides a useful tool for communicating with the community.

Safe System Assessments (SSAs) are a tool that considers and quantifies the degree of alignment of a design or concept with Safe System principles with the objective of minimising fatal and serious injury (Austroads 2016). The Austroads *Safe System Assessment Framework* (Austroads 2016) ensures consistent consideration of major crash types and assessment of crash severity, road user exposure and crash likelihood as they apply to each crash type.

It is good practice to conduct road safety audits (RSAs) for new facilities at a number of different stages from initial planning to opening. Comprehensive instructions and check lists are available in the *Guide to Road Safety Part 6A: Implementing Road Safety Audits* (Austroads 2019b). It is also good practice to audit existing facilities from time to time to ensure that hazards are identified and assessed for remedial treatment. At a network level, survey procedures and risk analysis tools are available which assess levels of risk over the entire road network. The need for feasibility stage road safety audits is lessened when SSAs are undertaken at the early planning and design stages. It is important that RSAs undertaken at the later stages in the project development cycle refer to the earlier SSA findings. This is to ensure that the project has not been adjusted or new design features included that lessen alignment with Safe System principles. The *Guide to Road Safety Part 6: Managing Road Safety Audits* (Austroads 2019a) details the need for alignment between the road safety audit process and Safe System principles.

As road authorities, councils are responsible for maintaining the roads they own. It is essential that asset management policies and practices are geared towards maintaining a safe road environment. Advice is available regarding a management system for maintaining adequate road surfaces (Austroads, 2009b). The *Guide to Road Design: Parts 1-7* (Austroads 2015-2021) provides advice in relation to line marking and delineation. Information on signage is available in the *Guide to Traffic Management Part 10: Transport Control – Types of Devices* (Austroads 2020a) and the *Traffic Control Devices Manual* (New Zealand Transport Agency 2008). An adequate inspection system (including night-time inspections for signs and delineation) is essential to ensure assets are adequately maintained.

Councils also manage traffic on the roads for which they are responsible. It is therefore important that traffic management arrangements, including parking, give due weight to safety considerations.

As well as being a road authority, a council has a responsibility for managing vegetation in streets, roadsides and public open areas. Proper awareness amongst outdoor staff can make a contribution to road safety by trimming vegetation to maintain sight distance at intersections and roundabouts, avoid obscuring signs, maintaining adequate lateral clearance, and maintaining overhead clearance to avoid forcing high vehicles into the middle of the road or forcing pedestrians off the footpath.

18.4.2 Action as a planning authority

As planning authorities, local councils have a duty to ensure that road safety is not compromised by excessive demands on the road system posed by developments and have the capacity to ensure developers take care of any potential safety issues as part of their development proposal. This may come about by requiring the developer to provide adequate road layouts and sight distances, or by relocating entrances or exits. When developments introduce new traffic movements, it may be appropriate to require a developer contribution to pay for changes to traffic signals or other facilities. Planning controls can also be used to prevent or restrict inappropriate development.

Vulnerable road users are of particular concern. Venues which attract pedestrians during hours of darkness require brighter street lighting than is necessary for the road system generally. Footpaths are important for providing separation between pedestrians and traffic, and it is essential that they are ready when the first pedestrians begin to use a new facility.

Good road safety outcomes are most likely to be achieved through effective communication with the developer at an early stage of the proposal. Good communication between council's planning and traffic staff is therefore necessary so that the fundamental requirements for a safe development can be identified before the developer's plans are progressed to the stage where change is resisted.

The *Guide to Traffic Management Part 12: Integrated Transport Assessments for Developments* (Austroads 2020b) recognises how planning decisions can strongly affect road safety outcomes and provides guidance on the assessment of safety effects of developments.

18.4.3 Action as an employer and fleet operator

Many council staff are required to drive as part of their duties, and all councils operate a vehicle fleet. This provides an opportunity to ensure safe operation of a council's own staff and vehicles, and to provide leadership to other organisations and the broader community in improving standards. Central to this endeavour is to have a safe driving or similar policy in place. The policies cover a range of issues, including fitness to drive, appropriate training for drivers, mobile phone and driving hours policies, and a commitment to purchase safe vehicles, based on Australasian New Car Assessment Program (ANCAP 2019) results. Councils are required to have such policies to meet their occupational health and safety obligations as employers. Under the chain of responsibility requirements, they must apply these principles and practices to contractors as well. In New Zealand, the responsibilities of businesses under the *Health and Safety at Work Act 2015* (New Zealand Government 2015) include ensuring the health and safety of workers when they are driving for work, and providing safe vehicles. The *Vehicles as a Workplace* (Work Health and Safety Guide 2019) provides guidance for dealing with road traffic hazards in line with workplace health and safety legislation.

18.5 Local Government and Community Road Safety Programs in the Context of the Safe System

Section 18.4 explained how local government road safety was recognised as an important element in national and state road safety strategies, and that local government programs should follow the same principles as road safety programs delivered by other levels of government. National and state road safety strategies in Australia have the Safe System approach as the foundation for their road safety strategies and action plans.

The Safe System approach is detailed in the *Guide to Road Safety Part 1: Introduction and the Safe System* (Austroads 2021a).

Roadwise, the Western Australian Local Government Association's road safety program, has developed a diagrammatic representation to show the Safe System guiding principles that local government must adopt to commit to a future of zero road fatalities and serious injuries. The diagram (Figure 18.1) shows the six guiding principles supporting the overarching principle. These principles acknowledge the various initiatives to consider when implementing a safe system, which include all relevant areas of road safety. The outer circle shows the safe system foundation initiatives overlapping the six principles. While each principle primarily relates to one initiative this is an integrated approach, therefore, each principle addresses more than one foundation.

Figure 18.1: Safe System Guiding Principles for Local Government

Source: Local Government Western Australia (2012)

In considering local programs, it is convenient to think about the distinction between actions which are core responsibilities for local councils, and actions which are best (or can only be) delivered through community groups. Although responsibility might lie in different places, these roles are complementary, and the effective partnerships will result in well-coordinated activities.

Table 18.1 shows how the Safe System elements find expression in local road safety programs. Separate columns have been used to show which are primarily local government functions and which are primarily community functions.

Table 18.1: Contributions of community road safety to the Safe System approach

Safe System factor	Local government	Community
Safe speed	Manage speed limits on local roads; review limits in response to changing land use and traffic; create low-speed environments; initiate local speed campaigns; deploy movable speed feedback displays to reinforce speed limits; evaluate benefits of low speed environments.	Provide local advocacy in relation to speeds on local streets; participate in speed reduction campaigns, possibly including movable speed feedback displays. Police have a critical role in enforcing speed limits, investigating crashes where excessive speed has been a factor and in providing comment and community education.
Safer roads and roadsides	Provide appropriate roads and road lighting to fulfil traffic function; conduct traffic and transport planning to manage infrastructure provision into the future; ensure adequate provision for vulnerable road users and heavy vehicles; conduct road safety audits of new and existing facilities; identify blackspots and other deficiencies and develop plans to eliminate them over time; develop asset management plans to maintain safe conditions with special regard to road surface, signs and delineation; manage vegetation in the roadside environment; develop pedestrian crossing management plans; establish processes for reporting and acting on road safety hazards; support older road users through attention to lighting, signage and delineation.	Lobby for actions to improve safety on local roads and roadsides; make council aware of road safety problems; participate in some aspects of the audit and review process (e.g. trucks, motorcycles, bicycles).
Safer vehicles	Have a safe driving policy in place that covers purchase of vehicles with good safety characteristics, fitness to drive, work and driving hours, and driver training; monitor fleet crash data; align safe driving with other OH&S policies; distribute information about infant and child restraints through clinics and health centres.	Develop awareness of ANCAP and used car safety ratings; encourage the community to purchase vehicles with the best safety features it can afford; promote the acquisition and use of protective equipment such as seat belts, infant restraints and helmets; Police have a role in enforcing restraint use and checking vehicle roadworthiness.
Admittance to the system	Support programs to assist the disadvantaged to obtain full licence; support the parents and mentors of learner drivers and learner drivers through a combination of education and practical experience.	Participate in programs to assist disadvantaged people to obtain full licence, provide advice and support for people no longer able to drive well; provide practical help for novice drivers to achieve new supervised driving requirements. Police have a role in checking for unqualified and disqualified drivers, and in detecting impaired drivers.
Education and information for road users	Identify road safety issues specific to the community and develop targeted education campaigns; support alcohol, speed and restraint and helmet use enforcement through media releases and education campaigns in partnership with the community; ensure council staff are aware of road safety issues and blackspot locations; educate the community about proposed road safety works and infrastructure changes.	Participate in campaigns targeted at local safety issues and supporting enforcement, particularly through local opinion leaders and media; take road safety messages to groups who are not responsive to mainstream media.

Safe System factor	Local government	Community
Understanding crashes and risks	Collate information on road safety hazards; act as advocate for improvements on all roads affecting the community, especially local roads; investigate crash locations in partnership with other stakeholders; support direct action by community organisations to reduce high risk behaviours.	Make available local knowledge of high risk locations and activities, and local knowledge of high risk groups in the community and their behaviour patterns; provide insights into their motivation, values and social context; advocate programs and actions to address these problems; participate in programs to counter high risk behaviours e.g. designated driver programs, driver reviver stops and coordinate them with enforcement.
Legislation and enforcement	Support and encourage enforcement activities through media releases and education campaigns; develop enforcement programs using by-laws officers for high risk locations e.g. parking at schools; coordinate enforcement with education and engineering programs.	Police are responsible for nearly all enforcement which is related to road safety. Community generally has a role in campaigns to support enforcement; act as an advocate for appropriate legislation and levels of enforcement; provide feedback to state/national government on programs; provide local publicity for and endorsement of new programs; integrate enforcement activities with local plans; publicise and support enforcement programs.
Planning*	Include road safety requirements in guidelines for developments; develop policies for bicycle and pedestrian safety to ensure they will be considered in new developments or changes to land use; use developer contributions to fund road safety projects; include road safety in all council plans; include road safety audit as part of the planning and approval process.	Make council aware of the road safety issues that will emerge through new developments and suggest possible ways to resolve them; raise road safety as an important environmental and social issue at community forums to discuss developments; lobby council and state/national government for changes to current practices.

**Although not specifically acknowledged in the Safe System approach, it is essential that Safe System principles be followed in planning and approval processes if they are to be reflected in the road system. It has therefore been included in this table.*

Road safety programs initiated, managed and delivered at the local level have a number of advantages:

- Local knowledge can be important in identifying problem locations on the road system. As road safety engineering becomes less reactive and more proactive, identifying high risk locations where serious crashes have not yet occurred is likely to become more important.
- Local government has strong links into the community and well established community networks.
- Community groups can mobilise resources for road safety purposes in a way which would not be possible with larger programs.
- Community groups can have an important advocacy role in raising local issues with all levels of government.
- Community programs can impart greater relevance to state or national programs by relating them to issues or locations with which the community is familiar.
- Community programs can engage with individuals and groups in the community that larger programs have difficulty reaching, including indigenous people and migrants where language and culture may pose significant challenges.
- Community programs can generate feelings of participation and ownership which assist in the uptake of messages.
- Community programs can have a high degree of acceptance because they are seen to address local issues directly.

18.6 Objectives of Community Road Safety

A review of community road safety programs for Austroads (Austroads 2002) identified the following objectives for community road safety:

- **Creating an informed community**. It is important to develop an awareness of road safety issues and to develop an understanding of the nature of the problems and possible solutions. This is important not simply from the point of view of changing individual behaviour, but for creating a climate of opinion where effective countermeasures gain local support. Local programs are important in raising awareness and understanding by reference to local examples which drivers encounter on a regular basis. The creation of informed views amongst the public helps ensure support for the right countermeasures which are likely to be effective in particular situations, and avoids naïve countermeasures with high face validity, but which are not supported by evidence.
- **Mobilising resources to tackle road safety issues at a local level**. One of the key objectives of local road safety programs is to assist local stakeholders in road safety – largely the local representatives of state or national bodies, such as road authorities, police, ambulance and health services – to focus efforts in a coordinated way. It is also important to involve the larger employers, industry groups and local groups such as service clubs and organisations representing road users in planning and service delivery. Local programs can also be effective in mobilising resources, including help in kind, volunteers and money from the local community and businesses.
- **Promoting effective action at a local level**. Local road safety programs aim to ensure effective action at the local level. Since the most pressing road safety problems are shared by all communities, an important part of this consists in applying statewide or nationwide programs with local relevance, e.g. by media statements which highlight local aspects of the speeding or drink driving problem. To some extent, actions which tackle specific local issues which have not yet resulted in casualty crashes may be justified. Failure to address high profile local issues, even if they are perceived problems which have not so far resulted in casualties, may adversely affect the credibility of the program as a whole. Local programs also have a role in encouraging good practice, partly by making ideas and findings more widely available to key stakeholders and the community in general.
- **Integrating activities**. There is scope at the local level to make sure activities and organisations are mutually supportive, e.g. by ensuring stakeholders who primarily support one activity do what they can to support other aspects of the plan by lobbying or distributing publicity. The most important aspect of integration is capacity building and the formation of social capital, which emerges as mutual confidence and trust from the experience of working together.

18.7 Requirements for Sustainable Community Action

The review of community road safety (Austroads 2002) identified the essential requirements for sustainable local government or community road safety programs. There are three essential sets of considerations – the requirements at the local level, the support available at the central level, and the climate of relations between the central administrators and the local deliverers.

- **Requirements at the local level**. The essential requirement at the local level is for a stable, representative body with good links to the community to undertake the sustained delivery of a road safety strategy or to coordinate activities if there is no strategy. In Australia and New Zealand, specific arrangements vary from jurisdiction to jurisdiction, but the body may be the council itself, a body established under the auspices of the council, or an independent body established with support from local and/or other levels of government. In order to be effective, the local road safety body must have personnel who understand the community and get things done within the community; they need commitment to the concept of a local road safety program rather than specific knowledge. The local body depends on partnerships with and between its stakeholders and other groups to deliver on road safety.

- **Support required from central government or other body**. There are three essential requirements of the next level of government, be it state (Australia) or national (New Zealand). First, it must also provide continuity through a stable organisation that is going to support local road safety over a substantial period. People in the communities need that degree of assurance before they commit to the significant investment in time, resources and community goodwill to establish a local road safety program. This is most usually a branch of the road authority, but in some cases the lead agency is affiliated with local government.

  The second requirement of the central organisation is to supply expertise, both technical expertise in road safety issues, and management expertise in the running of programs and the delivery of services. Not all local communities can be expected to have this expertise, although with suitable help and training they can begin to develop these skills. As confidence grows in working together, and with professional training the participants in the strategy can be expected to develop capacity.

  The third essential role of the central body is to facilitate funding. While some funding may be expected to come from council and some from the community itself, mainly in the form of sponsorship by the main players in the local economy, it is general practice to have available a pool of money for projects for which local programs have to apply, justifying the expenditure in the process. This money need not come from the road authority (although often much of it does), and in some cases the compulsory third party injury insurer is a major source of funding. The essential role of the central body is to ensure this funding is available, that application and reporting processes do not become too demanding for the relatively small sums involved, to assist local bodies to prepare funding applications, and to ensure a balance is struck between fairness, equity and proposal quality.

  A further role for the central body is to provide encouragement and recognition to the local community programs. Good communication with councils is appropriate to reinforce the importance that the central body attaches to local road safety efforts. This can be further encouraged by providing events where representatives from local programs can hear about current road safety developments from experts, listen to the experience of other local programs, and present their own experiences. Awards for innovative and/or successful programs, and recognition of outstanding service, can also be part of this.

- **Relations between the central and local organisations.** Local programs may depend heavily on volunteers. Delivery of programs often depends on volunteers in the service clubs (e.g. ‘driver reviver’ or the community generally, e.g. schemes to help disadvantaged learner drivers achieve sufficient practice. In addition, the overall functioning of the program often depends on council employees taking extra duties and/or responsibilities. It is therefore important to ensure that contributions are recognised and that the administration of programs is kept as simple as is compatible with an acceptable level of accountability.

18.8 Strategic Partnership and Capacity Building

Two of the roles identified for local government, managing its own road system and planning decisions, are essentially its direct responsibility, and are carried out either by council staff directly or by contractors working under direction. However, even for these functions local government should take account of local preferences and priorities. Where road safety issues have been worked through to a road safety strategy and plan, based on consultation, and endorsed by further community consultation, then preferred directions for the community should be clear.

In terms of lobbying, local government is likely to do this more effectively if it can call on the support of community groups to endorse its position.

However, when it comes to engaging with the community, partnerships become particularly important, for the following reasons:

- efforts to reach particular target groups in the community depend on specialised organisations and social networks they develop (e.g. senior citizens, disabled)
- stakeholder organisations (especially the police) have the power to enforce aspects of safe road use
- volunteers are necessary for the delivery of some aspects of road safety
- sponsorship may be necessary to achieve satisfactory funding levels for some initiatives.

18.9 Capacity Building and Social Capital Formation

Capacity building and social capital are two closely related concepts which have attracted the attention of governments in recent years. They are closely linked and essential aspects of a sustainable local road safety program.

18.9.1 The concepts

The concept of capacity building was developed in the health promotion area and refers to a continuing process rather than a defined goal. Capacity building refers to three distinct processes – the development of a social and organisational infrastructure, delivery of a sustained program through a network of agencies rather than a single agency, and the capacity to identify emerging issues and formulate appropriate responses to them (Hawe et al. 2000).

Capacity is a capability acquired by the system as a result of networking and partnering. A useful way to think of this is in terms of the whole being greater than the sum of its parts – in this case the capacity of the system to deliver, sustain and adapt to change is greater than the component activities that have been undertaken to date.

An important insight from Hawe et al. (2000) is that capacity building is not an explicit goal of most health promotion activities, and so is neither rewarded nor monitored, despite being an extremely important outcome. A further useful insight is that much capacity building comes about through incidental learning (i.e. other professionals learning skills or content without being aware of it, e.g. when other staff learn about consultation skills by participating in community consultations led by someone with this experience), or through informal learning (i.e. being aware of learning skills or content on the job, but without a formal structure).

Hawe et al. (2000) recognise that capacity building is a dynamic process, and that required actions change as relationships develop. For example, early in the life of a partnership, the focus is in ensuring that the appropriate partners are involved and that the convenor is suitable for the task. Later in the partnership's development the focus changes to direction setting and task allocation.

Social capital is a similar but broader concept that has received considerable attention in recent years. Its beneficial effects on social and economic life have been extensively researched. The value of social capital has been endorsed by organisations which exist to promote economic development, such as the World Bank (2003) and the Organisation for Economic Co-operation and Development (2001). Governments throughout the world are recognising the importance of social capital and are reconsidering the way they interact with, and deliver service to, their communities. The OECD defines social capital as 'networks, together with shared norms, values and understandings which facilitate cooperation within or among groups'.

The information paper *Measuring Social Capital: An Australian Framework and Indicators* by the Australia Bureau of Statistics (2004) provides an overview of the concept of social capital, how it relates to other resources, and its composition.

Social capital is one class of resources available to a society, and must be considered in the context of other classes of resources, namely natural resources, produced economic resources (i.e. items that are generally understood to be 'capital' such as tools, plant, buildings, money, etc.) and human capital. It is worth emphasising the distinction between social capital (which is the capacity to do things that arise from people being able to work in groups) and human capital (which is the abilities and skills of individuals to do things). Inevitably, there is some overlap between the two terms (e.g. skills in organising and mobilising social networks) but the distinction is obvious enough to be useful.

Social capital may be thought of as consisting of attributes of social networks i.e:

- qualities – norms such as trust, reciprocity and inclusiveness, and common purposes such as social, civic and economic participation
- structure – attributes such as size, frequency of interaction, openness, and stability
- transactions – interactions which contribute to and draw from relationships, such as sharing knowledge and support
- network types – bonding (strengthening relationships between similar types of people), bridging (making connections between people who have less in common), and linking, or making connections to sources of influence or authority which provide financial and other support.

These attributes have aspects which can be assessed by qualitative or quantitative means which are capable of yielding consistent results:

- social capital
- social network analysis
- value of volunteers.

18.9.2 Application to social policy

Capacity building and social capital formation are already a reality in policy formulation in some jurisdictions. These are concepts which are readily applied to local road safety programs, and make explicit the importance of the social dynamics of the situation, something that road safety coordinators are very conscious of.

18.10 Resources for Implementing a Road Safety Plan

- **Resources within the community**. While various forms of support are available from external bodies, local road safety programs essentially rely on resources from within the community itself. Some of the most important of these are staff of the various local government and state or national government agencies, which are available within the community already. In their case, it is largely a question of pooling their efforts to address problems, and coordinating those efforts with the efforts of volunteers.
- **Volunteers**. Much of the input from local organisations will be in the form of volunteer time in delivering programs or serving on committees. Many volunteers have assisted local councils and/or community groups through their presence at stalls during community festivals or other activities such as staffing Driver Reviver operations or delivering leaflets. In other cases, it may involve local businesses taking on responsibility for programs as an adjunct to their normal commercial operations, e.g. hospitality venues which support designated driver programs, or service stations which promote vehicle safety checks.
- **Contributions in kind**. Contributions in kind are a way in which councils and businesses can make effective contributions to local road safety programs. Use of facilities and having staff assist in program development or delivery probably account for most of the help in kind. Other forms of help in kind include printing and other materials, provision of prizes, and donating food and drink to support road safety events.

18.11 Sources of Funding

- **Local governments' own resources**. There are three main ways in which local governments' own funding contributes to road safety programs. The biggest potential contribution in monetary terms is when safety is given a higher priority in the way in which funding is spent on maintaining and developing the road asset, and in influencing planning decisions. The second way is through direct funding of road safety activities, including the development of a road safety strategy and funding (either in whole or in part) a professional road safety officer. The third way is when road safety issues are dealt with by other branches of local government, e.g. provision of advice about child restraints through mother and baby clinics, or the involvement of youth workers with road safety projects.
- **National and state program resources**. Funding is generally available through programs directed towards local road safety programs, funded by the state or national government, or possibly through the third party injury insurers. Access to these funds often depends critically on the quality of the submissions and the extent to which they coincide with the objectives of the granting body. The state or national government officers whose job it is to support local road safety programs have an important role to play in training and coaching local road safety program stakeholders in the preparation of proposals.
- **Sponsorship**. Sponsorship is often an effective way of attracting funding from businesses. Sponsorship is likely to work best if there is ongoing recognition for their contribution e.g. by use of the company name or logo on materials, and an opportunity to present themselves as good corporate citizens. Major players in the local economy are the most obvious source of funding, but smaller businesses may also be interested in sponsorship for a variety of reasons, including publicity, pursuit of particular business objectives, or good corporate citizenship.

18.12 Mobilising Resources

- **Stakeholder organisations**. Stakeholder organisations are the most critical to organise, but this seldom causes problems. These organisations have some responsibility for road safety outcomes, so participation in a strategy or cooperating with other organisations is very much in their interest as it helps them discharge their duties more effectively. Some resistance may be experienced, particularly in local government circles, as there is suspicion that local road safety programs are a way in which state or national government can shift responsibility and costs onto local governments and communities.
- **Other local organisations**. Other local organisations, such as service clubs, have no direct stake in road safety outcomes, but are motivated by acting in the community good. Road safety is only one of the worthy activities they are likely to take on, and so road safety needs to compete with other activities. Giving prominence to these activities as essential elements of a road safety strategy may be an effective way of retaining commitment, provided recognition for effort and dedicated service is acknowledged. Managing organisations that donate in money or in kind can be challenging, as they are likely to want as much publicity for their organisation as possible. Firm governance may be required to ensure that all activities contribute to the road safety strategy's objectives in a coordinated manner.
- **Local media**. Local media is both a resource to be mobilised, and an effective tool for mobilising other parts of the community. Road safety generally gets good coverage from local media, as the issues can be given a very local perspective and potentially have a direct effect on the readership or audience. Establishing a good relationship between the media and the group responsible for implementing the plan or managing the program is essential. Having one spokesperson who is 'the face of road safety' for the community also helps. A regular stream of newsworthy stories with a strong local flavour, and preferably with suitable visuals, will maintain the relationship. Mention in the local media of the groups and individuals who contribute to the road safety program is an effective way of giving them recognition and strengthening their commitment to the activities they deliver.
- **The community**. The community itself is an important resource to mobilise. While many volunteers who help with activities do so as part of a local organisation, others participate in local road safety programs as individuals. It is also important to mobilise community opinion in favour of the program as this builds support from local government, provides social support for volunteers and stakeholder organisations, and creates a climate of support for initiatives that the community might otherwise resist.

- **Advocacy**. Effective advocates who can persuade decision-makers and stakeholder organisations of the merits of road safety are essential for road safety at all levels of government, but they are particularly important for programs at the local level where the essential communications are face to face and personal factors carry a lot of weight. Encouraging community groups to develop their skills as advocates is an important aspect of capacity building and human capital development.

18.13 Implementation

Implementation of a strategy or program carries with it a number of challenges. These include:

- **Coordination**. Many different activities have to be kept track of in a local road safety program, and many activities have to be timed to coincide with community events. They may be constrained by the availability of some people and resources due to training, leave or other demands on individuals or organisations. It is essential to develop a comprehensive timetable and stick to it, and to ensure stakeholder organisations are aware of the requirements of this timetable.
- **Motivation**. Keeping participants motivated is also a major challenge. It is important to choose achievable outcomes so that participants in the program gain a sense of achievement. Projects that will take a long time to deliver results or which have a poor chance of success should be avoided. A good spread of activities throughout the year is important to keep people engaged so that, on the one hand, the program does not become too demanding while on the other activities are not so far apart in time that individuals lose contact with the program. Feedback and recognition for contributions are also essential.
- **Sustainable action**. A local road safety program needs to be sustainable in the long-term if the community is to receive lasting benefits. The keys to sustainability are ensuring that the program is matched to local capacities and resources so that it can be delivered; achieving enough success to keep participants motivated and ensure ongoing commitment of resources; and keeping road safety in the public eye by effective use of local media to raise awareness of issues and publicise successes.
- **Evaluation and review**. It is essential to act on the outcomes of evaluations and reviews in order to ensure effective delivery of the program and efficient use of resources.
- **Communication**. Effective communication is essential for the effective running of local road safety programs. This includes communication with council and/or funding bodies, among stakeholders and with the community.

18.14 Monitoring, Evaluation and Review

For most purposes it is sufficient to separate evaluation into (a) process evaluation, (i.e. what was done and whether it could be done more efficiently or more effectively), and (b) outcome evaluation, (i.e. what has been achieved in terms of crash reduction and behaviour change). A review process is necessary to give effect to the findings of evaluations.

Monitoring and evaluation of road safety projects and programs is generally recognised as being important by jurisdictions but often done poorly or not at all. The purpose of an effective monitoring and evaluation process is to:

- identify and measure any changes that have occurred in crash frequency or severity,
- determine whether the objectives of the programme have been achieved,
- identify any unwanted or unexpected effects, and
- understand the public's stance on the programme and whether any concerns have been raised (PIARC 2015).

To be effective, evaluation needs to be built into programs from their inception. The best practice principles for monitoring and evaluation include:

- Monitoring and evaluation should be a requirement of all programs, and consider process evaluation, short-term indicators, longer-term risk reduction outcomes and the performance of the wider program.
- Evaluation of projects and programs should validate the risk reduction prediction.
- Results from monitoring and evaluation need to be shared to optimise the delivery of programs over time.
- Evaluation needs to account for external factors (including macro-economic factors) and regression to the mean.
- The monitoring and evaluation of programs needs to be assessed against the outcomes identified at the outset of the program.

18.14.1 Process evaluation

A process evaluation is concerned with how the delivery of actions is carried out and if the methods employed are effective. Thus, a process evaluation is aimed at enhancing the current road safety program of actions by understanding them more fully and also determining how they are perceived by the target group.

The type of information collected for a process evaluation will be dependent on the action to be carried out. The types of question which are useful to ask include:

- How much time and effort/money did it take to deliver specific actions or parts of programs? How did the timing correspond with what was originally planned? How well did this corresponded with the timing in the plan?
- Were any particular problems encountered during countermeasure implementation? What were they? Were the people delivering the activity suitable for the task in terms of relationship to the target group, skills and training?
- Did delivery of countermeasure meet requirements? (For example, in terms of the number of countermeasure items developed and delivered to the target group, the number of the target group attending event/receiving countermeasure, etc.)
- What was the impact of the countermeasure? (For example, in terms of media coverage and community reaction.)

The above information may be collected by simply recording information such as the number of attendees or extent of coverage. For big projects, qualitative research to determine the views of the target group via phone/email/mail survey or focus groups could be considered. For engineering treatments, meeting costs and timeframes will be more important. If the process evaluation shows a need for improvement, improved methods will need to be sought, perhaps from other jurisdictions who have implemented similar countermeasures.

It is imperative that the data collected be of good quality. Through careful examination of the results helpful recommendations for an ongoing program can be devised.

18.14.2 Outcome evaluation and the challenge of small numbers

Road safety programs are generally evaluated in terms of the crash reductions they achieve. These may be overall crash reductions, or reductions in the particular sub-set of crashes that would be expected to reduce. With local government and community road safety programs, it is generally not possible to carry out this type of evaluation as it is difficult to determine the exact role these programs play in relation to more general campaigns, e.g. state or national campaigns involving police enforcement, backed by advertising. A further difficulty is that there are generally insufficient crash numbers to support reliable evaluations. Underlying variability in the crash rate may mean that it is difficult to determine whether crashes have reduced or not. Small numbers also mean it is unlikely that any crash reductions are statistically significant. This possibility needs careful consideration since many people are likely to confuse a lack of statistical significance with ineffectiveness, with the result that interventions that reduce crashes by less than a statistically significant amount are interpreted as showing that the intervention had no effect, when the correct conclusion is probably that there were not enough crashes throughout the study period to conclude whether the treatment was effective or not (Hauer 1997). Possible solutions include pooling outcomes across communities and using behaviour change as a proxy measure.

18.14.3 Assessment in the light of the full range of objectives

Most discussions to date about evaluation in community road safety are centred on the concepts of process evaluation (what was done) and outcome evaluation (what was achieved). Outcome evaluation is a particular challenge for programs delivered at a local level because of the uncertain relations to more general interventions, and because crash numbers are too small to show any reliable changes, except perhaps for the largest and most effective programs in the largest local government areas. Careful evaluation of changes in safety-related behaviours has therefore been adopted as best policy for local government and community road safety.

Process evaluation has been easier to quantify and has been an essential part of accountability in many local programs, and has been based on considerations such as the number of events held, and the number of participants or attendees. If the formation of social capital is adopted as an explicit goal of governments, encouraging volunteering and participation will become an outcome in itself, and not simply a means to an end. Much of the same information will be sought, but the framework under which it is organised will change.

Experience with evaluation of local safety programs throughout Australia is that evaluation has the capacity to strengthen programs and, by implication, the networks that support them. The process of evaluation encourages participants to think more carefully about how success is to be achieved, and carrying out the evaluation may require program deliverers to acquire new skills and develop new capacities. Learning at the local level from evaluations allows specific activities to be delivered more effectively. These lessons can be generalised to new activities in the future. Being able to demonstrate that programs are effective is likely to increase confidence and trust amongst stakeholders, and increase willingness to be involved in future activities. Well-considered evaluation may therefore have a role in promoting the development of human and social capital.

However, the first priority for evaluation must remain the delivery of effective road safety to the community. The following framework includes all the essential aspects of evaluation:

- Program delivery outcomes – based on the behavioural changes achieved by different road safety activities, and progress in providing safer infrastructure.
- Human capital outcomes – based on the number of individuals acquiring specific competencies.
- Social capital outcomes – based on the number of individuals and organisations engaging in program activities, amount of time committed, and possibly measures of commitment and/or connectedness.
- Social network analysis – based on the linkages or contacts between individuals and groups and the extension of road safety knowledge beyond the initial network into workplaces and private life.

- Process evaluation – with the focus on smoothness of operation and quality of events and presentations rather than numbers attending.

The types of measurement which might be considered under each of these headings and the development work required to give effect to this framework are discussed below.

18.14.4 Program delivery outcomes

It is difficult to assess outcomes for local road safety programs in terms of crash reductions. However, there are two ways of measuring outcomes that can be confidently related directly to the safety of road use, road user behaviours and reduction of high-risk locations.

Systematic observation can be used to assess whether there have been changes in the way road users behave which are consistent with reduced road trauma. The behaviours are generally straightforward, such as restraint or helmet use, alcohol affected driving, and speed. The first two can be monitored directly by any interested party which approaches the issues systematically, and need only require simple equipment. Drink driving can be monitored with the cooperation of local police, through monitoring routine breath testing operations or through standardised alcohol enforcement operations (e.g. same place, time of day and number of testing officers) some weeks or months apart.

The difficulty lies in being able to attribute changes to local programs as distinct from state-wide advertising and enforcement activities. The approach works best if it is targeted at specific behaviours which have been the subject of recent local campaigns, and comparing results to those in a neighbouring area or areas which have not been subject to such interventions.

The reduction in high-risk locations is a way of assessing progress in addressing safety issues related to infrastructure. This may be done by regular reporting of the number of hazardous sites eliminated (e.g. by providing new facilities) or treated (e.g. by improving delineation or lighting). It would be helpful if the impact on safety can be quantified in some way e.g. by some statement relating to expected crash reductions or reduction in risk score according to the available models for assessing risk.

The method used to evaluate a program should account for external factors and regression to the mean. Ideally, the evaluation should incorporate the measurement of outcomes which link the mechanisms of change to the observed outcomes, for example through a program logic model or causal chain. The report *An Introductory Guide for Evaluating Effectiveness of Road Safety Treatments* (Austroads 2012) provides detailed methods for how individual projects can be assessed, including best practice for a range of evaluation methods including cross-sectional studies, before-after studies, and Empirical Bayes analysis.

18.14.5 Human capital outcomes

Human capital outcomes refer to the specific competencies acquired by participants in the local government/community road safety process. These activities embrace a wide range of roles, skills and competencies. For example, among council engineering staff, the number who has attended crash investigation and remediation courses is an indicator of council's capacity to address safety issues.

Similar considerations apply to other stakeholders in the community offering a range of services, e.g. service stations which offer approved infant restraint fitting services. At a less formal level, experiences such as organising a 'driver reviver' operation during a holiday weekend, or delivering an older road user discussion group can also be considered as examples of human capital.

The organisational and social skills associated with the successful operation of a local road safety committee over the long-term, keeping its stakeholders engaged and maintaining its profile in the community should also be borne in mind. These are functions shared between the road authority support staff, council professional staff who provide support to the committee and the community members who serve on the executive.

18.14.6 Social capital outcomes

The information paper *Measuring Social Capital: An Australian Framework and Indicators (*Australia Bureau of Statistics 2004) has suggestions about how social capital might be measured. Despite the complex conceptual framework presented in the ABS report the underlying concept is relatively simple.

Social capital may be thought of as consisting of attributes of social networks. i.e.:

- qualities – norms such as trust, reciprocity and inclusiveness, and common purposes such as social, civic and economic participation
- structure – attributes such as size, frequency of interaction, openness, and stability
- transactions – interactions which contribute to and draw from relationships, such as sharing knowledge and support
- network types – bonding (strengthening relationships between similar types of people), bridging (making connections between people who have less in common), and linking, or making connections to sources of influence or authority which provide financial and other support.

Measurement is by means of responses to a number of questions about feelings or behaviours which indicate the extent to which social capital is evident in the situation.

Possible questions might include items such as:

- When was the last time, when you were driving, you gave way to a pedestrian when the road rules did not oblige you to do so?
- When was the last time a driver failed to give way to you as a pedestrian?[1]
- How often do other people speed?
- When did you last discuss a road safety issue with a family member or friend?

18.14.7 Social network analysis

Social network analysis is an approach which has a role in a sophisticated process of evaluation. This approach focuses on the links between individuals and/or groups, and the position of the individual or group in the network of social connections. For example, some individuals or groups may have a very high number of linkages, and be central to the functioning of the network. Others may have fewer linkages, and be linked to the central groups or individuals by a number of linkages through other groups or organisations. This approach may have value in understanding the patterns of influence in the networks that support local government or community-based programs, in planning how to make better use of these networks for the delivery of programs, and for monitoring how connectedness changes as a result of involvement in road safety programs.

The website of the International Network for Social Network Analysis, accessible at https://www.insna.org/, provides further information and resources relating to social network analysis.

[1]A long period since this occurred would indicate a high level of social capital formation.

18.14.8 Process evaluation

While outcome evaluation in its various forms is essential for judging the success of a program and deciding whether or not it should continue, process evaluation has value in identifying why programs were successful or otherwise. Some aspects of evaluation which have been considered 'process' up to now are more likely to be considered aspects of social capital and capacity building outcomes, e.g. who attends or participates, and what ongoing contact they have with the community road safety program.

This implies that process evaluation should in future focus more on issues such as how smoothly projects run, the quality of materials and presentations, the impressions they made on their target audience, the challenges that arose and how they were overcome.

18.14.9 Towards a comprehensive evaluation process

Some work will be necessary to develop a comprehensive evaluation process which meets all these objectives. Measurement of human capital, social capital and social network analysis are new in the road safety context. However, these are aspects of policies which cover all areas of government activity. It therefore seems appropriate that there should be some commonality in the way in which the various government organisations which engage with the community should use the same methods to assess how well they are achieving this aspect of their objectives. So far as possible, a comprehensive evaluation process should draw on a conceptual framework and practical techniques which are shared by different government agencies.

There may need to be two sets of related evaluation tools – one for evaluating activities and programs at the local level, and a second set of tools for evaluation of local government/community road safety programs at the regional or state level. So far as possible, the outcomes of local evaluations should fit into the regional or state evaluations. This can be achieved by ensuring a standardised format for 'core' evaluation items, while encouraging local programs to extend the evaluation to include some additional elements which are felt to be especially relevant to that locality or the issue being evaluated.

18.15 Review

It is essential that road safety programs are subject to review. The purpose of reviewing programs is to assess and interpret the results of the evaluations, and make decisions as to whether to continue, expand, modify or end particular road safety activities.

If an activity has been running successfully and appears to have the potential to continue to deliver results, the most probable decision would be to continue the program, although perhaps some degree of personnel change or refreshing of the program is called for. Perhaps there would be scope for expanding the program into new areas, or to run it for longer each time. If it is a task that has run its course, e.g. slow points have been installed at all key locations in the municipality then it may be time to end that activity and move on to the next priority.

If an activity has not been as successful as expected, then it would be important to know why. The results of process evaluation might reveal how many people were reached by the activity, give some insight as to the demographic profile of persons reached, and provide feedback on what people who attended thought of the event. There may be scope for changing things like the time and place an activity is delivered, aspects of the program itself, or the group delivering it. Alternatively, if the activity is still not successful despite one or more attempts to revive it, it may be appropriate to discontinue the activity.

The timing of the review should depend on the nature of the program or activity being reviewed. The activity must have been going for long enough to have some experience worth reviewing, but the sooner the review can be carried out, the sooner any problems can be identified and dealt with.

It is important that the results of the review be made available to others that are running or are considering running similar programs. Points to emerge from the review can be important in 'benchmarking' with other programs, and in passing on the features that make for successful activities and a successful program.

18.16 Communication and Reporting

Effective communication is essential for the successful running of a local road safety program. This communication needs to take a number of different forms, which will vary in their content, detail and timing. These communications are the responsibility of the managing committee, and will probably be delegated to an individual or small group.

18.16.1 Reports to council and to central authority

The extent to which reports are provided to council or one of its committees will depend on council requirements, which in turn are likely to be determined by the extent to which road safety activities (and in particular a road safety plan) are embedded in council objectives. Reports to a central body may be required on a regular basis, or may be required to account for project funding. These reports are likely to be formal requirements which must be complied with.

18.16.2 Communication with participants in the road safety program

It is essential to keep participants in the road safety program in touch with what is happening in the program, and for them to be confident that other participants are hearing about their work. Most of this communication is probably most effectively carried out informally, as part of normal operating processes. It is essential to have regular meetings of the management committee at which progress and problems with each aspect of the plan or each activity engaged in are reported as regular items of business. It is then up to the representatives of each of the stakeholder organisations to pass this information on to their membership.

An alternative approach is for the central funding body to produce a regular newsletter which reports highlights and milestones from the different local programs and which is then circulated widely amongst program participants and amongst supporting councils. This enables new approaches or particularly successful projects to be supported, gives recognition for achievement, and carries announcements in relation of events and training opportunities.

18.16.3 Communication with the general public

It is desirable to keep the general community informed of the road safety plan or program. This will help build support for future measures, including some which might be controversial. Support from the community will tend to make elected representatives more supportive of the program, and recognition by the local community will be reinforcing for participants and encourage them to keep contributing. In addition to these benefits, there is the possibility of being able to influence road user behaviour directly by items appearing in the media.

It is important to develop a working relationship with both print and electronic media, which are likely to be the main channels of communication with the public, and to make the most of newsworthy stories as they emerge.

18.16.4 Communication with other communities

To date, local road safety programs have had some opportunities to engage with each other or to exchange ideas through state conferences and regional meetings, and in some cases through sharing road safety officers. However, there is no mechanism for sharing experiences with similar municipalities in different jurisdictions. Since conditions vary within states as well as among states, an arrangement which encouraged the exchange of ideas and experiences between similar communities could be useful. A web site would seem to be well suited for this exchange.

In New Zealand, Road Safety Coordinators are represented by a professional road safety body, the Safe and Sustainable Transport Association (SASTA). The association encourages information sharing amongst members on safe and sustainable transport, makes submissions on behalf of members and provides opportunities for practitioners to share best practice via a thrice-yearly newsletter.

19. Regional and Remote Areas

Road trauma in regional and remote areas is a major national road safety problem. Drivers and riders on regional and remote roads in Australia and New Zealand are at an unacceptably greater risk of road deaths and injuries than those living in major cities. Based on road crash data for 2016, 65% of all road crash fatalities occur on regional and remote roads in Australia while, for New Zealand, the proportion is markedly higher at 78%. In Australia, 837 people were killed on regional and remote roads in 2016 while over the same period in New Zealand, 257 people were killed on rural roads.

The higher rate of fatalities and injuries from crashes on regional and remote roads and the road safety issues affecting these communities are clearly deserving of attention and require identification of the most effective evidence-based countermeasures.

The preceding sections of this part to the Guide are relevant in regional and remote areas, however the purpose of this section is to further understanding of the nature and causes of crashes in these areas, and to identify and contextualise measures to reduce future road trauma.

19.1 The Context

Regional and remote road safety faces a number of challenges including travelling over vast distances to towns and cities, low population density, extreme climate and difficult geography. More specifically, there are a number of transport, economic and social challenges unique to regional and remote areas that impact on road safety:

- low traffic volumes which influence investment in infrastructure when using traditional assessment methods
- lower quality transport infrastructure and roads due to long road networks and limited resources
- limited telecommunications service coverage and infrastructure
- low population density resulting in diseconomies of scale
- vast distances to travel to major service centres and cities
- limited access to health, education, social services and employment opportunities
- long distances to travel to receive treatment at trauma centres and rehabilitation services
- limited public transport options with existing services relatively expensive and infrequent
- lack of all-weather access to communities and services
- isolation from the rest of the country due to geographical and seasonal constraints.

19.1.1 Defining regional and remote areas

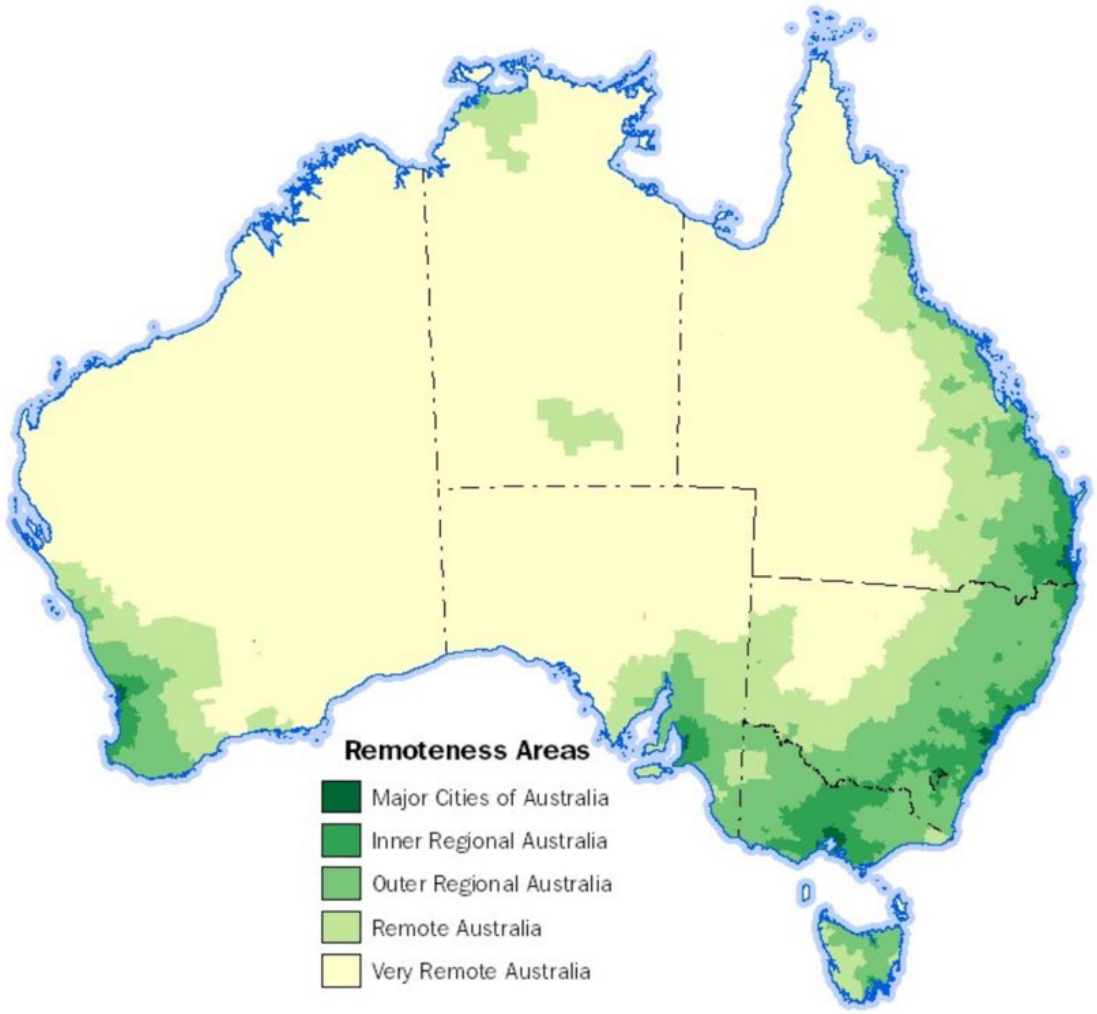
Across Australia and New Zealand, each jurisdiction applies their own definition of urban, regional and remote areas in relation to where a crash occurs. These definitions may be based on speed limits, population densities, roadside development, or distance to goods and services (including access to emergency and medical services). In an effort to overcome these discrepancies, an existing uniform indicator that defines urban, regional and remote areas was developed to stratify Australian crash data.

Relative remoteness is measured in an objective way using the Accessibility and Remoteness Index of Australia (ARIA+), which is derived by measuring the road distance from a point to the nearest populated localities and service centres (Australian Bureau of Statistics 2018). It is essentially a measure of distance or accessibility to goods and services. Using the ARIA+ methodology, remoteness changes over time with changes in population centre size and improvements in road networks. As a consequence, remoteness areas are reclassified every five years, with the latest remoteness structure revision in 2016 (Australian Bureau of Statistics 2018).

The Australian Statistical Geography Standard (ASGS) uses the ARIA+ methodology to define Remoteness Areas using five classes of relative remoteness across Australia (see Figure 19.1):

- major cities of Australia
- inner regional Australia
- outer regional Australia
- remote Australia
- very remote Australia.

Figure 19.1: Australian remoteness areas



Source: Australian Bureau of Statistics 2018

While the ASGS classification of remoteness areas provides a measure of access to services (goods and medical), it is acknowledged that it only provides one aspect of the measure of the differentiation between urban 'major cities' and regional and remote environments. The characteristics of the road environment in which a crash may occur, including the speed limit, type of infrastructure and sparseness of roadside development, may also be used to classify the crash location. In addition, due to the nature of the remoteness measure (i.e. distance from services), Hobart and Darwin are currently classified as inner regional. With respect to road safety, the road environment (including infrastructure and speed limits) in these capital cities more closely reflects those of built up major cities. Unfortunately, it was not possible to reclassify these cities in the crash data.

While acknowledging the limitations, this classification of remoteness areas is regarded as the best means of urban/rural differentiation currently available and used for national road trauma statistical summaries in Australia. Even though there are changes to the boundaries, using an objective and consistent process for classifying remoteness areas allows comparisons between data published over time.

New Zealand does not use the same classification system for determining regional and remote areas. Instead, for road safety crash statistics, classification of the location of a crash is based on the speed limit of the road (i.e., a speed limit of 80km/h and over is indicative of regional/remote). Therefore, to achieve consistency in classification between the two crash data sets, an approximate equivalent categorisation was applied to the New Zealand crash data in this analysis. In consultation with the New Zealand Transport Agency, the seven major cities or 'territorial local authorities' (i.e. Auckland, Christchurch, Wellington, Hamilton, Tauranga, Lower Hutt, Dunedin) classified as major urban areas by the *Statistical standard for geographical areas 2018* (Stats New Zealand 2017) were categorised as 'major cities' and the rest of New Zealand considered as 'regional/remote'. These major cities primarily have populations greater than 100,000. It is recognised that this definition considers the characteristics of the area (i.e. population density, distance to goods and medical services) rather than characteristics of the road (i.e. speed limits, infrastructure). A future project could investigate the most appropriate definition of 'regional and remote' in Australasia for road safety purposes, one that accounts for aspects including the road environment, speed limits, infrastructure and distance to services.

In order to be consistent with the original *Guide to Road Safety: Part 5* and the current classification of the New Zealand crash data, the regional (i.e. inner regional, outer regional) and remote (i.e. remote, very remote) categories for Australia have been combined for the crash analysis.

19.1.2 Crashes in regional and remote areas

This section describes current trends in regional and remote road trauma in Australia and New Zealand. The analysis of national regional and remote crash data is not simple as the definition of 'regional and remote' differs by state and territory. This is also the case for Australian and New Zealand crash data. Consequently, a definition for regional and remote crashes has been developed based on the location of the crash, distance or access to services and population density.

Around one third of Australians live in regional or remote areas, but two thirds of fatal crashes occur in these regions. In 2016, there were 837 people killed on regional and remote Australian roads representing 65% of all road crash fatalities (see Table 19.1). In regional and remote areas, the fatality rate is 12.2 deaths per 100,000 population in Australia, which is almost five times greater than the rate for major cities, at 2.6 deaths per 100,000 population.

While just under half of New Zealanders live in regional and remote areas, three quarters of fatal crashes occur in these areas. In 2016, there were 257 fatalities in regional and remote areas within New Zealand representing 78% of all road crash fatalities. Similar to Australia, the fatality rate in regional and remote areas of New Zealand (13 deaths per 100,000 population) is five times greater than the rate for major cities (2.6 deaths per 100,000 population).

Table 19.1: Population and fatal crash statistics by location, 2016

Location	Population [a]		Fatalities[b]		Fatality rate per 100,000
	N	%	N	%	
Australia					
Major cities	17,331,653	72.7%	458	35.3%	2.6
Regional/remote	6,879,156	27.3%	837	64.7%	12.2
Total [c]	23,850,784	100%	1,296	100%	5.4
New Zealand					
Major cities	2,716,700	57.9%	71	21.6%	2.6
Regional/remote	1,976,500	42.1%	257	78.4%	13.0
Total	4,693,200	100.0%	328	100%	7.0

[a] *Source: Australia: Australian Bureau of Statistics 2017, New Zealand: Stats New Zealand 2016*

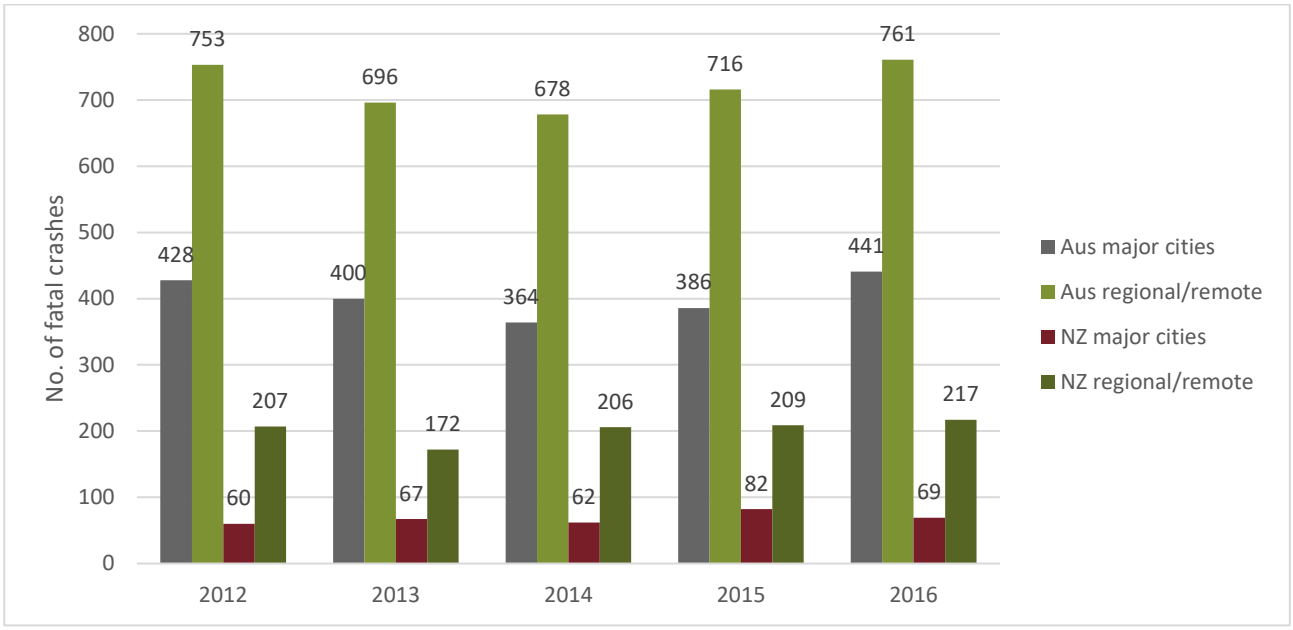
[b] *Source: Australia: BITRE 2018, New Zealand: Ministry of Transport 2017*

[c] *Includes unknown remoteness area*

19.1.3 Crashes on regional and remote roads

Figure 19.2 presents the numbers of fatal crashes occurring each year during the period of 2012 to 2016 by remoteness category in Australia and New Zealand. It can be seen that in both countries there was a higher number of fatal crashes in regional and remote areas than in major cities. There was a slight decrease in fatal crashes in both regional/remote areas and major cities of Australia from 2012 to 2014, after which the numbers increased in 2015 and returned to being roughly the same in 2016 as they were in 2012. Despite some variance from year to year between 2012 and 2016, there were no discernible trends in the numbers in New Zealand for either regional and remote areas or major cities.

Figure 19.2: Regional and remote fatal crash trends (2012 to 2016)



The number of casualty (i.e. fatal and injury) crashes occurring each year during the period of 2012 to 2016 by remoteness category are displayed in Figure 19.3. In Australia, there was a higher number of casualty crashes in major cities compared to regional/remote areas. This was also the case in New Zealand, although the differences between the numbers for major cities and regional and remote areas were smaller. Between 2012 and 2016, there have been consistent reductions in casualty crashes in regional and remote areas of Australia, as well as in major cities. There were also reductions in regional and remote areas and major cities in New Zealand between 2012 and 2014, but the numbers increased in 2015 and 2016 to be higher than they were in 2012.

Figure 19.3: Regional and remote casualty crash trends (2012 to 2016)

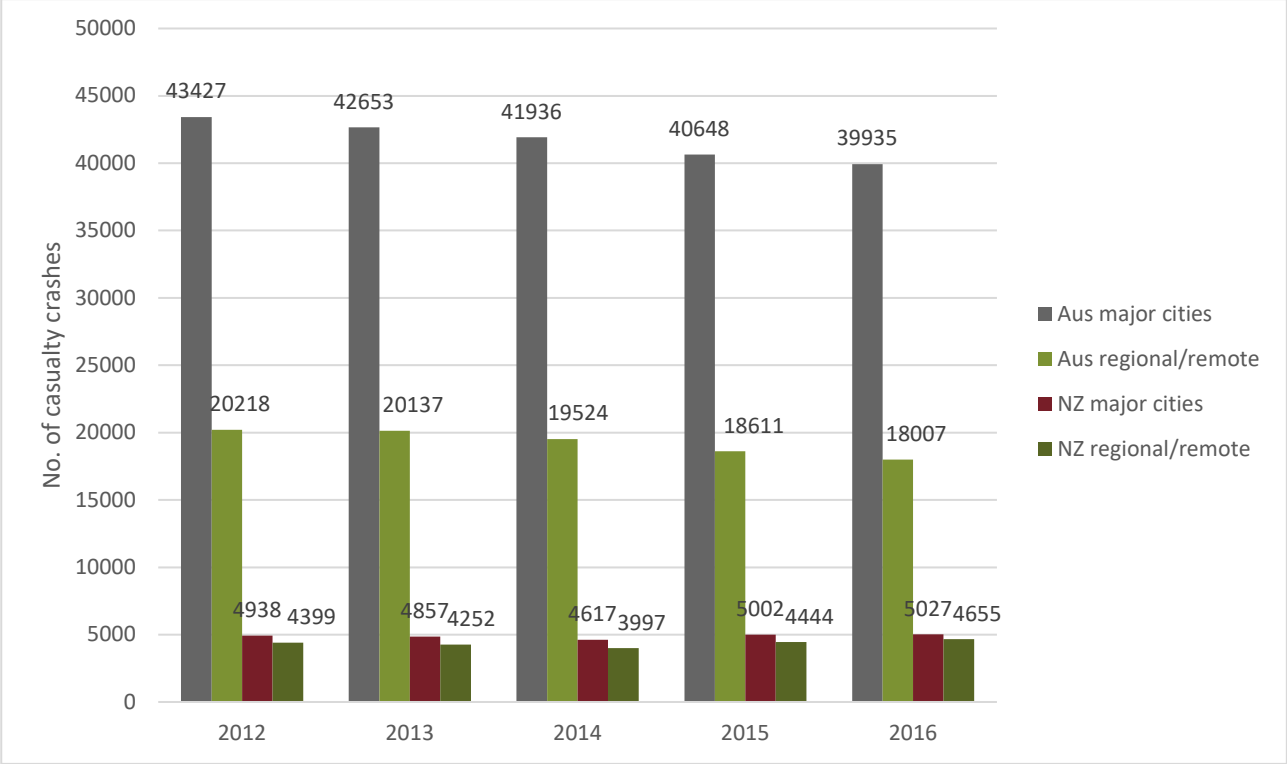


Table 19.2 compares fatal, serious injury (i.e. admitted to hospital) and other injury (i.e. seen by private doctor or hospital treated but not admitted) crashes in regional and remote areas of Australia and New Zealand. Major cities are also included for comparison. Values represent average annual crash numbers over five years (2012 to 2016). Crashes with a higher severity of injury (i.e. fatal, serious injury) were less frequent than crashes with a lower severity of injury (i.e. other injury) for both Australia and New Zealand and both major cities and regional and remote areas. However, fatal and serious injury crashes represented larger proportions of the average total casualty crashes in regional and remote areas (4% fatal in both Australia and New Zealand, 37% serious injury in Australia and 22% serious injury in New Zealand) compared to major cities (1% fatal in both Australia and New Zealand, 27% serious injury in Australia and 16% serious injury in New Zealand) in both countries.

Table 19.2: Average annual casualty crashes (2012 to 2016) in regional and remote areas by severity

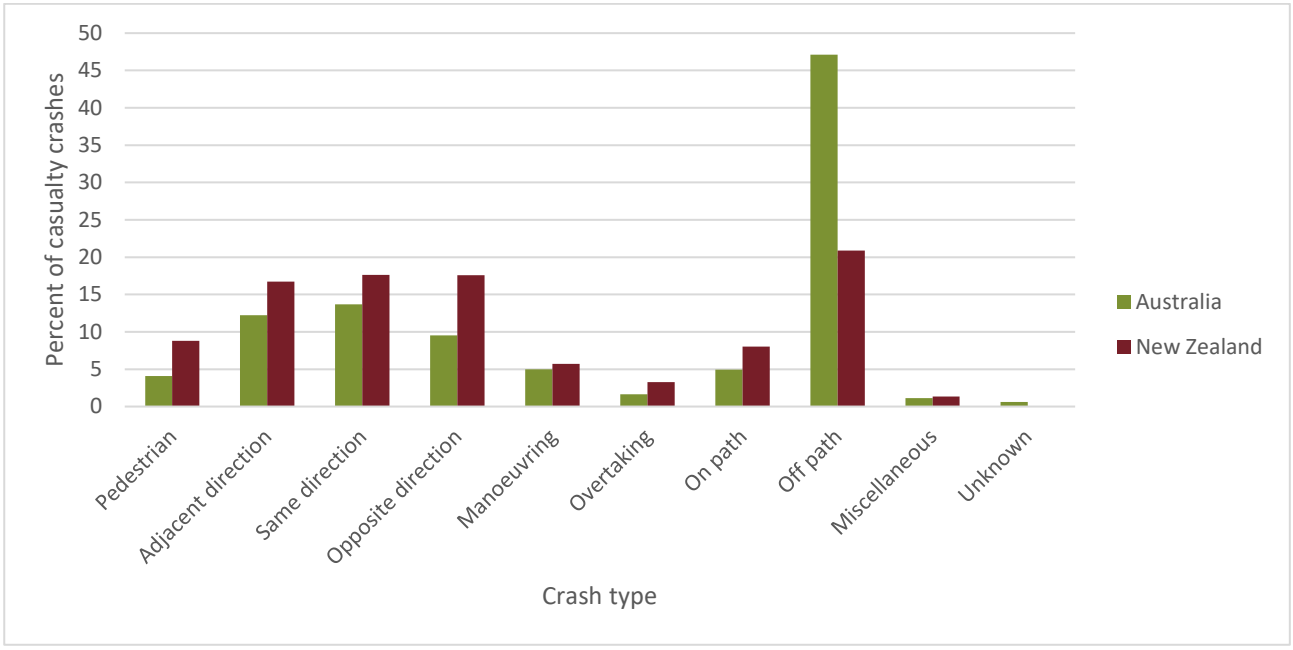
Location	Fatal crashes		Serious injury crashes		Other injury crashes		Average total fatal and non- fatal injury crashes
	N	%	N	%	N	%	
Australia							
Major cities	404	1	11,242	27	30,074	72	41,862
Regional/remote	721	4	7,165	37	11,413	59	19,299
New Zealand							
Major cities	69	1	817	16	4,118	82	5,005
Regional/remote	200	4	1,008	22	3,366	74	4,575

In the following figures, the average annual (2012-2016) percentages of fatal, serious injury (i.e. admitted to hospital) and other injury (i.e., seen by private doctor or hospital treated but not admitted) crashes are presented for regional and remote areas in both Australia and New Zealand.

The percentages of average annual regional and remote casualty crashes by crash type between 2012 and 2016 are presented for Australia and New Zealand in Figure 19.4. Values represent the percentage of the total average annual number of casualty crashes. Off path (e.g. hit fixed object and run-off road), same direction (e.g. rear end, side-swipe), adjacent direction (e.g. intersection crashes) and opposite direction (e.g. head-on, right turn in front) crashes account for a large proportion of casualty crashes in regional and remote areas of both Australia and New Zealand.

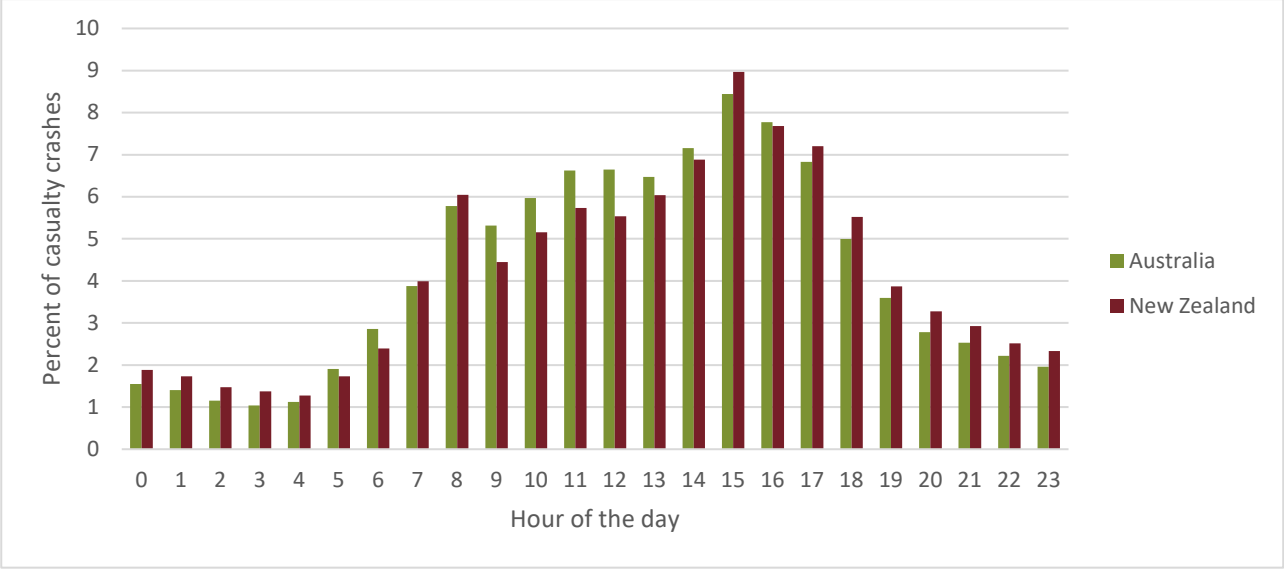
Subsequent analysis of fatal crash data only was undertaken for two crash types associated with a high crash risk in regional and remote areas. This analysis revealed that the average annual number of fatal single vehicle crashes between 2012 and 2016 on regional and remote roads was 380 in Australia or 52.7% of fatal crashes and 100 in New Zealand or 49.5% of fatal crashes. For fatal head-on crashes, the average annual number between 2012 and 2016 on regional and remote roads was 160 in Australia or 22.2% of fatal crashes and 58 in New Zealand or 28.7% of fatal crashes.

Figure 19.4: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by crash type



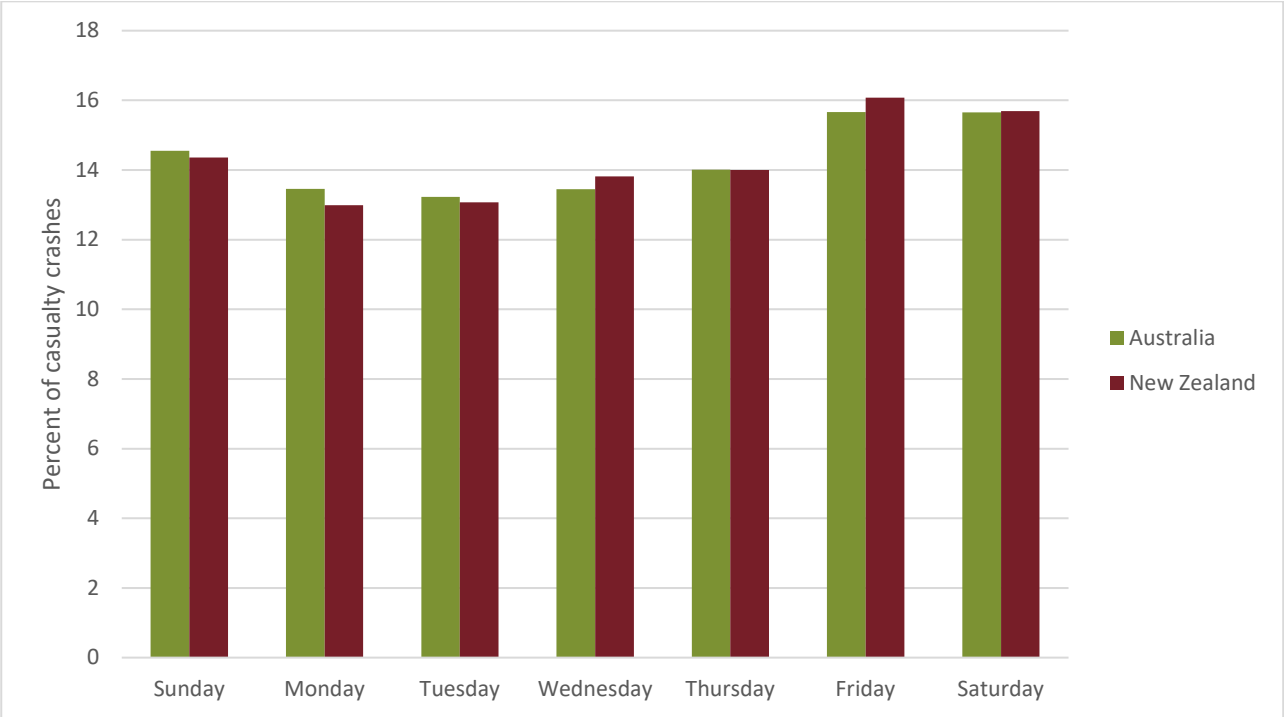
As shown in Figure 19.5, the largest proportion of regional and remote casualty crashes in both Australia and New Zealand occurred during daylight hours (roughly 8am to 7pm). The numbers for both countries peaked at around 2 pm to 6 pm.

Figure 19.5: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by hour of the day



The percentages of average annual regional and remote casualty crashes by day of the week are presented in Figure 19.6. The proportions were slightly higher on Fridays and Saturdays in both Australia and New Zealand and slightly lower during the rest of the week.

Figure 19.6: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by day of the week



The percentages of average annual regional and remote casualty crashes by the month of the year are shown in Figure 19.7. Despite variances from month to month, there was a slight reduction in the percentages for Australia and New Zealand around winter to early spring or the 'dry season' in Northern Australia (June to September).

Figure 19.7: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by month of the year

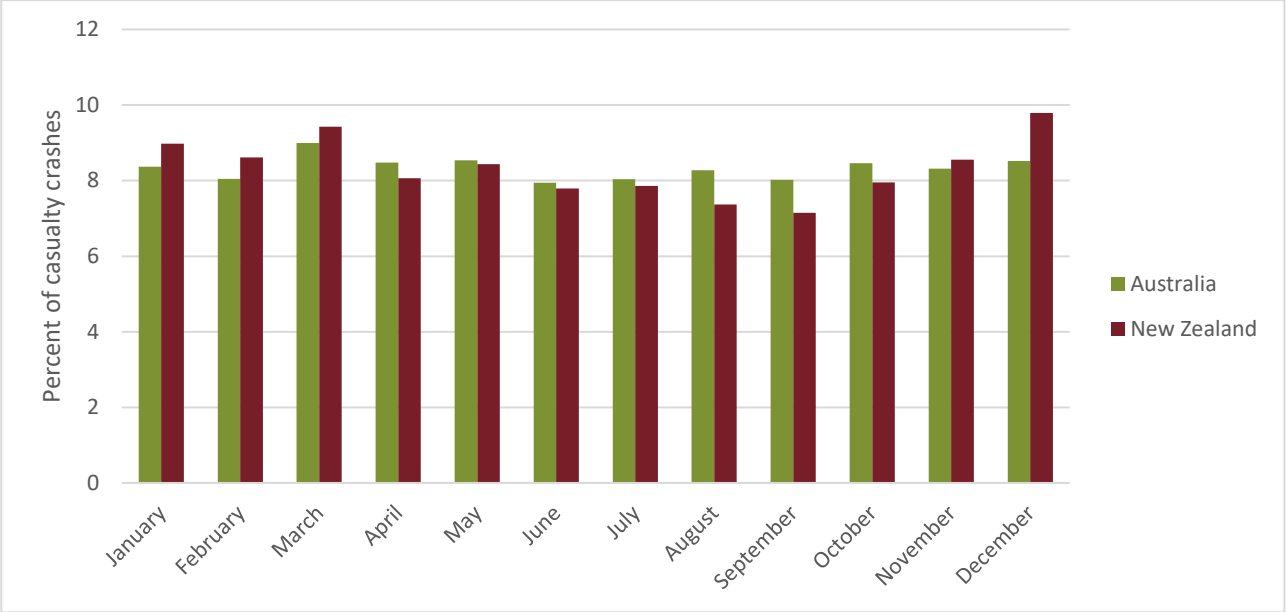
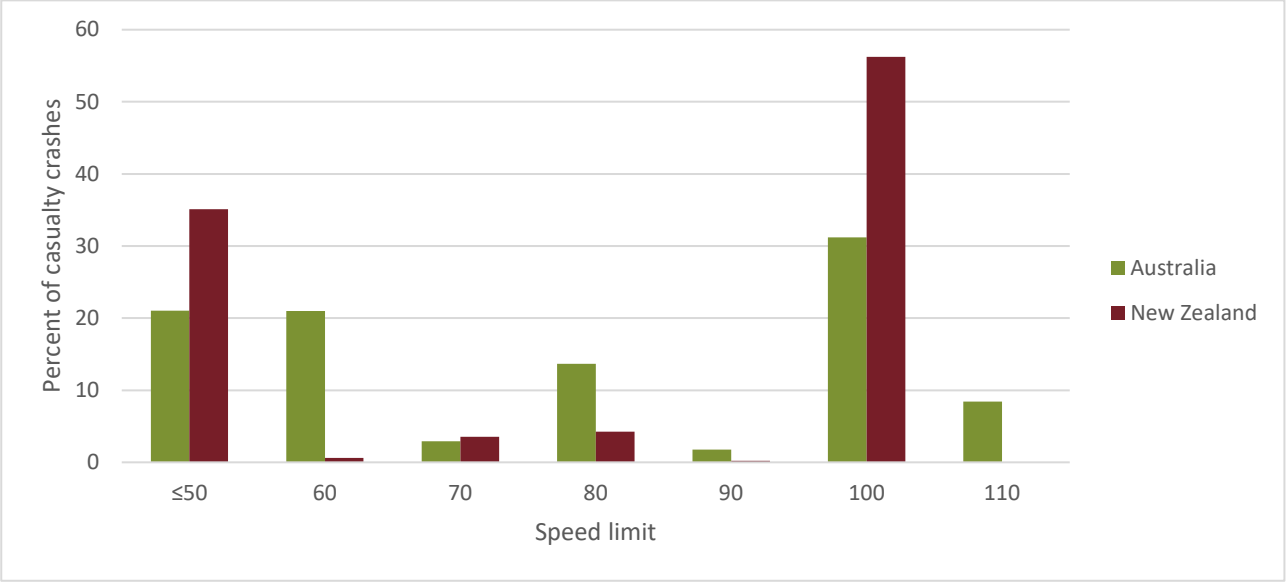


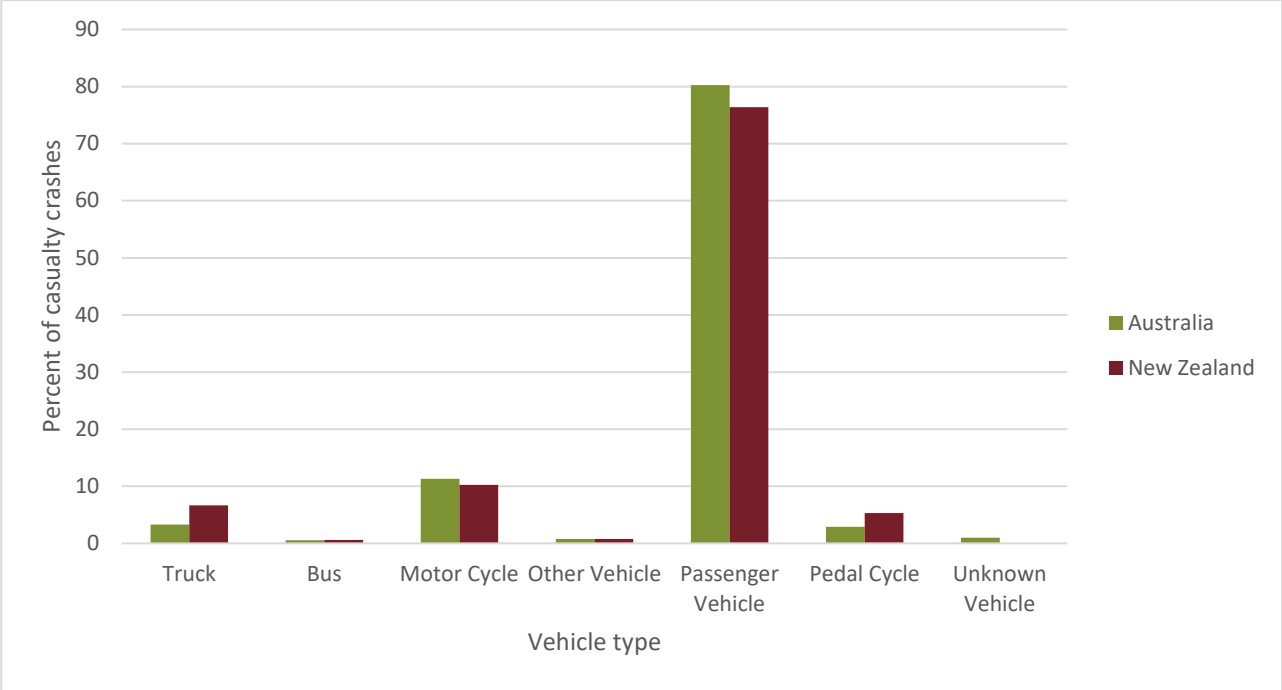
Figure 19.8 displays percentages of average annual regional and remote casualty crashes by speed limit zone. The largest proportion of crashes in both countries occurred in 100 km/h speed limit zones. The lack of crashes in some speed zones (e.g. 60km/h,110km/h in New Zealand) is likely to represent differences between the countries in commonly applied speed limits. Around 36% of crashes in New Zealand and 42% of crashes in Australia occurred in 50 and 60 km/h speed zones, suggesting a substantial proportion of crashes also occur in regional/remote towns.

Figure 19.8: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by speed limit zone



Percentages of average annual regional and remote casualty crashes by vehicle type are presented in Figure 19.9. Passenger vehicles were involved in almost 80% of casualty crashes in both Australia and New Zealand, while motorcycles were involved in around 10% and trucks and pedal cycles were involved in less than 10%.

Figure 19.9: Percentages of average annual casualty crashes (2012 to 2016) in regional and remote areas by vehicle type



Note: Articulated truck and heavy rigid truck combined for the Truck category. Light commercial vehicles included in Passenger Vehicle category.

19.1.4 Casualties on regional and remote roads

Rather than examining casualty crashes, this section examines the proportions of average annual casualties (fatal and injury) from crashes in regional and remote areas across Australia and New Zealand for the years 2012-2016. The percentages of average annual casualties by age group are shown for males in Figure 19.10 and females in Figure 19.11. The distributions by age group were very similar for males and females. In New Zealand, young males aged 17-25 accounted for the greatest proportion of injuries followed by males aged 40-59 years; in Australia the greatest proportion of injuries were for males aged 40-59 followed by young males (17-25 years). In both Australia and New Zealand young females aged 17-25 accounted for most injuries, followed closely by females aged 40-59. Note that the total number of casualties was highest for males in both countries for each age group.

Figure 19.10: Percentages of average annual male casualties (2012 to 2016) in regional and remote areas by age group

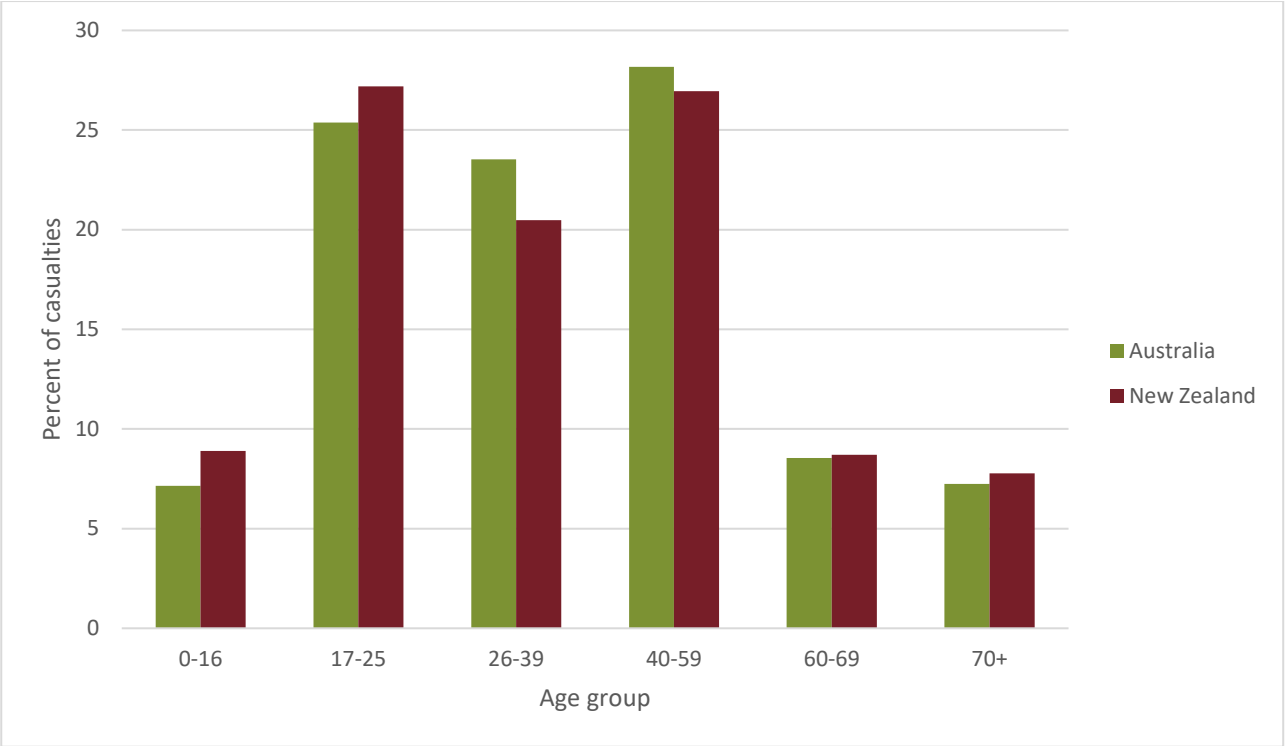


Figure 19.11: Percentages of average annual female casualties (2012 to 2016) in regional and remote areas by age group

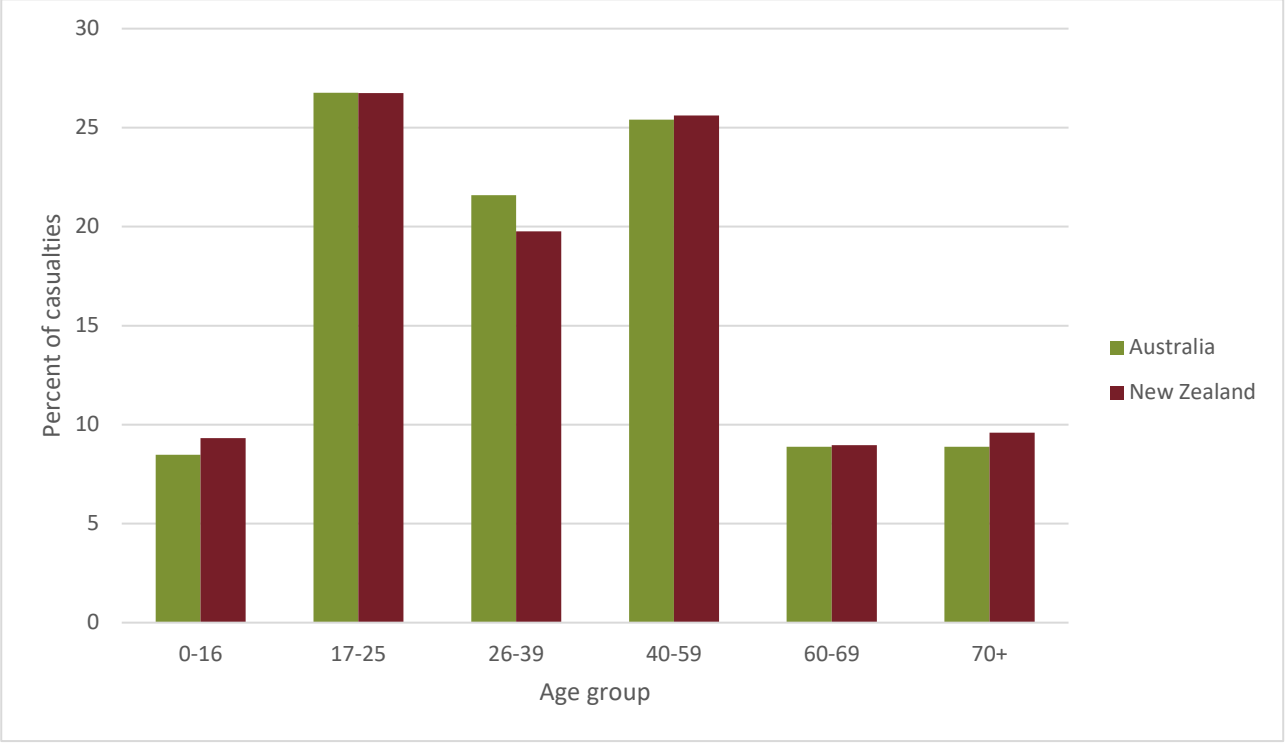
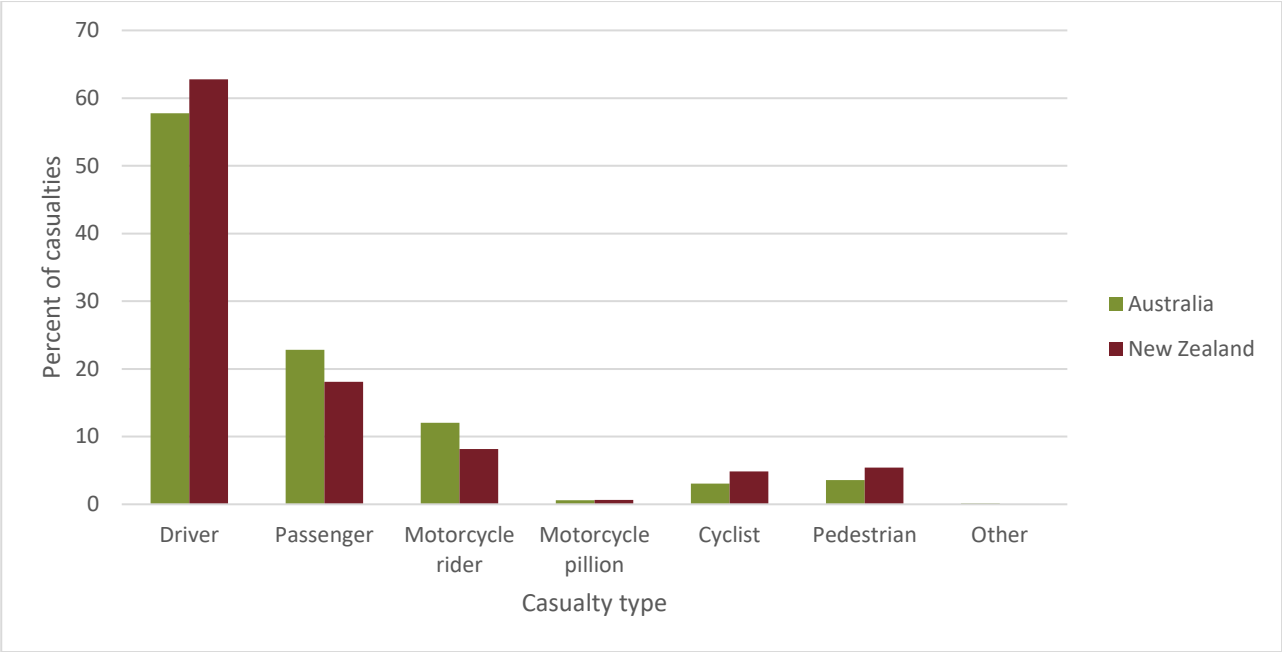


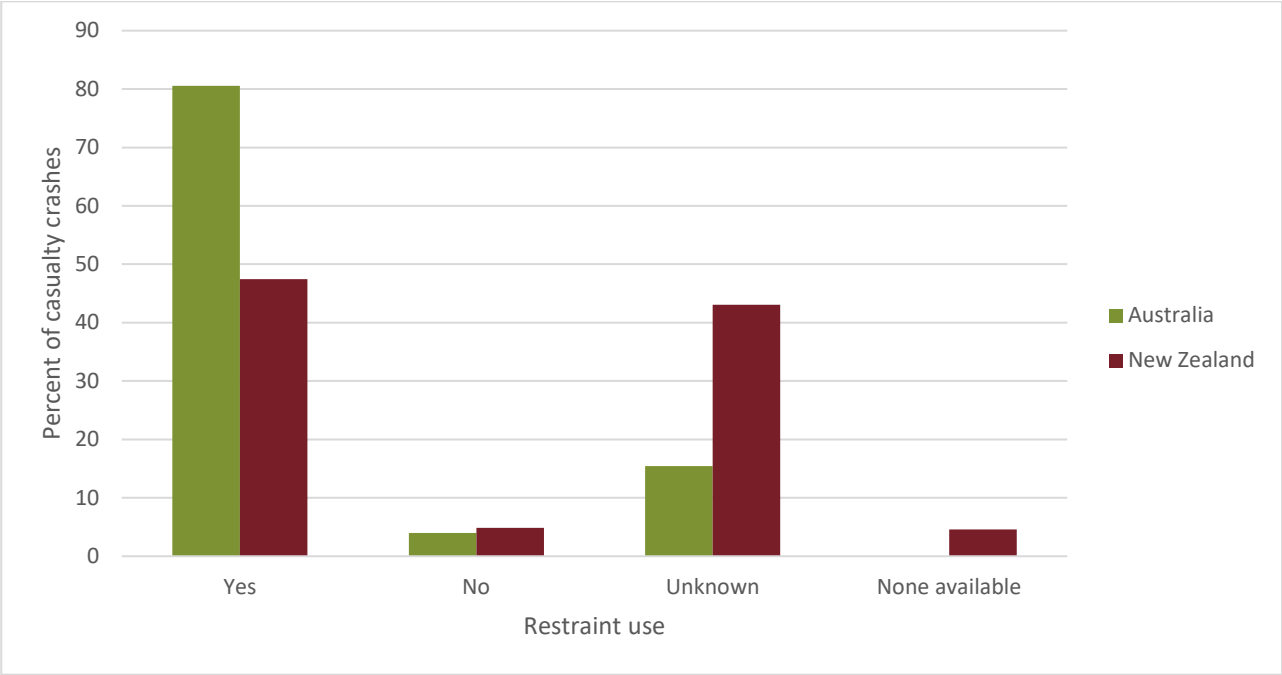
Figure 19.12 shows the proportion of average annual regional and remote casualties by casualty type. Drivers accounted for the largest proportion of casualties in both countries, followed by passengers and motorcycle riders.

Figure 19.12: Percentages of average annual casualties (2012 to 2016) in regional and remote areas by casualty type



The percentages of average annual regional and remote casualties (drivers and passengers) by restraint use are presented in Figure 19.13. It can be seen that 80.6% (95.3% of those with known restraint use status) of casualties in Australia and 47.5% (90.7% of known restraint use status) in New Zealand were restrained, while 4.0% (4.7% of known restraint use status) and 4.9% (9.3% of known restraint use status) respectively were unrestrained. The category of 'None available' was not present in the Australian data.

Figure 19.13: Percentages of average annual casualties (2012 to 2016) in regional and remote areas by restraint use



Notes: None available was not a category in the Australian data

It was not possible to obtain data on the number of casualties by type of location of the crash (e.g. cross intersection, T intersection, roundabout or midblock). Instead, the data that were available were the number of casualties from crashes at intersections. These data showed that the average annual number of casualties from crashes at regional and remote intersections between 2012 and 2016 was 8159 in Australia or 31.6% of total casualties and 1261 in New Zealand or 21.7% of total casualties.

19.1.5 Summary of the regional and remote crash trends

Analyses of regional and remote crash and casualty data, based on the average number of crashes occurring over the period 2012 to 2016, identified the following trends or issues:

- Injuries are skewed towards higher severity in regional and remote areas in both Australia and New Zealand, with higher proportions of fatalities and serious injuries observed than in major cities.
- In Australia, off path regional and remote casualty crashes are a significant problem. In New Zealand the main crash types are more evenly distributed between same direction, adjacent direction, opposite direction, and off path crashes.
- There is a peak in regional and remote casualty crashes in both Australia and New Zealand between 2pm and 6pm.
- The proportion of regional and remote crashes in both Australia and New Zealand are slightly higher over weekends and lower through the week.
- In Australia and New Zealand there is a lower proportion of regional and remote crashes over the winter months and early spring.
- In both Australia and New Zealand, a substantial proportion of regional and remote casualty crashes occur on high speed roads, particularly those with a speed limit of 100 km/h or above, but also in regional/remote towns (i.e. speed limit 50-60km/h).
- Passenger vehicles are most commonly involved in regional and remote casualty crashes in both countries.
- Overall, a greater number of males were injured in regional and remote areas than females. In both Australia and New Zealand, males in the 40-59 and 17-25 age groups account for the greatest proportion of regional and remote casualties.
- In both Australia and New Zealand young females aged 17-25 account for most casualties in regional and remote areas, followed closely by females aged 40-59.
- In both countries, drivers account for a substantial proportion of regional and remote casualties.
- Of those for whom restraint use status was known, 4.7% of driver and passenger casualties in regional and remote areas were unrestrained in Australia, and 9.3% of driver and passenger casualties in New Zealand.

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Appendix A Haddon Matrix Conceptual Basis for Countermeasure Development

Once the crash problem is clearly identified the Haddon Matrix can be used to derive potential countermeasures. The Haddon Matrix, a conceptual model developed by William Haddon more than four decades ago, by applying basic principles of public health to the problem of traffic safety is a useful tool to determine which countermeasures address a particular crash problem. See Table A 1.

There are three elements from which countermeasures can be chosen – human, vehicle and environment. There are also three time periods or phases – pre-crash, in-crash and post-crash, creating a matrix of nine cells, each of which identifies possibilities for intervention to prevent the crash or injuries occurring, or to reduce the effects of harm sustained in the crash. This leads to four broad strategies for reducing crashes and minimising their impact on individuals:

- exposure control – e.g. provisions in graduated licensing to restrict the number of passengers and/or driving late at night
- reducing crash risk – e.g. improved braking, better signs and road markings
- improving road user protection – e.g. improved crashworthiness, restraints and laws to require their use, more forgiving road environment
- improving assistance to injured persons – e.g. faster emergency response times, better trauma care.

Table A 1: Haddon matrix showing examples of countermeasures

Element	Phases		
	Before a crash	**During a crash**	**After a crash**
Human	Training, education, behaviour (e.g. not drinking), attitudes, enforcement, conspicuous clothing on pedestrians and cyclists, exposure control.	Wearing in-vehicle restraints.	Prompt emergency medical service response, better trauma care.
Vehicle	Primary safety (e.g. good brakes, roadworthiness, visibility).	Secondary safety (e.g. occupant protection, crashworthiness).	Devices to attract attention (e.g. mobile phone, horn).
Road	Road design (e.g. delineation, good road geometry, good surface condition, visibility).	Roadside safety (e.g. clear zones, frangible poles, vegetation selection, adequate safety barriers).	Median breaks and shoulders provided on freeways to facilitate access for emergency vehicles, ITS congestion and incident management.

Source: Based on Austroads (2009c), adapted from Haddon (1980)

Appendix B Detail of METS Modelling Approach to Target Setting

The most recent Australian strategy employed a Macro Estimates Target Setting (METS) modelling approach. The main purpose was to estimate the level of serious casualty reductions that could be achieved during the life of the strategy and to indicate at a very broad level what kind of action would be required to bring this about. This process was informed by either reliable agency-supplied statistical data or the results of a review of Australian and international research on the effectiveness of a number of road safety interventions. The METS analyses allowed different levels and combinations of initiatives to be easily compared. The savings as a result of these initiatives were estimated relative to the level of serious casualties that could be expected to occur in the absence of a significant road safety strategy or the baseline case. As with any modelling exercise there were some levels of uncertainty and it was necessary to make assumptions about the underlying nature of the road transport system into the future. Two main whole-of-system influences were accounted for:

- future growth in serious casualties as a result of increasing exposure, reflected by vehicle kilometres travelled
- future reductions in serious casualty rates due to the total effect of a series of road safety measures introduced, too small to be individually measured, and the gradual effects of increasing motorisation.

A number of useful outputs can be created by the METS process: the cumulative numbers of serious casualties saved over the life of the strategy; the performance of the strategy in its final year compared to the most recent year data is available; total strategy cost; cost per serious casualty saved; monetary savings to society resulting from the serious casualty savings; and the ratio of monetary savings to strategy cost. These outputs form the basis of setting achievable and cost-effective targets for the life of the strategy.

See Corben et al. (2008) for further detail about the METS process.

Appendix C Detail of Swedish system-wide method for modelling road trauma

In 2012 the Swedish Transport Administration introduced a new method to generate a suitable target for reducing the number of fatalities in 2020 based on actual traffic crashes that occurred in Sweden during the course of 2010. The process used is described in its generic form here using the terms base year (2010) and target year (2020).

Each crash that resulted in a fatality was analysed on the basis of a chain of events that ranged from “normal” driving to collision.

A chain of events that leads to a fatality can be broken at a number of different links, each one representing an opportunity to intervene in the injury process. Studying crashes in this manner permits management of the interaction between countermeasures and allows more detailed projections of future trauma levels.

In-depth crash data is used for fatalities and probabilistic data is used for severe injuries.

The analysis is performed in two steps.

1. Predict the percentage of fatalities and severe injuries that will be counteracted by likely vehicle and infrastructure technology trends up to the target year covered by the strategy. The assumptions concerning vehicle and infrastructure technology trends are cautious.
2. Analysis of the potential of new countermeasures to further reduce fatal and severe injury outcomes by the target year.

A key feature of the approach is that it makes use of accurate information about the safety technology with which vehicles will be equipped through the strategy period. Infrastructure trends are also more accurately projected. Based on the data generated by the in-depth studies, each fatal crash from the 2010 base year is examined to determine whether it would have occurred or been fatal under conditions projected for the target year. A fatality that can be avoided as the result of a change to a particular condition (for example, the future vehicle might be equipped with autonomous emergency braking) is then removed from the analysis such that it does not affect the examination of the potential of the next change to a condition. Thus, the theoretical calculation cannot prevent a fatality more than once.

Examining all conceivable conditions in the target year of the strategy and applying them one by one to the various crashes that occurred in 2010 base year generates a total effect for all conditions without double counting the benefits of countermeasures.

This approach makes it easier for the road safety effort to concentrate on the crashes that are not being eliminated by ongoing vehicle and infrastructure technology trends and that therefore require additional attention.

Severe injuries are analysed with the same approach as for fatalities but the conditions are different. Because the projected number of severe injuries is based on the probability of medical impairment, no data are available that permit identification of individuals with such injuries. People must be analysed instead based on the probability that they will sustain severe injuries.

Calculations were performed for each person who was injured in 2010 to determine the probability that they would develop a medical impairment (severe injury). Information from hospital data was supplemented by data from police about vehicles and the chain of events leading to collision.

In this way, each individual who was injured in 2010 was assigned a risk of developing a medical impairment. Subsequently applying the vehicle and infrastructure technology projected for the target year to each traffic injury in 2010 (according to the same method as the analysis of fatalities) permits an analysis of the probability that the same crash would lead to medical impairment in the future. The reduction of the Risks for Permanent Medical Impairment (RPMI) projected between the base year and the target year are then added up, generating a combined prediction of the total reduction in the number of severe injuries for target year based on the anticipated measures, as well as the number of injuries that still need to be prevented (the "residual") in order to achieve the strategy targets.

An important step in the new approach was to update the performance indicators used to manage and monitor the road safety effort. New information and targets, as well as the introduction of new countermeasures, meant that the current set of performance indicators needed to be reviewed. Moreover, certain additional conditions needed to be monitored to verify that the assumptions of the analysis were still valid.

See Swedish Transport Administration (2012) for further detail about this approach.

Appendix D Managing Risk Associated with Road Users

Managing risk associated with road users is a duty which road authorities undertake in partnership with police, the court system, and health sector. At present, there is no comprehensive system of risk management pertaining to road users, but rather a range of separate initiatives which have emerged over the years. The principal ways in which risk associated with road users is managed are as follows:

D.1 Entry to the System

In Australia and New Zealand, road and/or transport authorities have a duty to ensure that all persons in charge of motorised vehicles, beyond a very low threshold, have the requisite sensory, motor and cognitive abilities to manage their vehicle, and that they have acquired the requisite knowledge regarding road rules and operating procedures in traffic, along with the practical driving skills to be able to drive safely.

D.1.1 Fitness to drive

Austroads has published a comprehensive guide on assessing fitness to drive, which covers all aspects of physical and mental ability to drive. This is intended as a guide to medical practitioners and other professionals who are called upon to make an assessment as to whether a person is fit to drive or not. It contains separate criteria for the drivers of commercial vehicles, to whom additional criteria are applied in recognition of the greater potential for harm when large vehicles are involved in crashes.

Eyesight is the way in which the fitness to drive guidelines impact most road users. The Austroads guidelines require basic standards for visual acuity and visual field. Most jurisdictions back this by undertaking screening for static visual acuity at the time of the first licence application, using the Snellen eye chart or an equivalent device. Some jurisdictions test only when the first licence application is made, while others repeat the screening on each licence renewal. At present, South Australia and Queensland do not carry out any screening, placing the onus on the individual to declare any visual abnormalities, with Queensland currently in the process of considering whether to re-introduce some form of screening. Only New Zealand routinely tests for both acuity and visual fields, using special testing apparatus.

Persons who have sensory deficits, or who have movement or strength limitations, can often be helped to drive safely by the installation of suitable driver aids such as additional mirrors or video cameras, steering wheel handles, and hand-controlled accelerators and brakes. There is a well-developed body of expertise and a workforce capable of applying it to assist with these problems. The role of the road or traffic authority is in ensuring that persons with abilities are properly assessed, that they are given sound advice regarding which aids are necessary in their particular circumstances, and that conditions applied to the licence of a person with a disability are appropriate.

D.1.2 Driving licences

Road and transport authorities have a responsibility for ensuring that drivers have the required knowledge of rules and operating procedures and that they have acquired a sufficient degree of practical driving skills before being allowed to drive independently.

It is mandatory for drivers and riders in all jurisdictions to pass a theory test before they are issued with a Learner's permit which permits them to drive under supervision. The theory test covers a range of issues, including road rules and priority in different situations, recognising and understanding road signs and markings, understanding roadworthiness requirements, alcohol and drug prohibitions and restrictions, and fatigue. Before being allowed to drive unsupervised, candidates are required to pass a practical driving test, in which the candidate is exposed to a range of typical driving situations. However, given its relatively short duration, it is limited in terms of what skills can be tested and in terms of the depth to which these skills can be tested. Following passing the basic test, drivers are then placed on a probationary licence, the conditions of which vary among jurisdictions. Some jurisdictions now include a hazard perception test as part of the migration to full licence in an effort to encourage drivers to acquire the skills of 'reading the road' characteristic of mature, low-risk drivers.

D.1.3 Licences for other vehicles

Operating a motorcycle, rigid truck or bus, or articulated truck requires a licence for that particular class of vehicle. Obtaining these licences requires a practical driving test, which assesses skills in handling the class of vehicle in question.

D.2 Removal from the System

Complementing control over entry to the system as a means of managing the risk associated with drivers is the responsibility for removing drivers from the system whose driving poses an unacceptable threat to others and themselves. This may come about through injury or disease, particularly those conditions associated with old age, or may come about through persistent serious offending.

D.2.1 Fitness to drive

In the event of serious injury or debilitating illness changing their capacity to drive, individuals are obliged to notify the relevant authority of their changed capacity to drive. A thorough-going assessment is then carried out to determine whether and under what conditions the individual can continue to drive, relying on the body of expertise described in the section on fitness to drive.

Although the same obligations apply in the case of age-related conditions, termination of licence on these grounds tends to be more contentious. The onset of the conditions may be gradual, so that the individual has little awareness of diminished capacities. The same conditions which affect driving may affect other aspects of awareness and decision-making, making it hard for the individual to make a reasoned decision. Medical practitioners are placed in a difficult position as drawing attention to an individual's problems with driving may have implications for the therapeutic relationship. Road authorities generally have a three-pronged approach to this issue. First, they provide advice to older drivers about how to manage trip choice and aspects of their driving to minimise risk. Second, they provide advice and support (usually indirectly to carers and others intimately involved with older people) regarding surrendering of licences when the individual feels they can no longer cope with driving - this is the preferred way for ending a driving career. Third, they will cancel a licence if the individual is no longer capable of driving safely.

D.2.2 Serious and repeat offenders

Responsibility for removing serious and repeat offenders from the road system is a responsibility which is exercised jointly with police, licensing authority and the court system. Police are generally responsible for detecting and prosecuting offences (although road and transport authorities do have a role, especially where heavy vehicles are concerned). Court systems are responsible for determining guilt and applying penalties. Although many serious offences and repeat offences carry automatic periods of disqualification, courts may have discretion to waive a period of disqualification under certain circumstances, and may have considerable discretion over the length of the disqualification.

Removing an individual from the driving system is generally seen as a form of punishment. However, it is also a risk management tool, provided it can be enforced. Removing the driver from the system prevents the driver posing a risk to other road users.

An inherent problem of this approach is that, in societies like Australia and New Zealand, the primary function of courts is to consider evidence of offences committed, make determinations of guilt or innocence, and decide penalties. Their core concern is justice for the individual, not risk management. Offenders are therefore likely to be given the benefit of the doubt when it comes to imposing disqualifications or deciding on their length.

A further weakness of the system is that many drivers who are disqualified frequently take the risk of driving while disqualified. Although there are provisions for severe penalties, including imprisonment, they seem to be imposed only after repeat offending. This is further exacerbated by a low probability of detection for driving whilst disqualified. In this context, it is perhaps not surprising that the management of risk posed by road users has not been more successful.

D.3 Emerging Possibilities

New technologies open up new possibilities for controlling the risk posed by road users.

D.3.1 Controlling access to the road system

Technology to permit only qualified drivers to start and operate vehicles has been available since the early 1990s (Goldberg 1999). It consists of a ‘smart’ licence which electronically stores personal details, licence classification, conditions applying to the licence, and possibly a record of some biological identifier to ensure that the licence can only be used by the person to whom it was issued. A reader is mounted in the vehicle, interlocked with the ignition system. It would prevent a vehicle being started by anyone other than a qualified driver with a current licence to drive that class of vehicle. The system would also keep track of who was driving the vehicle and when. Obviously, it will take several years before this technology becomes sufficiently widely disseminated through the vehicle fleet for it to be an effective means of reducing access by unlicensed or unqualified drivers.

While it would be naïve to think that the combination of smart licence and ignition-interlocked reader would eliminate driving by disqualified drivers, it would certainly make it much more difficult, and hence make orders relating to disqualification much more effective.

D.3.2 Eliminating possibilities for offending

Existing and emerging technologies have the potential to greatly reduce certain types of offending, including some offences that currently pose the greatest risk in road safety terms. Three developments are of particular interest.

Alcohol Effective alcohol ignition interlock systems (AIS) have been available for several years and are widely used in Australia to deal with drink drivers. While having an AIS fitted does seem to reduce recidivism while the device is fitted, research does indicate that they are only effective for as long as the device is installed. Research into the effectiveness of AIS often concludes by saying that they should only be removed after a prolonged period of demonstrated alcohol-free driving. For the minority who appear unable to modify their behaviour in the long term, indefinite compulsory use of AIS may be the only way they should retain their driving privileges (Bailey, Lindsay & Royals 2013).

Speed Effective speed limiters have been available for years. The risks associated with excessive speed by persistent open road speeders could be substantially reduced by requiring these offenders to have a speed limiting device fitted to any vehicle they drive, operating along the same lines as an alcohol interlock. However, this would not affect the problem of speeding on urban roads. Intelligent speed assist (ISA) devices are available and are effective on all types of road. They work by determining the vehicle's location through the global positioning system (GPS) and cross referencing this information with a digital map that contains speed limit data. They can be set to either issue an audible or visual warning when the vehicle exceeds the speed limit by a certain margin, or to physically prevent a vehicle from exceeding the speed limit. Currently, ISA is seen as a positive safety feature of vehicles in the same way as autonomous braking or lane keep assist and its installation in vehicles is not compulsory. No jurisdiction in Australia or New Zealand mandates the use of ISA as a penalty for speeding. The European Parliament recently voted to make ISA compulsory in all cars sold in the European Union by 2022 and for all motorists to be required to use it if fitted (Reid 2019). It is estimated that if ISA was fitted in all cars in Australia, fatal crashes could be reduced by up to 24% and by up to 59% if active speed limiting ISA was installed (howsafeisyourcar.com.au).

Seat belts. Use of restraints is at high levels in Australia and New Zealand, but fatalities involving unrestrained vehicle occupants are disproportionately high. Seatbelt reminder/interlock systems already on sale in some markets could improve this. Systems that play increasingly louder reminder messages if a vehicle seat is occupied but the matching seat belt is not fastened are commonplace in vehicles.

The general principles for risk management outlined in the main document can be applied to the management of risks associated with road user behaviour. However, it appears that this has not been done in a systematic way to date. In order to manage risk effectively, the basic stages of risk identification, analysis, evaluation and treatment for risks associated with road users need to be undertaken.

Appendix E Data Sources

There are a large variety of data sources that can be used when assessing levels of risk. This appendix highlights some of these, although there may be others that will need to be considered, depending on the local context and objectives.

The most obvious source of data of relevance in the road safety context is that from crash databases. Crash data are an effective tool in assessing crash causation, including factors relating to human, vehicle or road related issues. Crash data is collected by the police, either at the scene of the crash, or subsequent to this. All Australasian jurisdictions have agreed to work towards a minimum common dataset, although in many cases, more detail than this minimum is already collected. This information is integrated into a crash database for ease of accessibility and analysis.

However, there are other relevant sources besides police based crash data that could be drawn upon. For example, information on crashes is available from hospital data (which may be of use when examining crashes which are generally under-reported, including pedestrian and cyclist crashes) and insurance data. However, these additional sources of data are often difficult to access, and police-reported crash data is often used for this task.

Pro-active assessments of safety also provide a valuable source of information. Methods including road safety audit (Austroads 2019a) or network based assessments add useful information on potential risks. Further information is available from public feedback and consultation on specific crash sites. This may highlight additional sources of risk (although whether this is actual or perceived risk will need to be determined).

Information from asset management and road inspection will also be of relevance, as issues highlighted through these processes can often provide information on level of risk (for example relating to road surface condition). For further information on these issues, refer to Austroads' *Guide to Asset Management* (Austroads 2018a).

Traffic volume data is often used as a source of data, especially in conjunction with crash numbers to provide crash rates. This technique is particularly useful in helping identify routes, areas or crash types that fall above the average expected. Similarly, pattern analysis can be undertaken to identify common crash types for treatment (for instance drink drive, speed, fatigue, and run-off-road crashes). Vehicle classification data is also sometimes used to identify vehicle specific issues.

Enforcement and monitoring data, including measurement of vehicle speeds, or helmet and seat belt wearing rates may also be of use when assessing the effects of some treatment types. This information can be used to identify safety issues, and also for monitoring purposes.

When assessing the level of risk associated with the legal context, there is a need to consider the appropriate legislation, as well as legal precedents. This is a constantly changing area, especially in Australia at present. Consultation with appropriate legal advisors will most likely be required.

Appendix F Qualitative and Semi-Qualitative Analysis

F.1 Risk Classification

Risks can be classified according to likelihood of occurrence, and consequences if they do occur. In cases where there is limited objective information, a qualitative approach can be taken. As an example, risks can be classified as to whether they are high, significant, moderate or low, as below:

Figure F 1: Risk classification

Likelihood	Risk Classification				
A Almost Certain	S	S	H	H	H
B Likely	M	S	S	H	H
C Moderate	L	M	S	H	H
D Unlikely	L	L	M	S	H
E Rare	L	L	M	S	S
Consequence	Insignificant	Minor	Moderate	Major	Catastrophic

H = High risk; S = Significant risk; M = Moderate risk; L = Low risk

The level of risk may be attached to some form of action. For example, immediate action or senior management attention may be required for high risks. This approach is also useful as an initial screening before more in-depth analysis is undertaken.

Alternatively, a semi-quantitative analysis can be undertaken using the same qualitative scales as above, but applying numerical values. Risk can be ranked in ‘bands’ from low to high:

Figure F 2: Linear ranking

Likelihood	Risk Classification				
5	15	19	22	24	25
4	10	14	18	21	23
3	6	9	13	17	20
2	3	5	8	12	16
1	1	2	4	7	11
Consequence	1	2	3	4	5

F.2 Fault and Success Trees

In order to examine likelihood in more detail, a systems engineering technique, such as a fault tree can be used to assess probabilities of occurrence in more detail. The fault tree follows a path of undesired events (and the probabilities of those events, for example, on a per annum basis) to provide an overall likelihood of the particular fault being considered. Success trees operate in a similar manner although the results are based on the probability that an item is available and is therefore preferred by reliability engineers. Examples of the various methods are shown below.

Figure F 3: Fault tree methods

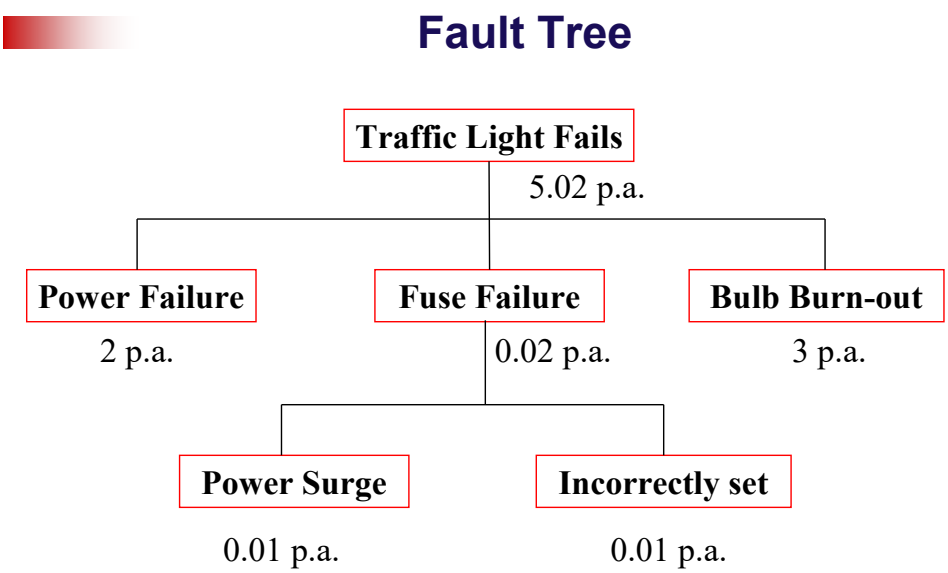
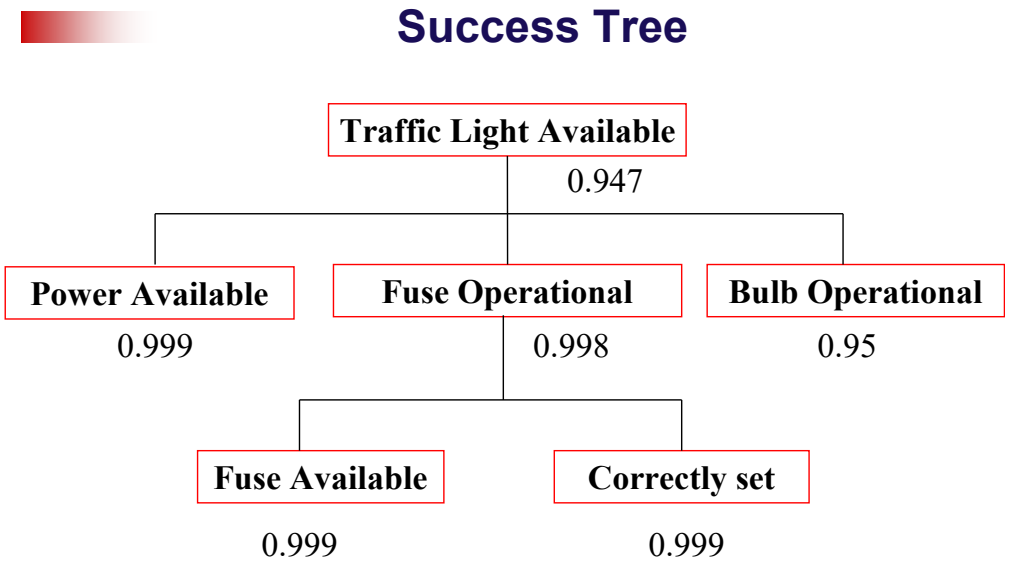


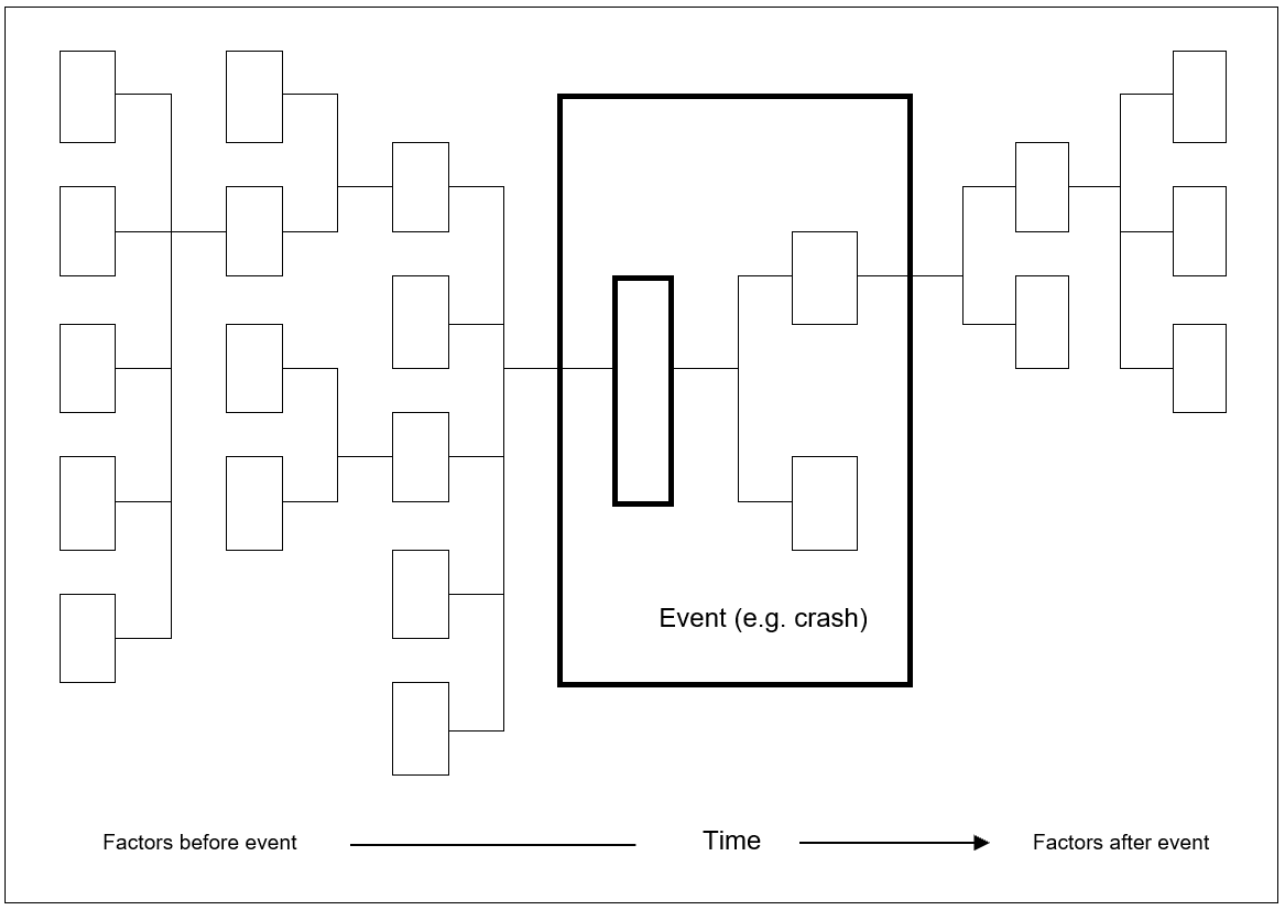
Figure F 4: Success tree



F.3 Cause-consequence Diagram

The cause-consequence diagram is an extension of the above models, where a series of factors can influence the occurrence of an event, and a series of factors affect the outcome of the event. The purpose of cause-consequence is to identify chains of events that can lead to undesirable consequences. Prior events could include driver, vehicle and environmental factors that may influence a crash. After factors could include roadside hazards or access to emergency services. A schematic example is shown below.

Figure F 5: Schematic example



Appendix G Benefit Cost Analysis

This appendix discusses some of the issues involved in conducting an economic appraisal. For further information relating to crash risk, full details on how to conduct an economic appraisal are presented in the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b). For a more in-depth coverage on issues relating to economic appraisal, see Australian Transport Assessment and Planning (ATAP)

The most common forms of benefit cost analysis used in assessing crash risk are the benefit-cost ratio (BCR) and Net Present Value (NPV). Both rely on information on benefits gained from the treatment (usually savings in crash costs which incorporates changes in the number and severity of crashes, and costs associated with implementing the treatment (including initial capital costs and any increase in ongoing operating or maintenance costs). The cost savings are often attributed over a number of years, and standardised costs for different crash types used. Future annual costs and benefits are reduced (or discounted) to the equivalent of present day values so as not to distort future dollar values.

BCR is the ratio of benefits over that of costs. A ratio of greater than 1.0 indicates that the project provides greater benefit than its cost. NPV is the difference between costs and benefits (costs are subtracted from the benefits), with a positive NPV meaning that the project is of benefit.

Below is an example from the *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021b) Appendix C.7.1, and this in turn comes from Ogden (1996).

The example is the installation of a roundabout in an urban area to address an intersection problem. It is assumed that the capital cost of the scheme is $20,000, and that there will be no change in vehicle operating costs, or vehicle flow through the intersection. There is currently an average of one adjacent approach crash per year (the associated crash cost for this was estimated at $42,000 based on Queensland Department of Main Roads data for 1998. It was assumed that a 70% crash reduction could be expected from the introduction of the roundabout. The appraisal period was 10 years, and the discount rate was 4% per annum.

In the ‘do nothing’ case, the annual cost of crashes would continue at $42,000 per year. With the introduction of the roundabout, we would expect an annual benefit of $29,400 (or a 70% reduction in the cost, based on a 70% crash reduction). A benefit is assumed over a 10 year period, and there is a need to discount this. At a discount rate of 4% per year, the present worth of $1 per year over 10 years is $8.11 (this can be calculated, or derived from discount tables). Multiplying the annual benefit of $29,400 by 8.11 provides a total benefit of $238,000. With an installation cost of $20,000, the NPV is $218,000 ($238,000 - $20,000), and the BCR is 11.9 ($238,000 ÷ $20,000).

It is also recommended that sensitivity analysis be conducted, for instance by varying the crash reduction percentage, or the capital cost of the scheme to determine the effect of any errors or variations in the assumptions.

The problem with the traditional method of conducting economic appraisals in road safety projects (i.e. the method described above) is that they rely on there being a crash history in order to generate crash savings. As Australia and New Zealand move towards embedding the Safe System, increasing emphasis should be placed on proactive treatments that address an identified risk, but possibly not a recorded crash history. In these cases, applying a crash reduction factor would not produce crash savings as the crash history is already zero. There exist a number of ways of dealing with this problem:

- Identify a similar road/intersection nearby that does have a crash history and use its *crash rate* to determine a predicted number of crashes on the subject section. This can then be used as a proxy for an actual crash history and crash reduction factors can be applied as normal.
- Use one of the tools described to produce a risk score that can be used as a proxy for a crash history. Crash reduction factors can then be applied as normal to generate crash savings.

Appendix H Example Monitoring Databases

Collection of information on the safety performance of various measures is important to determine how effective these measures are. Monitoring databases are used to meet this need, and typically include information on the type of measure, location, and crashes both before and after treatment. A number of states in Australia maintain such databases, but it is often not possible to draw conclusions about reductions in crash numbers due to the small number of schemes of different types. National crash database systems exist in a number of locations, and given the greater number of potential safety schemes, allow greater scope for detailed analysis. Examples of such databases include the Crash Reduction monitoring system in New Zealand and the CMF Clearinghouse in the USA.

H.1 New Zealand Crash Analysis System

The New Zealand Crash Reduction Study Program started in 1985, and since 1989 a monitoring system has been used to collect information on its effectiveness. The New Zealand Crash Analysis System (CAS) is used to evaluate the overall effectiveness of the program, as well as the success of treatments or packages of treatments where this is possible.

Information collected includes:

- location
- road features (including road type, speed limit, road classification, and roadside development
- cost of treatment (including provision for estimated and actual costs)
- treatment used (including provision for multiple treatments)
- date each treatment was implemented
- crash type addressed.

As the monitoring system is an integral part of the crash database system (which is also linked to the asset management system), it is possible to conducts complex analyses.

Reports are periodically released on the effectiveness for specific treatment types based on the information within the database. Given that all schemes completed as part of the Crash Reduction Study Program are included in the database, this could be seen as a relatively unbiased record of different treatment types. In addition, account is taken of underlying crash trends, with each site assigned a comparison group of injury crashes. However, the data is not adjusted for the issue of regression to the mean, so it could be expected that the results overstate the effectiveness of various measures.

H.2 CMF Clearinghouse

Funded by the U.S. Department of Transportation Federal Highway Administration and maintained by the University of North Carolina Highway Safety Research Center, the CMF Clearinghouse is an online database of crash modification factors derived from studies on the effectiveness of actual road safety treatments that have been installed. The database can be accessed at http://www.cmfclearinghouse.org and is free to use. The entire database can be downloaded for detailed analysis offline. As of 2019, there are some 7,000 individual CMFs contained in the database.

To be included in the Clearinghouse, studies must meet a number of criteria which include:

- The study must be based on actual crash data, not surrogate measures of safety such as speed reductions, near misses, or give way behaviour.

- The study must have the objective of quantifying the safety effect of a roadway feature or characteristic (as opposed to being an academic exercise of comparing model forms).
- The study must be focused on determining the safety effect of an infrastructure characteristic, feature or modification that would fall under engineering responsibilities (e.g. not planning-level or area-wide characteristics such as land use or demographics; not safety efforts unrelated to engineering such as public safety awareness campaigns or enforcement efforts).

The research literature is reviewed four times a year to identify eligible studies for inclusion in the Clearinghouse and is therefore kept up to date. Ten regular publications are reviewed, together with studies submitted by users of the database.

Searches can be based on a number of criteria, but the most basic is by countermeasure. The information contained in the database is broken down into categories and subcategories. For example, for a countermeasure search of 'roundabout' results are presented in the following categories: bicyclists, interchange design, intersection geometry and speed management.

Details of the individual studies in each category are tabulated and enable an average CMF to be calculated. In this way, studies that are not relevant to the situation at hand can be discounted to remove factors that may unfairly influence the score. Details provided include: the CMF itself, an assessment of the quality of the study (out of five stars), crash types considered, crash severities considered, the area type (urban, rural, etc) and a link to further details about the study itself which would enable the user to decide if it is applicable to their situation.

Austroads' **Guide to Road Safety Part 7: Road Safety Strategy and Management** details the process of road safety strategy development, management, evaluation and risk assessment. It outlines options for strategy development and details the value of a 'vision' in driving strategy development. It covers the stages of a strategy lifecycle, including problem analysis, countermeasure selection, target setting and safety performance indicators, development and implementation. It also details the importance of, and methods for, monitoring and evaluation.

Guide to Road Safety Part 7

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