SCHOOL JOURNEY SAFETY - A COMPARATIVE STUDY OF ENGINEERING DEVICES

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This paper describes a Transfund research project undertaken by Transport Engineering Research New Zealand (TERNZ). LTSA crash data indicates that approximately 40% of child pedestrian injuries occur on the home-school journey. Consultant traffic engineers, local authorities, schools, Safekids, LTSA and Transit NZ have all highlighted the on-going traffic safety problems at schools and the "chaos" at the school gate. In order to improve the safety of children when travelling to and from schools, current engineering measures used in NZ and overseas, and their effectiveness have been reviewed and a comprehensive "tool box" of engineering intervention devices has been proposed for use by traffic engineers, local authorities, schools, planners, and other key stakeholders. The review included the use of an extensive questionnaire seeking the opinions of experts on the effectiveness of different treatments.

Introduction

A recent Organisation for Economic Co-operation and Development (OECD) 2004 report showed that New Zealand rated 23rd out of the 25 OECD countries in keeping children safe in traffic. This is reflected in the LTSA crash data which indicates that approximately 40% of child pedestrian injuries occur on the home to school journey.

There has been a dramatic change in the way that students travel to and from school. Increasingly children are reliant upon private motor vehicles, rather than other modes of transport like walking and cycling. This change can be seen in the results of the LTSA 1997/98-travel survey (Land Transport Safety Authority 2000).

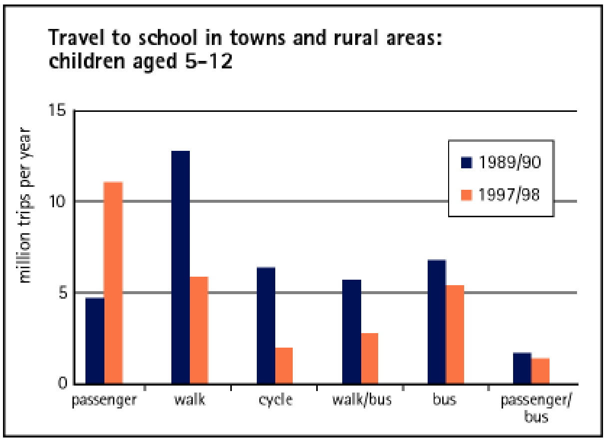

Figure 1. Travel to school in towns and rural areas
(LTSA 1997/98 Travel Survey (2000))

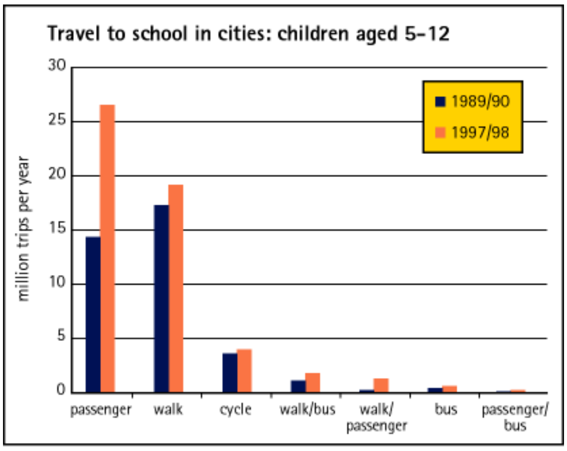

Figure 2. Travel to schools in cities

The increased number of students who travel as passengers in private cars has significantly increased the traffic volume around schools in the critical pre- and post-school periods. Data extrapolated from the travel survey showed that for the 5 – 10 age group, children who walked had the highest injury rate, approximately double the average risk of injury; while the risk of injury for children as passengers in a car or cycling was closer to the average risk rate.

Methodology

A literature review was undertaken focusing primarily on: safe crossing places, traffic calming, footpath/cycle paths, parking, intersections, warning (including variable message signs), bus stops, and security. Other issues relevant to school journey safety reviewed were: the roading environment (traffic speed, traffic volume, road geometry, topography and land use), perceived safety risks, and relevant legislation.

To establish the type of engineering devices currently used, and a measure of their effectiveness for improving safety for children on their home to school journey, two questionnaires were prepared and circulated to practitioners and stakeholders both in New Zealand and overseas. The questionnaires to the road controlling authorities were more extensive, designed to pick up on their experience and their role in implementing any improvements to the road networks. Refer to Appendix A for a list of respondents, and Appendix B for a sample of the questionnaire.

From reviewing the information submitted, a list of the most effective countermeasures could be developed. The questions sought to find a ranking of the effectiveness of the devices along with views of where they were appropriate to be used. The analysis of the New Zealand responses was compared against that of overseas in terms of safety and cost.

The results of the literature review and the survey were used to compare current New Zealand treatments against those used overseas and gaps in knowledge were identified. A framework was then developed for a toolbox for engineering practitioners and community use.

Results

The issues that surround school journeys were found to be very complex and intertwined. The low number of incidents that involve children at specific locations meant that it was very difficult to draw substantive conclusions except where a long term study had been conducted. As a cautionary note, it is important to note that the majority of the literature sourced was of a general nature, and care needs to be taken when interpreting this information or applying it to specific situations. Notwithstanding these comments, it is considered vital that the literature be considered when designing guidelines for best practice.

Much of the literature has focused upon safe places to cross, and showed that there is no one 'magic bullet' that will be the best solution for every crossing situation. The best solution will be found only through understanding the suitability of each kind of device for the prevailing road conditions such as traffic speed and traffic volume. One of the most contentious issues in the literature surrounds the use of signalised mid-block crossings with high rates of non-compliance by both pedestrians and drivers and more severe injuries to the pedestrian.

Cost is an important factor in the choice of an appropriate engineering safety device. The support from road controlling authorities and municipalities is essential along with the political will to improve safety and to ensure adequate funding is dedicated to the task. Of equal importance is the need for road controlling authorities to provide relevant policy documents and guidelines for their officers and the community to refer to.

A key theme that has come from the survey both in New Zealand and overseas is the increased use of visibility enhancing devices such as the traffic cones, fluoro signs at pedestrian crossings, day-glow message signs and bright fluoro jackets. A range of colours are being used and a range of messages displayed, however it would seem to be that conspicuity of the sign is the most significant factor. Other engineering devices currently used that are considered to be effective in improving safety include: school patrols, signalised crossings, speed zones, pedestrian (zebra) crossings, Kea crossings, footpaths, and pedestrian refuge islands. The overseas responses that were obtained indicated that footpaths, speed zones, pedestrian refuge islands, special markings and road narrowings were used to improve the safety of children. These devices were also used to slow vehicle speeds.

Although not technically an engineering safety device, safety programmes were seen as a growing area of safety opportunity with Walking School Buses being increasingly adopted as a safety measure in New Zealand. In New Zealand, LTSA and the RCAs fund Road Safety Officers, who help to implement such programmes. The cost of associated physical works is often shared by local, regional and national providers.

Urban and rural situations drastically affect the appropriateness of devices, and the importance of tailoring a device to suit the surrounding environment and traffic situation. The following table sets out a comparison of the effectiveness of each device.

Table 1. Comparison of engineering safety devices used

Type of device	Survey results	Literature review results
Safe crossing places: Uncontrolled		
• Kerb extensions / road narrowings	Well used in New Zealand, average to moderate rating for safety effectiveness (5-8 out of 10) Cost - $2,000-$12,000 each. Response from Canada: they are used with bollards at major crossing points both at intersections and mid-block	Useful for channelling pedestrians to a crossing point. More effective when combined with parking restrictions (to preserve sight lines between pedestrians and motorists)
• Pedestrian refuge islands	Extensively used in New Zealand moderate to higher rating for effectiveness (5-9 out of 10) Cost - $800-$10,000 each.	Increase driver awareness. Safety gains minor, however where refuge islands are installed without kerb extensions (that is when road width is not narrowed) safety problems may be increased.
• Adult supervision or warden crossings	Adult supervision required at NZ school pedestrian crossings, and warden crossings; however not listed in survey responses. Crossing warden's moderately rated for effectiveness (6 out of 10) Adult Crossing Guards rated high for safety effectiveness from overseas survey responses (9 out of 10). Guards hired by the municipality to assist children and crossing the road at peak times Cost - C $12,000/guard/year	
• Raised platforms	Moderate use in New Zealand and moderate safety rating (7 out of 10). Cost - $6,000 each Response from Canada: also used as part of pedestrian crossings, 2-3 metres width	Restricted mainly to CBD
Safe Crossing Places: Controlled (part time)		
• Kea crossing (School crossing)	Increasing use of Kea crossing. Generally rated as being quite effective (6-10 out of 10) Cost - $3,000-$16,000 each. Local or Collector roads only, not on rural roads or urban arterial (or main) roads	New Zealand has a high non-compliance rate with the installation of these crossings to standards and recommendations. Anecdotally the crossings are effective. There also seems to be anecdotal evidence regarding the non-compliance rates of drivers around these devices
• School patrols	Rated high for safety effectiveness (8-10 out of 10), moderate use in New Zealand Cost - $4,000-$10,000 each	
Safe Crossing Places: Controlled (full-time)		
• Pedestrian crossing (zebra)	Rated moderate to high for safety effectiveness (6-10 out of 10), average 8. Widely used in New Zealand, primarily in urban areas Cost- $800-$20,000 Not over multi-lane roads with two or more lanes in one direction. Not on high speed roads and generally not in rural areas (where speeds are high). Moderate rating for safety effectiveness from overseas survey responses (7 out of 10), used in urban areas only	May be safer for children than crossing elsewhere, however crashes still occur on marked pedestrian (zebra) crossings. New Zealand crossings have a high non-compliance rate with installation of crossings to standards and recommendations. Australia reports no reduction in crash numbers when pedestrian crossings installed. However such installation results in a 30% reduction in total number of accidents in the pedestrian network. Pedestrian crossings marked on raised platforms (wombat crossing) have an 8% reduction in traffic crashes. The respondent from Canada mentions that effectiveness is reduced in winter due to snow cover
• Mid-block signalised	Rated high for safety effectiveness (8-10 out of 10), not a large number of installed in New Zealand Cost - $8,000 to $80,000	Some safety improvements include non-skid surfaces and guard rails at mid-block pedestrian crossings. Signalised midblock crossings have higher crash rate than signalised intersections,

crossings	Higher rating for safety effectiveness and overseas response (8 out of 10). Used in urban area only Cost - C $45,000-$65,000 each Comments from Canada about high standards of signs and markings required.	and pedestrian injuries more serious at midblock crossings compared to those at signalised intersections. Both pedestrian and motorists non-compliance with signals a problem. Adjustments to signal phase times may provide some safety benefits. However midblock signalised crossings are effective on high volume roads. Pelican/toucan/puffin/double puffin
• Signalised intersection		Generally effective, crashes mainly involved turning traffic, injuries less severe (than midblock crashes). Compliance with traffic signals a problem in low traffic volume of situations.
Grade separation	Very effective, relatively small number used in New Zealand and overseas. Appropriate for very high traffic flows and/or very high traffic speed. e.g. motorway or freeway	Most effective, however very expensive. Some problems with personal safety for subways, and lack of used for over bridges
Crossing railway lines		Safety gates, mazes, fences, warning lights at signals recommended for it grade crossings. Grade separation. Specific safety audits needed.
Warning devices for crossing place		
School crossing signs	Moderate rating for safety effectiveness in both urban and rural areas overseas (6 out of 10). Large number used as reported in overseas survey responses Cost - C $65 each Comment from Canada on change from blue and white format to fluorescent yellow-green being effective	
School crossing ahead signs	Moderate rating for safety effectiveness in urban and rural areas (6 out of 10), moderate number reported from overseas survey responses Cost - C $65 each	
Advance flashing lights	Rating varies from low to moderate for safety effectiveness (4-8 out of 10 in urban areas; and 7 out of 10 in rural areas). Relatively small number installed in New Zealand Cost - $1,500-$4,000 each Moderate rating for safety effectiveness by overseas response (7 out of 10), low number used by overseas response. Often used in conjunction with speed restriction sign In Canada typically a flashing amber light is used to enhance school area and speed limit signage.	Effective and slowing vehicle speeds, however speeds of them still above the signed speed limit. Reductions in speeds when lights operating (significant in some cases). Less effective when compared to physical traffic calming measures. Flashing lights may also have a negative impact on secondary speed reductions outside hours of operation. Can be more effective when installed at the crossing site itself and activated by the warden.
Fluoro desks	Moderate to high safety rating (6-8 out of 10), extensively used in New Zealand. Note: these are only applicable to pedestrian crossings and are attached to the black and white poles to enhance visibility. Cost - $60-$100 each. Only used with marked pedestrian (zebra) crossings. Not appropriate elsewhere.	
Belisha beacons	High rating for safety effectiveness (8 out of 10). Very few reported to be used by the survey responses. Cost - variable	
Variable message signs	Rated high for safety effectiveness (10 out of 10 for both urban and rural areas). Very few installed in New Zealand. Cost - $12-$20,000	
Speed sensitive signs		Effective when alignment and appearance of road otherwise encourages high speeds. Effective at specific location. Effectiveness diminishes with time

Flashing lights at signals	Varied rating in urban areas (4-8 out of 10), and moderate rating in rural areas (7 out of 10). Very few installed in New Zealand. Cost - $1,500-$4,000 each	
Flashing LED lights on pedestrian crossing	High rating for safety effectiveness from overseas survey responses (8 out of 10). Flashing LEDs were controlled by only the adult guards. Cost - C $300 each	Installed on a trial basis however no evaluation available.
Special markings		
• Limit lines	Moderate rating for safety effectiveness (6 of 10). Extensively used in New Zealand. Cost - $50 each	
Specials signs		
• School crossing sign	Not listed in survey responses	
• School area signs	Moderate rating for safety effectiveness in both urban and rural areas overseas (6 out of 10), extensively used overseas. Cost - C$65 each	
• Children crossing sign	Moderate rating for safety effectiveness (7 out of 10). Extensively used in New Zealand. Cost - $300 each	
• Foldout Day-glow School signs	Moderate rating for safety effectiveness (6 out of 10). Cost - $100 each	
• Billboards	Moderate rating for safety effectiveness in urban areas and high safety rating in rural areas (7 out of 10 in urban areas, 10 out of 10 in rural areas). Small numbers used according to survey responses. Cost - $200-$600 each	
Traffic cones	Moderate to high rating for safety effectiveness (6-10 out of 10). Moderate use reported. Cost - $50-$100 each	
Slow traffic speeds / reduce traffic volumes		
Traffic calming	Appropriate for local and collector roads. Not appropriate for high volume main roads.	Found to be the most effective way of improving safety close to schools and in residential areas (by slowing vehicle speeds and reducing traffic volumes)
• Speed humps	Moderate to high rating for safety effectiveness (5-8 out of 10). Large number reported to be used in survey responses. Cost - $3,000-$10,000 each	Most effective in slowing vehicle speeds and decreasing traffic volumes (if an alternative route is available). Speed bumps reduced the number of child injuries in residential streets (by reducing speed)
• Chicanes	Low to average rating for safety effectiveness (5 out of 10). Relatively few reported in survey responses. Cost - $10,000 each	
• Raised platforms	Moderate rating for safety effectiveness (7 out of 10), relatively few reported in survey responses. Cost - $6,000 each	
Road narrowings	Average to high rating for safety effectiveness in both urban and rural areas (5-8 out of 10 in urban areas, and 7 out of 10 in rural areas). Moderate number reported in survey responses. Cost - $2,000-$12,000 each	
School zones		Used in many countries, most effective when targeted to school start and finish times (when children are at present) and when combined with warning devices such as an flashing lights or variable message signs. Can be problems with compliance to the reduced speed limit.

		Australia has School Speed Zones, and these vary in terms of speeds and times they occur from State to State
Reduced speed limits	40km/h speed zone rated high for safety effectiveness in rural areas (8 out of 10), very few reported in survey responses. Restricted speed limits in urban areas rated moderate for safety effectiveness (6 out of 10). Cost - $45,000 Comment from Canada: compliance with speed limits is highly dependent on police enforcement	Reported 60% reduction in fatalities if a pedestrian is involved in an accident when average vehicle speeds are reduced from 48 km/h to 40 km/h. That is an accident reduction of 3.85% for every km/h in reduced speed limit.
Safe route to school programs		
Safe route to school programs	Safe route to school program rated moderate for safety effectiveness from overseas survey responses (7 out of 10). Used in urban areas only Walking school buses rated moderate for safety effectiveness from overseas response (7 out of 10). Used in urban areas only	High overlap with local road safety plans, and therefore very valuable to include school route studies in the development of local road safety plans. Traffic calming, low speed roads, speed humps, raised surfaces and signals most effective in improving traffic safety, these measures aim to reduce the speed. Speed reduction and provision of safe crossing places (together with education and enforcement programmes) is common to most safe route to school programs. Important that both perceived problems and crash records examined in these programs.
Footpaths		
Safety audit (from child's perspective)		Pedestrian safety audits made from child's perspective, and the subsequent implementation of the results of that audit is effective.
Maintenance		Clearing vegetation and keeping the footpath cleared of obstructions (such as parked cars, advertising boards, street furniture etc) addresses children's feeling of being unsafe when walking to school.
Widening		Helps to address children's feeling of being unsafe (by providing greater protection from roadside vehicles), and promotes increased pedestrian usage.
Walkway		Continuity of walkway/footpath with appropriate safe crossing places effective
Protection of footpath from roadside vehicles		
Pedestrian barriers / fences	Moderate rating for safety effectiveness (6-7 out of 10), moderate use. Cost - $100 per metre ($500-$1,000) Rated high for safety effectiveness from overseas response (10 out of 10), used to prevent students from crossing midblock. Cost - C $75 per metre	Effective to reroute pedestrians and cyclists away from dangerous crossing areas or places.
Bollards	None reported in survey responses	
Special markings for pedestrians (feet at Road edge)	Effective in channelling pedestrians to crossing places	
Barrier at entrance to on-site School parking areas	Rated high for safety effectiveness (8 out of 10), moderate use reported in survey responses. Cost - $100 each	
Underpass / over bridge	Rated very high for safety effectiveness (10 out of 10), very few reported in survey responses. Cost - $500,000 each	

Road closure	None reported in survey responses	
Conspicuity devices for children		
Safety jackets	High rating for safety effectiveness (8 out of 10), used primarily for adult supervisors at crossing places. Cost - $300 each	
Personal reflective conspicuity aids (dangles, sashes, etc)		Conspicuity of pedestrians, cyclists and motor vehicles remains a major safety issue. Benefits child pedestrians and cyclists. Reflective tangle tags, armbands, strips on school bags etc. is recommended.
Cycle paths		
Cycle lanes on roads	Average to high rating for safety effectiveness in urban areas, high rating and rural areas (5-10 out of 10 in urban areas; 10 out of 10 in rural areas). Small number reported in survey responses Cost - between $150-$2,500 per kilometre to install	
Cycle lanes on footpaths	Moderate rating for safety effectiveness (6 out of 10). Small number reported in survey responses.	Cycle safety projects have shown varied results, with some projects making traffic safety considerably worse while others producing considerable safety improvements. These schemes include cycle paths, tracks and road markings.
Bus safety		
Recessed bus stops	Moderate rating for safety effectiveness (6 out of 10). Small number reported in survey responses.	Recommended where site distances are restricted, and where traffic speeds and volume are high.
Bus waiting areas		Wide waiting area (minimum two metres) and fencing recommended where large numbers of bus passengers wait. One-way bus system recommended in rural areas at schools.
Conspicuity of buses		Recommended that visibility of buses is increased
Warning signs on buses		Flashing lights recommended when buses are stopped
Legislation regarding vehicles passing buses		Non compliance with reduced speed limit around stationary buses a problem
Parking		
Drop-off/pick up zone	Higher rating for safety effectiveness (8 out of 10), small number reported in survey responses Kiss of and ride program rated moderate for safety effectiveness from overseas response (7 out of 10), but with controlled location for dropping off or picking up children and parents not allowed to leave vehicle. Cost - $2,000 per school	Found to be effective where comprehensive treatment at school frontage, including access to internal car parks, indented bus bays and passenger drop-off zones.
Car parks	Rated high for safety effectiveness in both urban and rural areas (10 out of 10 in urban areas, 8 out of 10 in rural areas). Small number reported in survey responses.	

Recessed parking bays		Effective in increasing visibility between child pedestrian and motorists
On Road parking		High-density on Road parking may increase the risk for child pedestrian injury. Visibility of child pedestrian affected by on Road parking.
• Part-time restrictions	Moderate rating for safety effectiveness, moderate numbers reported in survey responses. Cost - $100 each	
Personal security		
Lighting		Recommended
Visibility		Maintaining vegetation overgrowth and type of education on footpaths and walkways through parks and reserves recommended
Planned routes		Open environment, to address fear of people hanging about
Legislation		
Burden of responsibility for child pedestrian cycle crashes		Best performing countries on children's safety in traffic have a law which places the burden of responsibility of drivers involved in a collision with a child (Badinter Law) Legal requirements for child cyclists under the age of six to be accompanied by an adult (15 or more years of age) in some countries. Cycle helmet wearing regulations in some countries. Pedestrians have right of way at corners, whether or not crosswalks all marked by painted white lines; drivers required to stop for any pedestrian crossing at corners or other crosswalks and are not allowed to pass the car from behind that are stopped.
Willingness to fund engineering safety improvements		Evidence shows that the community is more likely to be prepared to pay for traffic safety in communities of economic equality. Communities in general seem to be willing to pay reasonable amounts for safety improvements and spend time on education programs
Speed limits		Motorists are required to stop when coming upon a school bus that has stopped on either side of the road with its lights flashing in some countries. Reduced speed limits when passing a school bus in some countries.
Land-use planning		City planners and traffic engineers need to take into consideration in pedestrian perceptions of risk when designing efficient and pedestrian friendly facilities. The built environment should be constructive in a way that stimulates children's growth while guarding against unsafe interaction with traffic. Urban design features can be used to improve the safety of children in the road environment. Municipalities and local authorities need to improve the safety of children on their home to school journey by including safety features such as walkway and cycleway linkages and greenfield areas, and ensuring that safety, from child's perspective, is included when redevelopment takes place.

The study also found that:

- Traffic calming, low speed roads, speed bumps, raised surfaces, and centralised crossing places are the most effective treatments for improving traffic safety (Atkins 2002; Tester, Rutherford et al. 2004); these treatments often result from school route studies (Jensen and Hummer 2002); and are part of Safe Routes to School type programmes (Rose 2000)
- Providing wide footpaths with greater protection from roadside vehicles together with regular maintenance and removal of footpath obstructions and overgrown foliage helps to address children's feelings of being unsafe, and promotes pedestrian usage (Jensen and Hummer 2002; Draitzki, Laing et al. 2003; McMahon 2004)
- When projects involve cycle paths, tracks, and markings it is unclear which measures have produced significant improvements; there are significant statistical differences ranging from safety being made considerably worse to considerable improvements (Atkins 2002)
- The slowing of traffic speed in the vicinity of children has been shown to have considerable benefits often with a reduction of incidents and a reduction in the severity of injuries (Cairney 2000; ITE 2004; Davies 1999). Speed limit signs should be combined with a number of other traffic management treatments (Croft 2004)
- Warning devices such as flashing amber lights located at crossing places in front of schools has a considerable safety improvement impact (Aggarwai and Mortensen 1993; Hawkins 1993)
- Variable message signs, although had some effect on slowing speeds, were not as effective as physical traffic calming measures (Davies 1999), or had as much impact as children being present on the roadside (Osmers 2001); the impact of the sign diminishing over time (Osmers 2001)
- Safety devices at railway level crossings appear to be primarily aimed at motorists, with very little to warn pedestrians, especially children, of approaching trains (Mainroads 2004, Cuthbert 1998). Improving conspicuity of trains is seen as being important (Cairney 2003)
- Trespassing on railway corridors is a serious safety concern (Cuthbert 1998, Transport Canada 2004)
- School bus safety is a common concern worldwide and school bus related fatalities are more likely to occur in the afternoon and involve children who have just left the bus. Increasing school bus conspicuity and improving vehicle designs, the roading environment, and introducing consistent national audits are recommended safety improvements (LTSA 2002, Austroads 1999)
- Designing a road environment that recognises children's capabilities as well as their limitations will inherently be a safer place for children and the public at large (McMahon 2004); and roads with high traffic volumes and high traffic speeds are of major concern for children (Jensen and Hummer 2002) and are considered to be a major injury risk factor (Roberts 1994).
- Focusing on perceived problems raised by children and parents helped to identify problem areas (Jensen and Hummer 2002, Kennedy 2004). However it is equally important to investigate crash data.
- The best performing countries with regards to keeping children safe in traffic had supportive, active and progressive legislation (Hillman 1993, McMahon 2004)

This study has identified gaps in overseas knowledge and New Zealand practice in several areas with regards to improving safety for children on the school journey. These areas include:

- Safety measures for pedestrians crossing railway lines
- Mid-block crossings - overseas research highlights safety concerns regarding non-compliance and the severity of injuries that occur at these crossings
- Pedestrian safety audits - there does not appear to be guidelines that specifically focus on the safety for pedestrians, and the overseas literature has highlighted the need for such audits to be taken from the child's perspective of pedestrian safety
- Long term evaluation study of safety in school catchment areas to establish the safety (and transportation) benefits of implementing area-wide engineering safety devices.
- Bus safety
- Conspicuity of school buses
- Legislation - the study highlighted the importance of having the support of a legal framework and political will for addressing safety issues for children on the school journey

Conclusion and Development of Toolbox

The comparison of engineering safety devices showed some significant differences between the types of devices used in New Zealand compared to those used overseas. The most significant difference between the situation in New Zealand and that overseas is the lack of emphasis in New Zealand on the benefits of slowing vehicle speeds at locations where children congregate. The benefits of reducing speeds in school speed zones is well documented overseas. This form of treatment is starting to be used in New Zealand and relevant guidelines are now being developed. Other significant treatments include the implementation of traffic management or traffic calming measures.

There are some conflicting views with regards to the safety of signalised mid-block pedestrian crossings, and the authors of this study suggest further evaluation and analysis of crash data is needed. Much of the literature reviewed has focused on the effectiveness of providing additional warning devices, such as flashing lights, to highlight the presence of a pedestrian crossing. Some attention has been drawn to the need for better visibility of children, with recommendations for reflective conspicuity aids that can be worn by children.

The form of a safe place to cross the road is dependent on the use of the crossing and the environment in which it is placed. The complexity of these factors combined with the uncertainty of whether crossing places are installed to current safety standards, makes comparison between the types of crossings inconclusive. There are no "quick fixes" for the provision of safe crossing places and additional warning devices need to be tailored specifically to each individual site.

There appears to be a lack of information on the merits of providing warning and safety treatments aimed at pedestrians at railway level crossings. Safety devices at railway level crossings appear to be primarily aimed at motorists, with very little to warn pedestrians, and especially children, of approaching trains. School bus safety is a common concern worldwide. Some countries use programs that focus on children's behaviour on the bus. The New Zealand literature is currently focused on providing better warning signs on school buses, especially when they are stopped. The best performing countries had a supportive legislative framework and the political will to provide the necessary facilities, programs and funding that is required to keep children safe. In these countries the legal responsibility for child/vehicle crashes was placed primarily on the motorists.

Finally the research has concluded that a variety of devices can be used for different situations; often with the addition of complementary devices. It is important to understand the suitability of the device for targeted user groups rather than focussing on the effectiveness of the device in the wider population. There are significant differences between urban and rural situations and these can drastically alter the effectiveness and appropriateness of any device or devices selected.

In order for the findings to be useful to practitioners and the community, the knowledge gained needs to be transferred into a practical guide or toolbox. Several options for a decision making process for the selection of appropriate engineering devices have been put forward for consideration.

As a follow-on to this research, it is strongly recommended that the different formats for the Process and Toolbox highlighted in this report, be developed further. It is recommended that a number of schools be tested as Case Studies to determine the most appropriate model. In developing the toolbox it is essential that key stakeholders such as LTSA, School Road Safety Reference Groups, Road Controlling Authorities, and injury prevention groups such as Safekids are involved and/or consulted with during this development.

A “decision tree” flowchart is suggested as a model for assisting practitioners and the community in the process of selecting appropriate devices. The process steps would include:

- identification of the safety problem
- identify a range of possible solutions
- check the “fit” with relevant standards, guidelines and policies
- assessment of the benefits and disbenefits of each
- check the “fit” in surrounding road scene
- consultation with all stakeholders.

This type of process recognises the essential element of visiting the site and ensuring the proposed safety intervention device chosen fits the existing and future road environment and use. Accompanying the “decision tree” flowchart it is suggested that a matrix be developed that shows the type of engineering solutions that could be considered for particular safety problems and the benefits and disbenefits of each.

The Toolbox should:

- be aimed at treating specific safety concerns
- provide information on “best practice” engineering safety treatments
- provide an easy to use framework for deciding on the type of device to be used
- provide a reference (or platform) for discussions between non technical persons and practitioners on ways of improving children's safety
- clearly emphasise that implementation of engineering safety devices is only one part of a holistic approach that also requires education and enforcement
- clearly emphasise the need to determine the wider impact of the implementation of any device
- emphasise the need to look at the wider road environment and the potential use of a selected treatment
- note that caution is needed if looking at devices in isolation of the wider road environment
- emphasise the need to refer to current standards, guidelines or policies
- be recognised as providing the engineering basis of an integrated system, rather than as a complete "quick-fix" solution.

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Appendix A – Survey Respondents

Summary Questionnaire A Respondents

There were 21 New Zealand responses to Summary Questionnaire A (30% of RCAs responded) with a total of 138 engineering devices described . One respondent did not indicate what district he represented. The response rate was just under 30% of the total number of Road Controlling Authorities in New Zealand. The table below lists the districts that responded.

Council		Devices
RDC	Rodney District Council	6
QLDC	Queenstown Lakes District Council	9
FNDC	Far North District Council	1
WDC	Whakatane District Council	3
NPDC	New Plymouth District Council	8
HCC	Hutt City Council	8
MDC	Marlborough District Council	3
TDC	Timaru District Council	11
PNCC	Palmerston North City Council	5
WaiDC	Waimate District Council	2
ODC	Otorohanga District Council	3
HDC	Hastings District Council	8
CDC	Clutha District Council	3
ACC	Auckland City Council	10
NSCC	North Shore City Council	23
MCC	Manukau City Council	6
FDC	Franklin District Council	1
WSR	Wairarapa Subregion; South Wairapa, Masterton, Carterton District Councils	12
ManDC	Manawatu District Council	2
RotDC	Rotorua District Council	11

There were 4 overseas jurisdictions who responded to the summary questionnaire A survey. 42 devices were described by the respondents. The table below shows the responding jurisdictions.

Location		Devices
CoC	City of Calgary, Calgary, AB, Canada	9
CoS	City of Saskatoon, Saskatoon, SK, Canada	7
BCC	Brisbane City Council, Brisbane, Qld, Australia	16
CoA	City of Ottawa	10 (plus 5 safety programmes)

Summary Questionnaire B Respondents

There were 5 organisations who responded to the Summary Questionnaire B. The table below shows the organisations who responded and the number of devices they described.

Organisation	Devices
NZ Police & Youth Education	3
NZ Police Northland District HQ	5
NZ Police Pukekohe	9
NZ Police Kerikeri	5
LTSA – Safer Routes	11

There was 1 response to the Overseas Summary Questionnaire B. 11 devices were detailed in the response. The table below shows the jurisdiction that responded and the number of devices.

Organisation	Devices
Road Wise Western Australia	11

Appendix B - Extract from Survey Questionnaire

QUESTIONNAIRE "A" **Summary Sheet**

Name: …………………………………………………………………………
Road Controlling Authority: ……………………………………………
Position: ……………………………………………………………………
Contact details: Ph. …………Email ………………Address

Device	Brief description and estimated cost per device (if available)	Urban Areas		Rural Areas	
		Estimate of number used	Effectiveness of device on a scale of 1-10*	Estimate of number used	Effectiveness of device on a scale of 1-10*
Zebra crossing					

Questionnaire "A - Safety improvement devices
Please use a separate sheet for each type of device. Just one response for urban or rural areas (if necessary please)

Type of Device being assessed: ……………………………………………………………
Please give a brief description

Effectiveness of the device
These questions are aimed at determining what the overall level of effectiveness your experience with this type of device has been. Please scale each question from 1 through to 10, with 1 being the least effective, and 10 being the most effective.

Safety
How do you rate this type of device with regards to improving safety for the children?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate this type of device with regards to slowing vehicle speeds?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate this type of device with regards to making children more conspicuous to motorists?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate this type of device with regards to making motorists more aware of the children?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Encouragement
How do you rate this type of device with regards to encouraging more children to walk to school?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate this type of device with regards to encouraging more children to cycle to school?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate this type of device with regards to encouraging children to use other non-motorised modes of transport to school?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Support for the type of device used:
The following questions are aimed at determining which devices solicit the most support from interested stakeholders. Please rate each question on a scale from 1 through to 10, with 1 being a minimal amount of support (or the greatest barrier to installation), and 10 being the most enthusiastic support.
How do you rate the degree with which funding for this type of device influenced its installation?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate the support given for this type of device from the Policy & Standards Organisations (similar to Land Transport Safety Authority in NZ)?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate the support given for this type of device from the Police?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate the support given for this type of device from the Road Controlling Authority or TLA, in terms of approval for the device and ease of implementation?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

How do you rate the support given for this type of device from the school?
☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6 ☐ 7 ☐ 8 ☐ 9 ☐ 10 ☐

Location/s where device typically used: The next set of questions aimed at determining the most appropriate location for the device to be used, reflecting the overall typical location for the device in terms of road classification, speed limit, distance device from school, whether full time or part-time operation, and number of child pedestrians or cyclists using it.