- On roadsides – as well as the deficiencies noted above, greater protection of a bridge structure was required.
- In some large areas where movement is controlled by road markings alone, there was insufficient deflection and advance warning was inadequate.
- Route issues – there were concerns about barriers, advance warning at intersections and of lane-loss (reduction from two lanes to one), and retention of the original signing causing information inconsistencies.

### Safer Roads Investment Plan

The iRAP ViDA software provided a Safer Roads Investment Plan based on the data collected during the "after" survey. This proposes additional countermeasures and indicates that there are still opportunities to enhance safety on the road. An economic analysis of safety countermeasure options identified countermeasures in this enhanced safety package of almost 80m Moldovan Leu (about 4m USD) that could potentially save almost 300 fatal and serious injuries over 20 years, a reduction of more than a third (36%) of those likely to occur in that period. This would save approximately 180m Moldovan Leu (about 8.9m USD) in crash costs with a BCR of 2. Countermeasure costs are approximate and vary according to particular locations.

The improvements include: installing or improving roadside barriers, shoulder rumble strips, central hatching, clearing roadside hazards and shoulder sealing. Measures identified in other parts of the study involve reducing speeds, upgrading and extending safety barriers; and installing village "gateway" treatments.

### Future recommended actions

Based on the assessment, the following recommendations are made:

- Enforce the speed limit at priority locations by means of average speed cameras, notably in the villages.
- Review the recommendations of the post-assessment Safer Roads Investment Plan and consider which investments may be a priority.
- Act on the recommendations of the Road Safety Audit at the specific locations recommended.
- Follow up those elements from the Road Safety Audit that are likely to be repeated at various points on the network. In particular, assess the location and design of barriers, notably those with ramped, unprotected or fishtail terminals.

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# *Perspective/Commentary on Road Safety*

# Tragic failure of a road system – an Australian example

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## Key Findings

- Globally, road and traffic systems are providing the conditions to allow some 1.25 million people to die every year.
- The application of root cause analysis methods can identify systemic factors in road injury.
- Some road authorities are not embracing a safe system approach to road safety.
- People are generally complacent about the continuing road trauma crisis.
- A louder community voice is the key missing element in the struggle to eliminate road deaths and injuries.

## Keywords

Safe system, systemic injury causation analysis, community demand

## Introduction

The first recorded automobile fatality occurred in Ireland, in 1869 (Fallon & O'Neill, 2005). The event was described as a "public scourge and a private tragedy." The coroner was moved to say, "This must never happen again." But then in 1899, Henry Bliss was killed when struck by a taxi in the United States while alighting from a streetcar.

Later, in post war 1947, J S Dean wrote a book entitled, "Murder Most Foul: a study of the road deaths problem." He concluded that "The 'reconstruction of Britain' will indeed be a dismal failure if it includes as a permanent feature of the national life the killing and maiming of a quarter of a million, or more, of persons every year on the roads…there is no reason for failure…all that is needed is the will to act." (Dean, 1947)

In 2004, leading road safety researchers (Peden et al., 2004) estimated that road fatalities and serious injuries will rise by 65% by the year 2020, that deaths resulting from road crashes will exceed deaths from HIV, malaria and tuberculosis, and is predicted to become the third leading contributor to the global burden of disease and injury. In its Global status report on road safety 2015, the World Health Organisation (WHO) reported that the worldwide number of traffic deaths has plateaued with 1.25 million people dying each year on the world's roads (World Health Organisation, 2015).

One becomes acutely aware of the magnitude and threat to the community when looking at the total number of deaths that occur in any country resulting from a traffic crash, and comparing that number to the number of deaths resulting from all the wars and disasters its citizens have suffered. For example, the total of fatalities Australia has suffered in all wars to date is around 103,000 of which only 36,000 occurred since 1925 (Australian War Memorial, 2013). Added to this number should be the number of Australians who have died as a result of natural and human created disasters (fires, bridge collapses, bombings, etc), being only around 1000. This total can then be compared to around 171,000 fatalities total resulting from all road crashes since records started in 1925. This is almost double the number over a shorter period.

The figures contrast in a similar way for the USA. Around 1.8 million road fatalities to date have been recorded since only 1966 (US National Center for Statistics and Analysis, 2004), compared to around 1.4 million fatalities from all wars, including the US civil war and disasters that include heat waves, hurricanes, floods, bombings, etc. (White, 2010). In the year 2000, fewer than 4,000 people were killed in the Twin Towers terrorist attack in New York, but more than 40,000 Americans are killed in road crashes *every year*. Yet US Government attentions to anti-terrorist initiatives far outweigh the attention to road safety in that country. Indeed, when the casualties of wars and disasters are compared to the casualties from traffic crashes for just about any developed nation, it becomes obvious that traffic crashes are a much greater risk to the health and well being of society.

Moreover, the incidence and severity of road crashes is somewhat more predictable and preventable than are other forms of injury causation. Much more so than natural disasters, where magnitude and location are difficult to predict, and wars, where injury is intentional, road trauma is known to be caused by certain characteristics of roads, vehicles and behaviours – all of which can be ameliorated.

From the early 1990s researchers and practitioners in the Netherlands sought to find ways to dramatically reduce road deaths. In recognition that human errors play a large part of road injury risk, Dutch Government stakeholders, at national, provincial and local levels, committed to take a planning and design approach to developing a sustainably safe road traffic system. The strategy emphasises the application of three safety principles in a functional hierarchy of the road network – functionality, homogeneity and predictability (Wegman et al, 2005). The challenge is to reorganise the road network into roads with *flow* functions, *distribution* functions and *local access* functions and to manage speeds, types of vehicles and road users' behaviours in accordance with the safety parameters that would enable people in the road environment to remain unharmed. The objective was to provide a road traffic system that is adapted to the capabilities and limitations of human road users. The design reference is the human being, considering human error and human physical tolerance to mechanical forces.

The passage of the Vision Zero legislation by the Swedish Parliament in 1997 was underpinned by a strong ethical basis for road safety. The Swedes took the bold position that it is unacceptable to trade safety for mobility in the road environment. One key premise of this new approach was that *"…the speed limits within the road transport system should be determined by the technical standard of vehicles and roads so as not to exceed the level of violence that the human body can tolerate"* (Tingvall and Haworth, 1999).

The strategy underpinning the Vision, is one of taking a quality management approach to managing safety in the road transport system. Road system designers, vehicle manufactures and those who employ professional drivers all have roles to play in developing and managing an inherently safe road transport system. Road infrastructure and vehicles must be designed to protect human bodies from the risk of injury, while the road users themselves be encouraged or forced to use vehicles and roads safely. Moreover, if the system is found not to meet these standards in any way, the defect must be corrected by the designers. The principles of Vision Zero state:

1. *'The designers of the system are ultimately responsible for the design, operation and use of the road transport system and thereby responsible for the level of safety within the entire system;*
2. *Road users are responsible for following the rules for using the road transport system set by the designers;* and
3. *If road users fail to obey these rules due to lack of knowledge, acceptance or ability, or if injuries occur, the system designers are required to take necessary*

*steps to counteract people being killed or seriously injured. (Tingvall and Haworth, 1999)'*

Throughout the 1990s, Australian States were actively pursuing road safety based on analysis of crash injury data and cost-beneficial selection and implementation of countermeasures to address road, vehicle and human factors attributable to road injury and death (Torpey et al, 1991). While this approach was achieving reductions in road fatalities, the reduction line on the graph was flattening in raw numbers. Around this time, Australian researchers began to highlight systemic risks in the road traffic system and in vehicles, calling for more attention to address these system problems (Grzebieta and Rechnitzer, 2001, 2002; Rechnitzer and Grzebieta, 1999). And in 2004 the Australian Transport Council (of Ministers) adopted the Safe System principle to form the basis of Australian road safety strategies (Australian Transport Council, 2004).

Then in 2010, the General Assembly unanimously resolved to declare 2011-2020 a Decade of Action for Road Safety (United Nations, 2010). An agreed Global Plan for the Decade was underpinned by the Safe System principle. However, even in 2016 – more than half way through the Decade that sought to reduce by half the world's road fatalities, they are not declining at all.

## A system-focused analysis

There is a growing concern that the safe system principles that are meant to underpin the Global Plan for the Decade of Action for Road Safety are not being applied in countries that are UN signatories to this global commitment. Applying safe system principles means that the road traffic system is designed and managed such that crashes are survivable. That is, this approach assumes that people will make mistakes in the road environment, and efforts are made to correct for, or ameliorate, the harmful effects of any impacts on the human body that may result from a crash event.

This is done by applying resources to prevent the risks of serious injury crashes, based on an understanding of the possible crash types and likely harm to human road users that can result from these crashes and addressing road, vehicle and human behaviours, as well as emergency response services, to prevent this harm from occurring. While preventing crashes from happening is ideal, the focus of the safe system approach is to eliminate the possibility of kinetic energy forces in a crash to result in an impact on the human body causing serious harm. This approach acknowledges that human beings are fallible. They make mistakes. To the extent that they control motor vehicles, lapses and errors are likely to result in crashes in the foreseeable future. A safe road system will prevent these mistakes becoming fatal or seriously harmful.

A system-focused analysis of how serious injury crashes occur can demonstrate how system failures contribute to human tragedies. Just as root cause analyses are conducted in workplace health and safety, a similar process can be applied to the analyses of road trauma events.

Let's apply a system-focused analysis to an example of a fatal crash that occurred in February, 2016 on a rural road in Australia.

The story in this article is true. One of my friends lost her husband in a car crash that should not have happened. This is the story of what happened returning from a lunch outing for Wendy's birthday. It is a classic illustration of a tragic system failure.

## Summary of Wendy's Victim Impact Statement

*After the last two fatalities on the road we travelled to return home, had the local road authority built a guardrail and improved the safety of the stretch of road where my husband died, I would be a happily married woman with a beautiful, creative husband six years my junior. I would be working as a planning consultant and author and living in the house we designed, and built, on a rural block in a tropical region of Australia.*

*I believe that Karl's death resulted directly from the road authority's decision (following the last crash in 2015 that resulted in two fatalities) not to erect a guardrail on the stretch of road that is both windy and dangerous, with inappropriate and dangerous road camber, frequent pooling of water and steep embankments. The memorial cross for that crash is located only eight metres from where our car mounted the kerb and tumbled 30 to 40 metres over the cliff into a shallow tidal creek.*

*The autopsy report showed that drowning was the sole cause of Karl's death.*

## Wendy's account of what happened

*We'd been out celebrating my birthday and we'd had a stellar day. We had had such a brilliant lunch at Mavis's Kitchen that we reckoned there was no need for dinner. We were in no hurry. We had travelled that stretch of road thousands of times since we bought our rural block in 2001. We knew the road very well.*

*On the wet road, the car aquaplaned on a bend, crossed the double line, hit the kerb, rolled down a steep bank for thirty out forty metres and landed on its roof in a shallow, tidal creek, facing in the opposite direction. I briefly blacked out and regained consciousness in the water. I found myself upside down. After seconds or minutes that seemed like hours, I located and unfastened my seat belt, as I watched water rising and coming through one open front window. Then it stopped rising, leaving me a small air pocket.*

*I'm sitting upright in the upside-down car in the creek, on the roof, with water to my chin, air above, and the floor above that. It was quite dark in the car because of the muddy water, even though it was light outside. Karl seemed some distance from me. I've been pushed (probably by the airbag) into the back of the car, facing Karl's back. He's tangled in his seat belt.*

*I have air on my side (the back) and he has none because the car landed on an angle. He's sitting up, silhouetted in water as dark as chocolate milk. I can barely see his head and cannot reach forward far enough to untangle him. His swimming hands describe small circles around his body. He appears to be unconscious. I reach forward and grasp one circling hand with my left hand. He has had no option but to surrender to the water that fills his space and then his lungs. He does not struggle. I hold his hand as he drowns, hearing a shocking gurgle of water, like a large sink emptying. His head flops to one side.*

*I'm desperate now. The water is still rising. The doors are stuck in mud. I scream: "Karl! Hold your head up!" Screaming at a dead man.*

*I take a last look at Karl, now slumped forward, and dive down to reach the passenger side open window. I force my shoulders through it, imagining I will need powerful strokes to reach the surface light. I forget to take a breath, swallow, splutter and cough. Then find myself standing in a metre of water outside the car.*

*Already people are crowding the narrow roadside above. "He's drowning!" I scream to those above. "Help us! Help us!"*

*Barefoot, trembling, stones cutting my feet, I observe a surreal tableau of airbags, shopping bags and roadmaps floating slowly through the hatch door, heading downstream. I reach for one and stop. How ridiculous!*

*Then I turn to see two men – later known as Rob and Bill – scrambling down the slippery, reedy bank. They wrench a huge stone from the creek side and smash the driver's side window. Rob dives in three times before he untangles Karl and hauls his lifeless body from the wreck.*

*When attempts at CPR fail, a police officer announces, first to others ("There's no pulse"), and then to me ("Madam, I regret to inform you that your husband is deceased").*

## Safe System?

Australia first developed the "safe system" approach based on the principles underlying Sweden's *Vision Zero* (Johansson, 2009)and the Netherlands' *Sustainable Safety* (Wegman et al, 2005). In 2004, all Australian Transport Ministers adopted safe system principles to underlie their road safety strategies (Australian Transport Council, 2004). This promised to ensure that systemic safeguards would prevent inherently fallible human road users to die as a result of a mistake they make on Australian roads.

In Wendy's story, Karl may have made a mistake. Although he was not exceeding the speed limit, he may have misjudged the condition of the road and driven too fast for that bend. It was not raining at the time of the crash and Karl thought he knew the road well. The speed limit was 80km/h, but the advisory speed on the bend in the road was 45km/h. Police estimated that he was travelling at 50km/h.

"Speed was the *root cause* of the crash," the local road authority claimed. Moreover, despite the police report of the crash they said "the car could not have aquaplaned." This is because, as they pointed out, there was a drain culvert near the crash site. However, when we inspected the site – even months later – the drain was covered in fallen leaves. The Police also observed that the fruit that drops on the road in that sub-tropical area also contributes to the road's slipperiness. The Police advised Wendy that had a guardrail been installed in that section, Karl might well have survived. The report on this crash included statements by Police that mentioned a history of serious crashes on this stretch of road – including those where vehicles landed in the river.

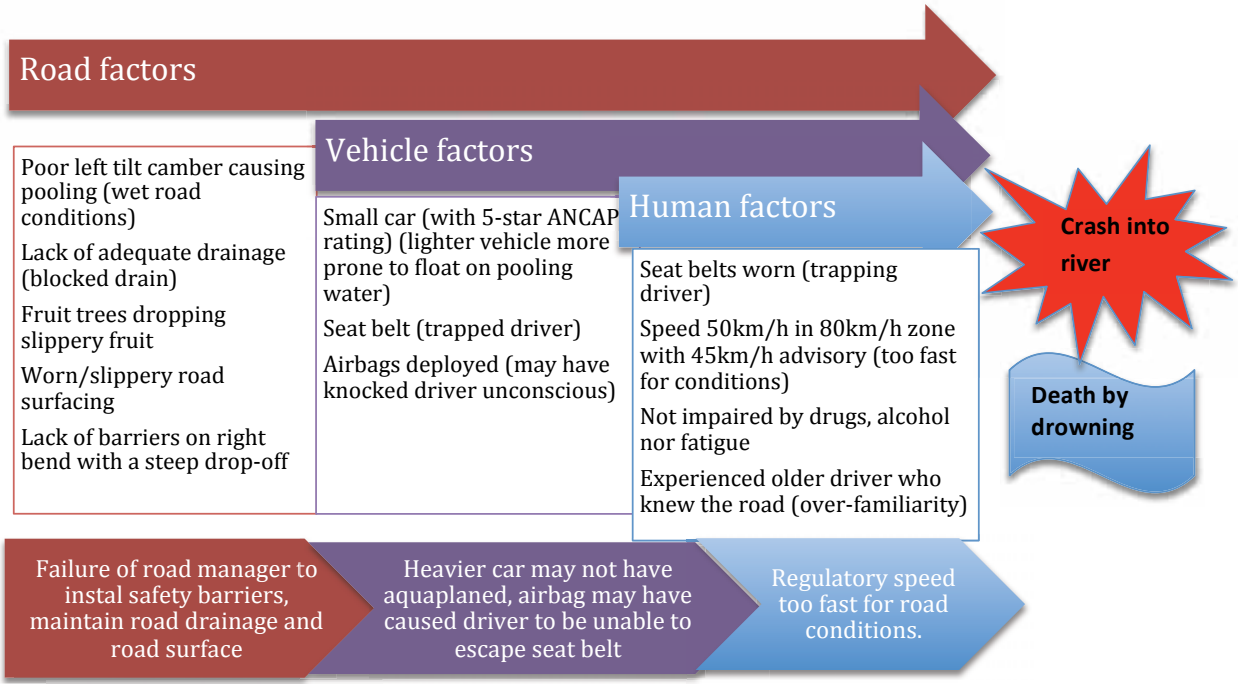


**Figure 1. Road, behicle and human factors involved in Karl's fatal crash**

However, advising motorists of the danger of that section of road and installing new interactive speed signs, telling drivers how fast they are travelling, was the solution adopted by the local authority following the double fatality crash only one year prior to Wendy and Karl's fatal crash. By September (7 months after this crash) the only action the authority had taken was to prepare applications for Black Spot funding (Black Spot funding is a Federally-funded scheme that road authorities can apply for. In 2016, the State of New South Wales alone had 500 active applications). They expect to be notified of the outcome of these applications in February, 2017 (one year after Karl's death).

Would the crash have been avoided or severity lessened if Karl had been driving slower? If Karl had seen the pooling of water, would he have slowed down, thus reducing the likelihood of the crash? Would Karl have survived if he had not been trapped by his seatbelt?

Wendy and Karl were travelling in a silver 5-star NCAP rated Volkswagon Golf. The airbags were deployed in the crash. If Karl had been superhuman and anticipated all possible hazards on that road and adjusted his driving accordingly, perhaps he could have avoided the fatal event. He clearly was not.

The road system managers did not take this possibility - this *likelihood* - into account. Systemic safeguards were woefully deficient.

## Systemic anatomy of Karl's fatal crash

The holes in Reason's (2000) Swiss Cheese lined up to enable a tragedy to unfold for Wendy and Karl. Figure 1 below indicates the system failures of this ent.

While the factors and failures identified here do not represent a comprehensive root cause analysis, it attempts to find some of the systemic inadequacies that contributed to Karl's death. The road was inherently unsafe for human motor vehicle operations. There were no safety barriers on a sharp right hand bend with no shoulder and a steep embankment down to a river. The road surface was slippery from worn pavement, pooling water, and fruit droppings.

Perhaps a heavier car would have held the road better. The car, with a 5-star safety rating, was structurally sound and there was little or no intrusion into the cabin. It is likely that the force of vehicle against the left, then right curbing spun the car backwards and the tumble down the steep embankment overturned the car (so that it landed upside down.) The airbags deployed with a force that prevented the driver sustaining impact injuries, but may have caused him to be unconscious and therefore unable to undo his seat belt.

The driver was travelling well under the speed limit, suggesting that the legal speed was set too high. Misjudgements about speed and road conditions would have contributed to the crash, perhaps due to familiarity of the road resulting in overconfidence.

This systemic analysis is an illustration of how human errors, combined with a lack of safety management, particularly of the road conditions, can result in a fatality.

Part of the systemic problem is a lack of proactive safety management on the part of the road authority. The fact that there had been a number of crashes at this site suggests some negligence on the part of the road managers. If the road were treated the same way as a workplace, the authority would be deemed culpable for the injuries that resulted from these crashes. Instead, the apparent attitude of these managers was that the driver was responsible for safely operating the motor vehicle, regardless of the unsafe road conditions. They even prevented the widow from talking about how this tragedy affected her – citing concerns over occupational health and safety for their staff (who might be upset by the story.)

This local authority said that they intend to make safety improvements – if the Federal or State Governments give them the money to do this. However, the impression given was one of discomfort in having to meet the people affected by the unsafe conditions that they provided, as though this was unfair to them. In fact, Wendy was granted the opportunity to meet with authority's staff only on the condition that she would speak only of the crash itself and not of how it impacted on her life, citing workplace health and safety policies (not to place staff in a situation that may upset them).

Unprotected roadsides on slippery roads with tight curves is antithetical to the "safe system" approach adopted as police by all Australian Transport Ministers in 2004. Roadside and median barriers were tested some years ago at the Crashlab (Transport for NSW) and the wire rope barriers in particular were found to be very effective in preventing serious injury crashes (See http://roadsafety.transport.nsw.gov.au/research/safer-roads/transcripts-road-safety-barriers.html). Yet the local road authority ignored Police suggestions that guardrails should be installed. When we met with this authority on 12 September, 2016, they advised that speed was the root cause of the crash, not aquaplaning as advised by Police attending the crash site. They further said, «[We] have not pursued guardrail at this location in isolation as it does not address these root causes of the crashes at this location. If [we] do not address the factors leading to loss of control on the corner, which it considers to be mainly speed related, [we] will potentially be faced with a maintenance issue from vehicles impacting with the guardrail, and new hazards the guardrail may create."

After Wendy and Karl's crash, the local authority has finally reduced the speed limit from 80km/h to 60km/h. Police estimated that Karl was driving no faster than 60km/h. The advisory speed sign suggests 45km/h around the curve. And while there is little doubt that Karl, being familiar with the road, was driving faster than safe for the prevailing conditions, a 60km/h crash into a guardrail may have caused the authority some "maintenance" issues, but the Police advised that had there been a guardrail Karl probably wouldn't have died.

An examination of authority's budget papers indicates that they spent $13million last year on recreational facilities, instead of erecting a barrier that would have cost around $100,000. They seemed to be of the view that unless they get additional funds from the State and Federal Governments, they do not want to spend money on making their roads survivable.

When we met with the road authority the mention of the safe system approach drew a blank on their faces. It seems that, even in Australia, we have a long way to go to embedding a culture of primacy of safety on the roads. We are still blaming the driver for making human mistakes, without serious recognition of our responsibility to make roads safe. This attitude in and of itself is a systemic failure.

The theme for the 2016 World Day of Remembrance for Road Traffic victims (see http://worlddayofremembrance.org) is "Vital post-crash actions: Medical Care, Investigation, Justice!" In Karl's crash case, investigation and justice were all but absent. The local Police told Wendy that the expert crash investigation unit would not come to investigate a single vehicle crash in a rural location. Therefore the reports of what contributed to the crash were insufficient enough for this road authority to blame the driver for his death. Where is the justice in that?

As long as this complacency and displaced sense of responsibility persists in road-managing agencies, the notion of safe system in reality is a long way off.

### How can we break this complacency?

Scientific evidence alone seems insufficient to influence policy makers. There is a wealth of research findings that can guide road designers and managers. Knowledge of what factors are involved in injury crashes is abundant. Knowledge of the solutions and technologies to ameliorate these factors are also abundant. Obviously, there will always be limitations on resources available to create a truly safe road and traffic system. However, the safe system principle demands that crashes should not result in injuries – certainly not in multiple fatalities at the same spot in a road network.

Increasingly, a greater advocacy role is being suggested for road safety researchers. While there are barriers for researchers to assume a policy advocate role, Australian road safety stakeholders by and large want to see road safety researchers become more pro-active in this space (Hinchcliff et al., 2008). The barriers identified include:

- Reluctance to upset or offend research funders;
- Lack of media advocacy skills;
- Lack of time to do unpaid work;
- Reluctance to appear biased; and
- Policy-makers' opposition to researcher media advocacy.

Nonetheless, the majority of stakeholders participating in the consultations undertaken by Hinchcliff et al reported that researcher media advocacy is a significant force within the road safety policy process.

The community voice for road safety in Australia has generally been quiet, relative to the voice in other countries. One notable voice has been Safer Australian Roads and Highways (SARAH), a not-for-profit association established by Sarah Fraser's family and friends, following the crash that killed her. Their mission is to advocate for road safety and to support those affected by road tragedies. In Sarah's case, a truck crashed into her vehicle that was parked in a breakdown lane on a motorway that was too narrow for her car to get completely off the motorway. This crash killed her and the person who came to try to fix her car. The stated beliefs of SARAH (See http://www.sarahgroup.org/background/who-is-sarah/) are:

1. *Each person's life is precious and can therefore never be ethically traded off against traffic mobility*
2. *No person should be placed in harm's way simply because of poor policy, poor planning, poor maintenance or poor procedures;*
3. *Each of us must drive to actively protect other road users, and especially those road users who find themselves vulnerable (ie. those involved in an incident, those who assist and protect, cyclists and pedestrians!)*

These beliefs are entirely consistent with safe system principles. Voices such as SARAH need to have their volume turned up. Were the road safety professionals to work more collaboratively in advocating for change, there could emerge a stronger demand in the community for improved investments in road safety.

## Conclusions

Despite all the technical knowledge we have amassed about road safety, Australian road authorities continue to treat safety – at best – as one of a number of competing corporate objectives. Instead of embracing the primacy of road safety, they carry out improvements to road safety only to the extent that budgetary allocations allow. We need to question the values that underpin those budgetary decisions. Until we begin to hear loudly voiced demands for making roads survivable, Australia will continue to fail to meet its *Safe System* objectives.

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# Re-invigorating and refining Safe System advocacy

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## Key Findings

- Safe System principles and Vision Zero for road safety are delivering successes in many countries.
- However, interpretations of the approach limit advocacy for road safety in two ways:
  - The push for road safety investment and action based on a moral imperative for zero road crash deaths is uncompelling for many critical audiences;
  - The approach is dismissed in many low and middle income countries (and even high income jurisdictions) because the prevention of all road crash deaths is seen as prohibitively expensive and unrealistic.
- Recommendations are made to address these limitations, in order to re-invigorate the adoption of Safe System principles.