SMARTER WAYS OF PRIORITISING COMMUNITIES FOR SAFETY IMPROVEMENTS

Authors:

Dr. Stacy Rendall

PhD, BE(Hons), GIPENZ

Transportation Researcher, Abley Transportation Consultants Ltd.

stacy.rendall@abley.com

Paul Durdin

BE(Hons), MIPENZ, CPEng, MInstD

Director, Abley Transportation Consultants Ltd.

paul.durdin@abley.com

ABSTRACT

Auckland Transport (AT) delivers targeted transport network safety improvements in a number of Auckland communities each year as part of its safer communities programme. The programme has the ultimate goal of improving the safety of active travel in the community and increasing the mode share of walking and cycling. The previous method of prioritising schools for inclusion in the programme took a reactive approach, on the basis of crash history. This paper describes the development of a robust, proactive risk-based prioritisation method, which identifies schools where the greatest safety and mode share benefits might be achieved.

The research utilised data collected as part of the Auckland Transport TravelWise schools programme and assessed aspects of accessibility, socio-demographic factors, and transport network risk by active and vehicle modes. Analysis indicated that travel time is the most meaningful predictor of current school mode choice. The new prioritisation method uses a range of risk assessment methods to prioritise communities by the potential to increase the number of school students with safe access.

The process developed through the research presents a smarter way to prioritise communities proactively: by considering the potential to reduce active travel risk. Smarter outputs at a community level identify areas of risk and safety impediment so that interventions can be more readily identified.

INTRODUCTION

Each year Auckland Transport (AT) identifies a number of Auckland communities to receive targeted transport network safety improvements through the Safer Communities programme. Implemented alongside the Travelwise travel demand management initiative, these improvements can include visibility improvements, traffic calming and infrastructure such as median refuges or kerb extensions. The programme has the ultimate goal of improving the safety of active mode travel and increasing the mode share of walking and cycling within Auckland. Although the programme is centred on schools, the goal is to improve outcomes for all travellers within a community. Consequently, the method focuses on active mode travel within communities, with schools as a community facility forming a basis of the assessment.

The previous methodology of prioritising schools for improvement took a reactive approach, based on crash history only. This paper describes the development of a robust, proactive risk-based prioritisation method, developed by Abley Transportation Consultants in conjunction with, and using input data supplied by, AT. The method identifies schools where the greatest safety and mode share benefits might be achieved. AT will use the prioritisation outputs to identify schools that warrant further investigation, including detailed assessment of the current travel patterns and safety issues for students of the school, prior to investment in infrastructure.

BACKGROUND

This section describes the superseded method of school prioritisation, introduces the school travel dataset used in the method development, describes risk-based approaches and presents specific active road user risk research used in the development of the prioritisation methodology.

Superseded prioritisation method

The superseded method used the NZ Transport Agency's Crash Analysis System (CAS) crash history data as an input to rank all Auckland schools, in terms of safety, within a spreadsheet tool. Crashes within 1km of the school were used as input for primary schools, and 2km for intermediate/secondary schools. The ranking process applied five crash categorisations:

- All fatal and serious crashes
- Selected intersection crashes (by junction and crash movement type)
- Pedestrian and cyclist crashes
- Speed-related crashes
- Selected loss-of-control crashes

Schools were ranked for each crash category, then the rankings were weighted and summed to produce an overall ranking. This process considered wider safety issues than just those related to active road users (pedestrians and cyclists).

School travel dataset

TravelWise, the existing travel planning initiative collects data of student travel mode share relating to before and after safety improvements and informational campaigns. The TravelWise dataset consisted of student-level residence and travel information for 107 urban and non-special/destination schools. Of these, 73 schools accepted primary aged children (school years ranging from 1 up to 6 or 8) while the remaining 34 schools were intermediate/secondary schools. The data included the travel mode used by the student in travelling to and from the school for up to a week. The dataset included an indication of the "preferred" mode of travel to school for students, but did not assess mode shift following the TravelWise initiative. The school travel dataset was prepared by combining the student's travel information with the geocoded student residence data.

Risk-based approaches

Crash history can be used to assess risks to travellers, termed *reported risk* (NZ Transport Agency, 2013a). However, this approach is wholly reactive, typically requiring someone to be killed or seriously injured before a problem is identified and corrective action taken. The High-risk intersections guide (NZ Transport Agency, 2013a) presents two alternative, proactive, assessment methods: *estimated risk* and *predicted risk*.

Estimated risk uses reported injury crashes (includes fatal, serious and minor injuries), but weights each crash by the *typical severity that might be expected for the type of crash* and the environment in which it occurred (type of intersection/road segment and speed environment), providing a better estimate of the underlying risk to travellers.

Predicted risk uses models based upon physical and operational characteristics that are known to affect risk, which means they can be used to identify risky locations before crashes have occurred (and as such, predicted risk equations are included in the NZ Transport Agency Economic Evaluation Manual (NZ Transport Agency, 2013b)), but may have high data requirements that can make application difficult on a large scale for existing intersections.

Predictive risk for active road users

New Zealand-based predictive risk equations for active modes have been developed by Turner et al. (2006) for the NZ Transport Agency. For pedestrians, the expected annual crash rate (crashes per year) of a midblock crossing location is calculated by (Turner et al., 2006):

$$A = b_0 Q^{b_1} P^{b_2}$$

Where:

- b_0, b_1 and b_2 are constants equal to 3.064×10^{-5}, 0.65684 and 0.2401, respectively
- Q is the two-way flow (average annual daily traffic (AADT)) of the road being crossed, derived from traffic count data
- P is the average daily pedestrian flow crossing the segment.

METHOD OVERVIEW

The new prioritisation method combines both *estimated* and *predicted* risk measures in a two-part process. Estimated risk measures are used to determine the broad risk classification for a school, then predicted risk measures prioritise schools within the risk categories. The method has a fundamental basis in accessibility modelling, and builds upon the accessibility models developed for AT by Abley Transportation Consultants (Baththana and Smith, 2013). Walking is the primary focus of the method, as the cycling mode share for school travel in Auckland is very low (Ministry of Transport (MoT), 2014). However, cycling risk is incorporated in the estimated risk assessment (i.e. schools for which an existing risk for cyclists is present) to determine high risk schools in the broad risk classification. Although the primary motivation for the research is to improve school travel safety, the aim is to improve safety for the community as a whole, using schools as a basis for identifying potential improvements. This factor is incorporated in the model development, as described below.

The intention of the method is to identify schools where the risk of walking to school is high, relative to other schools in the region. Although the outputs appear precise, their accuracy is dependent on the accuracy of the very large data inputs, they are therefore only intended to be used for comparing schools that have been assessed in the same manner. AT will use the prioritisation outputs to identify schools which warrant further investigation, including detailed assessment of the current travel patterns and safety issues for students of the school, prior to investment in infrastructure.

The method uses a series of catchments around each school, which are produced in a geographical information systems (GIS) software, calculating out from the school along the transport network until a certain limit is met. Two types of catchment are used in the prioritisation assessment:

- Time
- Predicted risk exposure

The method does not include or account for school zones (areas within which students must reside to be able to attend a given school), as less than half the schools in Auckland (213 out of 541 schools) have zones. A comparison of zones to the computed catchments used in this study is presented in a later section of the paper.

The GIS representation of the transport network contains a wide range of information, including vehicle flows along roads (which are crossed) and various types of pedestrian facilities present:

- Paths:
    - Footpath (alongside a road)
    - Off-road path
    - Rural (no facility, wide shoulder)
- Crossings:
    - Priority (controlled):
        - Signals
        - Zebra
    - Uncontrolled:
        - Crossing aid:
            - Kerb extensions
            - Median refuge
        - No aids:
            - Formal (i.e. kerbs dropped)
            - Informal – added to the network at regular points to represent possible pedestrian desire lines

The network allows impedance attributes (things which oppose flow, i.e. distance, time or risk) to be calculated, such that the lowest impedance route can be determined. Mathematical models are used to calculate pedestrian travel times on the network for various different crossing types, for example, Tanner's extended model is used for calculating the queuing delay at uncontrolled crossing facilities (Abley, 2002).

Time catchment

The time catchment represents a walkable area around a school. The time limit is based on the 95th percentile time travelled by children of the relevant age reaching education facilities in the New Zealand Household Travel Survey, as presented in **Table 1**.

School type (years)	Time (minutes)	Assumed walking speed (metres per second)
Composite (1-13)	29.4	1.1
Contributing (1-6)	25.0	1.1
Full Primary (1-8)	25.9	1.1
Restricted Composite (7-10)	33.7	1.1
Intermediate (7-8)	32.0	1.2
Secondary (7-10)	33.7	1.2
Secondary (7-15)	33.7	1.2
Secondary (11-15)	33.7	1.2
Secondary (9-15)	34.0	1.2

Table 1. Travel time catchments

Predicted risk exposure (risk threshold) catchment

Where the time catchment shows areas within a walkable time of the school, the predicted risk catchment identifies areas that can be accessed within some limit of risk exposure determined to be acceptable. The areas identified by this assessment are those that have a low risk path to school, although this may be substantially different from the shortest time path, for example. Predictive risk equations are applied to the walking network, as used for the time catchment. The annual risk per pedestrian is calculated on the basis of the type of facility available by:

$$r_{cross} = \frac{ab_0 Q^{b_1} P^{b_2}}{P}$$

Where:

- a is an adjustment factor to account for the type of crossing, as shown in **Table 2**
- b_0, b_1 and b_2 are constants equal to 3.064×10^{-5}, 0.65684 and 0.2401, respectively
- Q is the two-way flow (average annual daily traffic (AADT)) of the road being crossed
- P is the average daily pedestrian flow crossing the segment.

Note that crossing distance is not a variable in the equation.

There is no published model for determining the risk of walking along a road segment (on a footpath). However, crash data indicates that fewer than 5% of pedestrian crashes occur when walking along a road segment. This is not a reliable source for estimating risk, but given the lack of alternative data sources, the research assumes that the risk of walking along a 100 metre road segment is 5% the average collective risk of uncontrolled crossings. Consequently, the risk of walking along a road segment is assumed to be primarily a product of length, calculated by:

$$r_{along} = \frac{acl}{P}$$

Where:

- a is an adjustment factor to account for the type of crossing, as shown in Table 2
- c is a constant equal to 0.005966, which is the average collective risk (i.e. risk to all pedestrians, not risk per pedestrian) of uncontrolled crossings in the study
- l is the length of the segment, normalised to 100 metres

- P is the average daily pedestrian flow along the segment.

	Type	Adjustment factor (a)
Crossing	Uncontrolled	1.0
	Uncontrolled with pedestrian refuge	0.55
	Zebra crossing	0.72
	Traffic signals	0.19
Segment	Footpath	0.05
	Rural	0.1
	Off-road path	0

Table 2. Risk equation adjustment factors (International Road Assessment Program (iRAP), 2014)

Pedestrian flow approximation

Pedestrian flows, used in both equations above, were approximated. The approximation first estimated the pedestrian demand within each census meshblock, then used adjacency to apportion this demand to nearby meshblocks, as described below.

Demand within each meshblock was estimated using census journey to work data (2013 census) combined with school-related pedestrian flows. The latter was calculated by combining school location data with average Auckland walking mode shares (sourced from Ministry of Transport (MoT) (2014)), which were applied to the total roll for each school. The school mode share component does not account for the specific mode share at each school (which is not known). This produced an estimated total pedestrian demand within each meshblock, which was scaled by a factor of three to account for arrival, departure, and other pedestrian activity.

Demand was then apportioned to nearby meshblocks in a radial fashion. This process assumes that pedestrians travel through approximately six meshblocks between their origin and destination, which typically corresponds to 20-30 minutes of travel. Within meshblocks pedestrian flows were assigned to links and crossings, dependent upon the number of links and crossings within the area.

It is noted that the above method of approximating pedestrian flows is an approximation only, and a limitation of the current approach. This will be discussed in the limitations section below.

Overlap of predicted risk and time catchments

The overlap of these two catchments, as shown in **Figure 1**, is used in this research to represent areas that are both walkable and enable students to access the school with an acceptable level of risk. Areas within the time catchment that are outside of the risk catchment can represent the presence of safety issues, and may be used to identify unsafe parts of the network. Note that, as fewer than 50% of schools in the Auckland area have school zones, zones are not included in the analysis.

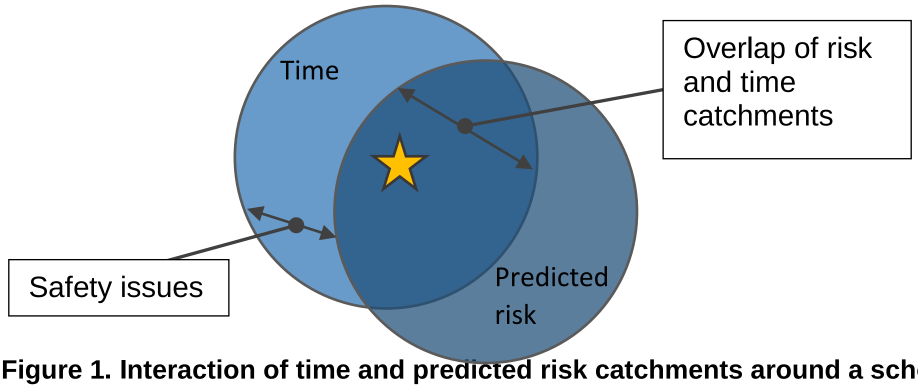

Figure 1. Interaction of time and predicted risk catchments around a school

TRAVELWISE DATA ANALYSIS

Analysis of the TravelWise data was performed to determine:

- The characteristics of travel risk relating to trips currently undertaken by students travelling to school. This in turn was used to inform development of the predicted risk catchments
- Relations between school travel mode share and vehicle risk, socio-demographic factors and accessibility (on the basis of time and predicted risk catchments).

Current travel risk

The analysis calculated the travel risk, using the equations outlined above, of students' current travel patterns. Firstly, trips for which walking was the main mode (that is, most frequent mode selected over the survey period) were extracted. Then the lowest risk path from each student address to their school was calculated (this path may be different to the shortest time or distance path). These paths were filtered to remove low-risk paths longer than the 99th percentile travel times calculated from the NZ Household Travel Survey (44 minutes for Primary schools and 50 minutes for Intermediate/Secondary schools), which could represent survey/geocoding errors or routes making unreasonable deviations to minimise risk exposure. The risk path data followed an exponential distribution, with many students able to access the school at low risk, then a limited number of students at increasingly high risk. Then the 85th percentile value of the risk paths was calculated. The output values, which are in terms of predicted crashes per pedestrian per year, are presented in **Table 3**. The risk threshold catchment contains students who can access the school without exceeding these limits of risk.

School type (years)	Risk limit (predicted annual crashes per pedestrian)
Composite (1-13)	0.000439
Contributing (1-6)	
Full Primary (1-8)	
Restricted Composite (7-10)	0.000473
Intermediate (7-8)	
Secondary (7-10)	
Secondary (7-15)	
Secondary (11-15)	
Secondary (9-15)	

Table 3. Risk catchment limits

Mode share analysis

Regression modelling was used to test a range of factors compared to the initial school mode share by walking/cycling. A weak negative correlation was found between income and mode share, but no correlations where found for other socio-demographic factors (including vehicle ownership and journey to work of origin area) or vehicle risk metrics. Mode share versus percent of students within the time or risk catchment for each school was used to assess if either factor was a predictor of the school travel mode share.

Results for percent of students in the time catchment versus initial mode share by walking are shown in **Figure 2**, with linear trend lines and goodness of fit statistics shown. The outputs show that the time catchment is a predictor of mode share, and displays a reasonable level of fit for both school groupings. There is some scatter between the predicted and observed values, but the data does show a strong linear upward trend. This suggests that interventions to increase the time catchment, by reducing pedestrian delays on the network, have the potential to increase mode share for a given school.

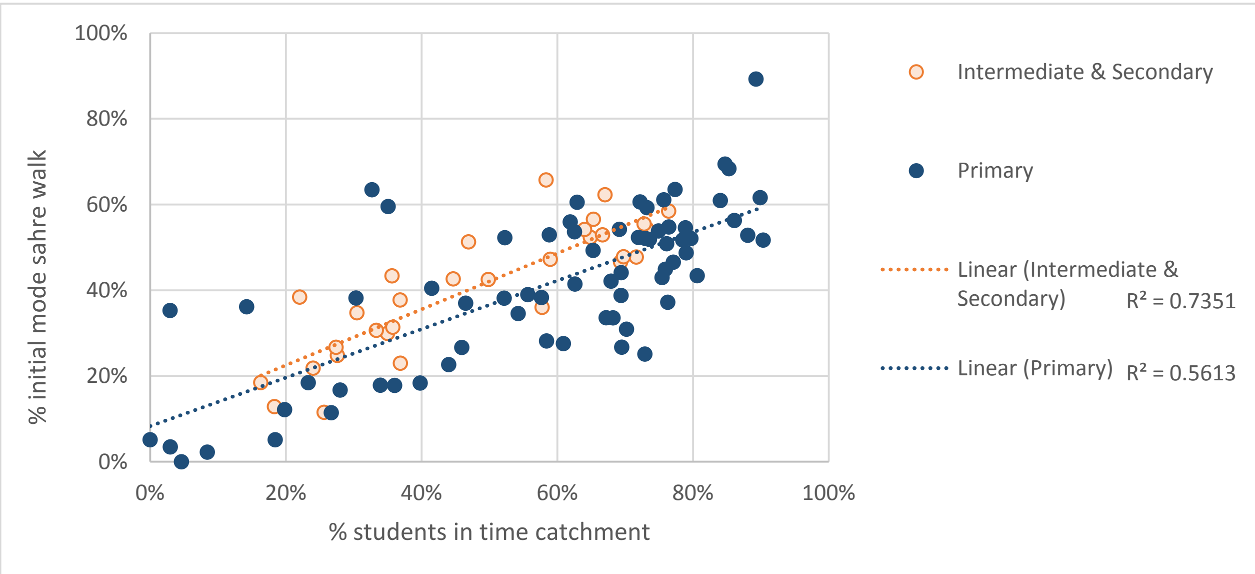

Figure 2. Comparison of percent students in time catchment versus initial mode share by walking

Once travel time was controlled for, the percent of students in the risk catchment alone was not correlated to mode share. However, to determine if the addition of the risk catchment increased the goodness of fit for travel time, the overlap of risk exposure and time catchments was compared to initial mode share, as shown in **Figure 3**. There is still a relatively strong correlation between percentage of students in catchment and initial mode share, but the addition of the risk catchment reduced the predictive power of the assessment. This suggests that students may currently be walking despite high risk exposure (i.e. do not consider risk in selecting a route), and indicates it is important that safety is considered for students who are able to walk (live in the time catchment).

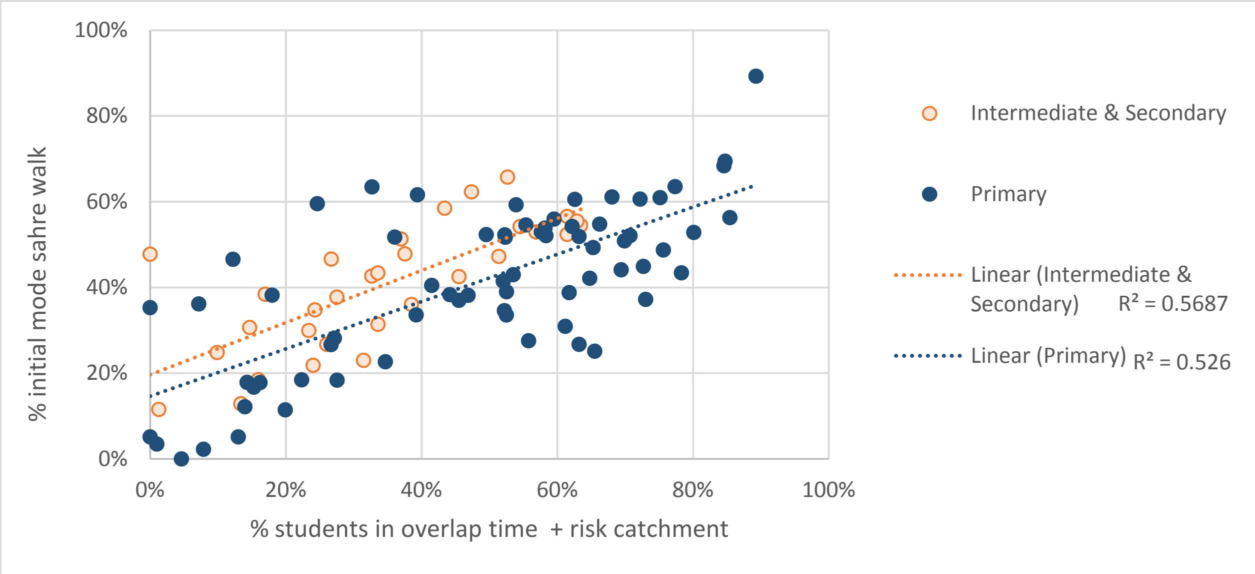

Figure 3. Comparison of percent students in overlap of predicted risk exposure and time catchments versus initial mode share by walking

PRIORITISATION METHOD

Schools are prioritised on the basis of two measures, the first determines an initial priority for schools, from High to Low, the second prioritises schools on the potential to improve safe access. The measures are:

1. Estimated risks to pedestrians and cyclists within the time catchment:
   - DSI risks clustered to road corridors or intersections
   - Overall DSI risk in catchment
2. Potential to increase the number of students in the time catchment that are also in the predicted risk (safe access) catchment

The combination of measures captures risky roads and intersections, overall risks (where risk may not be specifically clustered to a road or intersection) and the potential for improvements to increase the number of students with safe access to the school.

Comparison of catchments to buffers used in superseded method

To understand if the new method substantially changes the assessment, for example the number of students being assessed, a comparison of the fixed buffers used in the superseded AT method to the new time catchments is presented in **Table 4** and **Figure 4**. The size of the catchments shows large variation, as it is sensitive to geography and travel time. The average primary school catchment is slightly larger than that of the buffer method, but the intermediate/secondary catchment is noticeably smaller.

	Area (km^2)				
	Superseded Methodology buffers	New Methodology Time Catchments			
		Minimum	Average	Std. Dev	Maximum
Primary	**3.1**	**1.3**	**3.9**	**1.1**	**8.3**
Intermediate/secondary	**12.6**	**3.3**	**7.9**	**1.5**	**10.9**

Table 4. Comparison of existing method buffers and time catchments

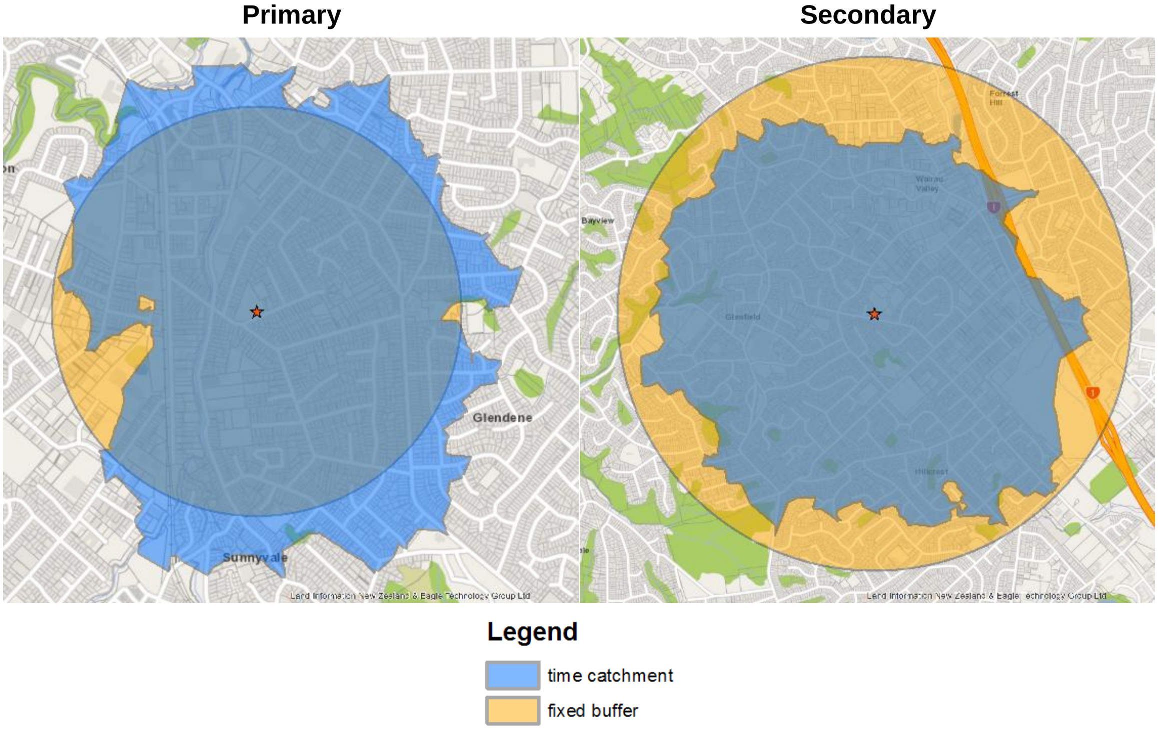

Figure 4. Comparison of average sized catchments to buffers for example primary and secondary schools

Comparison of catchments to school zones

School zones are areas around a school in which students must reside to attend a school. Fewer than 50% of the schools in the Auckland region have zones. Consequently, zones are not considered in the assessment. However, to assess the possible impact of excluding zones, **Table 5** contains a comparison of time catchments and zones for those schools with zones. The figures show that the zones are typically larger than catchments. However, comparing zone area to time catchment area for each school with a zone (using median value, as average is inflated by a small number of large zones) indicates that the zones are about twice the size of the catchments for intermediate/secondary schools, and about 80% of the catchment size for primary schools.

	Area (km^2)						Zone area/ catchment area	
	School zone			Catchments				
	Min.	Avg.	Max.	Min.	Avg.	Max.	Avg.	Median
Primary	**0.67**	**11**	**440**	**1.3**	**3.9**	**8.3**	**2.9**	**0.78**
Intermediate/secondary	**5.5**	**57**	**840**	**3.3**	**7.9**	**10.9**	**7.0**	**1.9**

Table 5. Comparison of school zones and time catchments

Estimated risk prioritisation

Unlike the predicted risk equations, which operate on the basis of annual risk exposure, the estimated DSI calculations indicate risk over a five-year period. Clustered DSI risks make use of the New Zealand road assessment program outputs for urban areas (Urban KiwiRAP) (Brodie et al., 2013). Overall DSI risks use the same severity indices as the clustered risks, however values are summed within the entire time catchment, not attributed to specific intersections or corridors. The criteria applied in determining the initial prioritisation are presented in **Table 6**. Schools that are not classed either High or Medium are given Low priority. The school takes the highest rating from either criterion, so a school with High overall risk and a Low clustered risk would be rated High.

Priority	Criterion	
	Overall DSI risk	Clustered DSI risk
High	3+ predicted DSI in time catchment	Time catchment contains: 1. any walk/cycle High/High-Medium risk intersection 2. > 100m of High/High-Medium risk corridor
Medium	1+ predicted DSI in time catchment	Time catchment contains: 1. any walk/cycle Medium risk intersection 2. > 100m of Medium risk corridor

Table 6. Initial school prioritisation by estimated risk criteria

Predicted risk prioritisation

This stage of the prioritisation ranks schools by the potential to increase the number of students within the time catchment that also have access to the school within the risk threshold. This prioritisation is based on the principle that the time catchment is a predictor of mode share, so students within it are likely to be walking, hence it is important to ensure that they can do so safely. Census data for the resident population (meshblock level) is assessed within GIS and the following values calculated:

- The number of residents that are aged for the school (i.e. Full Primary schools correspond to students aged from 5 to 12 years) within the time catchment
- The number of residents that are aged for the school within the overlap of predicted risk and time catchments

The analysis uses linear interpolation within areas, so if the catchment covers 50% of an area containing eight students, four will be counted. Census resident data is grouped into 5 year bins which are apportioned, so, for example, the count for a Full Primary school includes all the residents aged 5-9 and 60% of the residents aged 10-14. The counts are weighted proportional to the school roll, to produce an indication of potential students (d) by the following formula:

$$d = \frac{(c_t - c_o)}{c_t} r$$

Where:

- c_t is the count of potential students in the time catchment
- c_o is the count of potential students in the overlap of time and predicted risk catchments
- r is the school roll

SCHOOL CASE STUDY

The time and safe access catchments, and their overlap (which is a darker blue) for a contributing school (years 1-6) are shown in **Figure 5**. This school has no school zone. As the risk of crossing a road is much greater than the risk of walking along a road the catchment extends along routes where possible, but can be severed by roads, particularly those with higher traffic volumes. Crossing facilities near the school have the greatest benefit in increasing the safety for those who choose to walk.

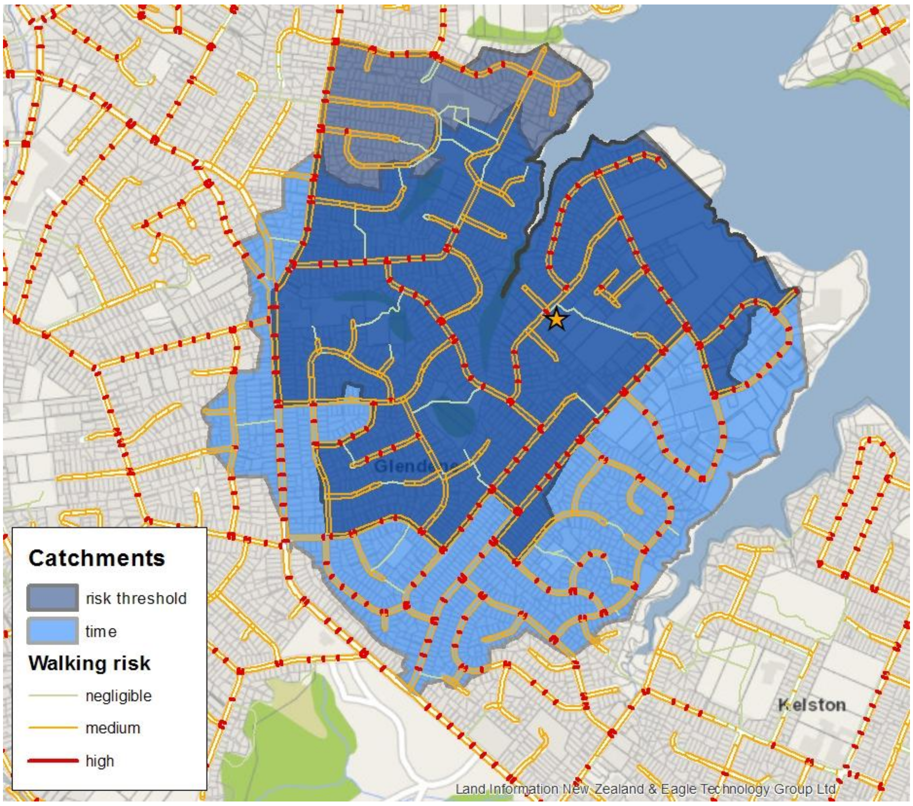

Figure 5. Network with walking risk, and time and safe access catchments around an example school

Data used for the estimated risk prioritisation is shown in **Figure 6** and **Figure 7**. The crashes in Figure 6 are for a 5-year crash period, and include all injury crashes (all movements). Although there are a number of crashes in the catchment shown in Figure 6 the typical severity of these crash types is low, equating to 2.5 DSI equivalents, presenting a priority for this criterion of Medium. The clustered crash risk measure shown in Figure 7, however, picks up the concentration of these crashes around an intersection and road corridor (110 metres in length), resulting in an overall High priority for this school.

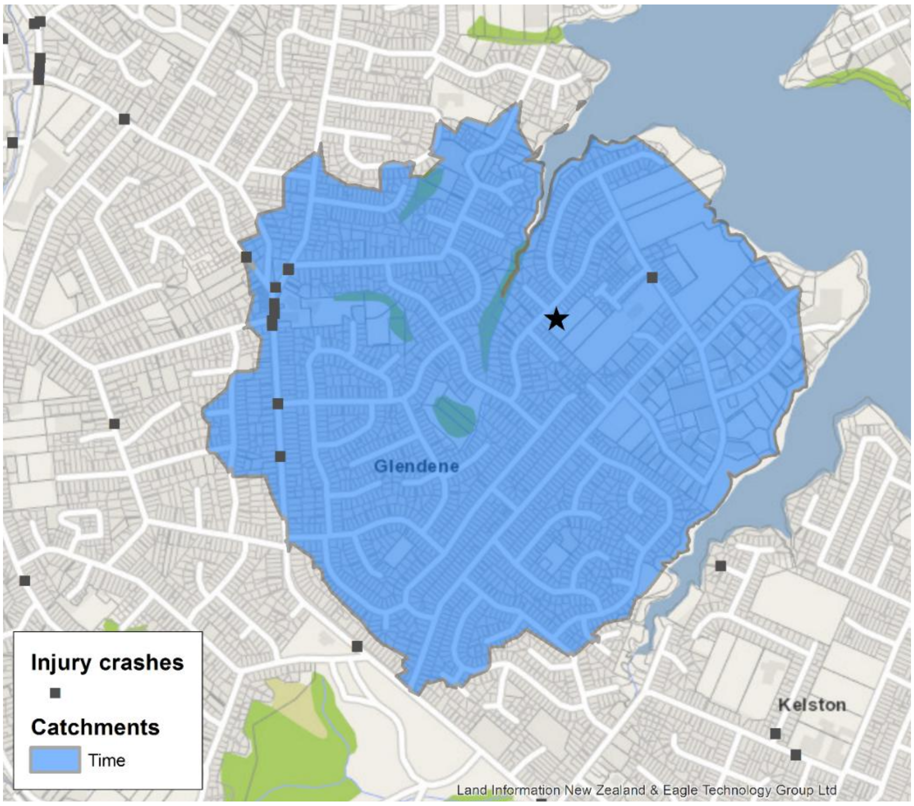

Figure 6. Injury crashes (5 years) and time catchment around the example school (note that the method weights these crashes by the relevant severity indices)

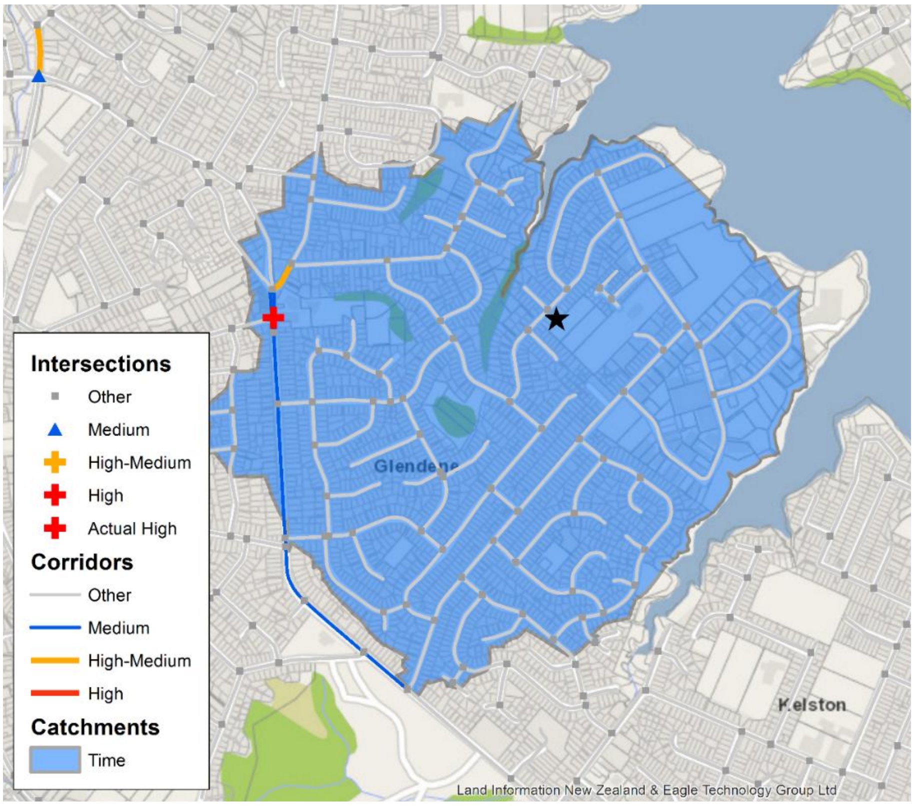

Figure 7. Clustered DSI risk and the time catchment around the example school

Data used in the predicted risk prioritisation of the example school is shown in **Figure 8**, including number of residents that are of the appropriate age for the school. The time catchment contains 708 potential students, while the overlap of time and predicted risk catchments contains only 430 potential students such that 39% of students in the time catchment live outside the predicted risk catchment. The school roll is 147, meaning the number in students living within the time catchment that could potentially be brought into the predicted risk catchment (through some form of safety improvement intervention), weighted for the school roll as described above, is approximately 58. This value would be compared to that of other schools to determine the final ranked priority for the school.

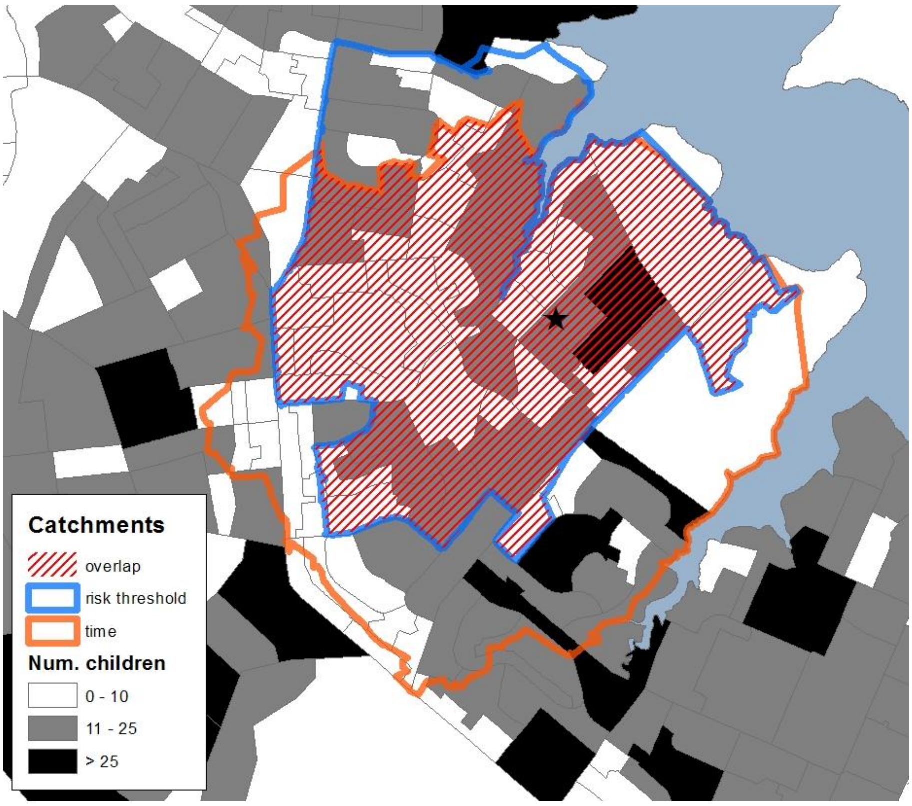

Figure 8. Overlap area compared to time and school aged student populations

DISCUSSION

The prioritisation method represents an improved method of prioritising schools for safety interventions. The development of the method, however, requires a number of assumptions, presents some limitations and raises some interesting points for discussion, as outlined below.

The results comparing students within the overlap of time and risk threshold catchments to students initially walking to school at each school, shown in Figure 3, indicates that the addition of risk reduces the correlation compared to time catchment alone (shown in Figure 2). This indicates pedestrians do not primarily aim to reduce risk in selecting a route to school. This suggests that improvements should be targeted to fall within time catchments and align with existing school travel pedestrian demand.

The method determines the priority classification for each school on the basis of estimated risk, after which schools are prioritised within the classification on the basis of predicted risk. This estimated risk aims to identify risky environments, not just risk related to school travel, and includes cyclist crashes.

School zones are not included in the prioritisation assessment, as fewer than half the schools in Auckland have zones. Future analysis should consider school zones, particularly where the school zone is smaller than the time catchment.

It is unknown how far pedestrians might divert to use a safer crossing. This should be a priority for future work, for example, in conjunction with a case study of actual pedestrian route choice (in terms of risk and time) behaviour for a school. This could include validation of the model by talking with school communities about where they live, where they walk, how they decide where to walk, and whether or not changes to infrastructure would influence their mode choice.

Limitations

No equation was identified for calculating the risk of walking along a road. Consequently, the method makes an assumption that the risk of walking along a road is proportionally less than the risk of crossing a road, using crash data to determine the proportion. The effect of this assumption is unknown, given that the model has not been validated. Future work could expand the literature search or conduct research to identify an appropriate equation.

Pedestrian flows are approximated from census and school data, and scaled up to estimate daily pedestrian travel. This demand is then attributed to proximate areas then the road segments and crossing within each area. This could have a significant effect on the model, as the risk equations include a safety in numbers effect. Future work should develop a more robust method for assigning pedestrian demand to the network.

CONCLUSIONS

The new prioritisation presents an improvement over the existing method for prioritising schools as a means of addressing community transport safety issues. It takes a proactive approach to identify risks without the need for people to be seriously injured or killed to highlight high risk locations. The new method combines accessibility modelling with a number of proactive risk measurement approaches to better identify schools where active mode share and safety can be improved jointly. The spatial nature of the method and its outputs also allows safety and mode share interventions to be more readily identified and tested. This method is well-aligned with the New Zealand road safety strategy 2010-2020 Safer Journeys programme (National Road Safety Committee, 2014), which uses a safe system approach focusing on all elements of road safety to provide a transport system increasingly free of death and serious injury.

ACKNOWLEDGEMENTS

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GLOSSARY

Collective risk	A measure of the total risk of DSI over a crash period (as opposed to personal risk, which is the risk per person/vehicle).
DSI	Number of deaths and serious casualties. May be reported, estimated or predicted.
Estimated risk	An estimate of the risk of DSI calculated from the reported history of all injury crashes weighted by the relevant severity indices for the movement type and speed environment. Usually expressed as DSI equivalents.
GIS	Geographical information system.
Personal risk	A measure of the risk of DSI to each vehicle/person entering the intersection, calculated from the collective risk divided by a measure of flow.
Predicted risk	Risk determined by prediction models based upon the physical and operational characteristics of an intersection that are known to affect crash risk. Usually expressed as DSI equivalents, but in this paper on the basis of crashes (not DSI equivalents).
Reported risk	Summary of the recent history of fatal and serious crashes at a site.
Severity indices	A severity index is the expected ratio of DSI casualties to all injury crashes. Tables of severity indices exist for each crash movement type, intersection type and speed environment. The indices are applied to injury crashes when deriving estimated DSI equivalents.