

CYCLE AND MOTORCYCLE CRASH TRENDS ON AUCKLAND CITY BUS LANE ROUTES

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ABSTRACT

Recognising the Government's encouragement of passenger transport and cycling as travel modes, this study assesses whether increased interaction of cyclists and buses has created a new hazard which runs contrary to road safety objectives. This study investigates whether the implementation of bus lanes changes or creates new types of hazards for cyclists (and motorcyclists), as shown in changes to crash rates or types by those road users. Relevant road safety literature from New Zealand and overseas is reviewed, and the five-year 'before' and 'after' crash statistics for four bus lane routes (plus one control route) are analysed via the CAS database. The results are examined to determine the influence bus lanes have on the safety of cyclists or motorcyclists, and show a range of clear trends, with the correlation of bus lane width and cyclist safety being of particular interest. The research will provide useful information to road safety advocates, transport planner and road designers, and assist in safely designing future routes for both buses and cyclists.

1 INTRODUCTION

The basis for commencing this study was the hypothesis that the implementation of bus lanes changes or creates new types of hazards for cyclists and motorcyclists, and that this should be proven by either (or both) an increase in crashes by those road users and/or an increase in the proportion of crashes attributable to the safety issue being studied.

This study was prompted by personal experience from the first author as a commuter cyclist along the Dominion Rd bus lane and witnessing frequent near-misses (and occasional crashes) between cyclists and motorcyclists using the bus lane and cars crossing the bus lane at side streets, particularly when that car is turning right.

Queued motorists tend to courteously leave a gap in the queue for another vehicle at side street intersections, and right turning motorists into and out of the minor intersection approach, quickly seek to take the opportunity provided but have reduced visibility into the bus lane due to the queued vehicles. Cyclists and motorcyclists using the bus lane then come into potential conflict with turning vehicles (refer to Figure 1). Motorcyclists are particularly at risk, due to their higher speeds. The first author has witnessed the aftermath of several serious crashes of this type, and been directly involved in numerous near-misses.

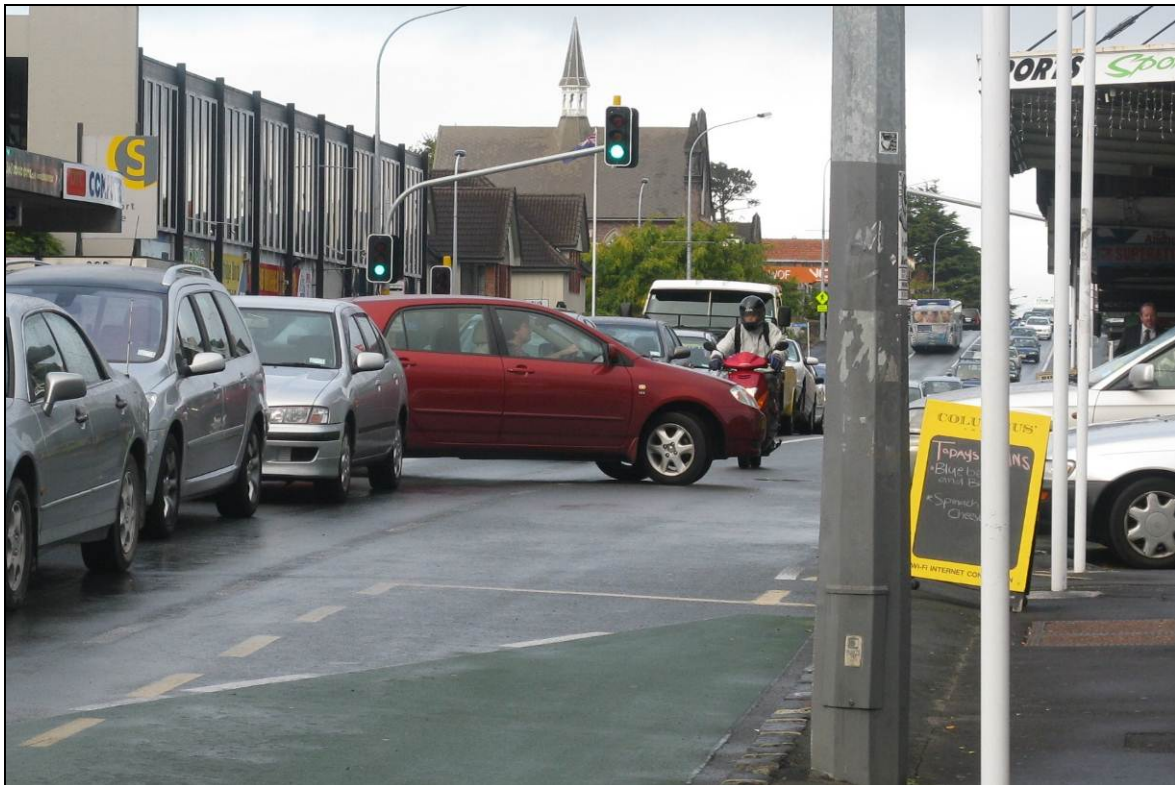


Figure 1 – Right Turning vehicle with limited visibility has come close to colliding with oncoming motorcyclist in bus lane

Anecdotal feedback from Auckland City Council's Road Safety Team is that in known crashes at such bus lane corridors many at-fault drivers stated that they were 'looking for buses' and overlooked the presence of cyclists or motorcyclists. Figure 2 shows typical scenarios of vehicles attempting to cross a heavily congested traffic lane and 'empty' bus lane. As can be seen, this can often lead to conflicts.



Figure 2 - Example of the multiple turning movements across bus lanes and the relative size of a cyclist within the lane

Analysis of this situation is warranted due to the Government's encouragement of passenger transport and cycling as travel modes, and hence the increasing presence of both bus lanes and cyclists on Auckland roads. Additionally, the severe hazard created by the potentially significant speed differential (vehicles travelling up to 50km/hr in the bus lane, versus 0km/hr in the traffic lane) and the need to ascertain the level and type of risk for any further bus lane designers. This research sought to determine whether this crash scenario is worthy of a closer examination. The NZTA Economic Evaluation Manual (2010) assists in this analysis.

This study specifically considers bus lane routes. It is noted that in equivalent multi-lane arterial roads without bus lanes, traffic queues tend to be equally split between both lanes and right turn movements can only occur when queued motorists in both lanes leave a gap – hence there is less chance of conflict with an obscured kerbside vehicle approaching at speed.

2 LITERATURE REVIEW

Research material on a range of relevant topics has been reviewed and considered, both from New Zealand and overseas.

2.1 Auckland Cycling Context

Auckland City Council (2008) found that the 2006 census recorded just over 2000 people as having cycled as their journey to work (1-2% of the total commuters), a level which has remained relatively steady compared to previous years. However this figure excludes cycling for any other trip purpose, such as to school, university or for shopping or recreation, so does not indicate the number of cyclists on Auckland roads.

From a road network of approximately 1400km in length, Auckland City has over 20km of dedicated cycle lanes, over 30km of shared facilities (includes bus lanes and off-road shared paths) and 2200km of footpaths. Around 900 people per year are injured on Auckland City roads. The council found that cyclists made up around 8% of road casualties but were typically 1-2% of road users (refer to Figure 3 for cyclist injury crashes in Auckland City from 2000 to 2009).

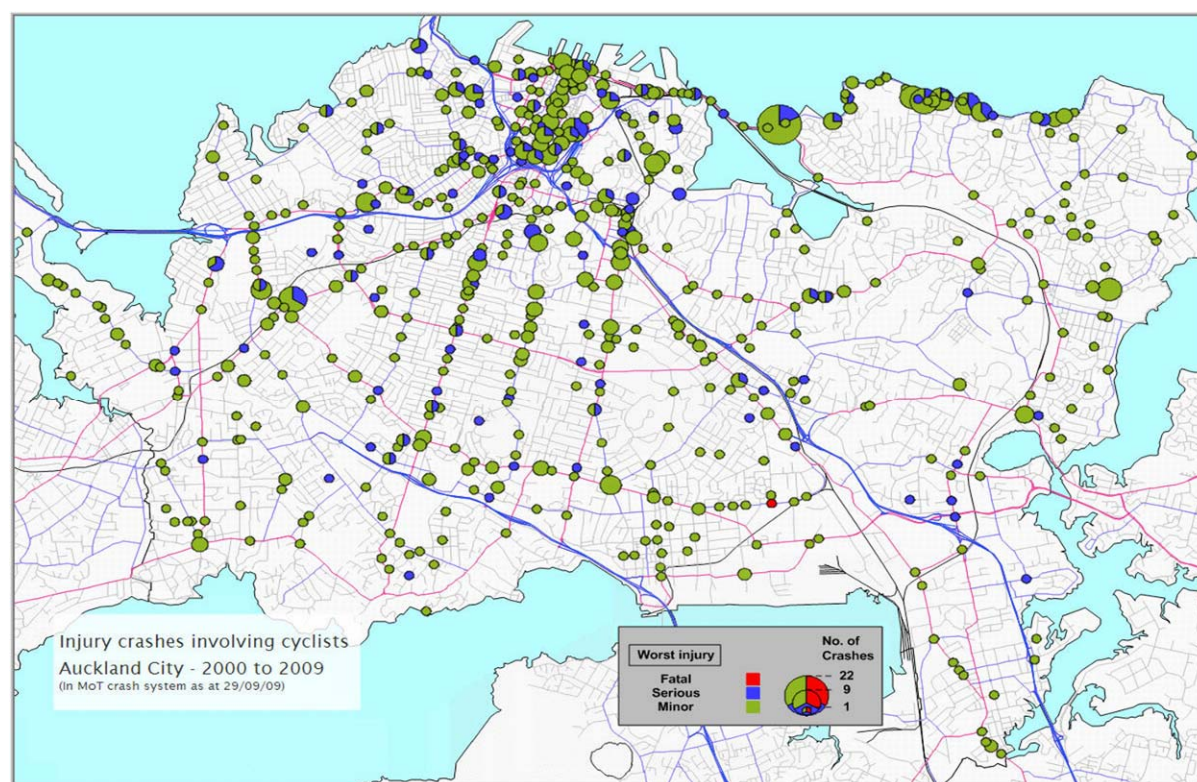


Figure 3- Injury crashes involving cyclists 2000-2009

In terms of the other vehicle involved in cycle crashes, the council noted very low proportions for larger vehicles (i.e. bus 4%, truck 3%) while cars make up 91% of the other vehicle type. The council lists the vulnerability of on-road cyclists and integration with passenger transport infrastructure as key challenges for improving the cycling situation, along with improving the attitudes of other road users.

2.2 Cycle Crash Trends and Locations

Turner, et al (2006) determined that cycle crash trends support the 'safety in numbers' effect, where the risk to each cyclist drops as the number of users increases. Hutchinson (2007) determined that the reason for this is that motorists are more mindful of cyclists. However, Bonham et al (2006) speculated that this safety benefit may accrue mainly to experienced commuter cyclists, who tend to already cycle in a safe and predictable manner, and not to inexperienced cyclists attracted onto the roads.

Auckland City Council (2008) reports that cyclist crash rates in the city are slowly increasing, whilst pedestrian rates are decreasing and motorcyclist crash growth is high. Turner (2006) noted that cyclist deaths nationally have generally been declining and the death/injury rate per 100,000 population has been dropping since 1970. However, this decreasing injury rate was linked to decreasing distances cycled, and therefore reduced exposure risk. Horspool (2008) noted that there is a perception within New Zealand that on-road cycling is unsafe,

partly verified by cyclists having the highest crash rate per distance travelled and being over represented in crash statistics.

Turner (2006) also found that cycling has a higher crash risk than motorised modes of transport, and that the causes tend to be different from those of motor-vehicle crashes. These are important issues, because as the perceived risks from cycling deter more people from participating, the risk per cyclist increases – a self-reinforcing and ever deteriorating situation. Therefore it is critical to identify key cycle safety issues and aim to address them.

Turner (2006) studied crash rates for cyclists in urban centres for the development of crash prediction models (APMs) and found that most reported cyclist crashes occur at intersections. This work also found that half of cycle crashes occur off-road or are on-road but do not involve a motor vehicle. For crashes occurring on-road, between 60 and 75% involved motor vehicles. 42% of crashes were found to occur at mid-block locations or driveways. Koorey (2005) found that 59% of reported urban cycle crashes are at intersections, with a further 19% occurring at driveways.

NZTA's Auckland City Road Safety Report (2009) notes that crossing/turning crashes make up approximately 33% of crash movement types. Poor observation (45%) and failure to give way (33%) are most common contributing factors to Auckland crashes, whilst "cyclist factors" contribute to less than 5%. An increasing number (61%) are at intersections.

In a GIS clustering study of Auckland cycle crashes, Horspool found that over 90% occurred within 20m of an intersection and the number drops off exponentially as the distance is increased. There were few mid-block crashes. Crash frequency were at the greatest density in the central business district as would be expected due to the greatest vehicle exposure, with the other main risk area being at busy intersections near shops.

Looking specifically at studies on bus lane routes, Ragland (2008) found that many vehicles failed to give way to pedestrians and cyclists. On-road cyclists were noted as having difficulty navigating among vehicles during lane changes, something not necessarily peculiar to bus lane corridors.

2.3 Relevant Factors in Cycle Crashes

As part of the study described previously, Turner (2006) found 'traffic failed to notice me' (48%), or 'traffic failed to give way to me' (28%) were identified by the cyclists as the main causal factor in the reported crashes. This is a key trend identified in a number of studies. Turner showed that in a Christchurch Hospital survey of injured cyclists, a high percentage (76%) of cyclists stated that other traffic failed to notice them or failed to give way to them.

Internationally, Knowles (2009) found that the driver having 'failed to look properly' was a key contributory factor for drivers at intersections, being identified in approximately 60% of serious crashes. 'Failed to look properly' was attributed to the car drivers in 57% and to the cyclist in 43% of serious collisions. The studies do not distinguish between whether vehicle drivers are looking but fail to see the cyclist or alternatively they fail to look for them. Equally, the strategies adopted by cyclists at intersections are also not well understood.

3 DATA COLLECTION

3.1 Methodology

To choose a group of comparable routes suitable for the assessment, a set of criteria was developed:

- A full five-year post-implementation crash record available (i.e. installed pre-2004)
- A typical urban residential route leading into the CBD edge, with multiple sidestreets (i.e. not a CBD or motorway location).
- A generally four-lane arrangement consisting of two bus lanes and two traffic lanes

Using the above criteria, four bus lane routes emerged as candidates for assessment (described in Table 1):

Table 1- Selected bus lane routes and details

Bus Lane Route and Location	Year implemented	Approximate Length (km)	Typical bus lane width
Dominion Rd – from Memorial Ave to View Rd	1998	3.7	3.0m
Mt Eden Rd – from Wairiki Rd to Symonds St	1998	3.1	3.25m
Sandringham Rd – from Grove Rd to New North Rd	1999	2.0	3.25m
Great North Rd – from Point Chevalier Rd to Newton Rd	2000	4.2	4.5m

For comparison purposes, a 'control' route without a bus lane was selected. This was New North Rd between Symonds St and Kitenui Rd (approximately 3.9km long with a typical kerbside lane width of 3.3m). This route was selected as it met the bus lane criteria (four-lane residential route leading into the CBD) but had not been treated as a bus lane route (other than a short section near Kingsland). To be consistent with the other routes, a 'year of implementation' of 2000 was chosen.

Crash data was obtained from the online Crash Analysis System (CAS) database, which contains all reported traffic crashes in New Zealand. For each route, using the year of implementation noted above, the CAS database was examined to extract information on the five year periods before and after that date. The information extracted from the CAS database requested every recorded crash involving the road user type of 'cycle', 'moped' or 'motorcycle'. The extent of route studied was only that along which bus lanes were present, not for the entire length of the route. Typically this meant that sections of each route furthest from the CBD were excluded from the assessment.

In order to treat each route consistently, typical traffic volumes were identified at a section where bus lanes are present along each route from recent year traffic counts and a growth factor determined. The volumes listed in Table 2 are seven day average ADT for the combined directions.

Table 2 - Route vehicular traffic information

Route	Typical traffic ADT 2004	Typical traffic ADT 2009	Simple growth rate
Dominion Rd (at Landscape Rd)	25022	24289	-3%
Mt Eden Rd (at Balmoral Rd)	22676	21663	-4.5%
Sandringham Rd (at Gribblehurst Rd 2004, Rossmay Terrace 2009)	19376	17483	-10%
Great North Rd (at Bullock Track)	21466	21960	2%
New North Rd (at Western Springs Rd)	17660	15378	-13%

As a general indicator of cyclist volumes and growth patterns, Auckland City Council's latest cycle monitoring programme was examined. Only three of the routes were part of the annual cycle monitoring programme, therefore no data was available for Mt Eden Rd or Sandringham Rd. ADT data has only been available since 2007, so the growth in the period 2007 to 2010 has been used. The data showed wide variability, however, across all routes within Auckland City, the 2010 cycle counts increased by 34% on 2009, and were up 64% on ten years ago (refer to Table 3).

Table 3 - Route cyclist information

Route	Typical cycle ADT 2007	Typical cycle ADT 2010	Simple growth rate
Dominion Rd (at Balmoral Rd)	344	296	-14%
Great North Rd (at Ponsonby Rd)	705	807	14%
New North Rd (at Mt Albert Rd)	226	306	35%

4 RESULTS

It is acknowledged that the relatively short sections of routes assessed meant that in many cases there were only low numbers of reported crashes to analyse. For instance, Sandringham Rd had 13 relevant crashes in the five year 'before' period and 14 in the five year 'after' period. The highest number of crashes identified on any one route was 65 in the Dominion Rd 'after' period. However, while the low numbers mean that the indicated results may not be statistically robust, the identified trends are valid insofar as they are discussed.

4.1 Total Cycle or Motorcycle Crashes

Overall, the results of the assessment showed that in general, there was no discernable increase in cycle or motorcycle crashes along bus lane routes following the implementation of bus lanes, with the sole exception of Dominion Rd – where a large increase was recorded. This would indicate that there are specific circumstances along Dominion Rd which have led to this increase, and those circumstances do not apply to the remaining studied routes.

As can be seen in Figure 4 below, the number of crashes in the years following the introduction of bus lanes along Dominion Rd rose by over 30%, whereas each of the other routes experienced a reduction or slight increase (which, given traffic volume increases, is effectively a reduction). These results would indicate bus lanes have little, if any, overall effect on the safety of cyclists or motorcyclists – pending the identification of the factors contributing to the Dominion Rd crash increase.

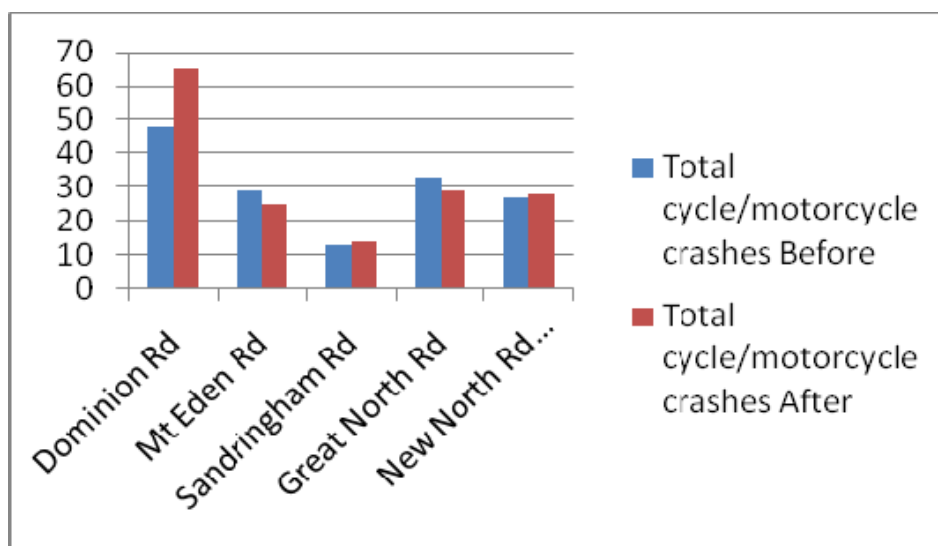


Figure 4 - Total cycle/motorcycle crashes before and after

4.2 Cycle Crashes

There is no clear trend in cycle crashes comparing the 'before bus lane' and 'after bus lane' crash numbers (refer Figure 5). Although most routes experienced a slight increase in reported crashes, this is within the range to be expected by either a growth in traffic volumes or cyclist numbers (or both). Given the significant increase in Dominion Rd motorcycle crashes, it is perhaps interesting to note the lack of a similar trend in cycle crashes along that route. If the original hypothesis was correct, it would be expected that a much more pronounced increase would be evident on bus lane routes, however this is not the case.

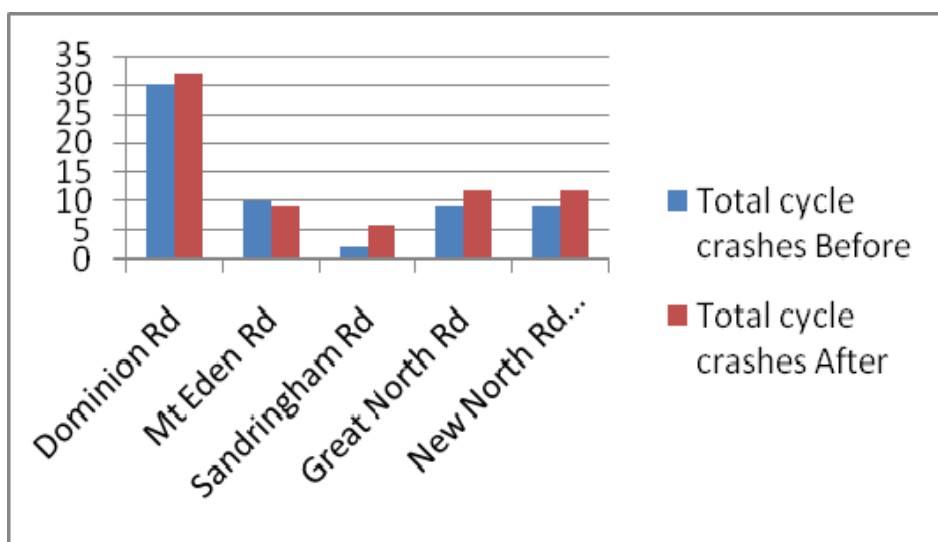


Figure 5 - Cycle crashes before and after

4.3 Motorcycle Crashes

One of the most interesting results is for the trends in motorcycle crash numbers. Every route decreased in reported motorcycle crashes - with the exception of Dominion Rd which increased by over 80% (refer to Figure 6). Given the regional road safety concerns about

increased rates of motorcycle crashes, it is surprising that there has been such a consistent decrease across so many of the studied routes.

This tends to indicate that there are specific problems with certain routes that makes them more unsafe for motorcyclists. There is no current data available on these routes on the proportion of motorcycle traffic on individual routes and furthermore whether they were travelling in the bus lanes or within the normal traffic lane. It would however seem unreasonable to assume that Dominion Rd motorcycle volumes have increased by a rate that matches the increase in reported crashes, whilst the other routes have experienced decreased motorcyclist numbers.

It is also interesting to note that the decrease in motorcycle crashes on those other routes is substantial in most cases, especially as traffic growth rates would mean that even a slight increase in crash numbers could arguably be a reduction in the crash rate. If the original hypothesis was correct, it would be expected that a clear increase would be evident on all bus lane routes, however this is clearly not the case and Dominion Rd appears to have a significant safety issue for motorcyclists to address.



Figure 6 - Motorcycle crashes before and after

4.4 Midblock versus intersection crashes

One area where bus lanes do appear to create a change in cycle or motorcycle crashes is in relation to the location (either midblock or at intersections). The results showed a consistent decrease in midblock cycle or motorcycle crashes after bus lanes had been installed (refer Figures 7 and 8). In comparison, the control route of New North Rd experienced a substantial increase in midblock cycle crashes. As crashes are identified as either located at an intersection or midblock location, the corresponding results for intersections showed the opposite – a consistent increase in cycle/motorcycle crashes on bus lane routes.

A reason for this may be the reduction in conflicting interaction between cyclists or motorcyclists and general traffic along midblock locations, where bus lanes are more typically present. The usual bus lane design along the studied routes includes midblock bus lanes starting just after and ending just prior to large signalised intersections. Therefore it would be expected that cyclist or motorcyclists would be more likely to interact with other vehicles

at intersections, where they must once again utilise the same lane and negotiate each other's turning and stopping movements.

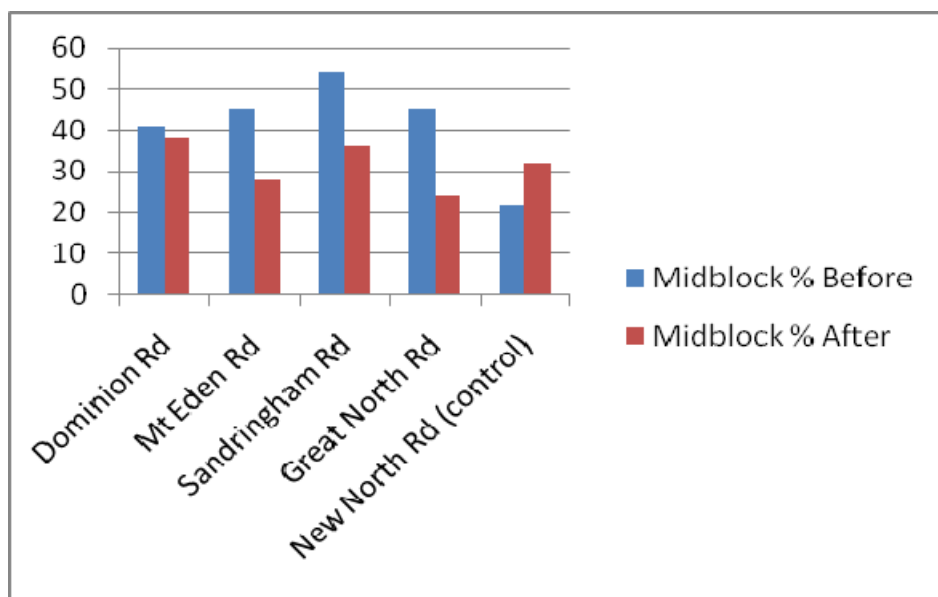


Figure 7 - Percentage of crashes occurring midblock before and after

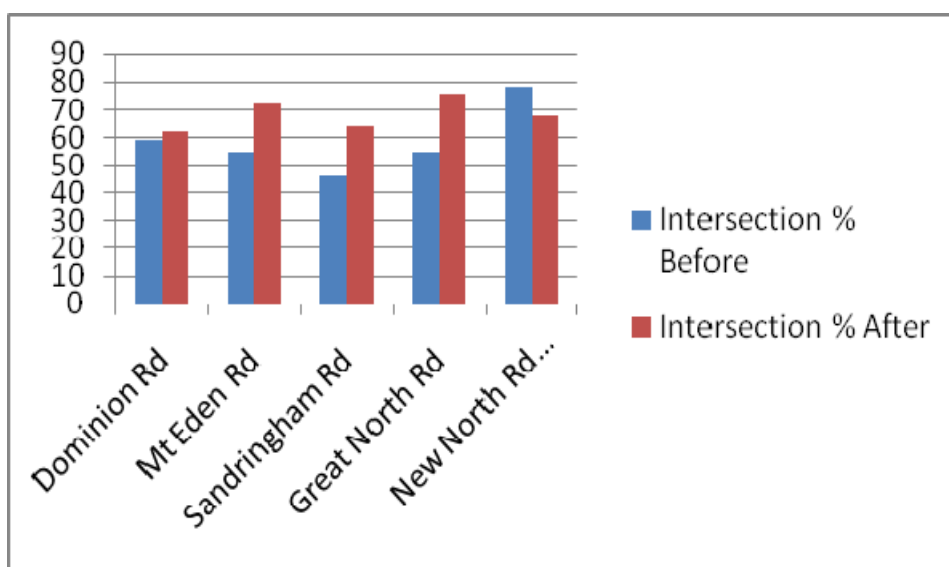


Figure 8 - Percentage of crashes occurring at intersections before and after

4.5 Day versus night crashes

Similarly, another area where bus lanes appear to create a change in cycle or motorcycle crashes is in relation to the time of the crash (as assumed by the description of 'light/overcast' meaning daytime and 'dark/twilight' meaning night-time). Assuming that cyclist and motorcyclist trips occurred at similar times in the 'before' and 'after' periods, the result show a consistent although relatively moderate increase in daytime cycle or motorcycle crashes for all routes where a bus lane had been installed (refer to Figure 9).

As with the midblock/intersection results, the control route of New North Rd experienced the opposite result - a very minor decrease in daytime cycle or motorcycle crashes. As crashes

are identified as either daytime or night-time, the corresponding results for night-time crashes showed a consistent but a greater degree of decrease in night-time cycle or motorcycle crashes on bus lane routes and once again an opposite increase on the control route.

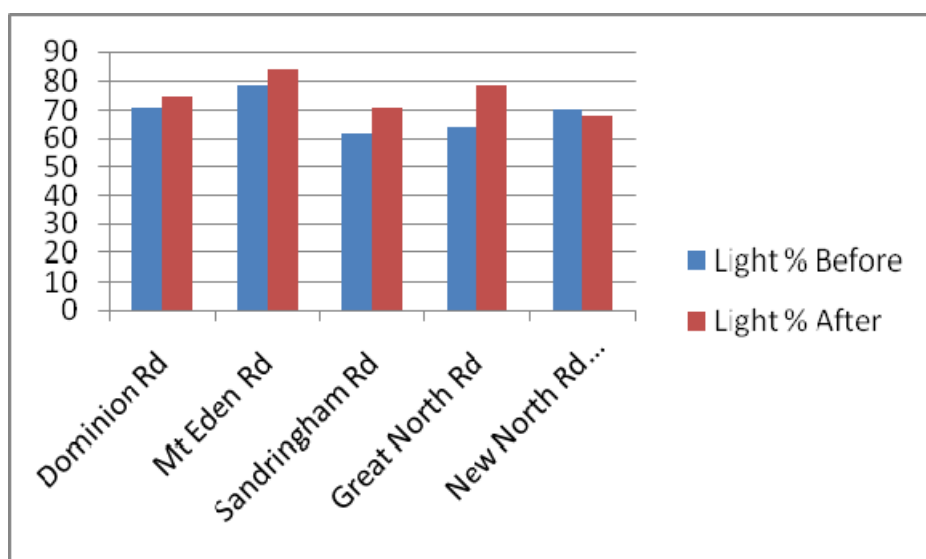


Figure 9 - Percentage of crashes occurring during daytime before and after

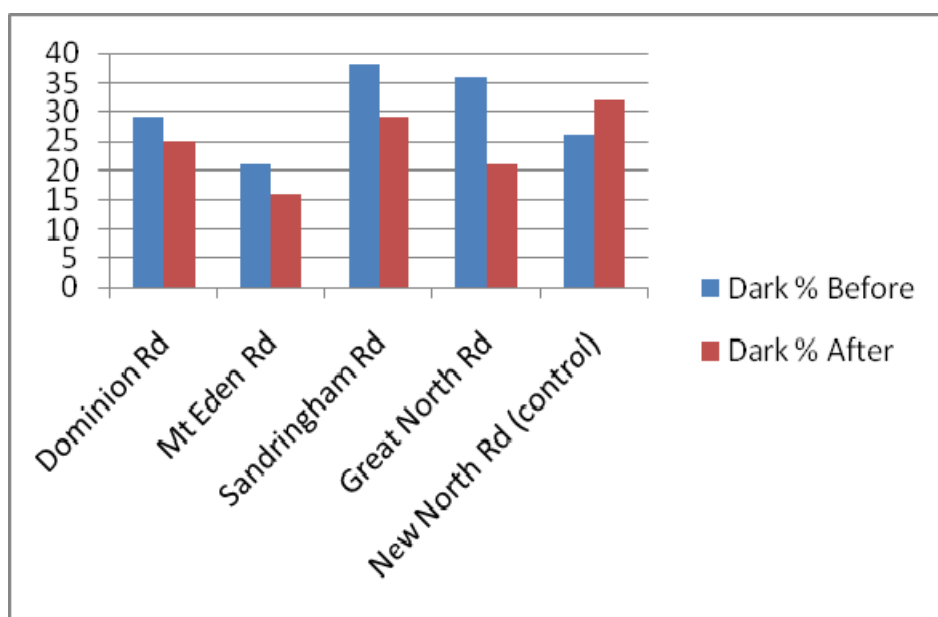


Figure 10 - Percentage of crashes occurring during night-time before and after

4.6 Other factors

The study also assessed factors relating to weather and the day of the week when the crash occurred. These results for the routes considered were unremarkable and are not elaborated further. The vehicle types involved in cycle and motorcycle crashes were also assessed to determine whether there was a change in the proportion involving buses. Again the results were unremarkable, which indicates that cyclists and motorcyclists sharing bus lanes with more free-flowing buses (operating at higher speeds due to the lack of traffic

congestion) do not particularly appear to be at a greater risk than when sharing a general traffic lane with those buses operating at the slower speed of general traffic.

The injury types resulting from crashes involving cyclists and motorcyclists were also analysed to determine whether post-bus lane crashes were any more or less severe than previously. Again the results were unremarkable.

4.7 Crash causes

A core driver for this study was the hypothesis that the implementation of bus lanes creates a new type of hazard for cyclists and motorcyclists, and that this should be proven by either (or both) an increase in crashes by those road users and an increase in the proportion of crashes attributable to the safety issue being studied. The relevant crash causes for this study are identified as 'crossing or turning', 'failure to give way' and possibly 'poor observation' crashes. This is based on the proposition that the presence of the bus lane next to a congested traffic lane creates an increased risk from turning vehicles (and their relative lack of visibility into the bus lane). In all cases outlined below it is the proportion (in terms of percentage) which is assessed, rather than the raw data.

For 'crossing or turning' cycle and motorcycle crashes and 'rear end or obstruction' crashes, the results were unremarkable. The literature review indicated that 'failure to give way or stop' was a leading factor in cycle crashes, however the results were again unremarkable.

Overtaking crashes were not expected to vary significantly, however the results do indicate a trend for an increase in the proportion of cycles and motorcycles involved in overtaking crashes (refer to Figure 11). Moreover, this result shows a major increase in the Dominion Rd route, indicating that the introduction of the bus lane along that route has indeed changed the situation such that overtaking crashes are more prevalent. Although the numbers involved in the remaining routes remain low and are therefore not necessarily as reliable, this crash cause is one of the few within this study to show a consistent change.

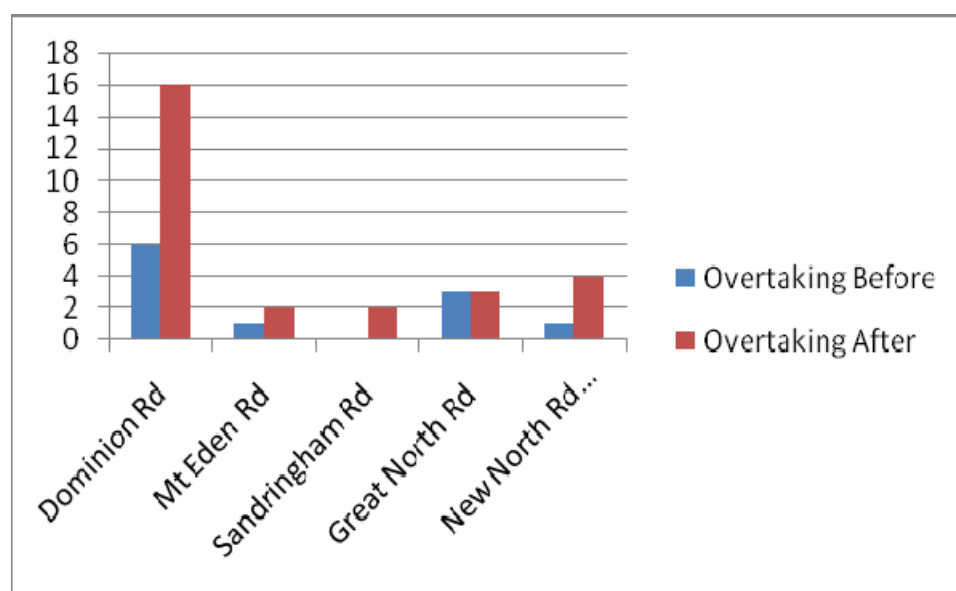


Figure 11 - Percentage of overtaking crashes before and after

4.11 Accident rate assessment

The New Zealand Transport Agency's Economic Evaluation Manual (Appendix A6, 2010) was used to assess the relative accident rates of the routes. It is noted that the selected routes and subject areas mean there is a limited amount of data available for analysis. As two routes did not record cyclist data, these have been excluded from the analysis, as such data is necessary to determine typical crash rates. The exposure rate for each route, was calculated, along with the expected 'site specific' accident rate.

Following the analysis of the existing crash rates, it was then necessary to determine the expected or typical crash rates for these routes. The two models used for assessing these routes were the "Conflict – urban mid-block pedestrian and cyclist facilities" and "Conflict – urban signalised crossroads" models. These were the only models which provided a specific cyclist assessment, which was the focus of this study. It is recognised that the majority of the intersections along the study routes are priority-controlled T and crossroads, however the models for these types of intersections do not allow for cyclist accident rates to be determined separately.

In simplistic terms, the combined midblock and intersection results is a representation of the typical annual crash rates for cyclists on these routes. This can then be compared to the actual crash rates (refer to Table 4).

Route	Typical midblk. rates	Typical int. results	Combined results	Actual rates	Ratio actual/typical
Dominion Rd	2.158	0.114	2.272	4.98	2.19 ≈ 2.2
Great North Rd	2.590	0.199	2.789	1.49	0.53 ≈ 0.5
New North Rd	1.319	0.128	1.447	1.49	1.03 ≈ 1.0

Table 4 - Expected cyclist crash rates per annum compared to actual

These results show that Dominion Rd has more than double the expected cycle crashes, whilst Great North Rd has around half the expected cycle crashes. Interestingly New North Road, the control route, has almost exactly the expected number of cycle crashes.

A likely explanation for this result is that the Dominion Rd bus lanes are 3.0m wide, whereas the Great North Rd bus lanes are typically closer to the 4.5m recommended standard width. The New North Rd traffic lanes vary in width but are typically 3.25-3.5m. This would seem to indicate that as would be expected the more generous bus lane widths up to the recommended widths result in a lower cyclist crash rate, whereas a narrower than standard bus lane width can increase the cyclist crash rate. There seems to be little else to differentiate the routes from each other in a way that aligns with the ratio of actual versus typical crash rates.

5 DISCUSSION

A core basis for commencing this research project was the hypothesis that the implementation of bus lanes creates a new type of hazard for cyclist and motorcyclists, and that this would be proven by new patterns in the crash statistics for bus lane routes. The reality has shown something quite different.

There was found to be no discernable increase in cycle or motorcycle crashes along bus lane routes in general following the implementation of bus lanes, with the sole exception of Dominion Rd – where a large increase was recorded. The isolated and large nature of the

Dominion Rd increase would indicate that there is a significant safety issue to be addressed along that route and indications are that this is strongly related to the bus lane width being too narrow – however further analysis of crash data sheds little light on the actual cause or nature of this problem.

Overall, the results indicate the implementation of bus lanes have little, if any, effect on the safety of cyclists or motorcyclists. There is virtually no change on any studied route in terms of cycle crashes, and an overall decrease in reported motorcycle crashes on all routes except Dominion Rd - which increased by over 80%. This lack of general growth in motorcycle crashes (bar Dominion Rd) is surprising given the regional road safety concerns about increased rates of motorcycle crashes.

One area where bus lanes do appear to create a change in the pattern of cycle or motorcycle crashes is in relation to the location. The results showed a consistent decrease in midblock cycle or motorcycle crashes after bus lanes had been installed. Notably, the control route of New North Rd experienced a substantial increase. This is potentially attributable to the relative lack of cyclist or motorcyclist interaction with general motorists in midblock locations. At intersections, however the results showed increases in cycle and motorcycle crashes. Another area where bus lanes appear to create a change was in regard to daytime versus night-time crashes. The results showed a consistent increase in daytime cycle or motorcycle crashes for all routes where a bus lane had been installed.

Whilst there was also no clear pattern in the proportion of crashes involving a bus, this indicates that the presence of a bus lane (which can be seen to increase the speed of buses) does not appear to cause a safety issue for cyclists and motorcyclists.

Overtaking crashes were not expected to vary significantly, however the results indicated a trend for an increase in the proportion of cycles and motorcycles involved in overtaking crashes. Additionally, this result identifies a major increase in the Dominion Rd route, indicating that the introduction of the bus lane along that route has changed the situation such that overtaking crashes are more prevalent.

Using NZTA's Economic Evaluation Manual, it was shown that Dominion Rd has more than double the expected cycle crashes, Great North Rd has around half and New North Road has almost exactly the expected number of cycle crashes. A reasonable explanation of this can be attributed to the variation in bus lane widths. It would seem that more generous bus lane widths up to the recommended design standard results in a lower cyclist crash rate, whereas a narrower than standard bus lane width can increase the cyclist crash rate.

6 CONCLUSIONS

The study has shown that:

- a) the implementation of bus lanes have little, if any, effect on the average crash rate of cyclists and motorcyclists using the bus lanes and therefore little effect on the overall safety of cyclists or motorcyclists.
- b) bus lanes appear to decrease midblock cycle or motorcycle crash rates, and proportionally increase them at intersections
- c) there appears to be a link between lane width and cycle crash rates, with the narrowest bus lane (3.0m - Dominion Road) having the highest crash rate and the widest (4.5m - Great North Road) having the lowest crash rate.
- d) Dominion Road showed a specific motorcycle crash problem not present in the other bus lane routes.

It is recommended that a specific crash reduction study be undertaken into motorcycle crashes along Dominion Rd. No further road safety actions are generated by this study, other than to provide information to road controlling authorities about the relative safety implications for cyclists and motorcyclists of implementing a bus lane along a route.

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