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Wang, JYT, Mirza, L, Cheung, AKL et al. (1 more author) (2014) Understanding factors influencing choices of cyclists and potential cyclists: A case study at the University of Auckland. Road and Transport Research: a journal of Australian and New Zealand research and practice, 23 (4). 37 - 51. ISSN 1037-5783

Understanding factors influencing choices of cyclists and potential cyclists: A case study at the University of Auckland

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Abstract

Like many other cities in the world, Auckland has been very much a car-based city for decades with a car modal share of almost 80%. Promoting the use of active modes, including walking and cycling, is no doubt one of the key strategies that should be considered. To help transform Auckland into a bicycle-friendly city, our first step is to determine the motivators of and deterrents to cycling. This study has two components. We first performed a comprehensive literature review of the lessons from international experience, focussing on what factors were found to have significant influence on the decision to use bicycles as a mode of transport. Based on the findings, we designed a web-based survey to identify the factors influencing the decision to commute by bicycle or not, as well as cyclists' and potential cyclists' route choice criteria. A pilot survey was conducted at the University of Auckland as a case study. The survey results are consistent with our findings from the literature review. We conclude that there are five main factors missing in Auckland: (1) safety; (2) a well-connected network of cycleways; (3) convenience; (4) policies to discourage car use; and (5) a good public transportation system integrated with cycling facilities.

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1 Introduction

Like many other cities in the world, Auckland has been very much a car-based city for decades. Tin Tin *et al.* (2009a) analysed the New Zealand (NZ) Journey-to-Work Statistics over a 15-year period (1991-2006) and concluded that increased car use from 1991 to 2006 occurred at the expense of active means of travel, including walking and cycling, as the trends in public transport use remained unchanged during that period. Auckland's transport system currently accommodates 4.2 million passenger trips each day, with modal shares of 80% private transport (mainly car), 16% active modes (mainly walking) and 4% public transport (mainly bus) (Auckland Council, 2011). This shows that Auckland's transport system is not sustainable at all as it is heavily reliant on fossil fuels. As summarised in May & Crass (2007), a sustainable transport system should:

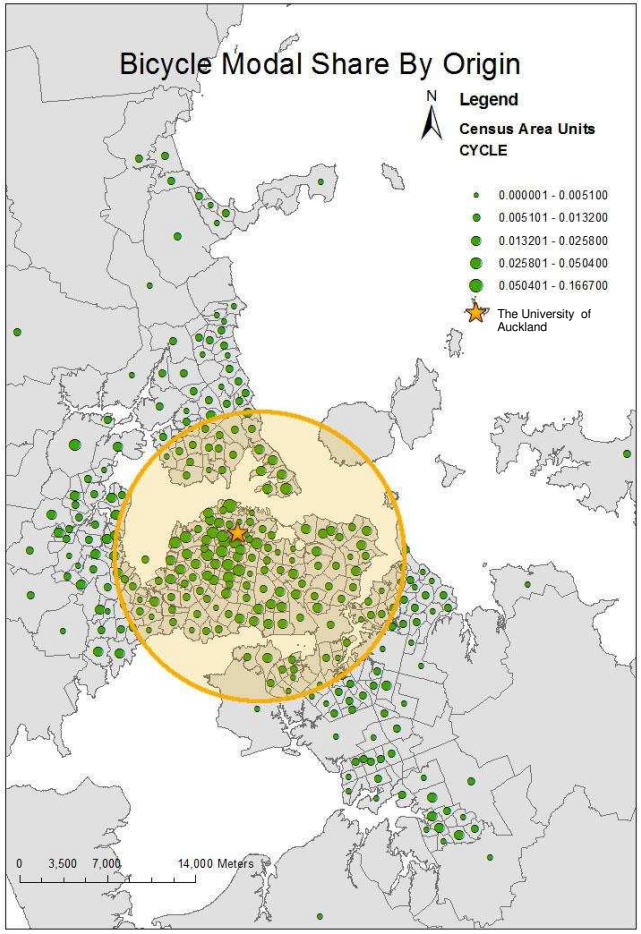
- Promote health (social sustainability);
- Increase equity within and between generations (social sustainability);
- Be affordable and efficient (economic sustainability);
- Use resources within renewal or replacement rates (economic and environmental sustainability); and
- Minimise the use of land (economic and environmental sustainability).

Applying this philosophy to transport planning, cycling is no doubt one of the most sustainable modes among all the transport modes, while the use of cars is definitely not sustainable. Cycling promotes health, does not require non-renewal resources like fossil fuels, does not produce vehicle emissions, poses less risk to other road users, and occupies much less space than cars.

Based on Census statistics of journeys to work in NZ, the modal share of bicycles is only 2.3% nationwide while in Auckland it is 0.9%, whereas the modal share of car trips is 74.8% nationwide and 78.8% in Auckland (Statistics NZ, 2006). Spatial analysis of the Census 2006 journey-to-work statistics of Auckland is performed to identify the current demand patterns of cycling trips are as illustrated in Figure 1. It is observed that bicycle commuting trips are concentrated around the central area, as highlighted by the circled areas in Figure 1.

Lindsay *et al*. (2010) estimated that a 5% of modal shift of short trips by motor vehicles nationwide is consistent with the goal of 30% modal share of urban trips by walking and cycling in the New Zealand Transport Strategy (MoT, 2008). However, based on the data collected from a marketing survey conducted by Sport and Recreation NZ (SPARC) and the Cancer Society of NZ to segment adults in terms of physical activity and healthy eating habits, Sullivan & O'Fallon (2006) found that the percentage in the 'precontemplation' stage, i.e. those who do not even consider using a bicycle, was as high as 45% for Auckland. For school children, Mackie (2009) found that the most significant barriers to students cycling to school for six intermediate schools were: the route to school, the amount and speed of traffic, crossing busy roads, and personal and bike security. As a result, the need for safe routes to school was a very clear priority for students and parents.

Promoting the use of active modes, including walking and cycling, is no doubt one of the key strategies to improve sustainability in transport (Auckland Council, 2011). In this study, our objective is to determine what might have been the deterrents to cycling in Auckland and what motivators might be effective to promote cycling.



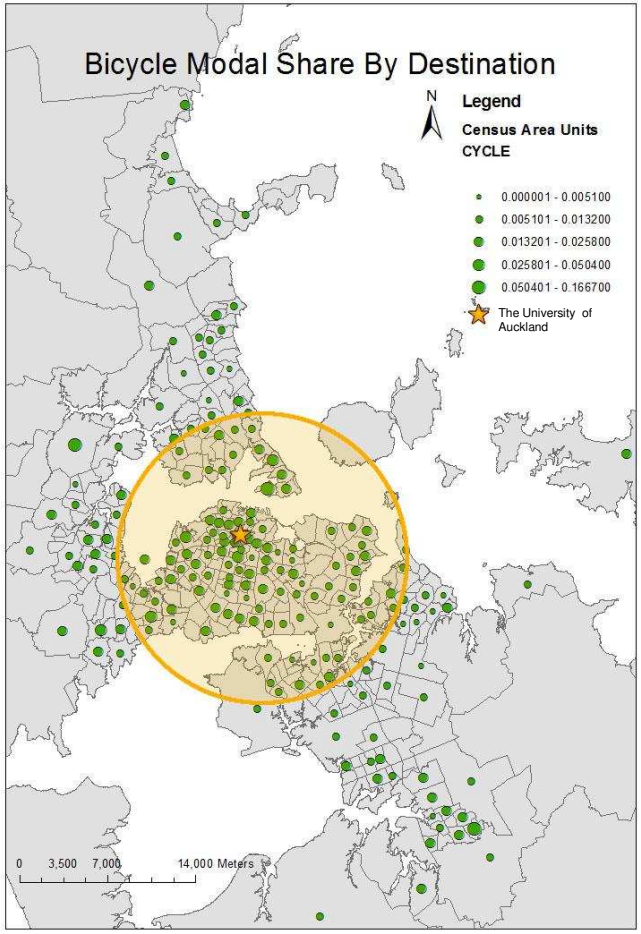


Figure 1 (a) & (b) Spatial pattern cycle trip modal share in Auckland by origin & destination (derived based on census data 2006 provided by Statistics NZ)

Table 1 Summary of a literature review on motivators of and deterrents to cycling

Motivators (Safety; Cycleways)

No.	Reference	Case Study	Safety Education	Low Traffic Volume	Presence of Safety Cameras	Low Traffic Speed	Better Lighting	Higher Population Density	Good Land-use Mix	Shorter Commuting Distances	Beautiful Scenery	Continuous Bike Facilities	Infrastructure	Smooth Surface Quality	Traffic Calming for Cyclists	Direct Route (Shorter Distances)	Flat to Moderate Hills	Off-street Path	Segregated Bike Paths and Routes
			Safety								Cycleways								
1	Betz *et al*., 1993	USA																	
2	Antonakos, 1994	Michigan	*	*		*								*					*
3	Hopkinson & Wardman, 1996	Britain																	
4	Stinson & Bhat, 2003	USA		*								*		*			*		*
5	Dill & Carr, 2003	USA											*						
6	Stinson & Bhat, 2004	USA	*						*	*			*				*		
7	Hunt & Abraham, 2007	Canada						*	*			*			*		*		
8	Gatersleben & Appleton, 2007	UK	*										*				*		*
9	Tilahun *et al*., 2007	USA																	
10	Martens, 2007	The Netherlands																	
11	Dill & Voros, 2007	USA		*		*			*			*	*	*		*			*
12	Wardman *et al*., 2007	UK																	
13	Parkin *et al*., 2008	UK census		*															*
14	Pucher & Buehler, 2008a	USA	*																*
15	Pucher & Buehler, 2008b	Review (Denmark, Netherland, Germany)	*						*										*
16	Akar & Clifton, 2009	USA	*		*		*		*	*		*		*	*	*			*
17	Koorey *et al*., 2009	Christchurch																	
18	Winters & Teschke, 2010	Vancouver (Canada)																	*
19	Winters *et al*., 2011	Vancouver (Canada)		*			*				*						*	*	*

Motivators (Discourage Car use; Convenience; PT)

No.	Reference	Case Study	Presence of Safety Cameras	Increase Fuel Cost	Limited Auto Parking	Speed Limit in Residential Area (30 km/h)	Car Free Zones	Give Cyclist Priority (Cycling Right-of-way)	Low Traffic Speed	Secure Parking at Work	Availability of Rental Bikes	Detailed Hardcopy Maps	Presence of Shower and Locker at Workplace	Providing Internet Route	Promotional programs and Financial incentives	Linking Bicycles with Public Transport	Parking Facilities at Stations
			Discourage Car use							Convenience						PT	
1	Betz *et al*., 1993	USA												*		*	
2	Antonakos, 1994	Michigan							*								
3	Hopkinson & Wardman, 1996	Britain															
4	Stinson & Bhat, 2003	USA															
5	Dill & Carr, 2003	USA															
6	Stinson & Bhat, 2004	USA			*					*			*				
7	Hunt & Abraham, 2007	Canada															
8	Gatersleben & Appleton, 2007	UK															
9	Tilahun *et al*., 2007	USA															
10	Martens, 2007	The Netherlands														*	*
11	Dill & Voros, 2007	USA							*	*			*			*	
12	Wardman *et al*., 2007	UK								*			*		*		
13	Parkin *et al*., 2008	UK census															
14	Pucher & Buehler, 2008a	USA					*			*		*		*	*	*	
15	Pucher & Buehler, 2008b	Review (Denmark, Netherland, Germany)				*	*	*		*	*	*		*	*	*	
16	Akar & Clifton, 2009	USA	*	*								*					
17	Koorey *et al*., 2009	Christchurch								*			*				
18	Winters & Teschke, 2010	Vancouver (Canada)															
19	Winters *et al*., 2011	Vancouver (Canada)						*									

Deterrents (Convenience; Discourge Car Use; Cycleways; Safety)

No.	Reference	Case Study	Type of Destination	Time of Departure	Dress Code	Longer Travel Time	Employment Status (i.e. part/full-time, etc.)	Adverse Weather Condition	Pollution & Noise	Gradient	Dangerous Traffic Condition	Lack of Daylight	Percentage of Heavy Traffic	Street with Auto Parking	Number of Difficult Intersections	Inconsiderate Drivers
			Convenience						Discourge Car Use	Cycleways	Safety					
1	Betz *et al*., 1993	USA														
2	Antonakos, 1994	Michigan	*	*	*											
3	Hopkinson & Wardman, 1996	Britain				*										
4	Stinson & Bhat, 2003	USA				*							*	*	*	
5	Dill & Carr, 2003	USA														
6	Stinson & Bhat, 2004	USA				*		*			*	*				
7	Hunt & Abraham, 2007	Canada								*						
8	Gatersleben & Appleton, 2007	UK						*		*			*			
9	Tilahun *et al*., 2007	USA														
10	Martens, 2007	The Netherlands														
11	Dill & Voros, 2007	USA	*				*	*		*						
12	Wardman *et al*., 2007	UK														
13	Parkin *et al*., 2008	UK census														
14	Pucher & Buehler, 2008a	USA														
15	Pucher & Buehler, 2008b	Review (Denmark, Netherland, Germany)									*					
16	Akar & Clifton, 2009	USA									*					
17	Koorey *et al*., 2009	Christchurch														
18	Winters & Teschke, 2010	Vancouver (Canada)														
19	Winters *et al*., 2011	Vancouver (Canada)						*	*							

There are two key components in this study. We first conducted a comprehensive literature review of the lessons from international experience from successful countries such as the Netherlands, Denmark and Germany, and unsuccessful countries such as UK and USA, focussing on what factors were found to have significant influence on the decision to use bicycles as a mode of transport.

Based on the findings from the literature review, we designed a web-based survey to fulfil two objectives: (1) to understand why the current bicycle modal share is so low, what the motivators that can attract potential cyclists are and, in particular, how their decisions to cycle or not are influenced by the built environment; and (2) to understand what factors are influencing the route choice of current and potential cyclists.

A survey was conducted via the University of Auckland intranet during the period 7th April to 6th May 2011. There were over 140 participants in total, including staff and students of the university. An incentive was given as an opportunity to win a NZ$50-coupon for the University Bookshop in a lucky draw. The location of the University of Auckland is right in the city centre of Auckland, as shown in Figure 1.

In this paper, we will first present the key findings from our literature review in Section 2, followed by the survey results in Section 3. A comparison of results from the literature review with other studies in New Zealand and the survey is then presented in Section 4. Finally, conclusions are drawn in Section 5.

2 Literature Review on International Experience

The factors with most significant effect on the decision to use bicycles as a mode of transport can be classified into five categories: (1) safety; (2) a well-connected network of cycleways; (3) convenience; (4) policies to discourage car use; and (5) a good public transportation system integrated with cycling facilities. An earlier version of the literature review is presented in Mirza & Wang (2011). A summary of the papers reviewed is depicted in Table 1. The key findings are summarised as follows.

2.1 Safety

Safety has been consistently identified in a large body of literature as the most influential factor on commuters' decision to cycle (Akar & Clifton, 2009; Dill & Carr, 2003; Dill & Voros, 2007; Gatersleben & Appleton, 2007; Hunt & Abraham, 2007; Koorey *et al.*, 2009; Parkin *et al.*, 2008; Pucher & Buehler, 2008a, 2008b; Stinson & Bhat, 2003, 2004; Winters & Teschke, 2010; Winters *et al.*, 2010). Some important factors considered as deterrents include: dangerous traffic condition (such as presence of numerous major crossing intersections, high traffic volume, etc.), presence of on-street parking and poor lighting at night (Antonakos, 1994; Dill & Voros, 2007; Hunt & Abraham, 2007; Parkin *et al.*, 2008; Stinson & Bhat, 2003, 2004; Winters *et al.*, 2010).

It is also recognised that safety education is important not only to cyclists but also to motorists (Antonakos, 1994). This is because the requirements as regards to safety might vary among individuals due to their differences in their perception about safety as well as the level of importance of safety to them. For instance, senior citizens and women are often more conscious about safety on the road and thus courtesy of motorists are important to them. Comprehensive safety education for cyclists of all age groups and training motorists to understand how to interact with cyclists sharing the road space is vitally important to promote safety in cycling (Akar & Clifton, 2009;

Antonakos, 1994; Gatersleben & Appleton, 2007; Pucher & Buehler, 2008a, 2008b; Stinson & Bhat, 2004).

Cycling-favoured traffic laws, such as putting all the responsibility of the crashes on motorists (except deliberate ones) and implementing the cyclist's right of way by police and courts, can also help improve safety for cyclists (Pucher & Buehler, 2008b). It is interest to note that, in unsuccessful countries such as USA, legislating safety helmets for cycling not only put all the responsibilities on cyclists' shoulders but also make cycling inconvenient. Moreover, the helmets might bring a false sense of safety for cyclists and increase the possibility of dangerous riding behaviour; simultaneously, motorists might reduce their consideration by assuming that helmets make cyclists less vulnerable (Pucher & Buehler, 2008a). This is supported by the accident statistics of 37.5 injuries per 10 million cycled-km in USA (where wearing helmet is mandatory) compared to 1.4 in the Netherlands (where wearing a helmet is not mandatory) (Parkin *et al.*, 2008).

2.2 A well-connected network of cycleways

Presence of well-connected cycleways, which can enhance the safety of the cyclist en route, is recognised as one of the most important motivators (Akar & Clifton, 2009; Dill & Voros, 2007). In terms of route choice, the most common features of a route which makes it desirable to cycle are: most direct, segregated bicycle lane with smooth surface quality, continuity of the route and en-route facilities (Dill & Carr, 2003; Dill & Voros, 2007; Hunt & Abraham, 2007; Stinson & Bhat, 2003; Wardman *et al.*, 2007). Different groups might have different preferences. For example, hilly routes are preferred by experienced cyclists for the purpose of exercising (Antonakos, 1994; Stinson & Bhat, 2003), increasing the pleasure of cycling (Antonakos, 1994) and offering more scenic views (Stinson & Bhat, 2003). The scenery is not an important issue for bike commuters; however, beautiful view along the route accompanied by flexible working time can encourage more people to cycle to work (Antonakos, 1994; Winters *et al.*, 2010). For fulfilling the needs of different types of cyclist, the best approach would be a mix of facilities (Antonakos, 1994).

2.3 Convenience

Flexible working hours, provision of secure parking, locker and shower facilities can all be effective incentives, and previous studies identified that secure and sufficient parking is more important and should be given a higher priority (Dill & Carr, 2003; Dill & Voros, 2007; Koorey *et al.*, 2009; Pucher & Buehler, 2008a, 2008b; Stinson & Bhat, 2004; Wardman *et al.*, 2007). Wardman *et al.* (2007) found that daily financial incentive is the most effective approach to attract commuters to cycle in the UK. Another successful approach in the Netherlands, Denmark and Germany is the provision of free bicycles for use during the day for short business trips (Pucher & Buehler, 2008a).

2.4 Policies to discourage car use

Discouraging car use creates an environment in favour of cycling and is therefore considered as one of the most important motivators. First of all, less private cars en route makes cycling safer and consequently encourage more people to cycle. Reducing speed limits also makes the environment more cycle-friendly.

Dill & Voros (2007) found that the number of cars in a household is negatively correlated with the decision to cycle. Accordingly one approach is to make owning a

car more expensive. Dutch, Danish and German cities impose high tax on car purchase, ownership and use in different ways (Pucher & Buehler, 2008a, 2008b; Stinson & Bhat, 2004).

Parking management policies such as high parking rates, limiting the number of car parks in the city centre (Stinson & Bhat, 2004), and changing car parking facilities to bicycle parking (Pucher & Buehler, 2008b), have been found to be effective policies to discourage car use. Other policies that other countries have successfully adopted are car-free zones, police cameras at intersections, advance stopline favouring cyclists, and turn restrictions just for cars (Pucher & Buehler, 2008b).

2.5 A good public transportation system integrated with cycling facilities

The combined use of bicycle and public transport has been considered by countries with successful cycling outcomes as a necessary step to make cycling irresistible (Pucher & Buehler, 2008b). It is pertinent to mention that bike racks to facilitate bike-and-ride is the only pro-cyclist policy that USA transportation manages to implement better than in the Netherlands. Nevertheless, data on the number of cyclists in the USA has revealed that this policy alone is not sufficient to increase bicycle ridership. Some other successful policies to promote bike-and-ride include: secure and extensive bike parking facilities in the stations, bike racks on public transport, and quick and cheap rental bikes at station (Pucher & Buehler, 2008b).

3 Survey results

Respondents are first classified into one of the following four categories, namely, cyclists, infrequent cyclists, potential cyclists and non-cyclists, based on whether they are already commuting by bicycle, whether they own a bicycle and whether they are interested in cycling. Obviously, cyclists are the ones who are already commuting by bicycle. Those who own a bicycle but do not commute by bicycle are considered as infrequent cyclists. Ones that do not own a bicycle but are interested in cycling are considered as potential cyclists, while the rest are non-cyclists. Each group will then be addressed with an appropriate set of questions. The questionnaire is available from the corresponding author upon request.

There is a slightly higher percentage of female respondents (55%). The distribution by type, namely, cyclists, infrequent, potential and non-cyclists, are quite different among the two genders. As highlighted in Table 2, 38% of the male respondents are cyclists while only 18% of the female respondents are cyclists.

Table 2 Number of repondents by type and gender

Type	Male		Female		Total	
Cyclist	24	38%	14	18%	38	27%
Infrequent Cyclist	25	39%	35	45%	60	42%
Potential Cyclist	8	13%	23	29%	31	22%
Non-Cyclist	7	11%	6	8%	13	9%
Total	64	45%	78	55%	142	100%

It is important to note that there is a much higher proportion of cyclist respondents (27%) as compared to the observation made in analysing the census data (0.9%). We believe that the key reason is that the respondents to the survey are all university staff and students. Cycling is generally a more popular mode of transport

for this community, especially for students, since they often live close to campus and have low income, and cycling does not cost money.

Due to the small sample size per group, we analyse the survey results for two subgroups: cyclists and others (infrequent, potential and non-cyclists), except when we compare the behaviour of male respondents to that of female ones. Note that the survey was designed to find out the motivators of and deterrents to cycling. It is important to separate cyclists from others.

3.1 Motivators of current cyclists

As shown in Figure 2, the number one motivator of cycling is to improve health and fitness, followed by care for the environment and cycling for fun.

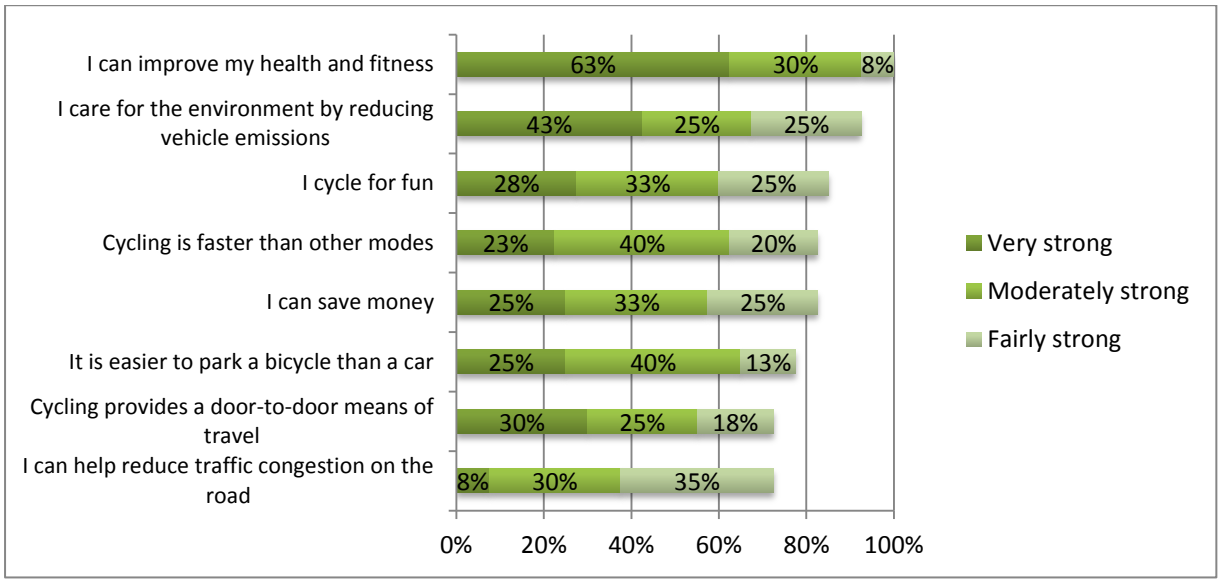


Figure 2 Motivators of current cyclists

3.2 Deterrents to cycling in Auckland

3.2.1 Safety

Safety is the number one deterrent to cycling. As shown in Figure 3, for infrequent, potential and non-cyclists, safety is the number one deterrent to cycling in Auckland. Other strong deterrents include unfavourable weather conditions and the need to carry things.

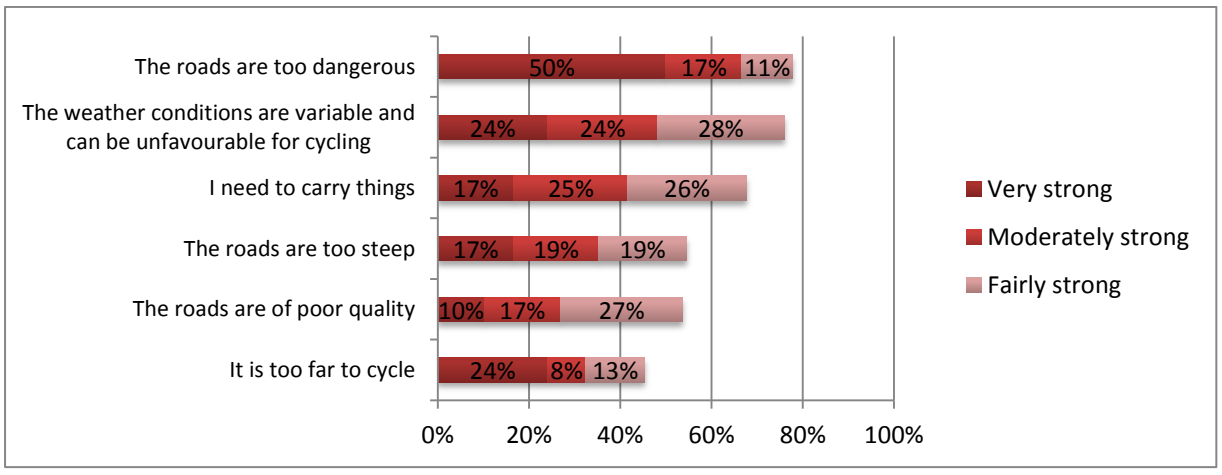


Figure 3 Deterrents to cycling

Women are more conscious about safety. As shown in Figure 4, 65% of male cyclists are cycling to work even though they are feeling unsafe while only 50% of female cyclists are doing so.

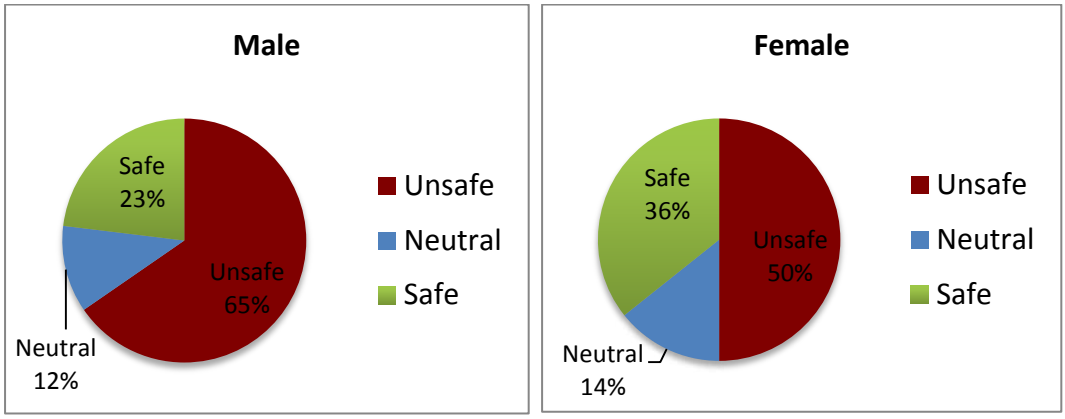


Figure 4 Cyclists' perception about safety

Not wearing a helmet may or may not be a good idea. Wearing a helmet is currently mandatory in Auckland. As shown in Figure 5, 48% of cyclists and 52% of infrequent, potential and non-cyclists are neutral towards making it not mandatory. Nevertheless, 43% of cyclists do not think that this is a good idea while only 24% of the others have negative feelings about it.

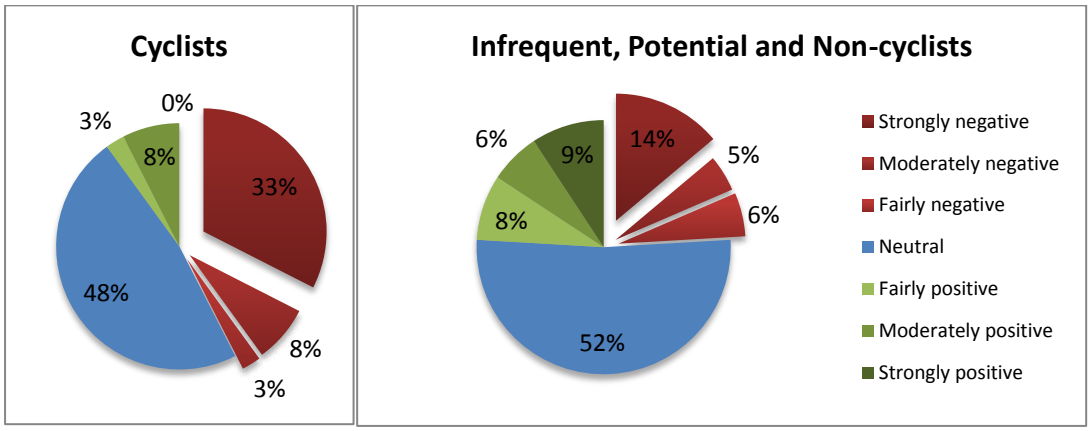


Figure 5 Influence of making wearing a helmet NOT mandatory

Everyone prefers less interactions with traffic and riding in safer conditions. Although cyclists and the others have different priorities in terms of their wishes, as highlighted in yellow in Table 3, both groups consider that improvement in safety at major junctions, reduction in traffic volume with less car, bus and truck traffic, enough lighting after dark and provision of special bicycle streets are preferred characteristics. Cyclists also consider other aspects that are related to their safety important, including strict enforcement of cyclists' rights, reduction of roadside parking, and motorists assumed by law to be responsible for almost all crashes with cyclists, as highlighted in blue in Table 3.

3.2.2 Provision of cycleways

Provision of a cycleway separated from traffic for the entire route is the number one motivator. As shown in Figures 6 and 7, all cyclists and 80% of infrequent, potential, and non-cyclists wish that there is a cycleway separated from traffic for the entire route.

Table 3 Top Ten Wishes

Factor	Cyclists		Infrequent, Potential and Non-cyclists	
	Rank	Percentage	Rank	Percentage
There is a cycleway separated from traffic for the entire route	1	100%	1	80%
Improvements in safety at major junctions, e.g. advanced stop lines, traffic signal priority for cyclists, etc.	2	98%	2	79%
Strict enforcement of cyclist rights by police and courts	3	93%	13	64%
Secure indoor/covered bicycle parking at destination	4	93%	5	71%
Reduction in traffic volume with less car, bus and truck traffic	5	90%	4	73%
The route has enough lighting after dark	6	90%	10	67%
Reduction of roadside parking	7	85%	19	59%
Cycling takes less time than other modes	8	80%	20	57%
Be able to take the bicycle on public transport	8	80%	9	68%
Motorists assumed by law to be responsible for almost all crashes with cyclists	10	78%	17	61%
Provision of special bicycle streets that limit car speeds and give cyclists priority over the entire width of the road	10	78%	10	67%
Good weather conditions	30	33%	3	76%
The route is flat	32	23%	5	71%
The route is away from traffic noise and air pollution	28	36%	7	69%
No need to carry bulky or heavy items	12	75%	8	69%

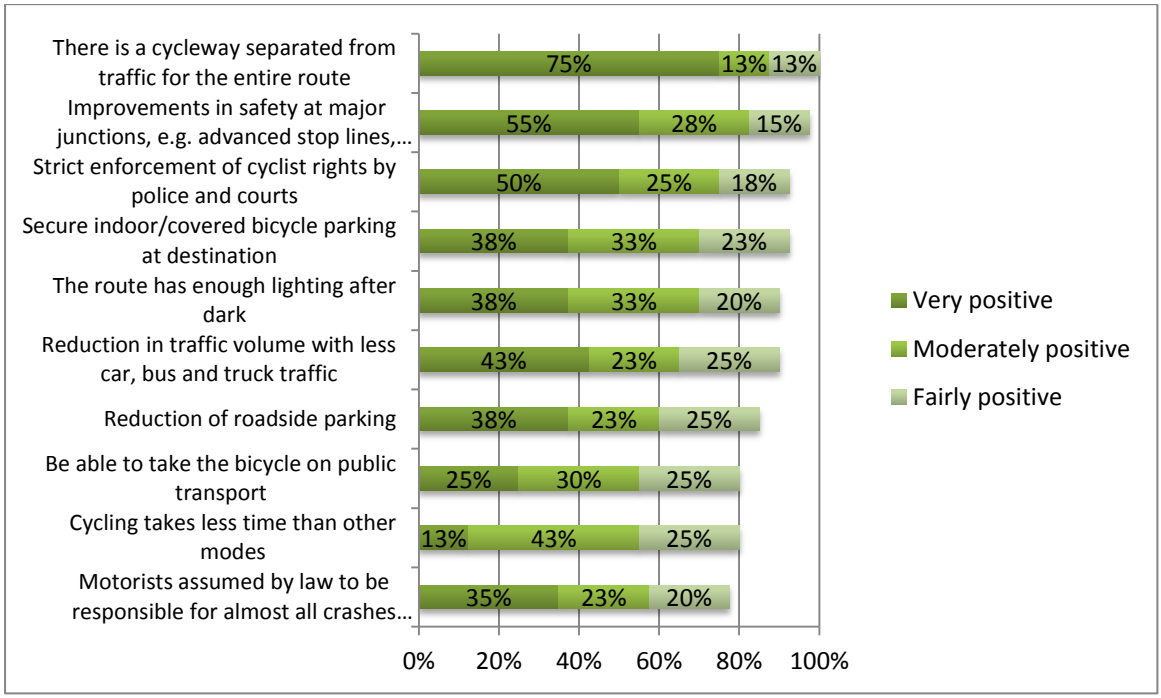


Figure 6 Top ten wishes of cyclists

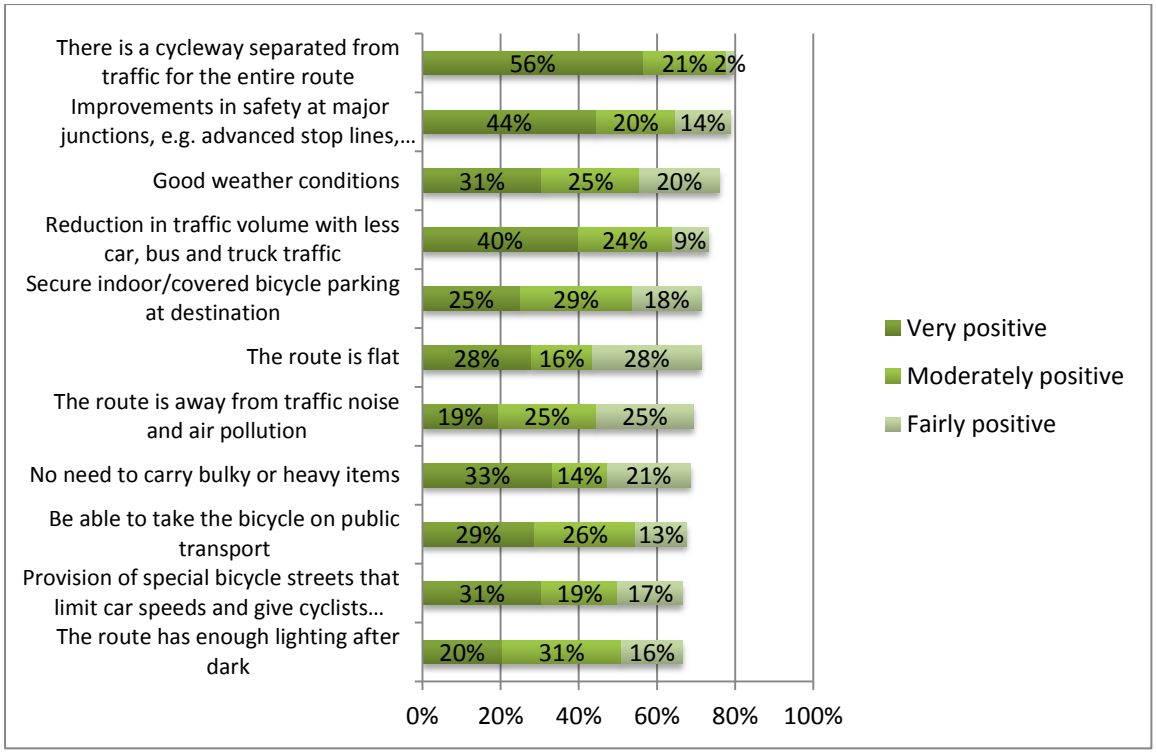


Figure 7 Top eleven wishes of infrequent, potential, and non-cyclists

Good surface quality, adequate width, being separated from traffic and continuity of cycleways are very important to everyone. As shown in Table 4, although cyclists as compared with the others have different priorities when it comes to preferred route characteristics, both groups have exactly the same set of top ten desired route characteristics. Among the ten, as highlighted in yellow in Table 4, good surface quality, adequate width, being separated from traffic, away from traffic noise and air pollution, and continuity of cycleways are the qualities that both groups are looking for at higher priority. The breakdowns of the percentage of respondents considering these factors to have positive influence are summarised in Figures 8 and 9.

Table 4 Top ten route characteristics

Factor	Cyclists		Infrequent, Potential and Non-cyclists	
	Rank	Positive Influence	Rank	Positive Influence
The route surface is of good quality	1	95%	5	72%
There is a cycleway separated from traffic for the entire route	2	93%	1	80%
The width of the cycleway is adequate	3	88%	2	79%
Less car, bus and truck traffic en route	4	85%	6	71%
The route is sufficiently direct	4	85%	8	66%
The route has speed limit of 50km/hr	6	78%	10	56%
The gradient is reasonable	6	78%	7	67%
The route is away from traffic noise and air pollution	6	78%	9	61%
The cycleway is continuous across minor road intersections	9	73%	3	74%

Advanced stoplines/traffic signal priority for cyclists at major junctions	10	73%	4	73%

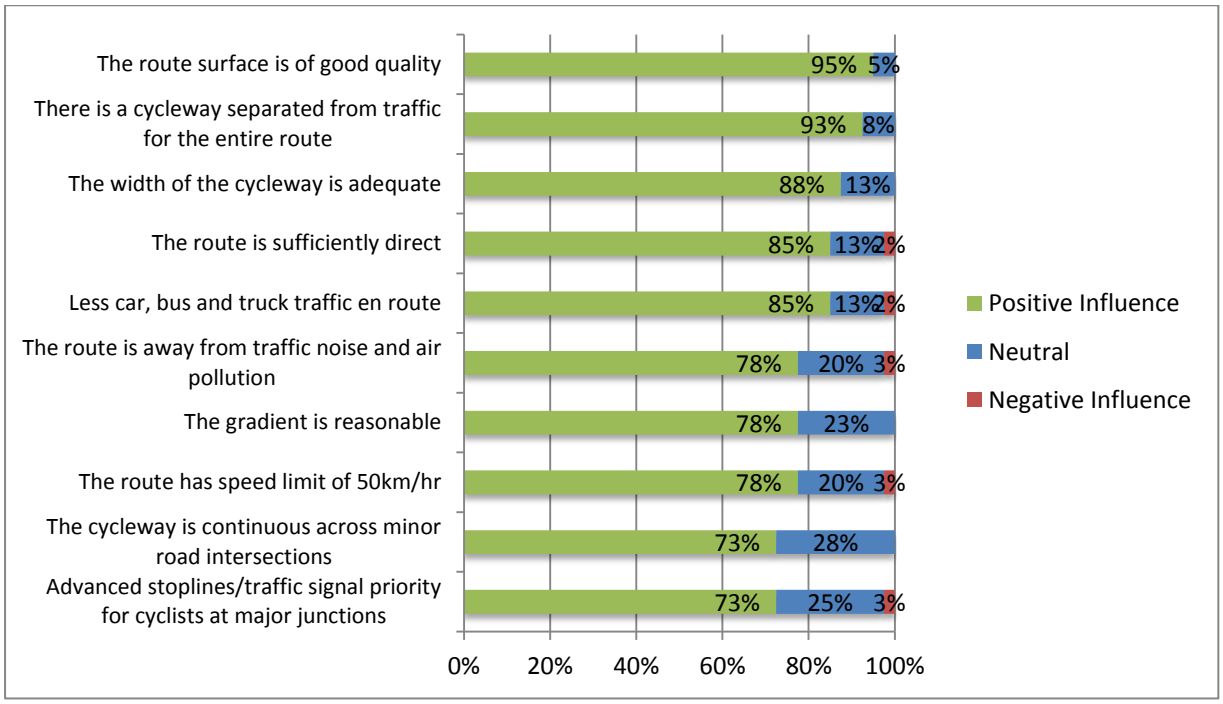


Figure 8 Top ten route quality characteristics for cyclists

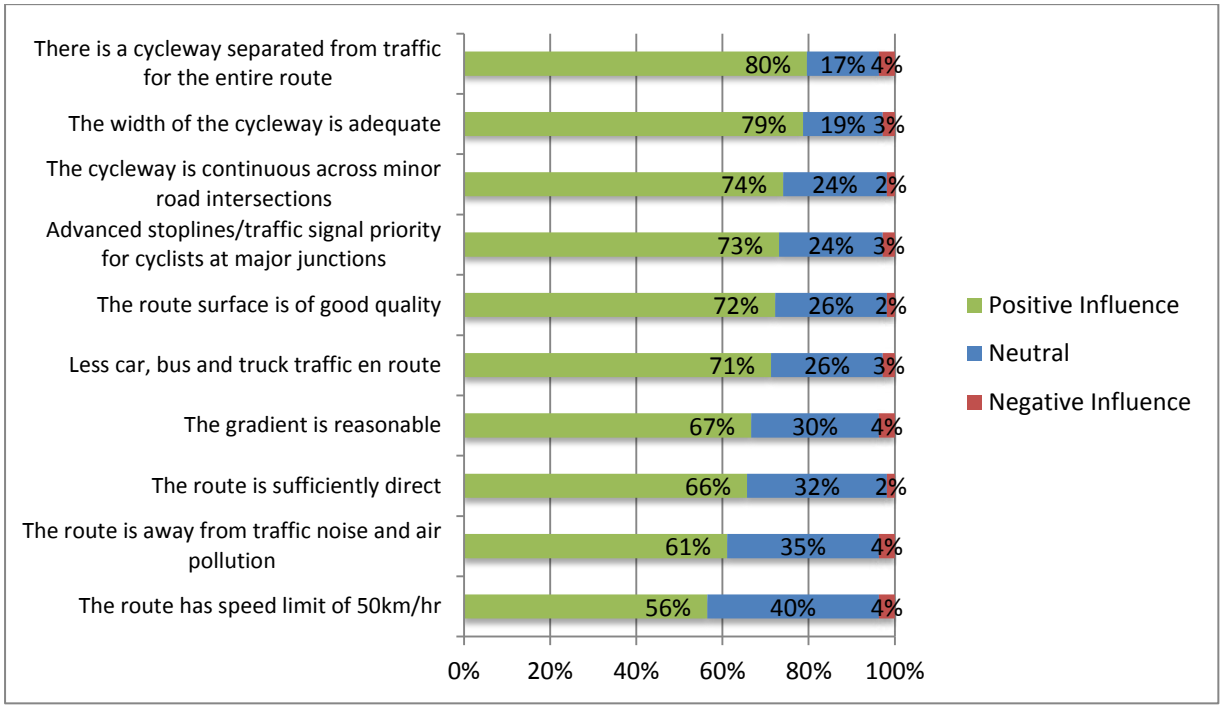


Figure 9 Top ten route quality characteristics for infrequent, potential and non-cyclists

Cyclists and most of the others like to be separated from traffic as well as pedestrians. As shown in Figures 10 and 11, 98% of cyclists and 81% of infrequent, potential, and non-cyclists prefer to ride on cycleways separated from traffic and pedestrians on both sides of the road. As shown in Figures 10 and 11, 88% of cyclists and 69% of infrequent, potential, and non-cyclists prefer to ride on

cycleways at least separated from traffic and pedestrians, even if the cycleway is on only one side.

About half of the respondents do not like sharing a lane with buses. As shown in Figures 10 and 11, 45% of cyclists and 56% of the others DO NOT want to share a lane with buses.

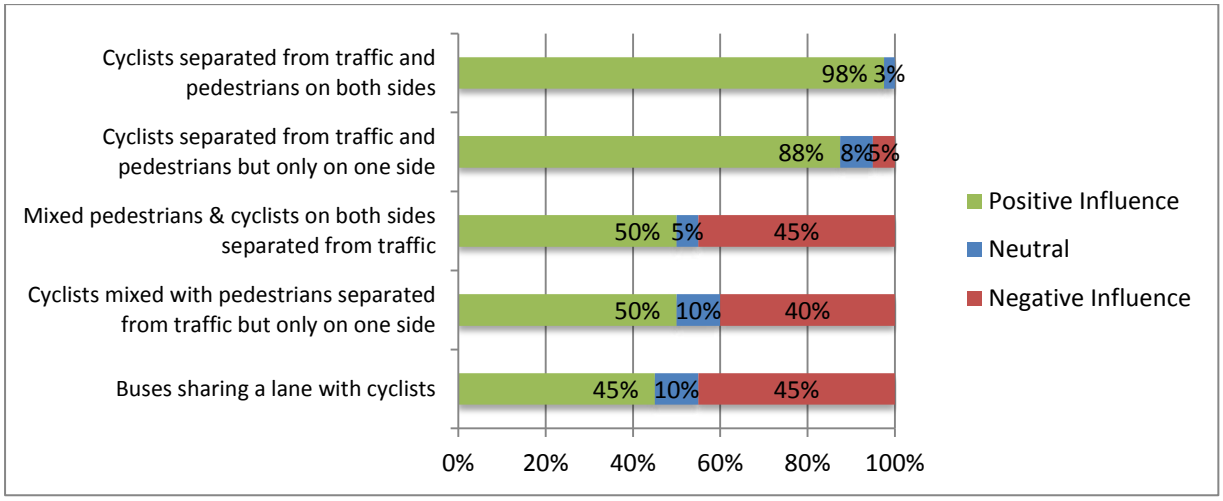


Figure 10 Cyclists' preference on type of cycleways

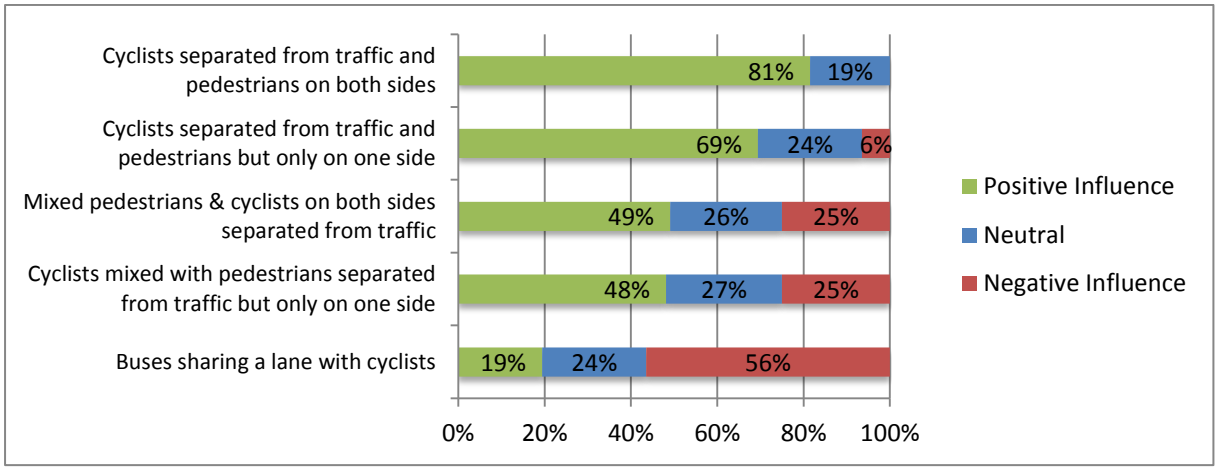


Figure 11 Infrequent, potential and non-cyclists' preference on type of cycleways

Roadside parking causes fear to cyclists. As shown in Figure 12 and 13, 48% of cyclists and 38% of infrequent, potential and non-cyclists have negative feelings towards roadside parking.

The majority prefer parking between traffic and cyclists. As shown in Figures 12 and 13, 95% of cyclists and 83% of infrequent, potential and non-cyclists prefer parking between traffic and cyclists (with segregation between parking and cyclists). The second choice (88% and 72% of cyclists and the others respectively) is a similar arrangement to the first choice, with level difference for cyclists but no segregation between parking and cyclists.

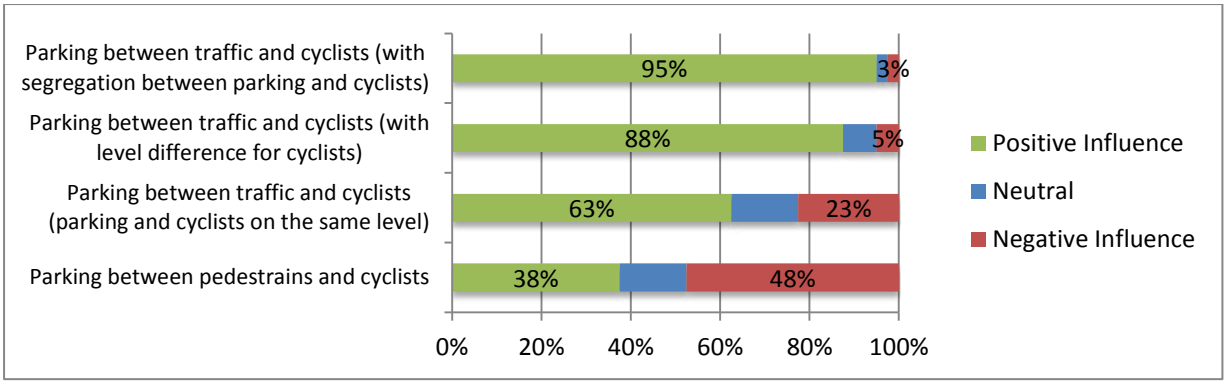


Figure 12 Cyclists' preference on parking arrangement

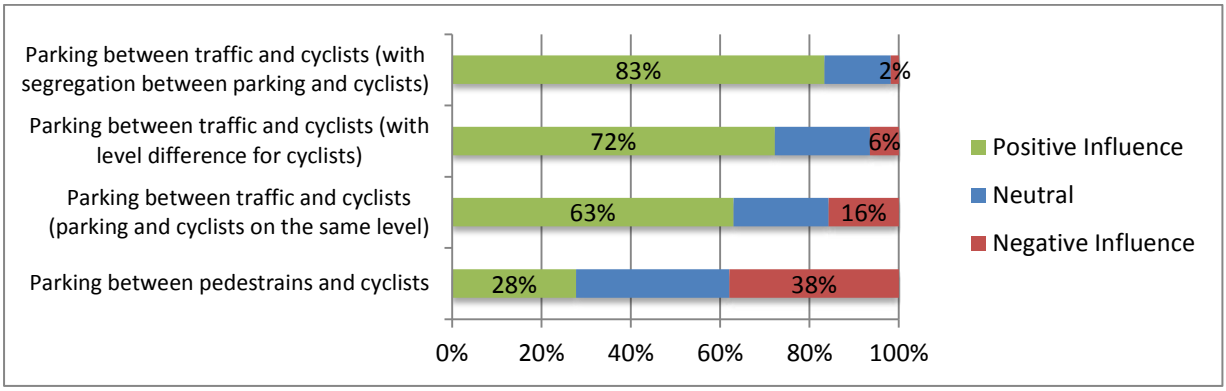


Figure 13 Infrequent, potential and non-cyclists' preference on parking arrangement

3.2.3 Convenience

Secure indoor/covered bicycle parking at destination is important for cyclists and others. As shown in Table 3, the availability of secure indoor/covered bicycle parking is among the top five on the wish list of both groups.

Weather conditions do make a difference. As shown in Table 3, 76% of infrequent, potential and non-cyclists will more likely cycle under good weather conditions. It is interesting to note that although only 33% of cyclists expressed that good weather conditions have positive influence on their level of satisfaction on cycling, as shown in Figure 14, 95% of cyclists would cycle less in winter while 84% will more likely cycle in summer.

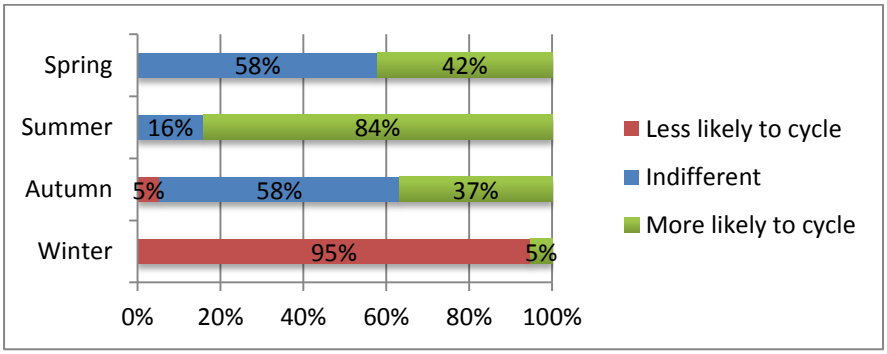


Figure 14 Seasonal effect on decision to commute by bicycle

3.2.4 Policies to discourage car use

Everyone prefers routes with less interactions with traffic and riding in safer conditions: lower speed limit and priority for cyclists. As discussed earlier,

everyone prefers less interactions with traffic and riding in safer conditions. In particular, as shown in Table 4, both groups prefer routes with less traffic, lower speed limit, away from traffic noise and air pollution, and with priority for cyclists. This also implies that policies that can discourage car use will also indirectly encourage cycling.

3.2.5 A good public transportation system integrated with cycling facilities

Being able to take the bicycle on public transport is one potential motivator. As shown in Table 3, to be able to take the bicycle on public transport is on the top ten wish list of both groups, with 80% of cyclists and 68% of infrequent, potential and non-cyclists supporting this idea.

4 Discussion

As discussed in Section 1, the survey was conducted at the University of Auckland with a sample size of just over 140 staff and students. This can hardly be representative of the Auckland region. Nevertheless, as demontrated later in this section, the results from this survey also support the conclusions drawn from our literature review of international experience and results from other studies (Kingham *et al.*, 2011; Sullivan & O'Fallon, 2006; Tin Tin *et al.*, 2010).

Safety. Cycling in NZ is not safe generally. Tin Tin *et al.* (2010) investigated exposure-based rates and profiles of traffic injuries sustained by pedal cyclists resulted in death or hospital inpatient treatment in NZ. The rate of fatal and hospitalised injuries among pedal cyclists has been increasing over the last decade in NZ. Cyclists had the second highest rate of traffic injuries compared to other major road user categories. Tin Tin *et al.* (2009a) investigated regional and individual differences in cycling and walking to work in NZ over a 15-year period (1991-2006). Among different regions in NZ, Auckland had the lowest prevalence of cycling and walking. The largest decline in cycling over the 15-year period was among younger age groups, particularly 15-19 year olds. Tin Tin *et al.* (2009b) investigated cyclists' attitudes toward environmental and policy measures that would encourage them to cycle more, particularly for work trips. 55% of respondents considered that reduced motor vehicle speed is important. Of those who reported travelling to work at least once a week, 43% of the respondents would consider cycling more if there were fewer difficult intersections. Kingham *et al.* (2011) found that safety was the most significant issue for potential cyclists, particularly in relation to vehicle driver behaviour (the perception that car drivers were not courteous) and traffic volume.

In our survey, safety is the number one deterrent, with 78% of infrequent, potential and non-cyclists considered the roads too dangerous (Figure 4). Everyone prefers less interactions with traffic and riding in safer conditions (as highlighted in Table 3).

Provision of cycleways. The provision of cycleways, in particular in Auckland, is very poor. The top two important factors for cyclists' decision to cycle were the provision of bicycle lanes (88%), and the provision of bicycle paths (76%) (Tin Tin *et al.*, 2009b). Not enough cycle lanes or paths is considered as one of the most common neighbourhood barriers to physical activity (Sullivan & O'Fallon, 2006).

In our survey, provision of a cycleway separated from traffic for the entire route is the number one motivator (100% for cyclist; 80% for infrequent, potential and non-cyclists) in our survey (Table 3).

Convenience. 65% of cyclists consider better bicycle security an important factor in their decision to commute by bicycle, and 61% of commuting cyclists considered the availability of shower facilities at work will encourage them to cycle more (Tin Tin *et al.*, 2009b). Kingham *et al.* (2011) also found that not having facilities at the destination for showering and changing was a barrier. In contrast to experience in successful countries, the prevalence of cycling to work did not vary significantly by personal income level over the years (Tin Tin *et al.*, 2009a).

In our survey, secure indoor/covered bicycle parking at destination is important for cyclists (93%) and for infrequent, potential and non-cyclists (71%) (Table 3).

Policies to discourage car use. As discussed above, Tin Tin *et al.* (2009b) found that reducing speed limit and the number of difficult junctions were considered to be important factors in cyclists' decision to commute by bicycle. Kingham *et al.* (2011) also found that traffic volume was a factor that created safety issue for potential cyclists. Rising fuel cost was considered to be a significant factor by 41% of commuting cyclists to encourage them to cycle more (Tin Tin *et al.*, 2009b).

In our survey, most respondents prefer routes with less interactions with traffic and riding in safer conditions: lower speed limit and priority for cyclists (as highlighted in Table 4).

A good public transportation system integrated with cycling facilities. Bike-friendly public transport is considered to be an important factor by 38% respondents (Tin Tin *et al.*, 2009b).

In our survey, 80% of cyclists and 68% of infrequent, potential and non-cyclists would like to be able to take their bicycles on public transport.

5 Conclusions

In this study, we first performed a comprehensive literature review of the lessons from international experience, focussing on what factors were found to have significant influence on the decision to use bicycles as a mode of transport. We found that there are five main factors that might have been missing in Auckland: (1) safety; (2) a well-connected network of cycleways; (3) convenience; (4) policies to discourage car use; and (5) a good public transportation system integrated with cycling facilities. We then designed a web-based survey to determine the motivators of and deterrents to cycling in Auckland and to understand what factors are influencing the route choice of current and potential cyclists. A wed-based pilot survey was conducted at the University of Auckland as a case study, where about 140 staff and students participated in the survey. As demonstrated in our discussion in Section 4, despite the small sample size, the findings from our survey are all consistent with our literature review as well as other studies in New Zealand. These five main factors are indeed barriers to cycling in Auckland.

It is evident that safety is indeed a number one concern for cyclists as well as those who do not cycle. Provision of a well connected network of cycleways is a must in order to promote cycling. The availability of shower facilities at work and secure indoor/covered bicycle parking at destination are both important. For a city with sparse distribution of employment centres like Auckland, strategies to promote the use of bicycles will not be sufficient without integrated policies to discourage car use. The use of PT system together with cycling facilities is particularly important for a city with a hilly terrain like in Auckland.

6 Acknowledgements

The authors would like to thank Mr Carl Ellaway of Auckland Council, Mr Peter Clark, Mr John Davies and Mr Brian Horspool of Auckland Transport for providing the spatial digital data and information support, Professor Matthias Ehrgott of the Department of Engineering Science, Professor Alistair Woodward, Professor Shanthi Ameratunga and Dr Sandar Tin Tin of the School of Population Health, and Associate Professor David Scott of the Department of Statistics, at The University of Auckland for their valuable comments on the questionnaire design and support during the survey, and Professor Mark Greer of Dowling College for his inspiration on the project topic. This project was supported by a research grant provided by Thematic Research Initiative (TRI) of The University of Auckland titled Transforming Auckland: Institutional, Technological and Cultural Innovations for Sustainable Cities. Ethical approval was obtained from The University of Auckland Human Partcipants Ethics Committee (Reference Number 2011/057).

7 References

Akar, G., & Clifton, K. J. (2009). Influence of individual perceptions and bicycle infrastructure on decision to bike, Transportation Research Record, 2140,165-172.

Antonakos, C. L. (1994). Environmental and Travel Preferences of Cyclists. Transportation Research Record, 1438, 25-33.

Auckland Council. (2011). *Auckland unleashed: The Auckland Plan Discussion Document*.

Betz, J., Dustrude, J., & Walker, J. (1993). Intelligent Bicycle Routing United States. Transportation Research Record, 1405, 21-27.

Dill, J., & Carr, T. (2003). Bicycle Commuting and Facilities in Major U.S. Cities: If You Build Them, Commuters Will Use Them. Transportation Research Record, 1828, 116-123.

Dill, J., & Voros, K. (2007). Factors affecting bicycling demand: Initial survey findings from the Portland, Oregon, region. Transportation Research Record, 2031, 9-17.

Gatersleben, B., & Appleton, K. M. (2007). Contemplating cycling to work: Attitudes and perceptions in different stages of change. Transportation Research Part A: Policy and Practice, 41(4), 302-312.

Hopkinson, P., & Wardman, M. (1996). Evaluating the demand for new cycle facilities. Transport Policy, 3(4), 241-249.

Hunt, J. D., & Abraham, J. E. (2007). Influences on bicycle use. Transportation, 34(4), 453-470.

Kingham, S., Taylor, K., & Koorey, G. (2011). Assessment of the type of cycling infrastructure required to attract new cyclists. New Zealand Transport Agency research report 449.

Koorey, G., Kingham, S., & Taylor, K. (2009). Attracting the next 10% of cyclists with the right infrastructure. Paper presented at the The 7th New Zealand Cycling Conference 2009.

Lindsay, G., Macmillan, A., & Woodward, A. (2010). Moving Urban Trips from Cars to Bicycles: Impact on Health and Emissions. Australian and New Zealand Journal of Public Health.

Mackie, H. (2009) 'I want to ride my bike': overcoming barriers to cycling to intermediate schools. NZTA Research Report 380.

Martens, K. (2007). Promoting bike-and-ride: The Dutch experience. Transportation Research Part A: Policy and Practice, 41(4), 326-338.

May, T., & Crass, M. (2007). Sustainability in transport: Implications for policy makers, Transportation Research Record, 2017, 1-9.

Mirza, L., & Wang, J. Y. T. (2011). Appraisal of Factors Influencing Choices of Cyclists and Potential Cyclists in Auckland. Paper presented at the The New Urbanism & Smart Transport 2011 International Conference: Towards Liveable Cities & Better Communities, held in Perth, Australia, September 2011.

MoT. (2008). The New Zealand Transport Strategy 2008: Ministry of Transport.

Parkin, J., Wardman, M., & Page, M. (2008). Estimation of the determinants of bicycle mode share for the journey to work using census data. Transportation, 35, 93-109.

Pucher, J., & Buehler, R. (2008a). Cycling for everyone: Lessons from Europe, Transportation Research Record, 2074, 58-65.

Pucher, J., & Buehler, R. (2008b). Making cycling irresistible: Lessons from the Netherlands, Denmark and Germany. Transport Reviews, 28(4), 495-528.

Statistics NZ. (2006). Table Builder, Journey-to-Work Census Statistics. Retrieved 24/08/2010, from http://www.stats.govt.nz/:

Stinson, M. A., & Bhat, C. R. (2003). Commuter Bicyclist Route Choice: Analysis Using a Stated Preference Survey. Transportation Research Record, 1828, 107-115.

Stinson, M. A., & Bhat, C. R. (2004). Frequency of bicycle commuting: Internet-based survey analysis. Transportation Research Record, 1878, 122-130.

Sullivan, C., & O'Fallon, C. (2006). Increasing cycling and walking: an analysis of readiness to change. Land Transport New Zealand Research Report 294.

Tilahun, N. Y., Levinson, D. M., & Krizek, K. J. (2007). Trails, lanes, or traffic: Valuing bicycle facilities with an adaptive stated preference survey. Transportation Research Part A: Policy and Practice, 41(4), 287-301.

Tin Tin, S., Woodward, A., & Ameratunga, S. (2010). Injuries to pedal cyclists on New Zealand roads, 1988-2007. BMC Public Health, 10(655).

Tin Tin, S., Woodward, A., Thornley, S., & Ameratunga, S. (2009a). Cycling and working to work in New Zealand, 1991-2006: regional and individual differences, and pointers to effective interventions. International Journal of Behavioral Nutrition and Physical Activity, 6(64).

Tin Tin, S., Woodward, A., Thornley, S., Langley, J., Rodgers, A., & Ameratunga, S. (2009b). Cyclists' attitudes toward policies encouraging bicycle travel: findings from the Taupo bicycle study in New Zealand. Health Promotion International, 25(1), 54-62.

Wardman, M., Tight, M., & Page, M. (2007). Factors influencing the propensity to cycle to work. Transportation Research Part A: Policy and Practice, 41(4), 339-350.

Winters, M., & Teschke, K. (2010). Route preferences among adults in the near market for bicycling: Findings of the cycling in cities study. American Journal of Health Promotion, 25(1), 40-47.

Winters, M., Davidson, G., Kao, D., & Teschke, K. (2011). Motivators and deterrents of bicycling: comparing influences on decisions to ride. Transportation, 38, 153-168.