Mastering the art of risk assessment

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Abstract

Risk Assessment is a key component of the Risk Management process and is commonly relied upon when undertaking Road Safety Audits and Risk Management Plans. The *Standards Australia* Document, '*AS/NZS ISO 31000:2009 Risk management – Principals and guidelines'* provides the industry standard framework for undertaking Risk Management.

Currently the 'Risk Assessment' component of the risk management process is broken up into three distinct steps: Risk Identification, Risk Analysis and Risk Evaluation. This paper explores some of the limitations associated with these steps, when considered in the context of road safety, and discusses opportunities to enhance the existing process.

The paper will also discuss how different organisations within Australia interpret the guidelines differently and the impact this can have on risk ratings and/or consequence of that risk. In addition, the influence the public and media can have on risk ratings will also be discussed.

The paper will also use examples to demonstrate that a robust risk assessment is more than just confirming that design standards have been met, but that sometimes compliance or non-compliance with standards can have a counterintuitive impact on the actual risk.

Introduction

What is risk?

Risk in the context of road safety, is the possibility of injury, damage or loss and refers to an 'event' that, whether predictable or not, has an uncertain outcome. Risk is the 'shadow side' of traffic and road use, attached to existing hazards and/or hazardous situations, waiting for a specific set of circumstances to occur which leads to such an event.

Types of risk

In regards to road safety, risk can fall into one of the following categories:

- *New risks*, which are associated with new design or a newly constructed facility;
- *Ever-present risks*, which are always present and constitute the majority of risks a road user may face;
- *Concentrated risks*, in which a combination of numerous, individual risks interact with each other;
- *Contagious risks*, in which a small risk triggers a larger risk, and causes a cascade effect of subsequent events; and
- *Sudden risks*, which occur without warning.

Risk management

Risk management is the systematic application of management policies, procedures and practices to the task of establishing the context, identifying, analysing, assessing, treating and monitoring risks. In the context of Road Safety, the risk management process is directed toward facilitating road usage, whilst managing adverse effects.

It should be noted however that some risk cannot be completely eliminated at a reasonable cost. Therefore instead of being eliminated, risk must be properly assessed and managed.

Within road authorities, risk management can be seen as managing internal and external influence to maximise positive outcomes, including safety, legal liability, public opinion, and budgets. Risk management also includes minimising the potential for damage (human, financial or image), loss, injury, or death.

Some of the benefits of risk management are:

- Improved planning, road performance and road users safety;
- Improved information for decision making;
- Personal wellbeing; and
- Safer outcomes for road users and pedestrians.

Existing risk management process

The *Standards Australia* Document, *'AS/NZS ISO 31000:2009 Risk management – Principals and guidelines'* provides the industry standard framework for undertaking risk management. It should be noted that these guidelines

are not specific to road safety but cover all forms of risk across different industries and disciplines. While the *Standards Australia* document provides a robust basis from which to assess and manage risk, it is also open to interpretation when used in the context of road safety. In some cases this can lead to misinterpretation, mistakes and in extreme cases manipulation of the process to meet preconceived outcomes. This paper explores some of the limitations associated with the existing guidelines, and discusses opportunities to enhance the existing process.

Risk management process

Risk assessment is a key component of the risk management process and is commonly relied upon when undertaking Road Safety Audits and Risk Management Plans. The *Standards Australia* Document, *'AS/NZS ISO 31000:2009 Risk management – Principals and guidelines'* provides the industry standard framework for undertaking risk management. Figure 1 shows the risk management process outlined in the Standards Australia guidelines.

The risk assessment component (highlighted with dashed line in Figure 1) of the risk management process is broken up into three distinct steps: risk identification, risk analysis and risk evaluation. This paper explores how the application of these steps could be modified in order to achieve a more consistent road related risk assessment.

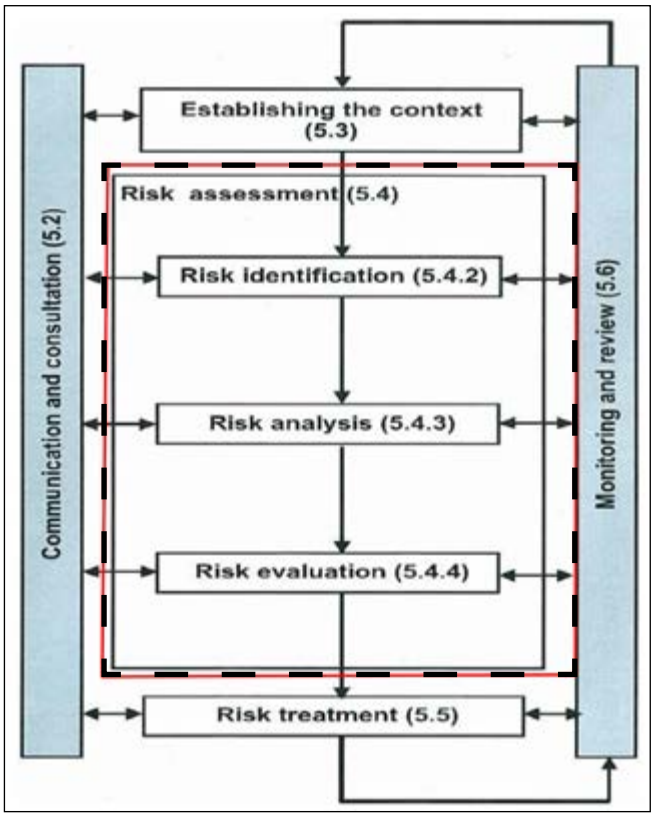

Figure 1: Risk management process (AS/NZS ISO 31000:2009)

Risk identification

Risk identification is the first identified step in the risk assessment process. However in the context of a road related risk assessment, risk cannot be identified nor could the idea of its existence be present without first identifying deficiencies. Therefore **deficiency identification** should be the starting point of every road related risk assessment.

Once all the deficiencies have been identified, each deficiency needs to be assessed to determine whether it represents a hazard (either individually or in combination with other hazards) or not. This can be considered as the **hazard identification** stage.

While the majority of identified deficiencies are likely to create hazardous situations (that carry some risk), not all of them do so. For example, an old-fashioned sign that is still clearly visible, retro-reflective and sending the clear message to the drivers does not create a hazardous situation. If a deficiency is not recognised as a hazard or does not create a hazardous situation, then no further consideration is required. Therefore the hazard identification stage also acts as a filter, meaning that not all deficiencies have to progress to the risk analysis stage.

In terms of the risk assessment process (in the context of road safety) these two steps effectively replace the risk identification stage, as shown in Figure 2 below.

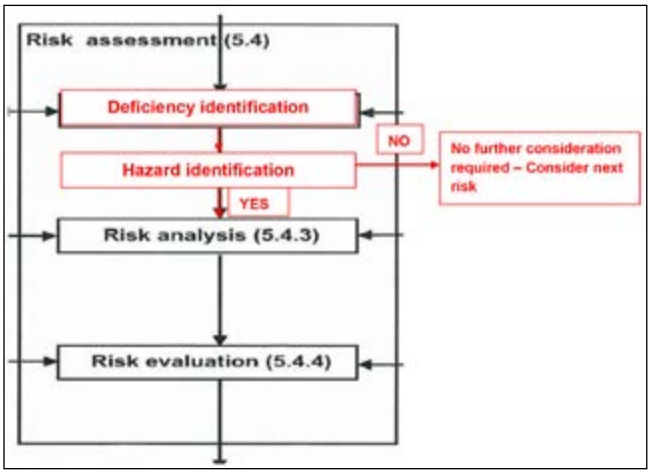

Figure 2: Refined risk identification process

Risk analysis

Risk analysis is the next step in the risk assessment process. The risk analysis process analyses the risk related to each hazard by combining estimates of likelihood and consequences.

Currently there is no uniform approach when it comes to determining likelihood and consequence. Instead, several organisations around Australia have developed their own criteria, resulting in a number of different likelihood and consequence tables.

Likelihood

Tables 1 to 4 show some of likelihood tables currently used in Australia, in which different terminology is used as well as different descriptions of their meaning. For example, according to Table 2, the lowest likelihood rating is described as the event that may *'occur less often than once every ten years'*, while according to the Table 3 the same likelihood rating is described as *'one incident occurs only once every three years'*.

These different definitions can lead to misinterpretation, mistakes and in extreme cases manipulation of the process to meet a desired outcome.

Consequence

Tables 5 to 8 show the corresponding 'consequence tables' used in Australia, in which different terminology is used as well as different descriptions of their meaning.

For example, according to Table 7, the second highest consequence rating is *'single fatality'* while according to Table 8 this would only result in *'serious injury'*.

As with the likelihood tables, the different definitions of consequence can lead to misinterpretation, mistakes and in extreme cases manipulation of the process to meet a desired outcome.

To reduce the opportunity of misinterpreting or misusing these tables, a standard set of definitions for both likelihood and consequence should be developed and rolled out nationally. Alternatively one of the existing definitions should be adopted as the industry standard.

Risk evaluation

Risk evaluation is the final step of the risk assessment process, and combines the likelihood and consequence of a risk. An evaluation of risks is required in order to prioritise risks, as road authorities are unable to mitigate all potential risks, given a finite level of resources.

Currently, there are a number of different risk rating matrices used to establish the threshold of what constitutes an unacceptable exposure (refer to Table 9 to 12).

Depending on which of these matrices is used, the resulting risk level would be different despite having the same likelihood and consequence.

For example, (with reference to Tables 3 and 7), if as a result of a hazard, a bus has 'negligible' chance to be hit by a train at a level crossing, which would most likely result

Table 1: Likelihood tables (AS/NZS ISO 31000:2009)

Rating		Likelihood of occurrence
Rare	1	The event may occur in exceptional circumstances or as result of a combination of unusual events.
Unlikely	2	The event may occur at some time but not likely to occur in the foreseeable future.
Possible	3	The event may occur within the foreseeable future or medium term.
Likely	4	The event will probably occur in most circumstances at least once.
Almost certain	5	The event will occur in most circumstances.

Table 2: Likelihood matrix (Austroads 2009 Guide to road safety Part 6: Road Safety Audits)

Frequency	Description
Frequent	Once or more per week
Probable	Once or more per year (but less than once a week)
Occasional	Once every five or ten years
Improbable	Less often than once every ten years

Table 3: Likelihood matrix for railway crossing (Roads and Maritime Services (RMS), 2011)

Likelihood rating	Description	Frequency of road users' crashes at, on approach and departure , or during the operation of a railway crossing
Extreme	The event is expected to occur in most instances	One incident occur at least once a month
High	The event will probably occur in most instances	One incident occurs between once a month and once in three months
Medium	The event might occur at some time	One incident occurs between once in four months and once in a year
Low	The event could occur at some time	One incident occur between once a year and once in three years
Negligible	The event may occur in exceptional circumstances	One incident occurs less than once in three years

Table 4: Likelihood table (Australian Risk Services Pty Ltd, 2008)

Rating code	Risk likelihood	Description
A	Almost certain	Common or repeating occurrence
B	Likely	Known to occur or "it has happened"
C	Possible	Could occur or "I've heard it happened"
D	Unlikely	Not likely to occur
E	Rare	Practically impossible

Table 5: Consequence table (AS/NZS ISO 31000:2009)

		Consequence area	
Rating		**Damage**	**Human**
Insignificant	1	Up to $10,000	First aid
Minor	2	Up to $1 million	Medical treatment
Moderate	3	Up to $5 million	Hospital treatment
Major	4	Up to $15 million	Single death
Catastrophic	5	Above $15 million	Multiple deaths

in 'multiple fatalities', the resulting risk is evaluated to be 'Medium' (refer to Table 11). If however AS/NZS ISO 31000:2009 risk rating matrix is used to evaluate the risk level for the same event, the resulting risk level would be "High" (refer to Table 9).

As a result, funding may be provided for remediation measures in the high case but not considered important enough in the medium case.

When undertaking any risk evaluation, it is also important to consider the motivations and expectations of the local community. However it is important not to be overly influenced by public opinion and to remain impartial when undertaking the risk evaluation.

Being influenced by public perception of the risk, means many professionals consider the 'worst case scenario' (as opposed to the most likely scenario) when assessing the consequences, especially if vulnerable road users such as pedestrians and cyclists are to be considered. Such an approach would result in as almost every single vulnerable road user related risk being assessed as 'High', making it very difficult to prioritise the allocation of fund for remedial measures. Alternatively, the magnitude of consequences should consider the 'most likely' outcome. This way, the estimated risk levels are more diverse, thus making it easier

Table 6: Consequence table (Austroads 2009 Guide to road safety Part 6: Road Safety Audits)

Severity	Description	Examples
Catastrophic	Likely multiple deaths	High-speed, multi-vehicle crash on a highway. Car runs into crowed bus stop. Bus and petrol tanker collide. Collapse of a bridge or tunnel.
Serious	Likely death or serious injury	High or medium-speed vehicle/vehicle collide. High or medium-speed collision with a fixed roadside object. Pedestrians or cyclists struck by a car.
Minor	Likely minor injury	Some low-speed vehicle collisions. Cyclist falls from bicycle at low speed. Left-turn rear-end crash in a slip lane.
Limited	Likely trivial injury or property damage only	Some low-speed vehicle collisions. Pedestrian walks into object (no head injury). Car reverses into post.

Table 7: Consequence table for railway crossing (Roads and Maritime Services (RMS), 2011)

Consequence rating	Road Safety
Negligible	No medical treatment required for road users
Low	Medical treatment required for road users
Medium	Serious injury occurs for road users
High	Single fatality occurs for road users
Extreme	Multiple fatalities occur for road users

Table 8: Consequence table (Australian Risk Services Pty Ltd, 2008)

Rating code	Risk likelihood	Description
1	Extreme	Fatality or permanent disability
2	Major	Serious injury or illness
3	Moderate	Moderate injury or illness
4	Minor	Minor injury or illness
5	Insignificant	No loss time injury

Table 9: Risk rating matrix (AS/NZS ISO 31000:2009)

Likelihood \ Consequence	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	High	High	Extreme	Extreme	Extreme
Likely	Moderate	High	High	Extreme	Extreme
Possible	Low	Moderate	High	Extreme	Extreme
Unlikely	Low	Low	Moderate	High	Extreme
Rare	Low	Low	Moderate	High	High

Table 10: Risk rating matrix (Austroads 2009 Guide to road safety Part 6: Road Safety Audits)

	Frequent	Possible	Occasional	Improbable
Catastrophic	Intolerable	Intolerable	Intolerable	High
Serious	Intolerable	Intolerable	High	Medium
Minor	Intolerable	High	Medium	Low
Limited	High	Medium	Low	Low

Table 11: Risk rating matrix for railway crossings (Roads and Maritime Services (RMS) 2011)

RISK LEVELS	Consequence				
Likelihood \	Negligible	Low	Medium	High	Extreme
Extreme	M	H	E	E	E
High	L	M	H	E	E
Medium	N	L	M	H	E
Low	N	N	L	M	H
Negligible	N	N	N	L	M

Table 12: Risk rating matrix (Australian Risk Services Pty Ltd, 2008)

Likelihood \ Consequences	Insignificant	Minor	Moderate	Major	Extreme
Almost certain	Significant	Significant	High	High	High
Likely	Medium	Significant	Significant	High	High
Possible	Low	Medium	Significant	High	High
Unlikely	Low	Low	Medium	Significant	High
Rare	Low	Low	Medium	Significant	Significant

to allocate funding for remedial measures. The following example describes this approach (see Figure 4).

As a result of an identified deficiency (the existing pedestrian crossing sign is too far removed from the pedestrian crossing), pedestrians could be hit by a car travelling at the speed limit of 10 km/h. Under such an unlikely scenario, the 'most likely outcome' would be minor injuries for a pedestrian and overall risk level would be evaluated as "Low". However in a very small number of cases the pedestrians, when hit, may fall awkwardly, hit their head and be killed. While this is the worst case scenario, the risk should still be assessed as "Low" despite the potential of a fatal outcome.

Figure 4: Example from a Road Safety Audit

Risk assessment: more than just compliance with the standards

A robust risk assessment is more than just confirmation that design standards have been met. Individual road elements may be quite safe in isolation but when combined with other standard elements, be unsafe (i.e. lead a significant number of road users to make errors).

The two examples below explain how sometimes compliance or non-compliance with standards can have a counter-intuitive impact on the actual risk.

Example 1: Public concern was raised regarding pedestrian and cyclist safety on the shared path over The Entrance Bridge (refer to Photo 1) due to its close proximity to the vehicular traffic.

The kerbs separating the road from the shared path were found to be substandard as they are not painted in white retro-reflective colour. Such a deficiency would normally be considered as a hazard but in this particular case, this deficiency actually improves the pedestrian and cyclists' safety. The grey coloured kerbing does not provide enough contrast with its background, ultimately resulting in drivers feeling uncomfortable about driving close to the edge of the road with traffic slowing down and keeping their vehicles away from the shared path. In this case, despite the described deficiency, the resulting risk evaluation was "Low".

Example 2: A newly constructed passing lane on the Bruce Highway was provided with new lighting which is fully compliant with design standards. Despite this, the provided road lighting does not extend far enough along the passing lane, resulting in excessive contrast between bright and dark areas (refer to Photos 2 to 4), causing eye strain and temporary blindness when entering the dark zone. This could result in drivers losing control, leading to a serious accident.

In this case, despite being designed and installed to the standards, the resulting risk evaluation was "High".

Photo 1: The Entrance Bridge

Conclusions

The paper provides the following conclusion in relation to the existing road related risk assessment process:

- when undertaking a road related risk assessment, the risk identification process should be replaced with two distinct steps - deficiency identification and hazard identification. Not only do these steps help to better define the risks, the hazard identification stage also acts as a filter, meaning that not all deficiencies have to progress to the risk analysis stage.
- the risk analysis process analyses the risk related to each hazard by combining estimates of likelihood and consequences. Currently there is no uniform approach when it comes to determining likelihood and consequence. Instead, several organisations around Australia have developed their own criteria, resulting in a number of different likelihood and consequence tables. These different definitions can lead to misinterpretation, mistakes and in extreme

Photos 2 and 3: Bruce Highway

Photo 4: Bruce Highway

cases manipulation of the process to meet a desired outcome. To reduce the opportunity of misinterpreting or misusing these tables, a standard set of definitions for both likelihood and consequence should be developed and rolled out nationally. Alternatively one of the existing definitions should be adopted as the industry standard.

- when undertaking any risk evaluation, it is important to consider the motivations and expectations of the local community. However it is important not to be overly influenced by public opinion and to remain impartial when undertaking the risk evaluation. When assessing risk, the most likely scenario should be considered and not the worse case scenario.
- a robust risk assessment is more than just confirming that design standards have been met, but that sometimes compliance or non-compliance with standards can have a counter-intuitive impact on the actual risk.

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