The Safe System Hierarchy of Control Framework for Local Roads

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Abstract

There remains a significant gap amongst practitioners between understanding and application of the Safe System approach, particularly on local government road networks.

The reasons for this are as complex as they are diverse, but a key deficiency is a lack of a structured framework that guides practitioners through the thought process of analysing, evaluating and determining the opportunities for developing Safe System solutions to managing their road safety risk.

This paper will outline a framework designed to assist practitioners apply the Safe System approach to their road networks and then allow them to communicate the outcomes to a diverse audience of technical, management, community and elected representatives.

Why A Safe System Hierarchy of Control Framework?

Overview

For over 10 years the Safe System approach to road safety has presented a simple, clear and readily accepted theory for improving road safety. It has been adopted in national and jurisdictional road safety strategies across Australia and New Zealand and is a framework that has many and varied potential applications for informing and improving road safety. As a framework it has been actively promoted to local government as an important means of dealing with their disproportionate contribution to road trauma in both countries.

But local government, as a road manager of over 80% of the Australian public road network, seems not to have embraced Safe System principles to the full extent that they could. The reasons for this are often put down to a lack of funding being available to upgrade local road networks to implement best practice (Safe System) measures.

This response perhaps reflects a lack of understanding of the core road safety issues that exist on local roads; it also indicates a misunderstanding of the diversity of potential opportunities available across a local council's area of responsibilities to apply Safe System principles to address their local road safety issues.

In turn, this can be put down in large part to a lack of effective local government focused Safe System information and readily accessible tools that assist council practitioners to evaluate road safety issues with a Safe System perspective and then guide them to develop responses through a Safe System lens.

Are local roads a safety concern?

It is too often the view amongst local government managers and elected officials that road safety is not a local government responsibility. Commonly it is believed that road safety rests with state and territory level agencies, typically in the form of more effective driver training, restricted licensing, and better targeted policing, or that federal and state governments should increase funding for black spot programs etc.

It is the case that local councils are the sole responsible entity for approximately 82% of the public roads in Australia, and a review of crash data indicates that 52% of casualty crashes and 40% of fatal crashes occur on these local council managed roads (Austroads 2010).

While initially this seems to suggest local roads are under-represented in casualty crashes, it is the case that they tend to carry a far smaller proportion of traffic in terms of vehicle kilometres travelled (VKT) as compared to state roads. Consequently, the relative risk of a casualty crash occurring on a local road is between 1.5 and 2.0 times that compared to state managed roads, and this can be even higher for certain types of roadways. For instance, there is over twice the risk of a casualty crash occurring on unsealed roads and more than three times the risk occurring on local streets, as compared to that on primary arterial roads (Austroads 2010).

The National Road Safety Strategy sets the target of a 30% reduction in the annual road crash fatalities and a 30% reduction in serious road crash injuries by the end of 2020 (Australian Transport Council 2011). If these targets are to be achieved then action to address crashes on local government managed roads is important, and core to this action is local government applying the Safe System approach to its road networks.

How Can Local Government Contribute?

The review of the National Road Safety Strategy 2011 – 2020 by Austroads (2015) reported agency and stakeholder feedback 'that much more needs to be done within road and traffic authorities and particularly in relation to local government', that there is 'insufficient capacity within local government to fully implement the Safe Systems approach' and that there is 'the need to breach the significant gap between understanding and acceptance of the Safe Systems approach and the practical application of agreed safety principles'.

A considerable amount of information about the principles of the Safe System approach has been developed since it was adopted in Australia over 10 years ago. This material provides discussion and explanation about the theory, its core principles – human error, forgiving road environment, lower (speed) impact forces, limits of human tolerance, shared responsibility – the aspiration of zero death and serious injury on our roads, safe travel and the four (or five) pillars, etc.

But much of the action on the ground, particularly for local government, remains focused almost exclusively on road infrastructure, and in this, priorities tend to be primarily about fixing existing roads through black spot and road repair style funding programs. While these are an important and necessary part of delivering Safe System outcomes, they are overshadowing the many other areas that local government can contribute to achieving road safety objectives and are effectively creating this 'significant gap' referred to by Austroads (2015).

Local government is arguably the largest provider of new road infrastructure in Australia and every road user – drivers, passengers, cyclists and pedestrians – interact with local roads on a daily basis, since they will at the very least begin and end their journey on council managed road networks. New residential, commercial and industrial development necessitate the construction of new and upgraded infrastructure such as footpaths, cycleways, new and wider roads and intersections. Before any works begin a significant amount of land-use planning effort occurs with councils preparing and approving masterplans, development control plans, development applications and ultimately development consent.

Once built, local government must maintain this road infrastructure, repairing failures, renewing signs and linemarking and upgrading the traffic facilities to cater for the greater demand placed on the network due to development growth.

Since the early 1990's, road safety officers (RSOs) have been active road safety advocates within local councils. Their role has primarily been to develop road safety education and awareness at the local level, working collaboratively with police, local health services and their state road agencies. But RSOs are also able to work internally to council to create an awareness amongst town planners, asset managers, designer engineers, council management, the elected councillors, and school and community groups.

With the diverse and intimate involvement of local government in the day-to-day planning and management of local roads there is great opportunity to embed the Safe system approach into local councils in a fundamental and sustainable way. However, breaching the 'significant gap' between understanding, acceptance and practical application requires appropriate practitioner tools that capture the full range of measures on offer from the Safe System paradigm.

Developing a Safe System Framework for Practitioners

Overview

The Austroads project *ST1769 Safe System Roads for Local Government* was developed by ARRB Group for Austroads 'to develop a greater understanding of Safe System principles amongst local government practitioners and through this, increase application of the Safe System approach on local government-managed roads' (Austroads 2016a). The research report was published in April 2016 (see Figure 1) and is the culmination of a four-year project that reviewed the crash experience on local government roads across Australia and New Zealand. It also looked at cost effective treatments that may be considered relevant to council managed roads, and assessed how content of the Austroads guide series could be expanded and made more relevant to local government practitioners.
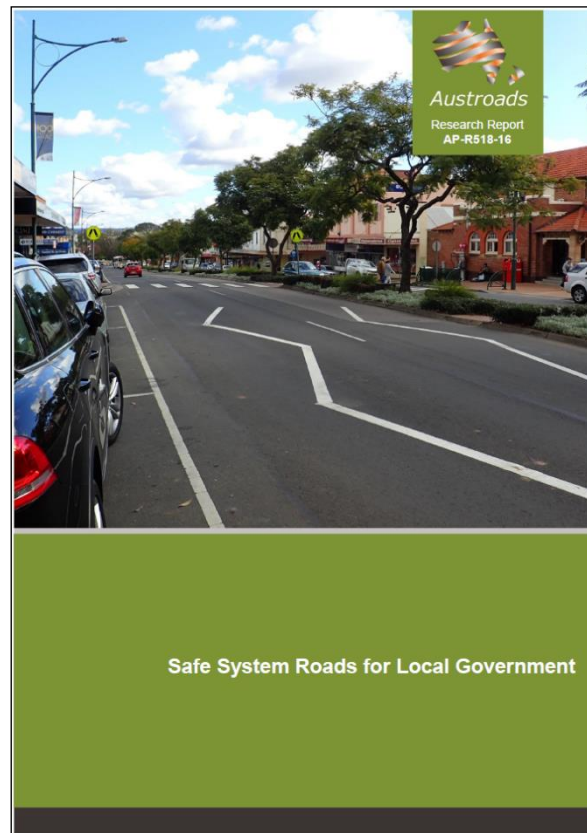
Figure 1. Safe System Roads for Local Government Austroads Report

The primary outcome of the project was the development of the Safe System Hierarchy of Control Framework (the Framework) as a means of gaining greater local government application of the approach to road safety.

The Framework combines the four Safe System pillars – Safe Roads, Safe Speeds, Safe People and Safe Vehicles – with the risk management hierarchy of control, a structure that is familiar to local government practitioners and regularly utilised as part of their workplace health and safety responsibilities.

The combination of these two safety approaches is designed to assist local government practitioners to assess road safety problems in the context of the Safe System approach, with particular attention given to each of the System pillars. This Framework is applicable to all manner of road safety problems, ranging from a general concern as perhaps raised by the community (e.g. traffic issues outside a school), to a developing road safety trend as perhaps identified through analysis of mass crash data (e.g. the local government area experiences a high proportion of single vehicle run-off road type crashes), and it can be used to evaluate a problem location, route or intersection that may have been raised via a road safety audit or a black spot analysis.

The intention of this approach is for the framework to place the Safe System approach readily in the forefront of practitioner thinking when analysing a road safety problem. It seeks to do this by providing a clear structure for evaluating potential measures to address road safety risk issues under each of the Safe system pillars and on the full treatment spectrum of removing (eliminating) the road safety hazard through to providing protection, education and awareness to road users who are exposed to it.

In this way, it aims to maximise the potential involvement of all areas of council in a multi-faceted solution.

For local government, consultation and communication is so often a fundamental element to any project or work outcome. This is particularly the case when dealing with road safety concerns, which the community might see or be exposed to on a daily basis. In this regard, the framework has been designed so that it can be used to clearly communicate the all the factors contributing to a road safety issue and to outline the options available for dealing with it across the full potential provided through the Safe System pillars and risk management approach.

The format of the Framework has been prepared so that it can be easily utilised within council's reporting processes via the Local Traffic Committee or as an attachment for main reports. The content and structure of the Framework is designed to promote discussion not only amongst and with council's technical road safety/road infrastructure staff, but also in reporting back to council managers, the community and the elected representatives.

Stepping through the Safe System Hierarchy of Control Framework

Safe System pillars

The Framework has the potential to be applied to the broadest of road safety issues that may be faced on local road networks, and it therefore intentionally references all four of the pillars currently represented in the Australian Safe System approach model – i.e. Safe Roads, Safe Speeds, Safe People and Safe Vehicles.

While some may hold the view that the Safe Vehicle pillar is of limited relevance to local government, it is important that no area of potential action and response under the Safe System approach be omitted from consideration. To omit any part of the Safe System approach,

automatically places constraints on the possibilities available to councils to address a local issue, removing a potential partnership or community promotion etc., and with the advent of smart and driverless vehicle technology, it is only a matter of time before council roads will need to have embedded in them support for co-operative intelligent transport systems (CITS).

The Framework can also be added to, if required, in order to fit with changes that may occur over time. For instance, the United Nations Global Plan for the Decade of Action 2011 - 2020 promotes a fifth pillar – Post Crash Response. This fifth pillar is increasingly being included in discussions about the Safe System approach in Australia, and has application in many local government areas through their involvement in the local rural fire services/country fire authority (RFS/CFA) or volunteer rescue associations (VRAs) etc., which are often first responders to motor vehicle crashes.

Risk management and hierarchy of control

The starting position of any risk management response is, and should be, the elimination of a hazard or risk. Similar to the approach taken to include all Safe System pillars, the Framework does not seek to limit the consideration of potential measures in response to a road safety concern.

It is often the case that local communities and councillors seek from their council solutions that eliminate a road hazard. However, this call for action is often made without understanding the cost or practical implications. It is also the case that for many road safety problems complete removal of risk is not possible and so alternate measures, and the risk benefit they offer, need to be considered.

The Framework has adopted a hierarchy of control approach that is derived from the established and familiar structure outlined in the Austroads Guide to Road Safety *Part 7 Risk Management* (2006), and updated to apply the revised approach presented in AS/NZS ISO 31000:2009 *Risk Management* (Standards Australia, 2013). The outcome is the four-tier risk control hierarchy described in column 4 of Table 1, titled Road Safety Hierarchy of Control.

Table 1. Hierarchy of risk control

Hierarchy of Control level	Austroads (2006a)	IS0 31000:2009	Road safety Hierarchy of Control
1	Eliminate	Removing the risk source	Remove the risk
2	Substitute	Avoiding the risk by deciding not to start or continue with the activity that gives rise to the risk	Reduce the risk
	Isolate		
	Engineer		
3	Administration	Changing the likelihood	Change road user behaviour
4	Personal protective equipment	Changing the consequences	Protect the road user
		Taking or increasing the risk in order to pursue an opportunity	Not applicable
		Sharing the risk with another party or parties (including contracts and risk financing)	Not applicable
		Retaining the risk by informed decision	Not applicable

An explanation of each risk control level, along with examples of the types of countermeasures is given in Table 2. It is acknowledged the examples in Table 2 are by no means exhaustive and over time a greater range of non-engineering countermeasures covering all the Safe System pillars will be added to the library in the Road Safety Engineering Toolkit.

Table 2. Example risk mitigation actions under the hierarchy of control

Hierarchy	Risk control method	Effect of control	Example[1, 2]
1	Remove the risk	Remove the hazard from the road and traffic environment	• Remove a tree or utility pole from the roadside area • Grade separated pedestrian crossings • Fully separated cycleway.
2	Reduce the risk	Replace one hazard with another, less severe and more controllable, hazard Physically separate road users from the hazard to minimise road user interaction with it, or modify the design of the road infrastructure to reduce road user interaction with the hazard and/or assist road user control	• Road safety barrier • Roundabout (replacing priority controlled cross or T-intersection) • Wide median or verge area with or without a safety barrier • Traffic signal control pedestrian crossings • Off-road cycleway • Increase lane and sealed shoulder width • Improve delineation of the carriageway • Provide pedestrian crossing with refuge island • On-road cycleway and shared zones • Improve Australian New Car Assessment Program (ANCAP) rating of vehicle fleet.
3	Change road user behaviour	Provide warning/advice to seek appropriate behaviour	• Curve warning/speed advisory signs • Reduced speed limit and school zone alert signing • Vehicle safety features such as speed alerts, lane departure warning, blind-spot monitoring, etc. • Enforcement, education and training.
4	Protect the road user	Use equipment to protect road users from death/injury	• Seat belts, anti-lock braking system (ABS), electronic stability control (ESC), automatic emergency braking (AEB) • Pedestrian airbags and bonnet designs • Replace a rigid lighting pole with a frangible pole.

[1]   The examples listed are not exhaustive. A range is provided to help illustrate the Hierarchy of Control approach.
[2]   Examples do not necessarily fall exclusively into one category of risk control.

Source: ARRB Group.

Evaluating road safety issues and problem locations

At the centre of the Framework is the pro-forma evaluation and road safety assessment report, which is comprised of two parts. When applied, the two part essentially break the process into two assessment stages:

• Stage 1 - Site Crash Risk Safe System Analysis form (see Table 3).

• Stage 2 - Safe System Hierarchy of Control Assessment form (see Table 4).

Each of these stages of the assessment are briefly discussed below.

Site Crash Risk Safe System Analysis

The intention of the first stage of the assessment is to assist collating safety issue/site information, including photographs and sketches that aid understanding issues and constraints, to document (in terms of a road location) the current conditions that may be contributing to the road safety issue or crash risk, and perhaps most critically have the assessment team critically analyse the problem as it relates to each of the Safe system pillars.

Importantly, this stage does not involve identifying any possible actions, treatments or countermeasures.

Table 3. Pro-forma Site Crash Risk Safe System Analysis form

Site description (provide an outline of the current site configuration, key features of construction, traffic management, etc.)	
• Provide an outline of the road and traffic arrangements at the site, covering the geometry, speed limit, signing, delineation, condition, roadside, etc. • Describe road user interactions and limitations of infrastructure to provide for all road users. • If available, summarise the crash history of the site (three and five years, FSI outcomes, top three crash types, dominant road/weather conditions, etc.).	
Crash risk identification (briefly summarise the crash experience and/or type of road safety issue/s at the site)	
Outline the road safety concerns that are present at the site; cross-reference crash data, road safety audit issues, observations of contributing behaviour from assessors, and how issues under the Safe System pillars might contribute to crashes or safety concerns.	
Safe System pillar analysis (identify hazards and road safety issues grouped under the relevant pillar)	
Safe roads: • What is it about the road that contributes to the safety concerns/problem?	Safe people: • What is it about road users and their behaviour that contributes to the safety concerns/problem?
Safe speeds: • What is it about the road speed environment that contributes to the safety concerns/problem and FSI severity of the crash?	Safe vehicles: • What is it about the road/vehicle interaction that contributes to the safety concerns/problem?
Site photographs (supplement the site description and problem definition using selected site photographs)	
Provide a map or aerial image of the site/route.	Provide images that highlight safety concerns, illustrate crash locations.

Safe System Hierarchy of Control Assessment

The purpose of the second stage of the assessment is to collate the results of brainstorming potential countermeasure responses across all four (or five) of the Safe System pillars, and to assign the most likely level of risk control (mitigation) that each might achieve if adopted.

There is the potential in this process for more than one countermeasure to be available under each risk control level, which results in options being available for a treatment program.

Once the countermeasure described across the first three columns – crash type, cause/hazard and control method – the assessment team should identify which pillar (or pillars) are applicable to each identified countermeasure.

It is possible that a countermeasure may address actions for more than one pillar and this should be acknowledged by noting it accordingly on the assessment form as shown in the pro-forma presented in Table 4.

A strength of presenting the assessment in this manner is that it provides a simple and quite visually easy method for identifying potentially higher value options. Countermeasures listed higher in the risk control hierarchy and across more than one Safe system pillar, suggest a higher road safety value could be achieved by adopting that particular option.

Equally, measures listed lower along the risk control hierarchy and addressing just specific Safe System pillars, may initially suggest a lower road safety value. However, it can be quickly determined that these may actually highlight niche or specialist responses/actions by areas of council that are not traditionally seen as being involved as a road safety responder, e.g. the town planning, road asset managers, and community services areas.

Table 4. Pro-forma Safe System Hierarchy of Control assessment form

Crash type	Cause/hazard	Control method	Safe System pillars			
			Safe roads	Safe speeds	Safe people	Safe vehicles
Remove the risk						
Describe the particular type/s of road crashes under consideration.	Describe the contributing factors to the cause of the crash (or potential crash), or the type of hazard under consideration.	What mitigation measures could be adopted to remove the hazard, or the likelihood of the particular type of crash resulting in a fatal/serious injury outcome?	✓			✓
Reduce the risk						
Describe the particular type/s of road crashes under consideration.	Describe the contributing factors to the cause of the crash (or potential crash), or the type of hazard under consideration.	What range of control measures could be adopted to isolate/separate road users from the hazard, or the likelihood of the particular type of crash resulting in a fatal/serious injury outcome?	✓	✓	✓	
Change road user behaviour						
Describe the particular type/s of road crashes under consideration.	Describe the contributing factors to the cause of crashes (or potential crashes), or the type of hazard under consideration.	What type of control measures could be adopted to inform and warn road users about the hazard, or the likelihood of the particular crash type fatal/serious injury outcome?			✓	✓
Protect the road user						
Describe the particular type/s of road crashes under consideration.	Description of the type of hazard or particular crash type under consideration.	What type of measures could be adopted to protect road users from the hazard, or the likelihood of the particular type of crash resulting in a fatal/serious injury outcome?			✓	✓

Note: The Safe System pillar checked with a tick is for illustrative purposes only.
Source: ARRB Group.

The Safe System Hierarchy of Control Framework is not intended to be the end of the road safety assessment process. Indeed, it should be considered just the beginning as it is designed to assist practitioners to collect their thoughts about a road safety hazard and the full range of potential countermeasure responses in a manner that reflects the Safe System structure.

Once this assessment is completed, it is then necessary to develop the potential countermeasures to a feasibility, concept or development/design stage, followed by an evaluation their cost benefit effectiveness to assist prioritising implementation within a road safety program. With this in place, the council will then need to seek appropriate funding, either from internal programs or other

sources, including state and federal government agencies, or third parties such as grants via motor accident insurers or commercial sponsors etc.

Working with other guidelines and assessment tools

The Safe System Hierarchy of Control Framework is complemented by, and complements, other practitioner tools and advisory guides prepared by ARRB Group for Austroads. Of particular relevance to local government are the research reports Safe System in the Planning Process (Austroads 2015) and Safe System Assessment Framework (Austroads 2016b), see Figure 2. Each provides local government planners and engineers with guidance about the applying the Safe System approach to their areas of managing council road and traffic infrastructure. Of particular note is the Safe System Assessment Framework, which provides a formulaic approach to assessing the level of Safe System compliance of potential treatment measures.

Figure 2. Companion Austroads Project Reports

Conclusion

The Austroads project *Safe System for Local Roads* (2016a) aligns well understood risk management principles with the Safe System pillars structure to provide a framework of analysis, evaluation, and application for local government.

The Safe System Hierarchy of Control Framework can be applied easily to locations with a documented crash history or just as readily to perceived and undefined road safety problems that are regularly brought to the attention of Council by the community and elected representatives.

The Framework seeks to establish Safe System thinking amongst practitioners rather than directing them to a more effective crash data and benefit cost analysis approach. The Framework is very much intended to be inserted into the early part of the whole road safety investigation process, working to provide a solid Safe Systems platform to later, more detailed assessments.

In this way, the Safe System Hierarchy of Control Framework is designed to first and foremost inform decision-makers of the range of options available to them via all the Safe System pillars, and to provide a clear indication of the level of effectiveness of each countermeasure to reduce the risk of fatal and serious injuries on their road network. Armed with this information, council managers, elected officials and the community can be shown what is required to remove a road safety risk, or how alternative solutions might reduce it, change road user behaviour or otherwise protect road users in a more cost effective manner.

Armed with the Safe System Hierarchy of Control Framework, local government practitioners across all areas of council – the engineers, the land-use planners, community services, councillors and community - are expected to be encouraged to have a greater involvement in road safety, and from this develop their own expertise in the Safe System approach.

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