Submission

No 16

INQUIRY INTO SCHOOL ZONE SAFETY

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In reply please quote :

Your Reference :

30 September 2011

Staysafe (Joint Standing Committee on Road Safety)
Parliament House
Macquarie Street
Sydney NSW 2000

Dear Sir/Madam,

School Zone Safety (Inquiry)

The Australian Road Research Board (ARRB) is pleased to make this submission to assist the inquiry into school zone safety.

ARRB is the premier national road transport safety research agency in Australia and New Zealand that has, for over 50 years, provided state and national road authorities with practical applied research and advice across the full range of services associated with managing public road networks.

ARRB develops, and is involved in the development of, the Austroads practitioner guides that are used by road agencies, consultants and developers for road design and management. ARRB also delivers knowledge transfer workshops to road practitioners on the Austroads guides and Australian best practice road management.

With offices in Queensland, Victoria, Western Australia and New South Wales, ARRB is regularly engaged by each of Australia's state road authorities to undertake research into state road safety issues and priorities.

In NSW this has included research and investigation into school zone road safety for the Roads and Traffic Authority (RTA) that is of direct relevance to parts a, b and c of the Committee's terms of reference for this inquiry. Two projects that ARRB has completed for the RTA that are directly relevant to the inquiry are:

- School Zone Alert System Evaluation, November 2007
- School Risk Prediction Model (SchoolRisk), October 2008 – April 2009

The school zone alert system project involved the analysis of traffic speed volume data collected during the trial of several technology and design alternatives for flashing light signing associated with school zone operations. The findings of this project informed the RTA about the effectiveness of the technology to reduce vehicle speeds through schools zones during school zone operating times.

The school risk prediction model project involved the development of a risk based model to assist the RTA to evaluate and prioritise school zones as a part of the rollout of the school zone alert system (i.e. flashing lights) across NSW.

The risk based evaluation tool, called SchoolRisk, considers a range of road environment and road user parameters as inputs and determines a relative risk score that can be used to rank school zone locations against one another. This risk ranking permits funding to the objectively allocated to the school zone locations presenting the highest risk to child pedestrians. Although developed for the flashing lights program, the model also identifies road and road user factors that contribute most to the relative risk score and in this way can be used to guide funding allocations for other treatment programs, such as traffic calming, pedestrian treatments etc.

The SchoolRisk project was comprised of the following areas to inform the model development:

- A review of national and international literature to assist identifying factors that are considered to contribute to the risk of a child pedestrian in school zones being involved in a vehicle-pedestrian collision.
- A review of RTA crash data for child pedestrian incidents, initially focussing on school zones, but also considering other locations to identify the most common and prominent contributing factors to vehicle-pedestrian crashes.
- A review of risk parameters and risk scores in ARRB's NetRisk model and from Austroads research to identify road and pedestrian factors already used in road safety risk assessments.
- Testing the SchoolRisk Model with real world school zones across NSW to determine the practicality and reliability of risk scoring against practitioner evaluations.

The findings of the literature review and analysis of pedestrian crash data was reported in a paper published in the proceedings for the Australasian Road Safety Research, Education and Policing Conference, held in Canberra in 2010. A copy of this research paper is included with this submission as Attachment 1.

Other detailed reports for the research and development of the SchoolRisk Model were prepared during the SchoolRisk Model project for the NSW RTA. Copies of these reports and background information about the model are available from the RTA.

Any risk-based approach requires an assessment of the following parameters:

- Likelihood of an event (crash) occurring
- Exposure to the hazard
- Severity of the outcome of an event (crash) occurring

In accordance with national and international risk management practice, the SchoolRisk Model considers these parameters in the context of a school zone road environment and a vehicle-child pedestrian collision. The model considers the inputs for each and calculates an overall relative risk score for each evaluated school zone.

Based on the literature review, analysis of the RTA crash data and ARRB's experience developing risk based models for other road safety evaluations, a range of risk factors contributing to child pedestrian crashes in school zones were identified for inclusion in the SchoolRisk Model. These risk parameters are summarised in Table 1:

Table 1: SchoolRisk Model – Risk Factors

Severity	Exposure	Likelihood
Approach speed limit	Peak hour pedestrian crossing volume	Number of traffic lanes to cross
	Average annual daily traffic volume	On-street parking configuration
		Existing sight distance available
		Number of conflicting traffic directions (for a pedestrian to cross)
		Existing speed management scheme (i.e. LATM)
		Existing pedestrian management scheme (i.e. No crossing, Childrens crossing, Supervisor, signals etc.)

Further detailed discussion about the basis for adopting the factors in the above table is outlined in the research paper in Attachment 1. This paper discusses other contributing risk factors such as age, soci-economic factors etc. in the context of child pedestrian crashes and would be of value to the inquiry by providing background data.

ARRB welcomes the opportunity to discuss further with the Committee the issue of safety at school zones. Please do not hesitate to contact either myself or Mr Arjan Rensen, Regional Manager, at the ARRB NSW/ACT office in Ultimo, Sydney for further information or input to this important inquiry matter.

Yours sincerely

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Development of a model for improving safety in school zones

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Abstract

Child pedestrians are some of our most vulnerable road users and Governments spend large amounts of money providing safe infrastructure to protect them. The NSW Roads and Traffic Authority's Centre for Road Safety (CRS) recognised that a systematic needs-based allocation system for infrastructure funding could assist the prioritising and selection process for school zone safety remedial measures, and engaged ARRB to assist in the development of a research model to support this approach.

Literature on child-related and school zone factors contributing to crashes including child pedestrian casualty crash data in NSW was reviewed. Crash data from the NSW Crashlink database and the Safety Around Schools database was analysed. In consultation with the CRS, ARRB then developed a risk model to objectively prioritise school zone road environments in terms of risk to young pedestrians. The model factors were: approach speed limit, peak hour pedestrian crossing volume and AADT, number of traffic lanes, on-street parking configuration, sight distance, the number of conflicting directions of traffic, speed management and pedestrian management schemes. The CRS used the SchoolRisk model to firstly identify and then prioritise school zones to assist their decision making for the allocation of funding for flashing lights on school speed limit signs.

Introduction

The application of a pro-active risk based approach to road safety is not a new concept. However, the reactive, crash history based response to ranking work programs remains the dominant method for road agencies for determining fund allocations. This is due, in part, to the ability to generate cost benefit analyses to support and justify the funding of projects and programs. At a community and political level, addressing known existing problems makes clearer sense when determining how to spend limited funds.

This approach is not as readily applied to road safety issues where there is a limited recorded crash history, but where, nonetheless, there is strong public and political support to implement improvements. Child pedestrian collisions in school zones are one such road safety problem. One of the most effective ways of protecting pedestrians from serious injury on the road is to reduce the travelling speed of motorised vehicles [4]. In 2009, the NSW Government sought to improve the safety of 40 km/h school zones across the state using flashing light technology to highlight the lower speed limit at school zone times of operation.

The NSW Centre for Road Safety (CRS) concluded that ranking sites against each other in an objective, measurable manner would assist the development of targeted treatments and allocation of funds. A risk based assessment approach is an accepted practice for assessing and managing potential safety issues. The process of risk assessment is described in considerable detail in *AS/NZS4360:2004 Risk Assessment* [40]. AS/NZS4360 defines risk assessment as 'the overall process of risk identification, risk analysis and risk evaluation'.

At the time there was no consistent tool available that would enable school zone sites to be assessed and ranked on the basis of need and predicted benefit. The aim of the project was to develop a *SchoolRisk* tool that would allow the NSW Roads and Traffic Authority to objectively assess risk to child pedestrians and thereby prioritise school zones that are in greatest need.

Project overview

The first step in the project was a literature review. The aim was to identify and quantify measurable demographic and environmental risk factors for child pedestrians and the relative effectiveness of devices which are used to mitigate environmental risks. The second step was analysis of crash data from the NSW Crashlink database, and the NSW Safety Around Schools database. The third step was the development of a risk assessment tool which assisted the NSW Roads and Traffic Authority to rank school sites in terms of need and predicted benefit from the installation of flashing light technology to highlight school speed limits. The findings from both the literature review and crash data analysis informed the final model.

Previous research

Measurable environmental and demographic factors were identified in the literature review for further investigation in the data analysis for their ability to rank school zones on their level of risk.

Traffic speed

At higher speeds vehicles cover more distance in equivalent reaction times; braking distance is increased; the vehicle is more difficult to control; and the force of any impact is increased. The relationship between impact speed and pedestrian fatality risk (given that a collision has occurred) is well-established [e.g. 4, 5, 25]. However, to calculate the risk of a pedestrian fatality it is first necessary to calculate the likelihood of a collision [e.g. 12]. It may be necessary to make additional allowance for the poorer speed judgement that children have compared with adults [39, 11].

In Australia and New Zealand, most child pedestrian casualties occur on residential streets [5, 42]. Evaluations of reductions in speed limits from 60 to 50 km/h in built-up areas have found pedestrian casualty crash reductions of between 20% and 50% [21, 23, 24, 28, 33]. Greater crash reductions have been achieved in urban locations [e.g. 21, 33]. By self-report, most drivers support school zone speed limits and comply with speed limits [14]. Actual compliance, however, is low. An early trial found 40 and 60 km/h school zones in Victoria to be effective in reducing mean speeds at school crossings within school zones, but approximately half the vehicles still exceeded the speed limit [46].

Both individual traffic calming devices and LATM (Local Area Traffic Management) schemes are effective in reducing speed and crashes (when designed and constructed correctly) [17, 28, 32]. Previous literature reviews have found no estimates of the effect of LATM schemes and individual traffic calming devices for pedestrian crashes [8, 21], but speed humps, platforms, islands, chicanes and mini-roundabouts have all been found to be associated with reductions in mean and 85th percentile speeds [28].

Traffic and pedestrian volumes

Vehicular traffic volume has a significant positive relationship with pedestrian-vehicle collisions [21, 38]. Traffic calming measures can reduce traffic volumes, but they also have negative impacts on emergency service vehicles and public buses [48].

US and European research has shown a significant positive relationship between pedestrian traffic volumes and pedestrian-vehicle collisions at intersections and at marked and unmarked 'crosswalks' [21]. There is debate about the relationship between pedestrian volumes and collisions with motor vehicles, with some predicting decreasing crash rates per pedestrian and/or cyclist as their volumes increase [e.g. 44]. However, this should not be misinterpreted to mean that absolute numbers are expected to decrease.

Complexity of crossings, including road width and number of conflicting directions of traffic

To cross a road safely, the pedestrian must first choose a place to cross, make a gap selection, and then traverse the road. Child pedestrians are considered particularly vulnerable because they are still acquiring the cognitive abilities necessary to make safe gap judgements and they are still gaining the experience necessary to identify dangers in the road environment.

Choosing where to cross: Young children have not yet developed an understanding of why it is unsafe to cross the road from between parked cars or on a blind curve [39]. Smaller physical stature makes children harder to see, making visibility of the footpath very important [12].

Gap selection: Primary school age children are still developing the cognitive abilities to consistently make safe crossing decisions [11, 27]. These skills include judging direction of a sound, distance, movement and speed. Young primary school age children do not have the ability to concentrate on more than one piece of information at a time and they may concentrate on irrelevant details [7, 39]. Young primary school children do not have a fully developed visual search strategy, and their peripheral vision information processing and visual acuity are still developing [39].

Crossing safely: Young children are still learning the correct use of crossings [30] and they understand things very literally. Therefore, if a young child is told a school crossing is a 'safe place' to cross, the child may believe it is always a safe place to cross with or without the supervisor and without regard for traffic [9]. Young school children are easily distracted and have the capacity to genuinely believe illogical things (for instance, 'all adults are nice people who will stop if they see me on the road' [39]). Older school children are more influenced by peer pressure and can be over-confident in their developing (but not perfect) abilities, leading them to take risks without necessarily believing that they are engaging in risky behaviour [41]. It also takes smaller children longer to cross the road, increasing their exposure [12].

Impact of crossing type on the complexity of the task

The width of the road influences the time that the pedestrian spends exposed on the roadway and the variance in lateral positioning that a vehicle can take at the crossing point [13]. Complex crossings with more lanes and/or more directions from which traffic can approach are more difficult for pedestrians to navigate safely [13]. However, midblock crossings are associated with higher levels of motorist and pedestrian misuse, as well as a tendency toward higher speed and (therefore) higher severity crashes [8].

Presence and effectiveness of protective engineering devices at crossings and along routes to the school

The majority of child pedestrian crashes in Australia and New Zealand occur at midblock locations, many of these occur around midblock crossing locations [8, 45]. Engineering methods of reducing risk include:

- separating pedestrians from moving traffic (e.g. footpaths, guardrails and/or grade separation[1]).
- reducing the width of the road to be crossed (e.g. kerb extension and wider footpaths)
- improving the visibility of approaching traffic to pedestrians and vice versa (e.g. kerb extensions, wider footpaths, prohibition of parking around crossings and intersections)
- reducing the number of directions that traffic can approach from at each crossing manoeuvre (e.g. pedestrian refuges and built medians)
- eliminating reliance on good gap selection by requiring traffic to stop so that pedestrians can cross (e.g. signalised, supervised and zebra crossings).

Amount of on-street parking and visibility of pedestrians to approaching traffic and vice versa

Kerbside parking around schools is associated with higher risk of child pedestrian injuries [38]. Parked vehicles block the driver's view of the footpath, and the pedestrian's view of moving vehicles. In 22% of fatal collisions involving children aged 5 to 12 in Australia between 1989 and 1994, the child had emerged from in front of a parked vehicle [18]. Banning on-street parking has been associated with a 30% reduction in casualty crashes involving pedestrians [6, 19].

Although there was no literature found that relates specifically to pedestrians, research shows an increase in risk to all road users when horizontal alignment is poor and sight distance is reduced [43].

Other factors

In Australia, children at the age when they typically start primary school (age 5 to 7) and start secondary school (age 12 to 13) have been the age groups most frequently involved in casualty crashes at times of day when they would typically be travelling to or from school [18]. Secondary school children travel further independently and therefore have a greater exposure to risks that they may not be fully equipped to deal with in their first few years of secondary school. However, because the journey to school is shorter for primary school children, they spend a greater proportion of their journey within the confines of the school zone [41]. Boys are more frequently pedestrian casualties than girls [18]. Children from low socio-economic groups are often more exposed to traffic (unaccompanied), more exposed to traffic environments which are less safe, and can be less informed about the risks of traffic. They have a higher risk of being a pedestrian casualty [10, 16, 20, 31, 38, 47].

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[1] Inexpertly designed guardrails can introduce sight-distance and visibility issues. Theoretically, grade separated facilities should eliminate casualties, but under- and over-passes are often unattractive to pedestrians who may find the grade too steep, feel their personal safety is compromised or feel like it is an unnecessary deviation.

Other pedestrian risk and safety models

The literature review identified a number of models for predicting pedestrian crashes in a US literature review [21]. Most were negative binomial regression models that predicted pedestrian crashes based on annual average daily traffic, annual average daily pedestrian traffic, and other site characteristics such as proportion of right-turn volume, number of lanes.

In Australia, a 'Star rating system' was developed to rate the safety of road crossings along school routes [13]. The model is based on five factors that influence the risk of crash and injury to a child pedestrian: (1) Speed limit; (2) Traffic volumes; (3) Road width; (4) Number of conflicting directions of traffic; and (5) Formal crossing facility. The concept for this model was to provide practitioners with an easy-to-use tool to assist in designing safe routes to school. Data on these factors are easy to collect through site visits and in some cases, local authorities will already have a record of all or some of the information.

The SafeST (Safe School Travel) package was introduced in Queensland in 1996. The SafeST package is multi-disciplinary and aims for a whole-of-community ownership of road safety for children. A component of the package is a plain language 'Checklist' that helps to identify school travel safety issues and guides the user to discuss solutions with their Queensland Transport Road Safety Consultant. A complementary resource, the *School Environment Safety Guidelines,* provides evidence-based recommendations and implementation instructions for improvements to the road environment [37].

Gaps in knowledge and limitations of previous research

In existing summaries of child pedestrian casualty rates, exposure is frequently neglected and much of the Australian literature is quite old. It is likely that both exposure and child pedestrian casualties have reduced in Australia over the last ten years, but it is difficult to find published statistics on this.

There is an established relationship between impact speed and risk of death to a pedestrian (e.g.[4]) and estimates of pedestrian fatal crash risk for a given travelling speed can be calculated by combining this with stopping distances at different travel speeds [12]. However:

- The relationship between impact speed and risk of death or serious injury to a child pedestrian may not be the same as for an adult pedestrian.
- Due to the difference in child pedestrian skills and behaviours, it is likely that the risk of a crash occurring is not the same for a child pedestrian as an adult pedestrian.

In assessing the effectiveness of engineering devices in terms of crash reductions for pedestrians:

- Crash reductions are often not given for child pedestrians and adult pedestrians separately. Crashes involving pedestrians are statistically rare events and it is therefore difficult to report meaningfully on crash reductions for pedestrians and even more so for different categories of pedestrians.
- Exposure is frequently neglected for treatments that are likely to attract and concentrate pedestrian activity around the treatments (i.e. designated pedestrian crossings). So, crashes at new pedestrian facilities may be seen to increase in relation to control sites but there is no way of knowing whether crashes are higher or lower per crossing or pedestrian trip.
- The problem of regression toward the mean is frequently not taken into account in studies where the treatment has been instigated in response to a crash problem.

Although it was not possible to address all of the issues listed above, the data analysis of the current project aimed to provide updated child pedestrian casualty statistics for NSW, and a depiction of the relationship between the road environment and child pedestrian crashes during school travel times. Attempts were made to include exposure, but unfortunately the provision of volume data in the school crash database was variable and biased towards schools where crashes had occurred.

Method

Data on all child pedestrian casualties in NSW during school travel times was obtained from the NSW Crashlink database. The NSW Roads and Traffic Authority provided ARRB with data on all crashes involving a child pedestrian between 2003 and 2007. Analyses were restricted to those crashes resulting in child pedestrian casualties in NSW between Monday and Friday during a school term between the hours of 7:30–9:30 am and 2:30–5:00 pm where the child was aged 5 to 18 years. In the context of this paper, 'casualties' refers to all injury severities and fatalities.

In addition, some of the analysis was restricted to those crashes occurring in school zones. Data on child pedestrian casualties in NSW school zones was extracted from the Safety Around Schools database maintained by the NSW Roads and Traffic Authority. Data from this source was matched with data from the Crashlink database to provide additional information regarding the incidents resulting in the casualties. Some additional population data was sourced from the ABS (Australian Bureau of Statistics) website [1].

Results

Characteristics of child pedestrian casualties during school travel times (NSW, 2003–2007)[2]

A total of 983 child pedestrian casualties occurred during school travel times in NSW between 2003 and 2007. They decreased from 220 for the year 2003 to 185 for the year 2007. Of those 983 child pedestrian casualties, 96 were identified as occurring in school zones.

The incidence of child pedestrian casualties during school travel times increased from age 5–12 years then dropped steadily (Figure 1).

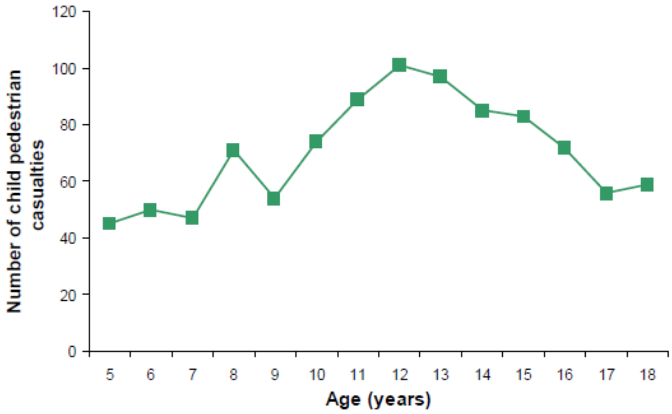

Figure 1: Age distribution of child pedestrian casualties during school travel times (NSW, 2003–2007)

The data analysis identified that males were generally more likely to be a pedestrian casualty during school journey times than females (Table 1). The difference was most pronounced in the early to middle primary school years (ages 5 to 8 years) and the difference generally decreased with age.

Table 1: Ratio of male and female child pedestrian casualties

Age group	*Female*	*Male*	*Ratio males to females*
5 to 7 years	48	94	2.0 : 1
8 to 10 years	78	121	1.6 : 1
11 to 13 years	125	162	1.3 : 1
14 to 16 years	113	127	1.1 : 1
17 to 18 years	58	57	1.0 : 1
Total	**422**	**561**	**1.3 : 1**

[2] All results in this section are based on analysis of data from the Crashlink database [34].

The majority of crashes occurred at journey home times, particularly between 3 and 4 pm. Both sexes were almost equally likely to be casualties at peak arrival and leaving times (8:30 am and 3:30 pm) but males were noticeably more likely than females to be casualties earlier in the morning, just before 3:30 pm and later in the afternoon (Figure 2).

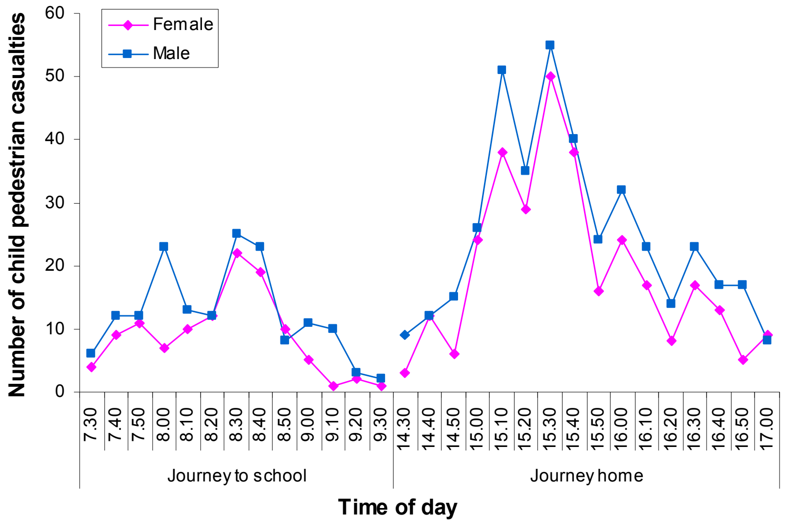

Figure 2: Child pedestrian casualties during school travel times by time of day and gender

Time of day when the casualty occurred was clustered around school arrival and leaving times for younger children (aged 5 to 10 years) and was more dispersed for older children (Figure 3).

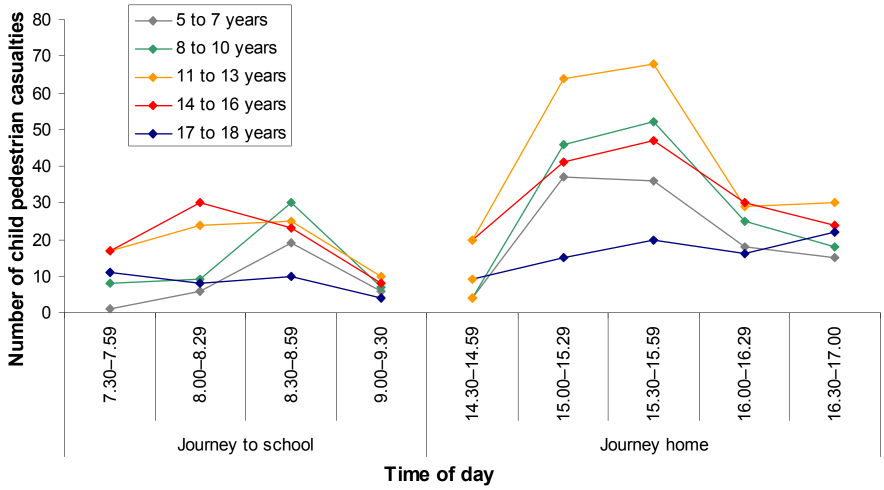

Figure 3: Child pedestrian casualties during school travel times by time of day and age group

The most common locations of casualties were two-way undivided roads (not shown) and younger children were more likely to be injured at midblock locations than older children (Table 2).

Table 2: Percentage of child pedestrian casualties occurring at midblock versus intersection locations during school travel times

	Age group (years)				
Type of location	**5–7**	**8–10**	**11–13**	**14–16**	**17–18**
Midblock	53.5	52.3	51.6	46.7	42.6
Intersection	45.8	47.7	47.7	53.3	56.5
Unknown	0.7	0.0	0.7	0.0	0.9
Total	**100.0**	**100.0**	**99.3**	**100.0**	**100.0**

The greatest proportion of casualties occurred on roads with a posted speed limit of 50 km/h, followed by 60 km/h and then 40 km/h. Older children were more likely to have incidents on roads with higher posted speed limits than younger children (Figure 4).

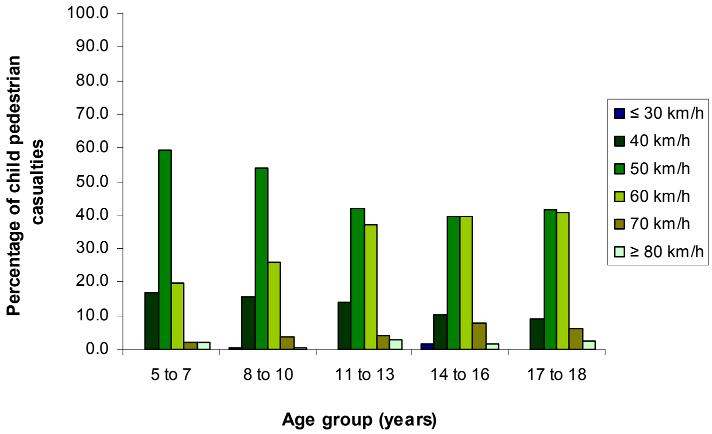

Figure 4: Proportion of child pedestrian casualties during school travel times occurring in different speed limit zones

In the majority of child pedestrian crashes during school travel times, the key vehicle in the pedestrian casualty was a car (or car derivative; 77% of vehicles) that was proceeding in their lane (88% of all vehicles). In a small number of cases the vehicle was turning right or left from their own lane (8% of vehicles). In nearly all cases, the vehicle was believed to have been travelling at a speed below the applicable speed limit

Child pedestrian casualties during school travel times were more likely to involve a child attempting to cross the road than performing any other manoeuvre (Figure 5). Younger children were more likely than older children, and males were more likely than females, to have been running across the road (genders not shown in graph).

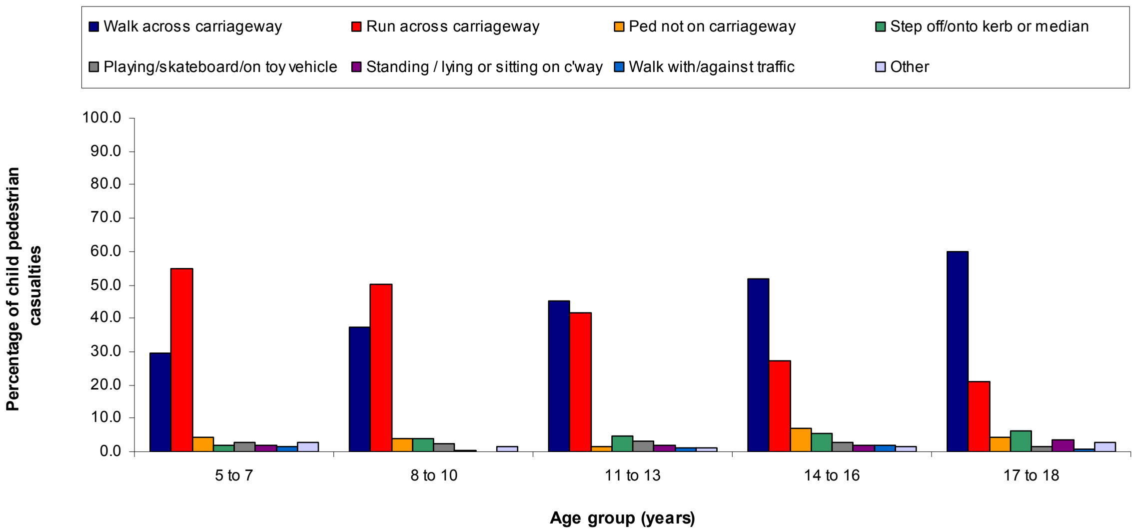

Figure 5: Percentage of child pedestrian casualties by age and pedestrian movement prior to incident

Crashes in school zones[3]

Of those casualties that occurred within 40 km/h school zones, the approach speed to the school zone had a positive relationship with casualty risk. Specifically, the relative risk of a child pedestrian casualty in a school zone with a 60 km/h approach speed limit was 1.6 compared with school zones with a 50 km/h approach speed limit.

The relative risk of a pedestrian casualty based on number of school zones with 2, 4 and 6 lanes of traffic was highest for school zones with four lanes of traffic and lowest for two lanes. When approach speed limit was also included in the calculation of relative risk, risk increased exponentially with increases in speed limit and increases in number of traffic lanes (Figure 6).

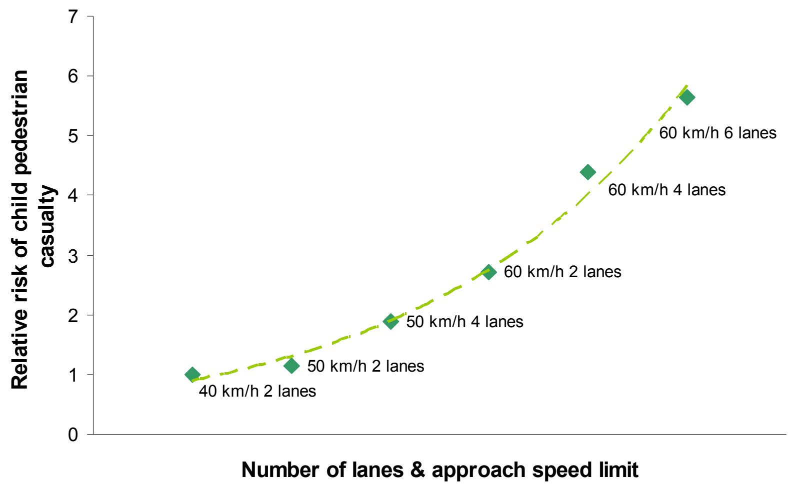

Figure 6: Relative risk of child pedestrian casualty by 2, 4 or 6 lane school zone

In at least one quarter of casualties that occurred when a pedestrian attempted to cross the road, they had emerged from behind a parked or stationary vehicle. The crash reports indicated that younger children were more likely to have emerged from behind a parked or stationary vehicle. Emerging from behind a parked or stationary vehicle was noted as the primary error factor 47% of the time when parking facilities were present compared with 23% of the time when parking facilities were not present[4]. Most casualties occurred on straight roads, but there were small variations in the percentages of different age groups who were casualties on curved roads. Crossing facilities were present at more than two-thirds of school zones where casualties occurred. Half of these were 'marked foot crossings' and a small proportion of the zones where a casualty had occurred also had school crossing supervisors.

Urbanisation, socio-economic status and child population[5]

Sydney, Wollongong and Newcastle LGAs had more child pedestrian casualties during school travel times per child population than rural NSW LGAs. Among Sydney LGAs, there were generally fewer children per high socio-economic status LGA and more children per low socio-economic status LGA. Socio-economic status was measured from the socio-economic index for areas (SEIFA) [1]. Higher scores on the SEIFA indicate higher social and economic wellbeing. There was a negative relationship between socio-economic status and pedestrian casualties per child population during school travel times in Sydney LGAs (but only for 5 to 9 year olds). For rural NSW (not including Wollongong and Newcastle) there were generally more children per high socio-economic status LGA and fewer children per low socio-economic status LGA. There was also a weak positive relationship between socio-economic status and pedestrian casualties per child population during school travel times in rural NSW LGAs (but only for 10 to 14 year olds).

[3] All results in this section are based on analysis of data from the Safety Around Schools database [34]

[4] Primary error factor was missing 50% of the time when parking facilities were present and 72% of the time when parking facilities were not present.

[5] Results in this section are based on analysis of data from the Crashlink database [34], supplemented with data from the ABS [1].

Table 3: Spearman correlation between LGA SEIFA score, child population and pedestrian casualties

Spearman correlation between SEIFA and …	*Sydney*	*Rural NSW*
Child population (5–19 yrs)	Rho[6] = - .546 ***	Rho = .435 ***
Pedestrian casualties / child population (5–9 yrs)	Rho = -.532 **	Rho = .135 (n.s.)
Pedestrian casualties / child population (10–14 yrs)	Rho = .105 (n.s.)	Rho = .248 **

*** p < .001, ** p < .01, n.s. = not statistically significant

Risk Modelling

Using the information from the literature review and data analysis, a series of contingency tables were produced, which allowed the computation of a 'relative risk index' for any particular site based on the characteristics of that site. The literature review and data analysis influenced what site characteristics were included in the final risk model, an overview of which can be seen in Table 4.

Table 4: Overview of factors included in the risk model

Severity	*Exposure*	*Likelihood*
Approach speed limit	Peak hour pedestrian crossing volume	No. of traffic lanes to cross
	Average annual daily traffic volume	On-street parking configuration
		Existing sight distance available
		No. of conflicting traffic directions
		Existing speed management scheme
		Existing pedestrian management scheme

Each cell in the contingency table contains a risk calculation based on the number of school sites with child pedestrian crashes divided by the total number of sites which share the characteristics of the row and column risk factors. Relative risks can then be calculated from these raw risk scores. The row risk factor in every table is approach speed limit as this is the most important factor for which the most complete data is available. Appendix A shows the input screen.

Discussion

The development of a road safety risk model is not without precedent. Other risk models have been developed using crash data to establish relative risk scores for specific parameters. Several studies were identified in the literature review that sought to examine pedestrian safety, particularly factors relating to childhood development, as a basis for understanding and improving safety in the road environment. One instance was found where an assessment process gives a 'star rating' to crossings on routes used by school children to and from school [13]. This model was not restricted to school zones and did not cover all the factors discussed in this project. No risk based assessment model was found that permitted a ready and reliable ranking of the specific road environments that are present at marked school zones.

A benefit of the *SchoolRisk* model is that it is relatively easy to add extra information about crashes and risk factors into the database and recalculate risk scores as the information becomes available. This

[6] Spearman's Rho was used in preference to Pearson's *r* because the SEIFA scale is an ordinal measurement and both the population per LGA and the crash data were positively skewed.

flexibility was a part of the design to ensure the approach maintained relevance and functionality to the NSW Roads and Traffic Authority over time.

Key Findings from the Crash Data Analysis

- 983 child pedestrian casualties occurred during school travel times in NSW between 2003 and 2007 – 96 (less than 10%) of these occurred in school zones.
- The likelihood of child pedestrian casualties during school travel times increases from ages 5 to 12 years then drops fairly steadily.
- More casualties occur at journey home than journey to school times.
- Males are more likely than females to be a pedestrian casualty during journey to and from school times, particularly in the early to middle primary school years and at more disperse times of day than the peak school start and finish times.
- Most child pedestrian casualties occur on 50 km/h two lane undivided roads.
- Most 40 km/h school zones in which child pedestrian casualties occurred had a 50 km/h approach, but relative risk was higher for zones with a 60 km/h approach, particularly if the zone had four or more lanes.
- Children were most likely to have been attempting to cross the road when they were struck – younger children were more likely to have been running than older children.
- Younger children were more likely than older children to have emerged from behind a parked or stationary vehicle. When parking was available, the primary error was twice as likely to be that the child emerged from between parked vehicles.
- Children in rural NSW were less likely to be pedestrian casualties during school travel times (per 10,000 children) than children in the Sydney, Wollongong and Newcastle metro LGAs.

Many of the age and gender differences are likely to reflect differences in levels of independent travel, trip length and destination, changes in travelling times and gradual improvement in pedestrian skills and impulse control (as discussed earlier in this paper). The most important environmental factors were speed limit, number of traffic lanes and parking. This is validated by previous research and these factors are reasonably intuitive. The positive relationship between speed limit and crash risk is well-established.

Number of lanes and speed limit can be considered a proxy measure for the type of road, traffic mix and traffic volume that the road carries. For instance, 60 km/h roads are typically two or four lane undivided roads. They are often minor arterials or collectors and potentially contain shopping strips. They are therefore more likely to carry higher volumes of traffic than 50 km/h local streets and to have more lanes of traffic for pedestrians to negotiate.

Parking can obscure pedestrians from vehicles and vice versa. Where parking facilities were present, the primary error factor was twice as likely to be that the pedestrian had emerged from behind a parked or stationary vehicle. This finding suggests that parking is an important factor to include in risk models, but without having an estimate of exposure, it is difficult to come up with an accurate risk score. Similarly, other factors that can obscure visibility such as the presence of curves in the road would likely be worthwhile inclusions if their prevalence in the school zone environment was recorded.

Through the exploration of previous research, risk scores were able to be developed for these factors. It is important to recognise that in this instance the values were not derived from local crash data. However, the parameters are seen as important to providing a valid school zone risk score.

Limitations

The success of the risk assessment method depends on the completeness of data for the following factors at all school sites (not just those at which crashes have occurred) in NSW:

- traffic volumes and pedestrian volumes
- speed limit during school travel hours and approach speed limit
- presence and concentration of LATM devices (these will influence vehicle travelling speeds around the school and probably also indicate a pre-instalment problem with excessive speed)

- types of roads surrounding the school, particularly on typical entrance/exit routes (i.e. one-way, two-way, two-lane undivided, divided etc. – relates to complexity of crossing task)
- location and type of crossing facilities (including traffic islands, pedestrian refuges and kerb extensions if possible – relates to complexity of crossing task)
- presence and type of on-street parking around the school (this has implications for pedestrian visibility).

Recommendations were made to NSW Roads and Traffic Authority regarding 'practitioner-friendly' low-cost methods of collecting this data.

Conclusions

The aim of the project was to develop a tool that would allow the NSW Roads and Traffic Authority to objectively rank and thereby prioritise school zones by risk. A tool has been developed that does this, and the feedback from practitioners using the tool has been good.

Although the original development of this risk model was for the prioritisation of flashing lights on school zone signs, the *SchoolRisk* tool has much broader potential application. *SchoolRisk* allows practitioners to objectively assess the level of risk in a school zone before children are injured. Once a practitioner has identified that a school zone has a high risk for child pedestrian casualties, the risk rating from the tool can also help provide justification for appropriate treatments.

Further development of the *SchoolRisk* model could include providing recommendations for treatments to manage risks in the school zone environment. To a certain extent this has been incorporated into the current version of the model by reporting the risk scores for each parameter and having the ability to rank the list of sites by not only the relative risk score but for specific risk factors also. This multiple ranking ability allows highest risk factors to be identified so specific countermeasures can be considered.

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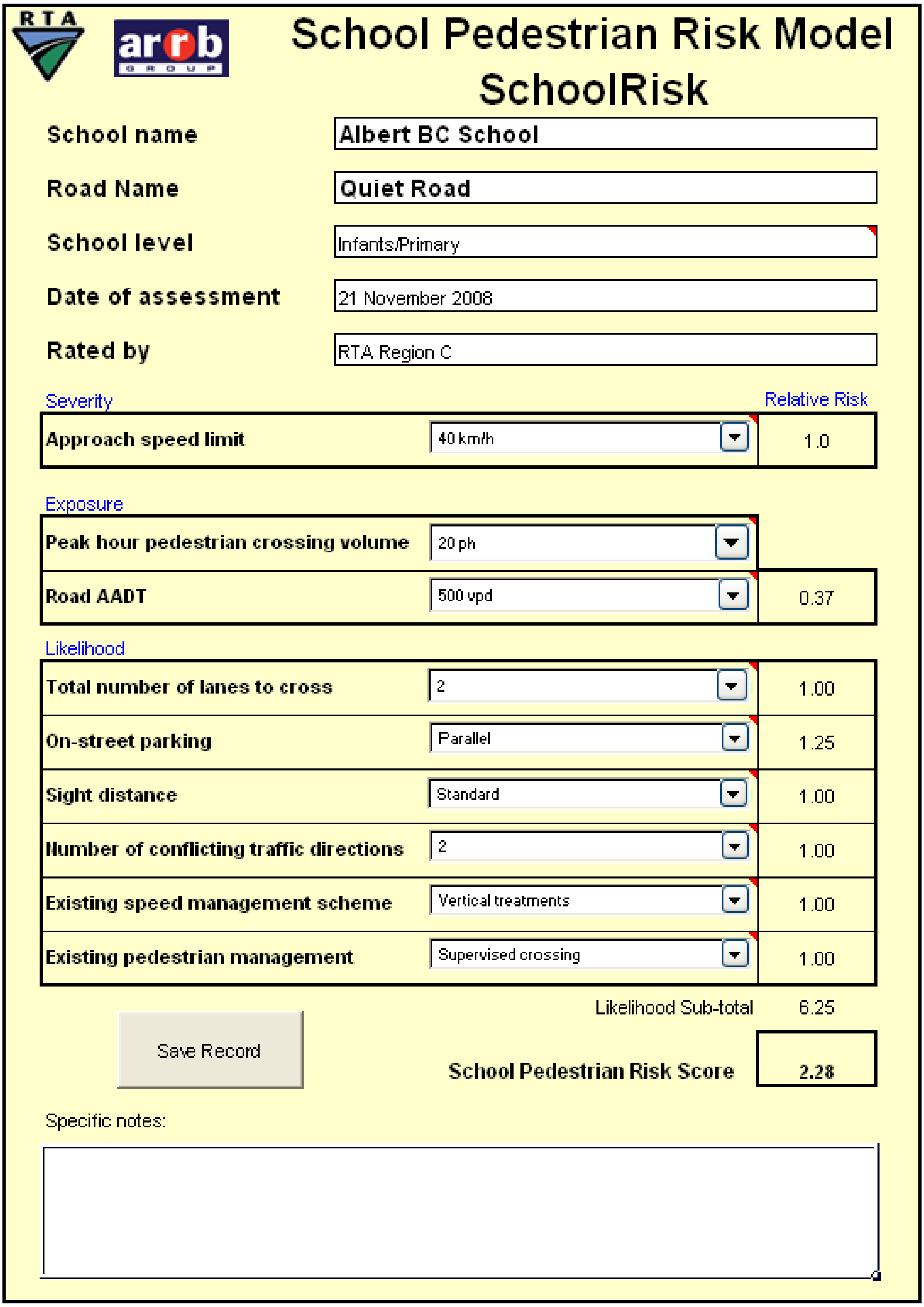
Appendix A – Risk Model input screen



School Pedestrian Risk Model
SchoolRisk

School name	Albert BC School
Road Name	Quiet Road
School level	Infants/Primary
Date of assessment	21 November 2008
Rated by	RTA Region C

Factor	Selection	Relative Risk
Severity		
Approach speed limit	40 km/h	1.0
Exposure		
Peak hour pedestrian crossing volume	20 ph	
Road AADT	500 vpd	0.37
Likelihood		
Total number of lanes to cross	2	1.00
On-street parking	Parallel	1.25
Sight distance	Standard	1.00
Number of conflicting traffic directions	2	1.00
Existing speed management scheme	Vertical treatments	1.00
Existing pedestrian management	Supervised crossing	1.00
	Likelihood Sub-total	6.25
	School Pedestrian Risk Score	2.28

Save Record

Specific notes: