Guide to Road Safety Part 1

Introduction and The Safe System

Austroads

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Guide to Road Safety Part 1: Introduction and The Safe System

Sydney 2021

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Guide to Road Safety Part 1: Introduction and The Safe System

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Abstract

The Austroads *Guide to Road Safety* has been developed to provide an overview of road safety and road safety practices in Australia and New Zealand. It consists of seven Parts.

Part 1 is an introduction to the Guide and The Safe System. It provides an overview of the structure of the Guide, its remaining seven parts and the interlinking and overlap between parts. It also describes Safe System, the guiding principles for road safety programs in Australia and New Zealand. The final section provides an overview of road agencies' responsibilities for road safety, and how performance in meeting these responsibilities is managed and measured.

At the time of publication, the 2021-2030 National Road Safety Strategy has not yet been released. A future project will update this Guide so that it reflects the Strategy.

Keywords

Road safety, safe system

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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 to the Guide to Road Safety

Road safety is a major strategic area for Austroads. The continuing reduction in road trauma is a key objective of all Austroads members. As such, the aim of the *Guide to Road Safety* is to provide the tools to assist organisations to fulfil this objective. The Guide also provides links to other Austroads Guides where road safety is a key consideration, or where aspects of other Guides cover essential aspects of changes to the road transport system which are being considered for safety reasons. For example, the *Guide to Road Safety* does not attempt to cover areas such as intersection design or pedestrian crossings but directs users to the relevant Parts in the Traffic Management or Road Design Guides. As well as meeting the direct needs of Austroads members, it is intended that the *Guide to Road Safety* will encourage and sustain partnerships with other road safety stakeholders by making key road safety concepts, principles and examples readily accessible.

The *Guide to Road Safety* is not intended to provide complete coverage of every aspect of road safety activities. Publications other than the Guide will continue to provide new information, promote discussion, or deal with issues where other stakeholders have primary responsibility, such as education or enforcement. Such publications may contribute to future revisions or expansion of the Guide.

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 Austroads *Guide to Road Safety* and the Safe System approach**
Part 2	Safe Roads	Guidance on assessing and treating roads to reduce the risk of fatal or serious injury crashes
Part 3	Safe Speed	Guidance on the management of vehicle speeds for improved road safety
Part 4	Safe People	Guidance on influencing behaviours for safe people and communities
Part 5	Safe Vehicles	Guidance 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	Practical guidance on implementing 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 throughout this Guide. It is noted that each pillar does not stand on its own but, rather, interlinks with other pillars to form the Safe System (Figure 1.1). As such, readers of this Guide are encouraged to refer to Parts that deal with multiple pillars when reading this Guide and must be cognisant of the interactions between pillars regardless of the specific focus area of their work.

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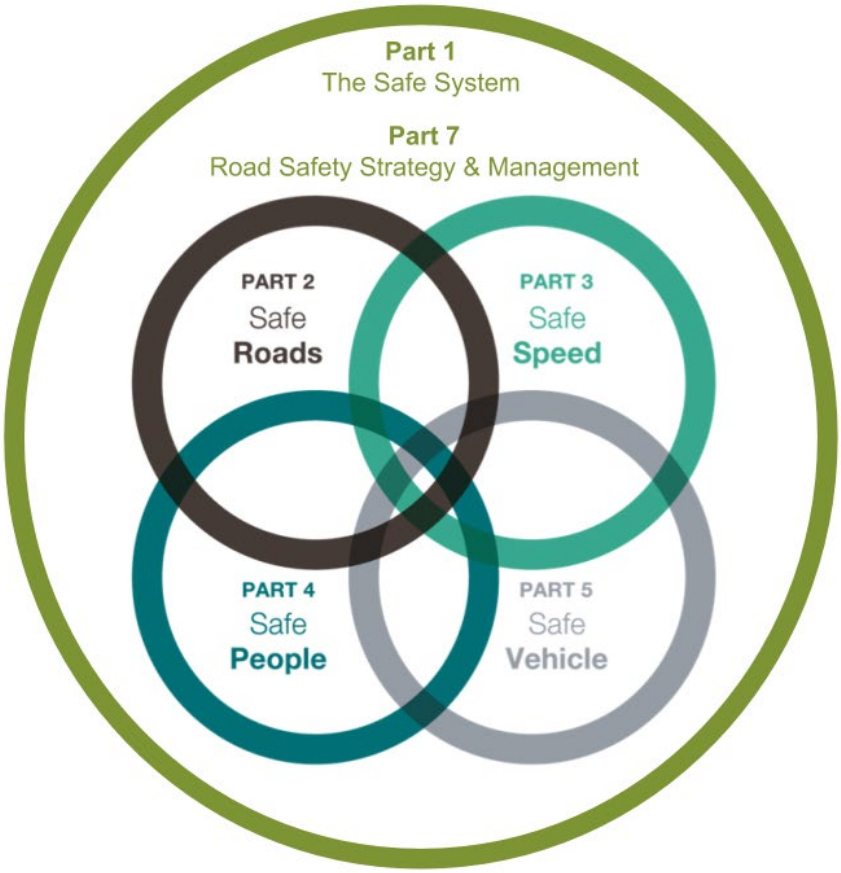
Figure 1.1: AGRS Part 2 to Part 5 interlink with each other and are guided by Part 1 and Part 7



1.1 Purpose of the Guide

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

Virtually all of us have grown up with death and injury as a seemingly inevitable consequence of the operation of road networks. With a growing awareness and understanding of safety issues, much progress has been made in past decades to reduce death and injury on the roads. Whilst there has been a strong focus on vehicle design and the performance of the road users themselves, improvements in traffic planning, management and infrastructure design have also contributed significantly towards overall improvements in safety. While the situation in Australia and New Zealand continues to improve over time, there is now a significant body of knowledge, theory and real-world examples that demonstrate how the rate of improvement can be increased substantially.

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Leading road safety countries have been pursuing a paradigm shift in the way the road safety problem is regarded since the 1990s, commonly referred to as the “Safe System” approach, the shift 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. A Safe System forces everyone to look at road safety from a public health perspective in which injury is avoidable and responsibility lies with system planners, designers and operators in addition to the road users. The philosophy of the approach is grounded in the ethical imperative that no one should be killed or injured when using the road system. From this standpoint it is unacceptable that the victims of road trauma are blamed for the outcomes of road user errors. Moreover, we must acknowledge that the way in which the road system has been designed and is operated may also contribute to crashes. A Safe System therefore is one in which roads are planned, designed and operated to be forgiving of human error so that severe casualty outcomes are unlikely to occur.

The document (Part 1) consists of:

- Section 1 (this section) is an introduction to the document and an overview of the structure of the Guide, its remaining seven parts and the interlinking and overlap between parts.
- Section 2 contains a description of Safe System, the guiding principles for road safety programs in Australia and New Zealand.
- Section 3 consists of an overview of road agencies’ responsibilities for road safety, and how performance in meeting these responsibilities is managed and measured.

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2. Safe System

The Safe System was endorsed in Australia in 2003 by the Australian Transport Council and adopted by Austroads in 2006. The approach is now integral to road safety strategies in jurisdictions in Australia and New Zealand as outlined in Table 2.1.

Table 2.1: Road safety strategies underpinned by the Safe System approach for jurisdictions in Australia and New Zealand

Jurisdiction	Supporting document/policy
Australia	National Road Safety Strategy, 2011-2020
New Zealand	Safer Journeys: New Zealand's Road Safety Strategy 2010-2020
Local Government	e.g. Mornington Peninsula DriveSafe 2008-2018 Vision Zero for Tāmaki Makaurau
NSW	NSW Road Safety Strategy 2012-2021
QLD	Safer Roads Safer Queensland: Road Safety Strategy 2015-2021
VIC	Towards Zero Road Safety Strategy and Action Plan 2016-2020
SA	Towards Zero Together - South Australia's Road Safety Strategy 2020
WA	Towards Zero – Road Safety Strategy for WA 2008-2020
TAS	Towards Zero - Tasmanian Road Safety Strategy 2017-2026
ACT	ACT Road Safety Strategy 2011-2020
NT	Towards Zero Road Safety Action Plan 2018-2022

While providing background information on the Safe System and its theories and principles, this Guide does not seek to make a case for the validity of the approach. The focus is now on how to operationalise a harm minimisation approach to tackle the future burden of death and injury through use of the road system and create a Safe System of road transport.

2.1 What is a Safe System?

The Safe System philosophy brings a public health focus to road safety whereby efforts aim for harm minimisation. At the centre of this is human fallibility and the fact that errors at present can lead to unintentional death and injury. Efficient movement should not be at the expense of human wellbeing.

An example of a visual representation of the Safe System is shown in Figure 2.1 adapted from the Queensland Road Safety Strategy (Department of Main Roads 2016). There are numerous similar depictions of Safe System models in various strategy and road safety documents.

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Figure 2.1: Portrayal of the Safe System

Source: Adapted from Safer Roads, Safer Queensland: Queensland's Road Safety Strategy 2015–21
http://roadsafety.gov.au/nrss/safe-system.aspx

There are four key principles that form the basis of the Safe System philosophy (International Transport Forum 2016):

- People make mistakes that can lead to road crashes
- The human body has a limited physical ability to tolerate crash forces before harm occurs
- A shared responsibility exists amongst those who plan, design, build, manage and use roads and vehicles and those who provide post-crash care to prevent crashes resulting in serious injury or death
- All parts of the system must be strengthened to multiply their effects; so that if one part fails, road users are still protected.

While we should continue to work to improve compliance and the cooperation of road users, we should also be open to the idea that solutions to these problems may lie outside the enforcement and legislative domain. Adopting an alternative intersection design, for example, may eliminate or mitigate some problem altogether.

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A topic of ongoing debate is the extent to which non-compliant and risk-taking behaviour should also be accommodated. Many Safe System approaches have been published indicating an expectation of “alert and compliant road users”. The rationale then becomes that no one should be killed or injured while legally using the road system. This aligns more closely with a historical view of road safety and excludes other possibilities under the “system” approach. For example, certain road designs may eliminate the possibility of non-compliant behaviour (e.g. illegal overtaking because a centreline barrier is in place). In addition, there is a need to protect innocent parties from the actions of others. For example, the key response to the burden of trauma caused by red light running over several decades has been to put safety cameras in place at selected sites in the network. However, red light running behaviour is a known phenomenon at signalised intersections. As such it should be expected and managed as part of system design and network operation (e.g. holding signals on red until the offending vehicle is clear). Additionally, our understanding of errors should not be limited to an assumption of deliberate and risky actions - there are many circumstances in which a road user might unintentionally run a red light.

The Safe System is usually considered in terms of key interacting “pillars”:

- Safe roads
- Safe speed
- Safe vehicles
- Safe people.

A fifth pillar, post-crash response, was introduced into the Safe System model by the United Nations in 2010 (World Health Organisation 2011) however it is not yet reflected in many portrayals of the Safe System in Australasia.

Each of the Safe System pillars is inter-related and problems in one area may be compensated by solutions in another. A true systems approach involves optimisation in planning, design and operation across all pillars however in practice this can be difficult. Vehicle design is predominantly an offshore activity within the private sector whereas planning, road design and operation are predominantly the domain of governments. Despite this, there are opportunities to ensure that there is synergy between the two. For example, intersection geometry could be established that maximises the occupant protection offered by current vehicle design. Road user performance can also contribute via training, enforcement and education. However, no matter how well this is done, errors will continue to occur.

Key inputs to the system commonly include:

- using data, research and evaluation to understand crashes and risks
- developing road rules and enforcement strategies to encourage compliance and manage non-compliance with the road rules
- managing access to the road through licensing drivers and riders and registering vehicles
- providing education and information
- being open to and seeking innovation
- developing standards for safe vehicles, roads, equipment and operation
- good planning, management and coordination.

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2.2 Pillars of the Safe System

The Safe System approach reflects a holistic view of the combined factors involved in road safety. A Safe System protects responsible road users from death and serious injury by taking human error and frailty into account. The four pillars of the Safe System are described in the following sub-sections.

Post-crash care is a further part of the Safe System. The speed and quality of the medical response to injury together with the accessibility and quality of rehabilitation services play crucial roles in the extent of trauma and subsequent recovery. Post-crash care is an expert area of knowledge led by specialists and organisations outside the transport sector and, as such, is not covered by this Guide. Readers are however encouraged to understand and consider how changes in post-crash care may reduce the trauma from road crashes especially in regional and remote areas.

2.2.1 Safe Roads

Factors related to the road and road environment have been identified as being the most strongly linked to fatal crash outcomes. Stigson, Krafft and Tingvall (2008) conducted an in-depth fatal crash investigation to identify factors contributing to the crash outcome (as opposed to crash occurrence). Whilst the study found strong interactions between the parts of the system (vehicles, road infrastructure and road users), the road-based factors most strongly influenced the high severity outcome.

A safe road environment forms an integral part of a Safe System. Such an environment is one which recognises the realities and limitations of human decision making. In other words, the road environment must not place demands upon the driver, or other road users, which are beyond their ability to manage, or which are outside normal road user expectations.

A safe road may therefore be described as one which is designed and managed so that it:

- provides a safe speed environment
- warns the driver of any substandard or unusual features
- informs the driver of conditions to be encountered
- guides the driver through unusual sections
- controls the driver's passage through conflict points or sections
- forgives a driver's errant or inappropriate behaviour (e.g. has a safe roadside).

It should:

- provide no surprises in road design or traffic control (the design matches expectations)
- provide a controlled release of relevant information (the design matches information-processing abilities)
- provide repeated information, where pertinent, to emphasise danger (again, to ensure the design matches expectations).

Designing a road according to these principles is not the same as designing a road which simply meets design standards. 'There is no reason to think that by meeting standards the appropriate level of safety is built into roads' (Professional Engineers Ontario 1997). A road designed to standards is not necessarily safe and a road which in some details fails to meet standards is not necessarily unsafe. There is no substitute for the application of sound road safety engineering experience, judgement and independent review.

Austroads *Guide to Road Safety Part 2: Safe Roads* (Austroads 2021a), *Guide to Road Design* (Austroads 2009-19) and *Guide to Traffic Management* (Austroads 2020a) provide detailed information for practitioners.

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2.2.2 Safe Speed

The management of vehicle speed is a crucial element of the Safe System. Travel speed leading up to a potential crash directly impacts upon both the likelihood and severity of a crash.

The chance of a crash is reduced at a lower travel speed because the road user has more time for decision making, is less likely to lose control, more able to take evasive action and can stop more quickly. Safety assisting vehicle technologies also have more time to have effect at lower speeds.

Importantly, the relationship between speed and crash risk is not linear. For example, crash risk doubles when the travel speed increases just 5 km/h above 60 km/h on urban roads or just 10 km/h on urban highways (Kloeden, Ponte & McLean 2001; Kloeden, McLean & Glonek 2002).

At lower speeds, the travel time between recognising a hazard and avoiding a collision increases, providing the driver with greater chance of avoiding a collision or minimising crash speed. If there is a collision, there is less impact energy involved and this will result in less severe injuries. A reduction of as little as 1–2% of the average speed can result in substantially greater reductions in fatalities and serious injuries.

The chance of surviving a crash decreases markedly above certain speeds, depending on the crash type. The critical crash speeds for various crash types are (Australian Transport Council 2011):

- pedestrian struck by vehicle → 30 km/h
- motorcyclist struck by vehicle → 30 km/h
- vehicle striking a pole or tree → 40 km/h
- side impact vehicle-to-vehicle crash → 50 km/h
- head-on vehicle-to-vehicle (equal mass) crash → 70 km/h.

Managing the inter-relationship between travel speed, road infrastructure design and vehicle safety is central to the Safe System approach. Speed management considers the function of the road within the transport network along with how the road is designed, managed and used.

When designing for safe speeds, therefore, practitioners should aim to design the road to encourage speeds that in the event of a crash will contribute to impact speeds being below the level of human physical tolerance to serious injury or death. Particular care should be taken to discourage low level speeding. Whilst less risky than higher-level speeding, speeding up to 15 km/h is so prevalent that it contributes to a large proportion of serious casualties.

Principles of ‘integration’ and ‘separation’, which are derived from the Swedish Vision Zero philosophy (Swedish Transport Administration 1997) can be applied. For example, in areas where there are large numbers of pedestrians, they should not be exposed to vehicle speeds any higher than 40 km/h and preferably less. This can be done through separating pedestrians from vehicles, or by lowering the travel speed of vehicles to a maximum of 40 km/h, thus ‘integrating’ the various road users.

Generally some form of traffic calming or signing is applied to assist road users in recognising the lower speed environment. Lower travel speed through temporarily reduced speed limits may also be applied for a specific time when pedestrian activity is high, such as around shopping precincts and near schools.

At intersections, car occupants should not be exposed to other adjacent approach motorised vehicles travelling at speeds higher than 50 km/h. This can generally be achieved through some form of traffic management such as roundabouts.

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In relation to roads where there is potential for head-on collisions the Vision Zero philosophy indicates vehicle occupants should not be exposed to speeds exceeding 70 km/h, or even lower speeds where there are heavy vehicles mixed with light vehicles. This also applies to roadside hazards. Where hazards cannot be removed or the vehicle traffic separated, lower travel speeds should be considered. In some European countries, such as Sweden, single carriageway roads with no central barrier, where there is the potential for head-on collisions, have speed limits of 70 km/h.

For higher design standard roads with high levels of roadside protection, and with little or no pedestrian or vehicle conflicts, safe speeds higher than 70 km/h may be achieved. Highways and freeways generally have higher limits, recognising the enhanced level of protection offered to road users and the minimisation of conflicts on these roads.

In Sweden, the application of 2+1 roads (i.e. a long section of road that has two lanes one way separated by wire rope barrier from one lane going in the opposite direction, then a long section with two lanes in the opposite direction and one in the other direction), allows for higher road speeds as the potential for head-on collisions has been reduced through the installation of the wire rope barrier and the passing opportunities increased with the double lane. Some Australian States are installing centre-of-the-road wire-rope barriers on single carriageway roads, and many already have median wire-rope barriers on divided carriageways.

Designing for safe speeds in this manner is consistent with the provision of self-explaining roads, a feature of a sustainable approach to road safety (OECD/ECMT 2006). Currently however, there are extensive parts of the Australian road network which do not apply Safe System speeds. Addressing these safety gaps is a matter of priority in the transformation towards a fully Safe System road network.

Austroads *Guide to Road Safety Part 3: Safe Speed* (Austroads 2021b) and *Guide to Traffic Management Part 5: Link Management* (Austroads 2020b) describe in detail, from a road safety and a traffic management perspective, speed management and the application of speed limits within a Safe System environment.

2.2.3 Safe Vehicles

The types of vehicles that use the road network and interact vary markedly (i.e. sedans, SUVs, motorcycles, bicycles, buses, and rigid and articulated trucks). The design of roads, therefore, needs to take account of the various characteristics of the vehicles using those roads. Important vehicle characteristics to consider are manoeuvrability, visibility, cornering and braking (Gardner 1996). New safety features are continually entering the vehicle market. Some of these features are estimated to dramatically reduce road trauma from their targeted crash types. To be effective, many new features require road conditions to meet specific threshold standards.

Austroads *Guide to Road Safety Part 4: Safe Vehicles* (Austroads 2021c) provides detailed information for practitioners. The Australasian New Car Assessment Program (ANCAP) maintains an up-to-date website with comprehensive information on vehicle safety features.

2.2.4 Safe People

More than half of serious casualty crashes are associated with human error. The Safe System approach emphasises that such errors should not result in fatal and serious injuries, and therefore the road environment should be forgiving of human error. There is also a need to reduce the occurrence of human error in the first place. It is important that road designers understand human performance, capabilities and behaviours.

Austroads *Guide to Road Safety Part 5: Safe People* (Austroads 2021d) provides detailed information for practitioners.

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2.3 The Transition to a Safe System

The Safe System approach represents a significant change in the way road safety is managed. Safe System principles aim to manage vehicles, road infrastructure and speeds to eliminate death and serious injury as a consequence of road use.

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. Whilst it is unlikely that absolute elimination is possible over the entire system, substantial gains and near elimination are possible in components of the system over varying timeframes.

Due to the complexity of the road system and its interacting components, a Safe System may take several decades to accomplish. No single pillar can achieve Safe System outcomes by itself, and contributions from the other pillars will still be required. Speed management can be used to achieve rapid and significant outcomes; vehicle safety, whilst effective, may take several years to have influence due to the time it takes to turn-over the fleet. Automated technologies show massive potential and deployment can be faster than infrastructure change alone; behavioural measures can also be effective but it is difficult to optimise outcomes.

2.4 How are Things Different Under a Safe System?

A Safe System that is accommodating of road user error will result in increasingly less severe road trauma as the road system is transformed. Many past practices continue to find application but new and different ways of doing things also emerge. As the Safe System approach is implemented there is a significant shift in thinking as to what criteria govern decision making in relation to road safety matters especially when crash consequence is considered. Increasing effort is going into systemic changes in the road system as the inherent risk of current practices and injury mechanisms become better understood. System designers too are changing how they develop solutions by placing a greater emphasis on seeking solutions across the pillars, rather than relying on a single pillar. Examples of the differences between a conventional and Safe System approach are shown in Table 2.2.

Table 2.2: Differences between a conventional and Safe System approach to road safety

	Conventional	Safe System
What is the problem?	Crashes	Fatalities and Serious Injuries
What causes the problem?	Mainly poor road user performance Speeding, drink driving, inattention, deliberate risk taking	System failures
Who is ultimately responsible?	Individual road users	System designers and operators
What is the major planning approach?	Incremental approach to reduce the problem with an associated residual crash problem	A systemic approach to build a safe road system and minimise the harm
What is the appropriate goal?	Optimum number of fatalities and serious injuries based on competing objectives	Towards the near elimination of death and serious injuries
What is the trade-off?	A balance between mobility and safety	Maximising safe mobility
How is the effort coordinated?	Incremental gain within individual pillars (roads / speeds / vehicles / people)	Optimise solutions across pillars (roads / speeds / vehicles / people) – pillars compensate for each other where performance is poor
What are the cultural manifestations?	Legal liability avoidance and risk aversion	Risk assessment, innovation, trials and demonstrations
Context of tools in use	Bias towards pre-existing crash history, understanding crash causes and likelihood, optimising the network for motor vehicles	Risk analysis based on network design attributes supplemented by crash data, understanding crash consequence, optimising the network for all road users and human frailty

Source: Adapted from the Swedish Transport Administration (1997) and Austroads SS2061 Workshops

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Fundamentally, the task will be to adopt a systemic approach to build and manage a safe road system focusing on core injury mechanisms. Safety needs to be the default position from which variations are justified as opposed to many current practices that lead to the need to justify changes to “add on” safety.

2.5 The Safe System and National Road Safety Strategies

Since its first adoption, the Safe System approach has been universally applied in road safety strategies across Australasia at all levels of government.

Both Australia’s *National Road Safety Strategy 2011–2020* (NRSS) and *Safer Journeys, New Zealand’s Road Safety Strategy 2010-2020* recognise shared responsibility for achieving a safer road transport system, the clear value of promoting community understanding and endorsement of the Safe System approach, and the importance of research to identify cost-effective interventions (Australian Transport Council 2011; Ministry of Transport 2010).

In the context of regional and remote road safety, the Australian NRSS acknowledges that the fatality rates per population are significantly higher in both regional and remote areas and highlights the importance of developing interventions in response to the different circumstances in regional and remote Australia. The strategy also recognises that there will be differences in needs for each jurisdiction. In 2015, Australia’s Transport and Infrastructure Council developed a *National Remote and Regional Transport Strategy (*NRRTS 2015) to provide a national strategic and coordinated approach to addressing transport infrastructure, service delivery and regulation challenges distinctive to regional and remote Australia.

In recognition of the continuing road safety problem in regional and remote areas, Australia’s current *Road Safety Action Plan (2018-2020)* specifies two priority actions that directly target regional and remote roads:

- ‘Review speed limits on high risk regional and remote roads, in consultation with the community’
- ‘Target infrastructure funding towards safety-focused initiatives to reduce trauma on regional roads’.

The *Road Safety Action Plan* also identifies remote road safety, and the investigation and implementation of key interventions, as a critical action on which all jurisdictions should work together to address. This action also highlights that efforts should be consistent with the National Remote and Regional Transport Strategy and consider whole of government approaches to remote transport issues.

The 2018 independent inquiry into the Australian NRSS (Woolley et al. 2018) made several important observations and recommendations relevant to regional and remote road safety. Importantly the Inquiry also highlighted the challenges for local government as the authorities responsible for much of this part of the road network.

New Zealand’s *Safer Journeys Road Safety Strategy 2010-2020* does not specifically focus on regional and remote road safety. However, under the Safe Road and Roadsides section, an area of high priority and concern, there is an action to ‘focus safety improvement programmes on high-risk rural roads’. There is also an action under the Safe Speed plan concerning speed zone management on high-risk rural roads. In addition, there is emphasis on other key road safety issues in regional and remote areas including reducing alcohol/drug impaired driving, reducing the impact of fatigue, increasing the level of restraint use and reducing the impact of high-risk drivers (including unlicensed drivers). The current action plan has specific actions to implement a national program of lower cost safety improvements on high-risk local rural roads and the continued implementation of a state highway road safety improvement program on rural roads.

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3. Transport Agencies' Responsibility for Road Safety, its Management and Measurement

This section introduces the role of transport and road agencies with respect to their responsibilities for road safety, the duty of care they have to the community they serve, the cost of road crashes to the community, legal liability, and how transport and road agencies can measure progress in road safety.

3.1 Core Responsibility

Road safety is a core responsibility for the Australian Government and for road authorities in Australia and New Zealand. However, road safety goals cannot be considered in isolation.

A lot is expected of the road transport system and other objectives must be acknowledged when considering road safety goals. In addition to its primary functions of providing for the movement of people and goods to support economic and social activities, the road transport system is expected to provide for all members of the community as road users in an equitable manner. It is also expected not to intrude unreasonably on residential and recreational areas, or on areas with high scenic or conservation values, and not to result in unacceptable levels of pollution or resource depletion. It is expected to deliver the benefits of mobility while retaining environmental quality, and to do so at reasonable cost whilst maintaining the highest levels of safety for its users.

In many jurisdictions, the interdependence of the leading stakeholders is formalised in a Memorandum of Understanding or similar agreement which sets out the respective commitments and responsibilities of the participating organisations, together with arrangements for coordination, consultation and review. The present document, and the *Guide to Road Safety* as a whole, should be relevant to these different road safety stakeholders as well as to the road authorities.

3.2 Costs to the Community

The community expects a high level of road safety and that the road transport system will be managed to produce good safety outcomes. This is reflected in the high profile of road safety in the political life of each State and Territory, and the wide coverage given to road crashes and their aftermath in the media.

Road trauma imposes a significant burden on the community. Each year, road crashes kill about 1,200 Australians and hospitalise another 32,500. The total estimated cost to society is $27 billion (using a willingness-to-pay method), and the direct human impacts are devastating: in addition to the many lives cut tragically short, debilitating injuries often result in lifelong pain, grief and suffering among road crash victims, their families and communities (Australian Transport Council 2011). While it could be argued that the Safe System approach is in principle at odds with allocating a monetary value to human life (as the Safe System approach does not treat life and health as commodities that can be traded off against other benefits), the European Commission views the use of economic analysis tools in road safety as complementary to the Safe System approach (European Commission 2018).

There are two common methods to attribute a value of life for economic purposes; the Human Capital Method or the Willingness-to-Pay method.

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Australian approaches to estimating the economic benefits of safety measures have conventionally been based on the human capital method of valuing human life. This technique treats an individual as a productive entity. Its application to transport safety involves estimating the victim's earning stream from the time of their premature death to the end of their actuarially expected lifetime. The willingness-to-pay approach is an alternative method that relies on individual preferences for reducing risk to life. Estimates are based on the amounts that individuals are prepared to pay for reduced risk (or to accept in compensation for bearing risk). For a particular type of risk, a value for society is generally calculated by aggregating and averaging values obtained from a representative sample of individuals. The willingness-to-pay approach is widely regarded as superior (BITRE 2009), however, the techniques for determining willingness-to-pay values vary and are complex.

Quantifying the cost of road trauma provides a means to prioritise and justify investments in road safety initiatives, develop business cases and undertake economic analysis.

When implementing the Safe System there are changes in the way that the business cases for safer road programs are being made. It has been common for programs to be considered in terms of the percentage reduction in fatalities or serious injuries (FSI) and business cases made around Benefit Cost Ratio (BCR), Investment Rate of Return (IRR) and Net Present Value (NPV). Whilst informative and correlated with FSIs, these measures are based on metrics that attempt to place an economic value on loss of life and health; when this is done, safety trade-offs are made which is in direct opposition to the ethical underpinning of the Safe System. Therefore, other metrics are evolving. These include the average cost per FSI saved, average FSI saved per annum per $100 m invested, residual FSI per annum/km and percent residual problem of the original. Some of these newer metrics have been a feature of road safety treatment prioritisation in Victoria and NSW in recent years (Infrastructure NSW 2018). A benefit of this type of approach is the ability to upgrade entire corridors for better safety outcomes when compared to the collective treatment of discrete sites along the corridor. Another useful outcome is that a more holistic approach can better avoid situations where there are differing safety standards along the corridor (e.g. having many 3 Star sections on a 5 Star road corridor). There is also evidence emerging that integrating alignment with the Safe System (with treatments already aligned with the Safe System) during the planning phases can be achieved at a fraction of the cost of a later project.

Two key principles identified in the Austroads report AP-R562-18 Best Practice in Road Safety Infrastructure Programs (Austroads 2018) are:

1. Countermeasures should generally be developed from a top-down rather than bottom-up perspective, focusing on maximising fatal and serious injury reduction but still returning a positive Benefit Cost Ratio (BCR)
2. Safety benefits should not be traded off against other transport costs, such as travel time.

It should be noted that these principles also apply to non-infrastructure programs

3.3 Road Authority Duty of Care

A series of court decisions at the start of this century led to removal of the doctrine of highway immunity which protected road authorities from legal claims arising from road deficiencies which they had not addressed. This 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 transport system, to assess and prioritise them, and have a system for remedying them (Sarre 2003).

These legal decisions established that road authorities owe road users and adjoining land owners a duty of care. That is, they are expected to keep the road transport system as safe as their resources will allow, and to alert road users to foreseeable dangers.

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.

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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 transport 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.

Jurisdictions have reacted differently to these and other legal developments. In Victoria, following extensive community and stakeholder consultation, the *Road Management Act 2004* (Victoria) was passed in 2004 to "establish a coordinated management system that will promote a road network at State and local levels that operates as part of an integrated and sustainable transport system". The key principles of the Act are:

- clear allocation of road asset ownership and management
- established processes and accountabilities for policy decisions and performance standards
- provision of operational powers to achieve targets and performance standards
- clarification of civil liability laws for the management of the roads (*Road Management Act 2004*).

Queensland, on the other hand, has legislated to provide some protection for road authorities similar to the earlier position that authorities could not be sued for not acting on problems of which they were not aware (*Civil Liability Act 2003*, Part 3 | Division 1| Schedules 35 – 37, www.legislation.qld.gov). However, these provisions do not apply if the act or omission of the authority is so unreasonable that the authority is not exercising its functions in a reasonable manner (schedule 36, subsection 2) or the authority had actual knowledge of the particular risk which resulted in the harm (schedule 37, subsection 2).

3.4 Legal Liability Issues

The type of innovation required to pursue Safe System principles is often perceived by practitioners and managers as a corporate risk. This is particularly the case for non-standard engineering. 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.

In New Zealand, supplementary guidance in the form of a Technical Memorandum (TM-2503) was released in 2012 to provide a focus for designing dual carriageway roads with a Safe System approach on Roads of National Significance (subsequently revised in 2013). The document places an emphasis on 'engineering logic' rather than 'definitive justification' for road safety and highlights that an engineer's knowledge, skills and experience may justify the use of viable non-standard treatments. Similar documents are currently under development by VicRoads in response to their Safe System Road Infrastructure Program (SSRIP).

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3.5 Implementing the Safe System Approach

Implementing Safe System is vision led and ethically based. Successful organisations create a clear expectation that their efforts aim to eliminate fatal and serious injury over the long term. A comprehensive approach to implementing the Safe System approach includes:

- Establishing governance structures which bring together the accountable stakeholders in road safety
- Setting targets for trauma reduction which in turn inform key performance indicators for transforming the road system in an effort to achieve trauma reduction targets.
- Embedding Safe System into practices across the decision-making functions of the organisation
- Developing and funding programs dedicated to the elimination of fatal and serious injury crashes through the transformation of the road system
- Establishing linkages between all programs and road safety outcomes especially in the establishment of Safe System performance metrics for maintenance and infrastructure programs.
- Maintaining an environment of innovation across all functions in pursuit of the Safe System vision.

Jurisdictions and organisations looking to advance and validate their approach to Safe System should consider adherence to ISO 390001 (International Organisation for Standardisation 2012) and conducting a Capacity Review consistent with the process recommended by the World Bank (Bliss & Breen 2013).

Austroads *Guide to Road Safety Part 7: Road Safety Strategy and Management* (Austroads 2020g) provides further information on planning and implementing action under the Safe System approach.

3.6 Measuring Road Safety

If road safety is to be managed effectively, then it is necessary to measure the amount and type of resource inputs, the road safety outcomes and the other outcomes which come about as a result of road safety activity (e.g. delays at traffic signals, reductions in exhaust emissions as a result of traffic calming, or reductions in fuel consumption through lower traffic speeds), and to understand how these affect the community. Effective management also requires an understanding of the links between inputs and outputs.

A number of different measures of road safety are available[1]. It is essential that practitioners understand the distinctions between them, and that they are aware of the advantages and disadvantages of different measures for different purposes.

- **Number of crashes, or numbers of fatalities and injuries**. Most crash data systems allow analysis in terms of number of crashes, or in terms of numbers of fatalities and injuries. The number of fatalities is usually the most up-to-date road safety measure with some jurisdictions having preliminary data available in daily updates. Crashes may be broken down by the most serious injury to result from the crash, e.g. fatal, serious injury, other injury and non-injury is a typical classification. Analysis in terms of crashes is a convenient way to look at the impact of infrastructure improvements or enforcement programs. Total numbers of fatalities and injuries for a jurisdiction are essential for evaluating the effectiveness of state-wide measures, such as vehicle crashworthiness, restraints and protective helmets. Numbers of fatalities and injuries are also important in describing the impact of crashes on the health of the community. The number of fatalities in particular is regarded as the key indicator by the media and is the indicator to which the political system is most sensitive. It does not take into account changes in population or travel.

[1] This section describes some overarching measures of road safety. More specific and targeted safety performance indicators are discussed in detail in the Austroads *Guide to Road Safety Part 7: Road Safety Strategy and Management* (Austroads 2021e).

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- **Fatalities and injuries per 100 000 population** takes into account changes in population, but not changes in travel. It is a measure of the safety of the population, and can readily be equated to other indicators of population injury, e.g. fatalities and injuries from other types of injury such as falls or burns per 100 000 population, or number of cases of heart disease or diabetes per 100 000 population. In terms of analyses in road safety, it is particularly useful when considering the overall impacts of road safety programs, or issues such as fatality and injury rates amongst different segments of the population (e.g. age, gender or residence).
- **Fatalities and injuries per vehicle kilometres travelled (VKT)** takes into account changes in travel. It is a measure of the safety of travel, and is particularly useful when considering issues such as the relative safety of different classes of road user, different types of vehicle, or different types of road. Crashes per unit of travel is also a useful measure, and may simplify analysis of the safety performance of roads. In practice, the units are varied to suit the needs of the situation, so that fatalities per 10^9 vehicle kilometres may be appropriate when comparisons between jurisdictions are being considered, fatalities per 10^8 vehicle kilometres when different road classes are being compared, and fatalities per 10^7 kilometres when short-distance modes such as walking or cycling are being considered.
- **Fatalities and injuries per 10 000 registered vehicles** is a proxy measure for fatalities and injuries per unit of travel, as the number of vehicles on register is generally readily available whereas data on vehicle use may not be available. It assumes a constant average amount of travel for vehicles. It is useful in overall analyses of traffic system performance, but has limitations when used for other purposes.
- **Fatalities and injuries per hours travel or per trip** provide an alternative perspective on safety of travel, particularly for low-kilometre modes such as walking and cycling. Rates are generally expressed as fatalities or serious injuries per 10^6 trips. Anderson, Montesin and Adena (1989) illustrate the value of this approach very clearly. When considered in terms of fatalities per kilometre travelled, walking appears to be a high risk mode compared to travel by car. For example, the fatality rate *per 10^7 kilometres travelled* for male pedestrians was 15.7 times higher than that for car drivers, but the fatality rate *per million trips* was only 2.1 times greater.
- **Risk score/rating** is a modern proactive method for assessing a road network for its potential for fatal and serious injuries in the future. There are a number of methods available to assist in assessing and quantifying the risk of a road, including tools such as the Australian National Risk Assessment Model (ANRAM), the iRAP and AusRAP star rating methods, Infrastructure Risk Rating (IRR) tools and detailed site tools such as the Kinetic Energy Management Model (X-KEMM-X). These methods provide advantages over reactive measures because they are not subject to the natural statistical variations in crash based systems.
- **Safe System transformation indicators** are increasingly being used to measure progress towards desired end state conditions for the road network. Such indicators are designed to trigger the action needed to 'close the gap' between current and target states at a road system level. Examples of these indicators are observed helmet wearing among cyclists and motorcyclists, seatbelt use by vehicle occupants and average travel speeds on the network. Importantly, Safe System transformation indicators are an evidence based set of measures chosen for their power to direct effort towards achieving the desired end state of the road system. Swedish Transport Administration (2012) provides explanation and examples of how this is done.

Different indices are appropriate for different purposes. Using the wrong index can give an exaggerated impression of the extent to which particular types of road users are at risk. In adopting the Safe System approach both Australia and New Zealand now place an increased emphasis on reducing fatalities and serious injuries and increasingly many of the road safety countermeasures used are targeted at these.

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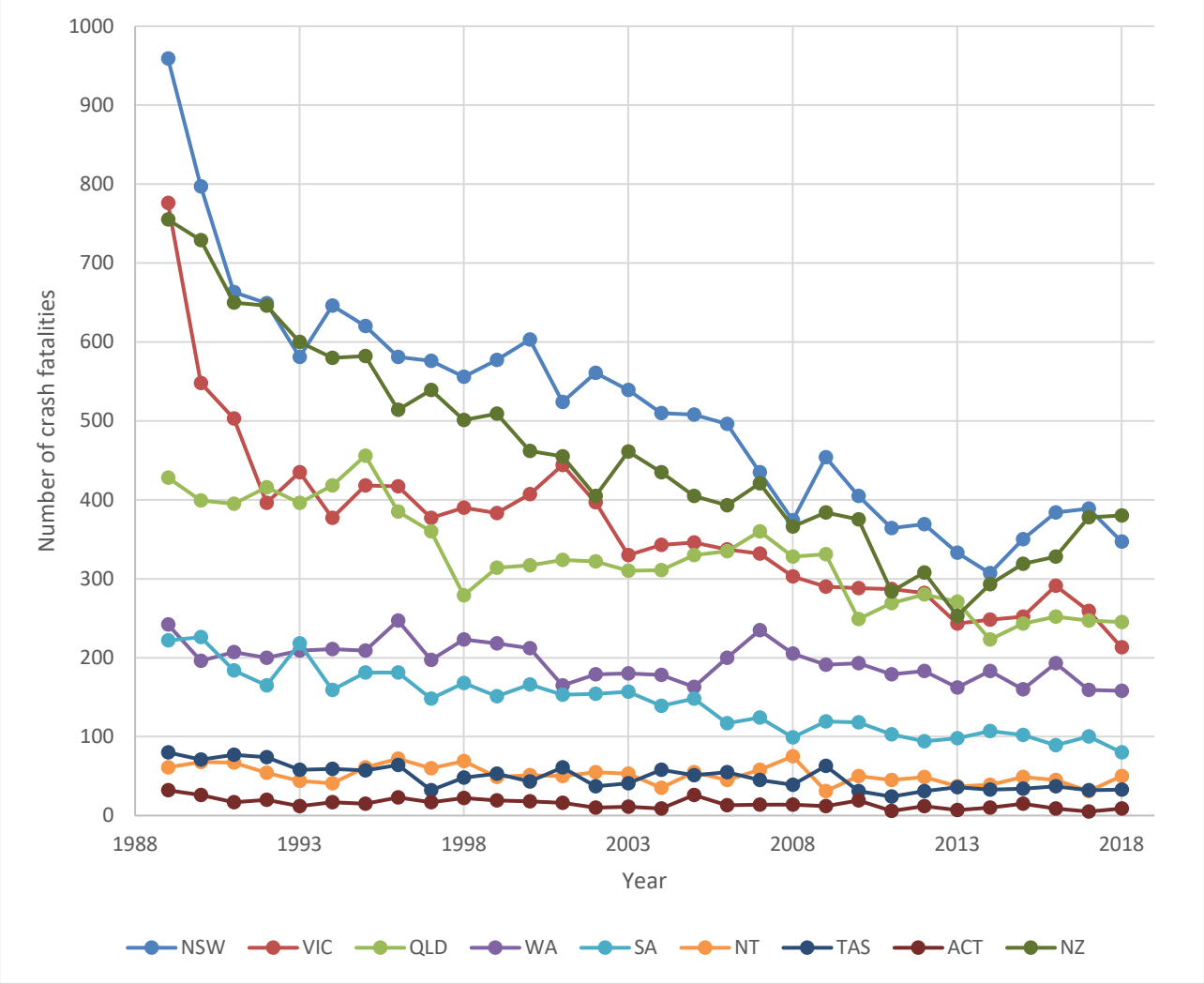
In Australia and New Zealand, it is generally accepted that all road fatalities are captured by the National, State or Territory crash data systems, and that the treatment of these events is sufficiently uniform for comparisons to be made across jurisdictions. Comparing injury data, however, presents serious challenges. Injuries are under-reported, and the extent of the under-reporting varies with factors such as the mode of travel, the seriousness of the injury, the location and the type of crash. One study, which investigated the matches between hospital records and police crash reports (Rosman & Knuiman 1994), found the lowest match was for single vehicle motorcycle crashes, where police crash reports matched only 27% of patients admitted to hospital as a result of that type of incident. The proportional rates for pedestrians and pedal cyclists were 69% and 74%, respectively.

The comparison of national data on injuries has always had problems, such as different ratios of injury crashes to fatalities in different jurisdictions. The collation of National statistics in Australia stopped for a period during the 1990s, but has since resumed, using data obtained from the Department of Health in each jurisdiction.

3.7 Progress in Road Safety

The number of people killed or injured on Australian and New Zealand roads has been reducing over the last decade, however the rate of the drop has slowed.

Figure 3.1: Number of reported road crash fatalities by year and jurisdiction



Source: *https://www.bitre.gov.au/statistics/safety/fatal_road_crash_database.aspx*

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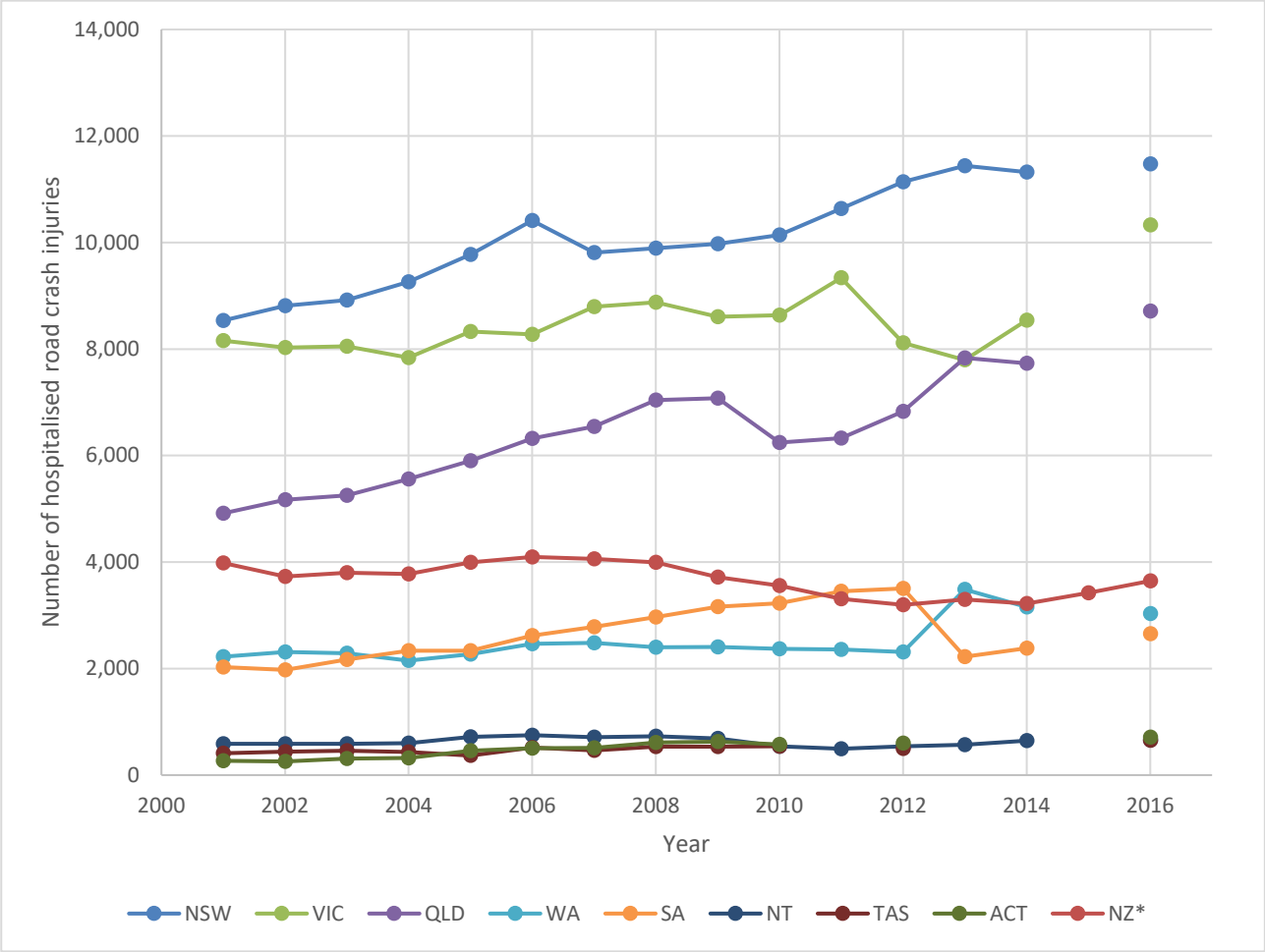
Figure 3.2: Number of reported road crash serious injuries by year and jurisdiction



Australian Data Source: https://www.bitre.gov.au/publications/ongoing/hospitalised-injury.aspx

New Zealand Data Sources: (1) https://www.ehinz.ac.nz/indicators/transport/road-traffic-injury-deaths-and-hospitalisations/#:~:text=in-,Road%20traffic%20injury%20hospitalisations%20increased%20from%202014%20to%202018,traffic%20injuries%20in%20New%20Zealand.&text=The%20hospitalisation%20rate%20for%20all,to%202018%20(Figure%207) and (2) https://www.stats.govt.nz/topics/population

Note 1: The following data points are missing from the data source for TAS and ACT: 2011, 2013, 2014 and 2015 and for NSW, VIC, QLD, WA, SA and NT: 2015

Note 2: New Zealand data has been estimated according to the following formula:

$$No.\ of\ hospitalised\ road\ crash\ injuries = \frac{Hospitalised\ road\ crash\ injuries\ per\ 100{,}00\ population}{100{,}000}\ x\ Total\ population$$

3.8 Evidence-based Approach

It is important to recognise that effective road safety programs must rely on an evidence–based approach. In the introduction to his influential book on before-after studies in road safety, Hauer (1997) makes the point that factual knowledge about road safety is not easy to obtain. Despite popular belief, the proposition that personal experience is a good source of factual knowledge about road safety is 'dangerously untrue' (p. 1). Nevertheless, 'the field of road safety abounds with strongly held but unfounded opinions…In road safety gut feeling and folklore are frequently wrong' (p. 1).

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Taking an evidence-based approach leads to the bulk of road safety funds being allocated to programs and projects which return high levels of benefit to the community. Evidence-based planning also reduces the time and energy devoted to programs or projects with no impact, or which are counter-productive. Although, in some cases, substantial investments are made in programs which are difficult to justify on the grounds of a demonstrated contribution to crash reduction (e.g. road safety education, or school crossing supervisors). Often in these cases, there are strong community expectations that such programs will be provided and there may be reasonable a priori or intuitive grounds for expecting them to have some effect even though it is difficult to measure. Caution must be taken when directing large amounts of money at programs with little or no evidence base. If an evidence-based framework for considering road safety initiatives is in place, it does not guarantee that only programs which meet set benefit-cost criteria will be invested in, but it does mean that investments will be undertaken in an informed manner and that decision makers will have a realistic picture of what can be expected from different forms of investment.

Much research in road safety is characterised by methods which limit the extent to which generalisations can be made. The two main methods open to road safety research are the cross-sectional comparison (e.g. Tsyganov, Warrenchuk & Machemehl 2006) and the before and after comparison (e.g. Sapkota, Anderson & Dua 2011). See the Austroads *Guide to Road Safety Part 7: Road Safety Strategy & Management* (Austroads 2021e) and the *Introductory Guide for Evaluating Effectiveness of Road Safety Treatments* (Austroads 2012) for detailed road safety evaluation methodologies including their limitations and constraints.

Care must be taken with the design and interpretation of road safety studies. The major (and seemingly inevitable) limitation on such studies is that, for a range of practical and ethical reasons, it is generally not possible to randomise the allocation of treatments to sites, as would occur in a classical experimental design. A further limitation in the case of road safety is that the number of sites (and hence the number of crashes) available for study may be small, so that results may be inconclusive. There is a danger that inconclusive results will be interpreted as showing a treatment is ineffective, when the appropriate conclusion should be that there are insufficient data to allow a reasonable test. The logic of statistical testing should prevent inconclusive results as being interpreted as supporting the hypothesis that a treatment is effective; however, wishful thinking or the need to be seen to be acting on a problem may result in this interpretation.

Despite the fact that research in road safety has its challenges, there is a body of reliable evidence from evaluation studies conducted in Australia, New Zealand and elsewhere. Although not all safety measures have been properly evaluated, there is evidence relating to a sufficient number of measures to guide the direction of comprehensive road safety strategies. Practitioners need to be able to distinguish these reliable findings from less satisfactory work, to have confidence in this work, and to use it to guide their own activities and to educate the public and the political system about the realities of road safety.

A recent development in road safety is the adoption of the practice of systematic reviews of research literature. In contrast to traditional narrative reviews, they focus on answering a particular question, set rules to define the type and methodological standards for the papers to be included, and try to consider all studies, not just those where treatments have been successful, in order to produce a comprehensive estimate of the likely effectiveness of a particular measure.

Statistical methods for estimating the effects of treatments pooled across several or many studies are also available (Elvik et al. 2009). A statistical technique, known as meta-analysis, focuses on combining and contrasting results from different studies in order to identify patterns among results, identify sources of disagreement and control for extraneous or irrelevant variables. Meta-analyses have been used to evaluate a number of road safety initiatives, for example: the effect of mass media campaigns on reducing crashes (Phillips, Ulleberg & Vaa 2011); the relationship between speeding and crash risk (Elvik, Christensen & Amundsen 2004); the effectiveness of random breath testing operations (Erke et al. 2009). As the body of road safety research increases, the meta-analysis technique is likely to find increasing application in the future.

There are well defined and accepted principles underpinning the Safe System approach to road safety. Thus, actions and measures that align with these principles should result in road safety improvements. Examples are; slowing vehicles through areas of conflict points to speeds and angles where energies are within tolerable levels, understanding that people will make mistakes and leave the road and creating a forgiving roadside or prioritising separation of vulnerable road users from high speed vehicular traffic.

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Where there is no proven solution to a particular problem, there may be a case for going beyond evidence-based treatments. Where this occurs, the treatments should be developed with reference to basic principles and careful consideration of accumulated experience with the most similar types of treatment that are available. It is essential to ensure that adequate evaluation of new treatments is undertaken.

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References

Anderson, P. R., Montesin, H. J. & Adena, M. A. 1989, *Road fatality rates in Australia 1984-85,* Report CR70, Federal Office of Road Safety, Canberra, ACT.

Auckland Transport 2019, *Vision Zero for Tāmaki Makaurau: A transport safety strategy and action plan to 2030*, Auckland, New Zealand.

Australian Capital Territory 2011, *ACT Road safety strategy 2011-2020,* ACT. Available from: <http://www.justice.act.gov.au/safety_and_emergency/road_safety/act_road_safety_strategy_and_action_plans>.

Australian Transport Council 2011, *National Road Safety Strategy 2011-2020,* ATC, Canberra, ACT.

Austroads 2009-2019, *Guide to road design,* Parts 1-8, AGRD01-08, Austroads, Sydney, NSW. Available from: <https://austroads.com.au/safety-and-design/road-design/guide-to-road-design>.

Austroads 2012, *An introductory guide for evaluating effectiveness of road safety treatments,* AP-R421-12, Austroads, Sydney, NSW.

Austroads 2018, *Best practice in road safety infrastructure programs,* AP-R562-18, Austroads, Sydney, NSW.

Austroads 2020a, *Guide to traffic management,* Parts 1-13, AGTM-SET, Austroads, Sydney, NSW. Available from: <https://austroads.com.au/publications/traffic-management/agtm-set>

Austroads 2020b, *Guide to traffic management part 5: Link Management,* edn 4.0, AGTM05-20, Austroads, Sydney, NSW.

Austroads 2021a, *Guide to road safety part 2: Safe roads,* AGRS02-21, Austroads, Sydney, NSW.

Austroads 2021b, *Guide to road safety part 3: Safe speed,* AGRS03-21, Austroads, Sydney, NSW.

Austroads 2021c, *Guide to road safety part 4: Safe people,* AGRS04-21, Austroads, Sydney, NSW.

Austroads 2021d, *Guide to road safety part 5: Safe vehicles,* AGRS05-21, Austroads, Sydney, NSW.

Austroads 2021e, *Guide to road safety part 7: Road safety strategy and management,* AGRS07-21, Austroads, Sydney, NSW.

Bliss, T. & Breen, J. 2013, *Road safety management capacity reviews and safe system projects guidelines (English),* World Bank Group, Washington DC, USA.

Bureau of Infrastructure, Transport and Regional Economics 2009, *Road crash costs in Australia 2006*, Report 118, BITRE, Canberra, ACT.

Department of Planning, Transport and Infrastructure 2011, *Towards zero together: South Australia's road safety strategy 2020,* SA. Available from: <https://www.dpti.sa.gov.au/towardszerotogether/road_safety_strategies>.

Department of State Growth 2016, *Towards zero: Tasmanian road safety strategy 2017-2026,* TAS. Available from: <https://www.transport.tas.gov.au/roadsafety/towards_zero>.

Department of Transport and Main Roads 2010, *Driver fatigue public education campaign 2009/2010*, Queensland Government, QLD.

Department of Transport and Main Roads 2015, *Safer roads safer Queensland: Road safety strategy 2015-2021*, TMR, QLD. Available from: <https://www.tmr.qld.gov.au/Safety/Road-safety/Strategy-and-action-plans>.

Elvik, R., Christensen, P. & Amundsen, A. 2004, *Speed and road accidents: An evaluation of the power model*, Report 740/2004, Institute of Transport Economics (TØI), Oslo, Norway.

Elvik, R., Høye, A., Vaa, T. & Sørensen, M. 2009, *The handbook of road safety measures*, edn 2.0, Emerald Publishing, Bingley, UK.

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Erke, A., Goldenbeld, C. & Vaa, T. 2009, *The effects of drink-driving checkpoints on crashes: A meta-analysis*, Accident Analysis and Prevention, vol. 41(5), pp. 914-919.

European Commission 2018, *Cost benefit analysis 2018.* Available from: <https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/pdf/ersosynthesis2018-costbenefitanalysis.pdf>.

Gardner, R. 1996, *Vehicle characteristics*, in K. W. Ogden & S. Y. Taylor (eds), *Traffic Engineering and Management*, Monash University, Clayton, VIC, pp. 21-32.

Hauer, E. 1997, *Observational before-after studies in road safety*, Pergamon Press, Oxford, UK.

Infrastructure NSW 2018, *Business case summary: Towards zero infrastructure program.* Available from: <http://www.infrastructure.nsw.gov.au/media/1726/towards_zero_business_case_summary_summary.pdf>.

International Transport Forum 2016, *Zero road deaths and serious injuries: Leading a paradigm shift to a Safe System*, ITF, Paris, France.

Kloeden, C. N., McLean, A. J. & Glonek, G. 2002, *Reanalysis of travelling speed and the risk of crash involvement in Adelaide South Australia*, Report CR207, Australian Transport Safety Bureau, Canberra, ACT.

Kloeden, C. N., Ponte, G. & McLean, A. J. 2001, *Travelling speed and the risk of crash involvement on rural roads,* Report CR204, Australian Transport Safety Bureau, Canberra, ACT.

Ministry of Transport 2010, *New Zealand's road safety strategy 2010-2020,* Safer Journeys, Wellington, New Zealand.

Mornington Peninsula Shire 2018, *DriveSafe 2008-2018,* Mornington Peninsula. Available from: <https://www.mornpen.vic.gov.au/Community-Services/Roads-Footpaths/Road-Safety-Programs/DriveSafe-RideSafe>.

Northern Territory State Government 2018, *Towards zero road safety action plan 2018-2022,* NT. Available from: <https://roadsafety.nt.gov.au/>.

Office of Road Safety 2009, *Towards zero: Road safety strategy to reduce road trauma in Western Australia 2008-2020,* WA. Available from: <https://www.rsc.wa.gov.au/RSC/media/Documents/About%20Us/Towards%20Zero/towards-zero-strategy.pdf>.

Organisational for Economic Cooperation and Development / European Conference of Ministers of Transport, Joint Transport Research Committee 2006, *Speed management*, OECD / ECMT, Paris, France.

Phillips, R. O., Ulleberg, P., & Vaa, T. 2011, *Meta-analysis of the effect of road safety campaigns on accidents,* Accident Analysis and Prevention, vol. 43(3), pp. 1204-1218.

Professional Engineers Ontario 1997, *Highway 407 safety review: A safety review of the first phase of the Highway 407 Project carried out for the Ministry of Transportation Ontario,* Association of Professional Engineers Ontario, North York, Canada.

Rosman, D. L. & Knuiman, M. W. 1994, *A comparison of hospital and police road injury data*, Accident Analysis and Prevention, vol. 26(2), pp. 215-222.

Sapkota, J., Anderson, C. & Dua, A. 2011, *Effectiveness of combined treatments: shoulder sealing and guard fence*, Australasian College of Road Safety conference, Melbourne, VIC

Sarre, R. 2003, *Liability in negligence and the High Court decisions in Brodie and Ghantous: where to from here for road authorities?* Road and Transport Research, vol. 12(4), pp. 3-12.

Stigson, H., Krafft, M. & Tingvall, C. 2008, *Use of fatal real-life crashes to analyze a safe road transport system model, including the road user, the vehicle, and the road*, Traffic Injury Prevention, vol. 9(5), pp. 463–471.

Swedish Transport Administration 1997, *Vision Zero*, Borlange, Sweden.

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Swedish Transport Administration 2012, *Review of interim targets and indicators for road safety in 2010–2020*, Publication 2012:162, Borlange, Sweden.

Transport and Infrastructure Council 2015, *National remote and regional transport strategy, NRRTS.* Available from: <https://www.transportinfrastructurecouncil.gov.au/sites/default/files/National_Remote_and_Regional_Transport_Strategy_2015.pdf>.

Transport for New South Wales 2012, *NSW road safety strategy 2012-2021,* NSW. Available from: <https://roadsafety.transport.nsw.gov.au/aboutthecentre/strategies/nswroadsafetystrategy/index.html>.

Tsyganov, A. R., Warrenchuk, N. M. & Machemehl, R. B. 2006, *Safety impact of edge lines on rural two-lane highways in Texas,* Paper presented at the Australia Road Research Board Conference, Vermont South, VIC.

Victoria State Government 2016, *Towards zero 2016-2010: Victoria's road safety strategy and action plan,* VIC. Available from: <https://www.towardszero.vic.gov.au/what-is-towards-zero/road-safety-action-plan>.

Woolley, J., Crozier, J., McIntosh, L. & McInerney, R. 2018, *Inquiry into the national road safety strategy 2011-2020*, Independently Published, Australia.

World Health Organisation 2011, Global plan for the decade of action for road safety 2011-2020, WHO, Geneva, Switzerland.

International Organisation for Standardisation

39001:2012, *Road traffic safety (RTS) management systems*. Available from: <https://www.iso.org/standard/44958.html>.

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Austroads' **Guide to Road Safety Part 1: Introduction and The Safe System** provides an overview of the structure of the Guide to Road Safety, and the interlinking and overlap between parts. It also describes Safe System, the guiding principles for road safety programs in Australia and New Zealand. The final section provides an overview of road agencies' responsibilities for road safety, and how performance is managed and measured.

Guide to Road Safety Part 1

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