Transport Planning and Design
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Speed surveys of powered transport devices

Report prepared for

Waka Kotahi

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1 Summary

Shared paths and cycling facilities are increasingly used by a more diverse group of people and transport devices. Continuing surveys conducted in 2017 and 2018, ViaStrada surveyed eleven sites in Christchurch, Wellington and Auckland during 2020 to find that:

- E-bike riders average 5.2 km/h and 8.8 km/h higher than unpowered riders (abbreviated as "un-p" in this report) on flat and hilly terrain, respectively.
- E-bikes are addressing the gender imbalance: on flat terrain, women make up 28% of unpowered cyclists but 44% of e-bike riders. On hilly terrain, women make up 23% of unpowered cyclists but 38% of e-bike riders.

Table 1-1: speed statistics (km/h) for bicycle riders (2020 survey only)

	Male (M)	Female (F)	All e-bike	All un-p	M un-p	F un-p	M e-bike	F e-bike
FLAT SITES								
Count	980	421	210	1191	862	329	118	92
Proportion	70%	30%	15%	85%	72%	28%	56%	44%
Average speed	**26.3**	**22.9**	**29.7**	**24.5**	**25.6**	**21.4**	**30.9**	**28.1**
Standard deviation	5.6	5.6	5.4	5.5	5.4	4.7	5.1	5.5
HILLY SITES								
Count	100	42	58	87	67	20	36	22
Proportion	70%	30%	40%	60%	77%	23%	62%	38%
Average speed	**13.8***	**13.8**	**19.2**	**10.4**	**10.8**	**9.0**	**19.5***	**18.2**
Standard deviation	5.6	5.6	4.7	2.9	3.0	2.2	5.1	3.9

*The difference in average speed of male and female e-bike riders in hilly conditions is not statistically significant

On flat terrain, the lowest average speeds are on the Hagley Park Uni-Cycle shared path, and the highest average speeds are on facilities that are more distant from the city centres (Table 1-2). The highest speed differences between e-bikes and unpowered bikes are (not surprisingly) on hilly terrain.

Table 1-2: e-bike use and average speeds (red indicates higher speed or speed difference)

Location	Facility type	% e-bikes	Average speed (km/h)		
			E-bikes	Un-powered	Difference
Colombo St	4.5 m wide bus lane	8%	27.3	24.2	3.1
Ferry Rd	Narrow cycle lane	16%	33.2	26.7	6.5
Hagley Park	4.0 m wide shared path	10%	26.0	20.4	5.7
Hutt Rd	3.0 m wide cycle path	24%	32.2	28.9	3.3
Roker St	Neighbourhood greenway	14%	26.4	22.7	3.7
Strickland St	2.2 m wide separated cycleway	12%	27.1	24.6	2.4
Quay St - path	2.7m wide separated cycleway	14%	28.8	22.2	6.6
Quay St - road	Bus lane	6%	32.0	25.6	6.4
Brooklyn Rd	Mixed traffic – on hill	50%	17.3	9.3	8.0
Glenmore Rd	Bus lane – on hill	30%	21.4	10.9	10.5
Constable St	Separated cycleway – top of hill	42%	23.6	17.4	6.2

Micromobility (e-bike and e-scooter) use increased from 2.6% in 2017 to 14.1% in 2020 (Christchurch) and from 10% in 2017 to 25% in 2020 (Hutt Road, Wellington). At Quay Street in Auckland the 2020 survey figure is 15%. On hilly routes the proportion of e-bikes is between 30% and 50%.

2 Introduction

Shared paths and cycling facilities in New Zealand are increasingly used by a more diverse group of people and transport devices.

As shown in Figure 2-1, import data show that the class of vehicles including e-bikes and e-scooters has grown in line with the "high growth" scenario predicted in 2016 research (ViaStrada 2017, ViaStrada 2020).[1] The downturn in 2020 is likely due to the pandemic closure of borders resulting in supply chain issues and the pause in e-scooter share operations.[2]

Given this growth, the potential for interaction and conflict on the transport network is increasing. The success of a shared path or cycling facility is dependent on its users and their experience of the infrastructure. Many facilities are of an insufficient width and designed with right-angle corners and poor sight distance at intersections, corner properties and curves. It appears that designers are fitting the facilities to the topography, available right-of-way, and budget – without sufficient consideration of user safety or comfort.

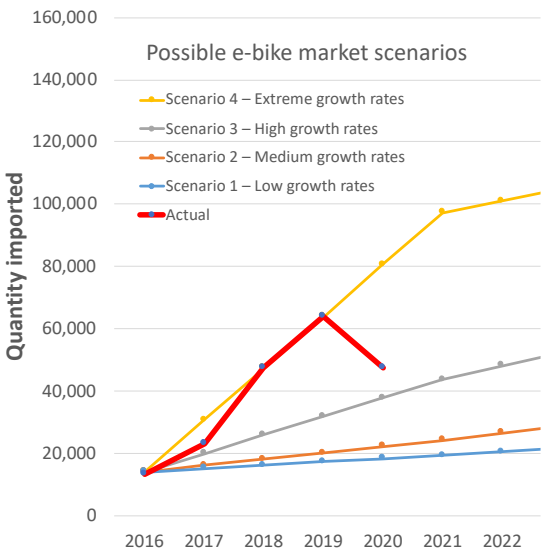

Figure 2-1: actual e-bike & e-scooter sales vs. forecast made in Research Report 621

New Zealand's Cycling Network Guidance (CNG) relies on two main sources for geometric design of cycling facilities: mainly Austroads Guide to Road Design Part 6A: Paths for Walking and Cycling (Austroads 2017), which in turn frequently references the US Guide for the Development of Bicycle Facilities (AASHTO 2012).

Cycle traffic flow and speed parameters are key inputs to most geometric design elements. A design speed is generally used, and guides give recommended values; sometimes with variations to allow for different types of cycles, users expected to use the facility, and gradient. Alternatively, data of actual speeds on-site or in the vicinity may be collected, in which case at least the 85th percentile operating speed should be used as the design speed. With the advent of electrically assisted bicycles and scooters ("e-mobility"), this research was conducted to answer the following questions:

1. What is the speed profile (mean, 85th percentile, maximum, and variance) of riders, both unpowered and electrically assisted, and has this changed over time?
2. Is e-mobility encouraging a shift in gender of users, with consequent impacts on route planning and design expectations?[3]

[1] Issues in using import data include a 2017 change in definitions and potential misclassification of goods due to the breadth of the definition; refer to www.viastrada.nz/e-bike-sales for more information.

[2] The approximately 40% downturn in quantity of imports from 2019 to 2020 was not matched by a downtown in the dollar value of imports, which fell just 5%. This may be due to fewer low-value e-scooter replacements needed during the pause in scooter share operations and a move towards higher priced e-bikes in the market.

[3] On average women are more risk averse than men, prefer greater separation between users, and will go further out of their way to use a route with higher perceived safety (Standen, Crane et al. 2017).

3 Methods

To determine the diversity and speed of the current population using cycle facilities, a speed and gender survey was conducted at several sites with different transport environments in Auckland, Wellington and Christchurch. This is a repeated and expanded effort of earlier studies conducted in 2017 and 2018. Table 3-1 shows an overview of sites and survey times by year.

3.1 Site selection

Sites were selected to obtain a range of facility types. For each site, an observation location was selected where riding speed was minimally or not restrained (i.e. "free speed") by traffic signals, yielding for other traffic, blind corners, etc. In anticipation of increased facility use, the 2020 survey used two researchers instead of one. This improved the accuracy of data collection especially during the "peak of the peak" period.

Table 3-1: overview – timing of data collection

Site	Facility type(1)	2017	2018	2020
Christchurch				
Colombo St	Bus lane 4.5m	07:36 – 08:30 21/03	07:30 – 08:30 28/06	07:23 – 08:30 29/07
Ferry Rd	Cycle lane 1.7m	07:30 – 08:30 22/03	07:30 – 08:30 29/06	07:25 – 08:30 21/07
Hagley Park	Shared path 4.0m	07:30 – 08:30 23/03	07:35 – 08:30 26/06	07:20 – 08:30 20/07
Strickland St	Separated cycleway 2.2m(2)	07:40 – 08:30 20/03	07:30 – 08:30 27/06	07:22 – 08:30 23/07
Roker St	Neighbourhood greenway	No survey	No survey	07:30 – 08:30 22/07
Wellington				
Brooklyn Rd	Mixed traffic 7.5m (uphill)	No survey	No survey	16:30 – 18:30 5/08
Hutt Rd	Segregated path 3.0m(3)	07:45 – 08:30 27/04	No survey	07:30 – 08:30 6/08
Glenmore St	Bus lane 4.0m (uphill)	No survey	No survey	17:00 – 18:30 6/08
Constable St	Separated cycleway 2.0m(4)	No survey	No survey	16:40 – 18:30 7/08
Auckland				
Quay St	Separated cycleway 2.7m	No survey	No survey	07:15 – 08:45 14/08
Quay St	On-road shoulder/bus lane	No survey	No survey	07:30 – 08:45 14/08

Notes:

(1) All dimensions approximate

(2) Strickland Street was converted from a 1.8 m cycle lane to a kerb-separated cycleway between the 2017 and 2018 surveys

(3) In 2017, Hutt Road was a shared path. Prior to the 2020 survey, the facility has changed to a cycle path separated from a 2 m wide footpath by paint markings

(4) Constable Street and Crawford Road link Newtown to Kilbirnie. This route has a kerb separator and is quite hilly. Originally it was hoped to survey at Crawford Road (on the Kilbirnie side of the hill) during the morning peak when there would be a tidal flow towards the city and plenty of space for observing uphill speeds. However the available survey time slot had to be shifted to the PM peak, and the uphill observation point was too close to an intersection for the observations to be free of traffic interactions and signal impacts. Opportunistically, the survey was done at a flat stretch of road on the top of the hill on Constable Street for riders travelling in both directions.

3.1.1 Timing and duration of survey

The timing of the surveys was the peak morning travel time of 7:30 to 8:30 hrs or the peak afternoon travel time of 16:30 to 18:30 hrs. This minimum one-hour duration was selected as it balanced sample size with study resources. Times earlier than 07:30 or later than 18:30 would have limited ridership and darkness would make classification difficult. By 8:30, the number of riders tends to drop off quickly to the point where additional time spent surveying would yield few observations.

3.2 Observed users

For 2020, researchers measured and reported the speed of all persons using a small mobility device such as bicycles, scooters and skateboards. In 2017 and 2018, only bicycle riders were measured.

E-bike identification was aided by presence of steady headlight (the vast majority of New Zealand unpowered bicycle riders use flashing lights, but e-bikes nearly all have steady beam headlights). The identification was confirmed by a visual scan for a hub or bottom-bracket located (mid-drive) motor. Gender was also determined based on observation.

3.3 Measurement technique

A Pro Laser III LIDAR (Light gun with accuracy of +/-1 km/h was used. This device has a range of up to 1800m but typically the subjects were measured at 100 to 200 m distance from the observer. The acquisition time of the gun is 0.3s and has a beam width of just 1 m at 300 m distance, allowing the observer to pick individual riders out from a group. By the time riders could see the observer, their speed had already been measured. In a few instances, observations were not possible until the rider had already passed by – in which case the measurement was taken as the rider departed.

3.4 Privacy

No imagery or identifying information was collected. For the latest 2020 survey, a sign with the text: "Anonymous survey ahead" was placed 300 to 500 m before the speed measurement to minimise the risk of privacy violation. Observations showed that people did not change their pedalling motion or speed in the vicinity of the sign.

In the event people were interested in or concerned about the researcher's activities a short explanation was provided. The few people who did stop had already had their speed measured before they recognised the surveyors, so the presence of the sign probably did not have any impact on the results.

3.5 Limitations

The following limitations of the research method are known:

- Possible observations errors (gender/device type) due to low-light conditions or misidentification
- Possible measurements and observation errors due to high density of traffic (this was rare)
- Timing of the surveys was different over the years. It is possible that colder temperatures and low-light conditions in 2020 could result in fewer casual (less committed) riders, who may have a different gender or speed profile. This also means that the volumes are not comparable between years, although volume trends are not an objective of this research. The data could be scaled to an average annual daily traffic if an analyst chose to do so.[4]

[4] https://www.nzta.govt.nz/assets/Walking-Cycling-and-Public-Transport/docs/cycling-network-guidance/tech-notes/Scaling-Spreadsheet-Technical-Note.pdf

4 Results of 2020 surveys

4.1 Flat sites

Summary of flat site data

Table 4-1 presents the descriptive statistics for observations at all flat sites in Christchurch, Wellington and Auckland.

Table 4-1: speed statistics for bicycle riders on flat ground (2020 survey)[5]

	Male (M)	Female (F)	All e-bike	All un-p	M un-p	F un-p	M e-bike	F e-bike
Count	980	421	210	1191	862	329	118	92
Proportion	70%	30%	15%	85%	72%	28%	56%	44%
Average speed	**26.3**	**22.9**	**29.7**	**24.5**	**25.6**	**21.4**	**30.9**	**28.1**
85th percentile	32	28	35	30	31	26	37	34
15th percentile	20	17	24	19	20	17	26	23
Range (85th-15th)	12	11	11	11	11	9	11	11
Max. speed	45	42	45	42	42	35	45	42
Min. speed	9	8	13	8	9	8	19	13
Standard deviation	5.6	5.6	5.4	5.5	5.4	4.7	5.1	5.5

Facility type differences

The results show that the proportion of e-mobility use is up to 18%. A higher proportion (25%) of e-mobility is observed on the separated cycle path in Wellington (Hutt Road) and a lower proportion (10%) on the shared bus lane (Colombo Street). E-scooter use is highest on the Hagley Park shared path (7%) and the Quay Street separated cycle path (10%).

The highest average speeds are seen on the Hutt Road, which might be explained by the relatively higher proportion of e-bike riders (25%) and the fact that the facility is at the terminus of a relatively long route alongside a busy, high speed highway to/from the Hutt Valley. The lowest average speeds are seen on the Hagley Park shared path, which might be related to the higher number and higher diversity of users, or the low stress and high amenity environment.

More research would help to confirm if the facility types are the determinant of the high and low speeds. Other explanatory factors could be the network context of the sites, the trip types associated with these sites, and the average distance travelled.

[5] Note: some tables in this document use abbreviations for formatting purposes. These include unpowered (un-p), electric powered (e-powered), electric bicycle (e-bike), male (M), and female (F). All references to speed are in kilometres per hour (km/h).

Table 4-2: average speed, number of observations and vehicle type proportions – flat sites

	Powered			Unpowered			All riders
	Bike	**Scooter**	**Total**	**Bike**	**Scooter**	**Total**	
Colombo – 4.5 m bus lane							
Avg speed (km/h)	27.3	22.5	**26.7**	24.2		**24.2**	24.5
Observations	14	2	**16**	142		**142**	158
Proportion	9%	1%	**10%**	90%	0%	**90%**	100%
Ferry – 1.8 m cycle lane							
Avg speed (km/h)	33.2	28.0	**32.9**	26.7		**26.7**	27.7
Observations	13	1	**14**	70		**70**	84
Proportion	15%	1%	**17%**	83%	0%	**83%**	100%
Hagley – 4.0 m shared path							
Avg speed (km/h)	26.0	21.9	**24.3**	20.4	10.7	**20.3**	20.9
Observations	31	22	**53**	277	3	**280**	333
Proportion	9%	7%	**16%**	83%	1%	**84%**	100%
Hutt – 3.0 m cycle path							
Avg speed (km/h)	32.2	30.8	**32.2**	28.9		**28.9**	29.7
Observations	94	4	**98**	291		**291**	389
Proportion	24%	1%	**25%**	75%	0%	**75%**	100%
Roker – quiet street							
Avg speed (km/h)	26.4	25.0	**26.3**	22.7		**22.7**	23.3
Observations	12	1	**13**	75		**75**	88
Proportion	14%	1%	**15%**	85%	0%	**85%**	100%
Strickland – 2.2 m separated cycleway							
Avg speed (km/h)	27.1	23.0	**26.7**	24.6		**24.6**	24.9
Observations	30	3	**33**	216		**216**	249
Proportion	12%	1%	**13%**	87%	0%	**87%**	100%
Quay – 2.7 m cycle path							
Avg speed (km/h)	27.7	23.3	**25.7**	22.2		**22.2**	23.0
Observations	14	12	**26**	89		**89**	115
Proportion	12%	10%	**23%**	77%	0%	**77%**	100%
Quay – bus lane							
Avg speed (km/h)	32.0	21.0	**28.3**	25.6		**25.6**	25.8
Observations	2	1	**3**	31		**31**	34
Proportion	6%	3%	**9%**	91%	0%	**91%**	100%
All sites							
Total Avg speed (km/h)	**29.7**	**23.3**	**28.5**	**24.5**	**10.7**	**24.4**	**25.2**
Total Observations	**210**	**46**	**256**	**1191**	**3**	**1194**	**1450**
Total Proportion	**14%**	**3%**	**18%**	**82%**	**0%**	**82%**	**100%**

Note: proportions are rounded to the nearest 1%; six "other" e-devices excluded

Gender differences

The proportion of women observed at flat sites was higher for e-bikes (43.8%) than for unpowered bikes (28%, Table 4-3). A larger proportion of female riders (21.1%) were using e-bikes than men (11.7%). The "other" category includes five skateboards and one self-balancing unicycle. One e-scooter was clocked at 49 km/h on Hutt Road, but as it was not on the facility being surveyed then this figure was excluded.

For all genders, e-bike riders average 5.2 km/h faster than un-powered riders. This has substantial implications when considering the width of facilities and providing passing opportunities. Un-powered male riders are 4.2 km/h faster than un-powered female riders but only 2.8 km/h faster when riding an e-bike. All speed comparisons between genders and type of bicycle were statistically significant ($p < 0.05$).

Table 4-3: average speeds (km/h), number of observations, and gender proportions – flat sites (2020)

	E-powered				Unpowered				Grand total	Bike diff.
	Bike	Scooter	Other	Total	Bike	Scooter	Other	Total		
Female										
Avg. speed (km/h)	28.1	23.0		27.4	21.4			21.4	22.9	6.7
StdDev.	5.5	4.8		5.6	4.7			4.7	5.6	
Proportion	21.1%	3.7%		24.7	75.3%			75.3%	100%	
Observations	92 (43.8%)	16 (34.8%)		108	329 (27.6%)			329	437	
Male										
Avg. speed (km/h)	30.9	23.4	21.0	29.5	25.6	8.0	17.0	25.6	26.2	5.3
StdDev.	5.1	5.3		5.9	5.4			5.4	5.7	
Proportion	11.7%	2.6%	0.1%	14.4%	85.4%	0.1%	0.1%	85.6%	100%	
Observations	118 (56.2%)	26 (56.5%)	1	145	862 (72.4%)	1 (33%)	1	864	1009	
Unknown gender										
Avg. speed (km/h)		23.8	39.0	26.8		12.0	15.7	14.2	20.5	
StdDev.		1.3		6.9		2.8	0.6	2.5	8.2	
Observations		4 (8.6%)	1	5		2 (66%)	3	5	10	
All genders										
Avg. speed (km/h)	29.7	23.3	30	28.5	24.5	10.7	16.0	24.4	25.2	5.2
StdDev.	5.4	4.8		5.9	5.5	3.1	0.8	5.6	5.9	
Observations	210 (100%)	46 (100%)	2	258	1191 (100%)	3 (100%)	4	1198	1456	
Male – female difference										
km/h	2.8	0.8			4.2				3.3	

Note: Proportions within genders represent the adoption rate of e-bikes, and are summed horizontally (excluding the subtotals). Percentages given in parentheses are the proportions of each vehicle type (e-bike, e-scooter, regular unpowered bike etc) used by each gender, and are summed vertically

4.2 Uphill sites

Table ***4-4*** provides the results of the 2020 data collection at the two steepest uphill survey sites in Wellington (Brooklyn Road and Glenmore Street). At these sites, 40% of the riders were on e-bikes and travelling 8.8 km/h faster than un-powered riders.

Table 4-4: speed statistics (km/h) for bicycle riders at two hilly sites in Wellington (2020 survey)

	Male (M)	Female (F)	All e-bike	All un-p	M un-p	F un-p	M e-bike	F e-bike
Count	100	42	58	87	67	20	36	22
Proportion	70%	30%	40%	60%	77%	23%	62%	38%
Average speed	**13.8***	**13.8**	**19.2**	**10.4**	**10.8**	**9.0**	**19.5***	**18.2**
85th percentile	21	21	25	13	13	12	25	23
15th percentile	8	8	14	7	7	7	14	14
Range (85th-15th)	13	13	11	6	6	5	11	9
Max. speed	29	26	29	17	17	13	29	26
Min. speed	5	5	11	5	5	5	11	12
Standard deviation	5.6	5.6	4.7	2.9	3.0	2.2	5.1	3.9

*The difference in average speed of male and female e-bike riders in hilly conditions is not statistically significant

Facility type difference

Table 4-5 shows speeds for each of three facility types at the three hilly sites (including Constable Street, where the measurement location was the top of this hill to remove the influence of a nearby traffic signal). E-scooters made up only 3.2% of observations, so henceforth all further comparisons are only related to bicyclists.

Table 4-5: average speed and proportion of e-bike and e-scooter use at three hilly sites

	E-powered			Unpowered	All riders	Bike speed difference
	Bike	Scooter	Total	Bike		
Mixed traffic - Brooklyn Road, 11% average grade, about 400 m from start of hill						
Avg. speed (km/h)	17.3	12.0	17.2	9.3	13.4	8.0
Observations	30	1	31	29	60	
Proportion	50.0%	1.7%	51.7%	48.3%	100%	
Shared bus lane - Glenmore Street, 6% average grade, about 800 m from start of hill						
Avg. speed (km/h)	21.4	17.5	21.1	10.9	14.1	10.5
Observations	25	2	27	58	85	
Proportion	29.4%	2.4%	31.8%	68.2%	100%	
Separated cycleway - Constable Street, flat portion after short 14% grade						
Avg. speed (km/h)	23.6	21.7	23.3	17.4	20.3	6.2
Observations	19	3	22	23	45	
Proportion	42.2%	6.7%	48.9%	51.1%	100%	
All sites						
Avg speed (km/h)	**20.3**	**18.7**	**20.2**	**11.8**	**15.4**	**8.5**
Observations	**74**	**6**	**80**	**110**	**190**	
Proportion	**38.9%**	**3.2%**	**42.1%**	**57.9%**	**100%**	

Gender difference

The proportion of women using the three uphill facilities in Wellington was higher for e-bikes (42%) than for unpowered bikes (24%) as shown in Table 4-6. All larger proportion (in fact, the majority) of female riders (54.4%) were using e-bikes than men (33.9%).

A measurement that is different than the results of the flat sites is the comparison of speed by gender. Uphill there is no significant difference measured between the average speed of male and female e-bike riders (or all riders).

Table 4-6: speed and gender of cyclists by uphill sites (2020)

	E-bikes	Unpowered bikes	All bikes
Female			
Average speed (km/h)	19.9	10.2	15.5
Standard deviation	4.6	3.5	6.4
Proportion	54.4%	45.6%	100%
Observations	31 (41.9%)	26 (23.6%)	57
Male			
Average speed (km/h)	20.6	12.3	15.1
Standard deviation	4.8	4.8	6.2
Proportion	33.9%	66.1%	100%
Observations	43 (58.1%)	84 (76.4%)	127
All genders			
Average speed (km/h)	**20.3**	**11.8**	**15.3**
Standard deviation	**4.7**	**4.6**	**6.2**
% of bikes (read horizontally)	**40.2%**	**59.8%**	**100%**
Observations	**74 (100%)**	**110 (100%)**	**184**
Male – female difference			
Average speed (km/h)	0.7	2.1	-0.4
p-value	0.0873	0.0003	0.472

Notes: For one observation, gender was unknown. The speed data of this case is included in the total. Only cyclists were analysed as the number of other riders (6, or 3.2% of the total observations) was too small to include.

Proportions within genders represent the adoption rate of e-bikes, and are summed horizontally. Percentages given in parentheses are the proportions of each vehicle type (e-bike, e-scooter, regular unpowered bike etc) used by each gender, and are summed vertically

5 Trends over time

5.1 Christchurch trends over time

Three years of data from Colombo Street, Ferry Road, Hagley Park, and Strickland Street are summarised in Table 5-1 and visualised in the following graphs.

Table 5-1: overview results 2017 – 2018 – 2020 – Christchurch

	2017 March	**2018** June	**2020** July
Number of observations			
# e-bikes	15	26	88
# e-mobility	15	26	113
# Unpowered bicycles	557	561	705
# Total users	572	587	793
% Increase in facility use since 2017		2.6%	43.0%
Relative to total			
% e-bikes	2.6%	4.4%	10.8%
% e-mobility	2.6%	4.4%	13.8%
% Female all riders	28.3%	31.2%	36.1%
% Female e-bike riders	40.0%	34.6%	54.5%
Speed (km/h)			
All bicycles			
Average	23.8	23.2	23.6
Standard deviation of average	4.9	4.8	5.3
85th percentile	29.0	28.0	29.0
e-bikes			
Average	30.0	27.8	27.6
Standard deviation of average	5.4	4.7	5.7
85th percentile	32.0	33.0	34.0
Unpowered bicycles			
Average	23.6	23.0	23.1
Standard deviation of average	4.8	4.7	5.0
85th percentile	28.0	28.0	28.0
Difference between e-bikes and unpowered bikes			
Average	6.4	4.8	4.6
T-test	2.10E-4	1.08E-05	3.52E-27

Trends in e-mobility

Over a period of just three years, the use of the four sites during morning peak hour has increased by 43%, from 572 to 793 users. During this period, the proportion of e-mobility use has also increased

from less than 3% to more than 13% during morning peak with the biggest increase between 2018 and 2020. During the same period, the introduction of e-scooters was observed. Figure 5-1 and Figure 5-2 visualise the rising use of e-mobility.

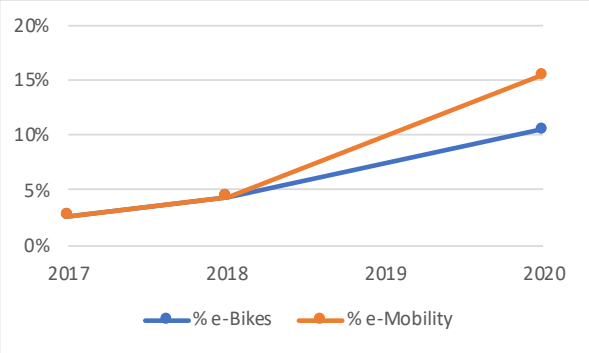

Figure 5-1: trend of e-mobility use

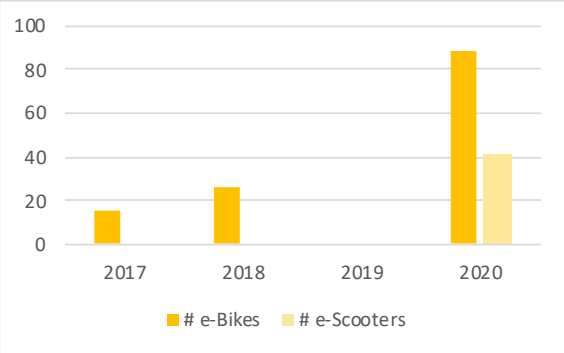

Figure 5-2: number of e-mobility devices observed

Trends in speed

Looking at the average speed data over time, a difference is observed between the average speeds of e-bike riders in 2017 (30 km/h) compared to 2018 (27.8 km/h) and 2020 (27.6 km/h), while the speed data of unpowered bicycle users shows a more stable value around 23 km/h for all years (Table 5-1). However, the 85th percentile speed of e-bike riders has increased from 32 km/h in 2017 to 33 km/h in 2018 to 34 km/h in 2020. Unpowered riders' 85th percentile speed stayed the same at 28 km/h.

Standard deviation is a measure of the variance in speeds amongst a group (type/class) of riders. Over time, the standard deviation in average speeds on an e-bike vary more than unpowered riders. For all time periods the standard deviation is greater for e-bike riders than unpowered riders.

The average speeds, standard deviation of speeds and the 85th percentile speed of unsupported cyclists (unpowered) are consistent within a difference of not more that 1 km/h.

The conflicts between the speed data of e-bikes over time can be explained by the rapid growth of its use. While the speed data for e-bike is based on only 15 riders in 2017 and only 26 riders in 2018, the data of 2020 is based on 88 riders. Future monitoring can confirm if the average speed will stabilise as seen in the analysis of the larger data sample of unpowered bicycles.

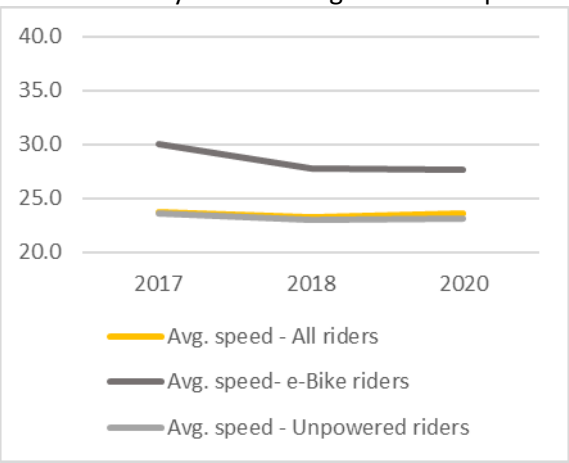

Figure 5-3: trend average cycle speed

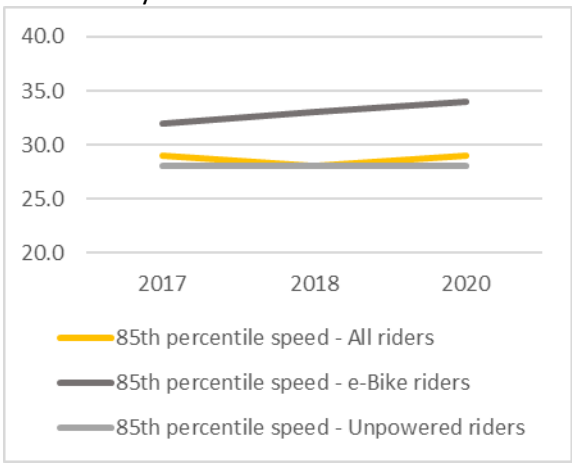

Figure 5-4: trend 85th percentile speed

E-bike riders average 27 km/h, significantly faster than the 23 km/h of unpowered riders. The same can be said about the 85th percentile speeds, which are over 30 km/h for e-bike riders and around

28 km/h for unpowered riders. The 85th percentile speed is often used for design speeds. For future guidelines, this research suggests a design speed of at least 30 km/h should be adopted.

Trends in gender differences

The proportion of female cyclists has generally increased (Figure 5-5). Women represent 55% of the e-riders in 2020 and it appears that female e-bike use is growing faster than the proportion of female cyclists in general.

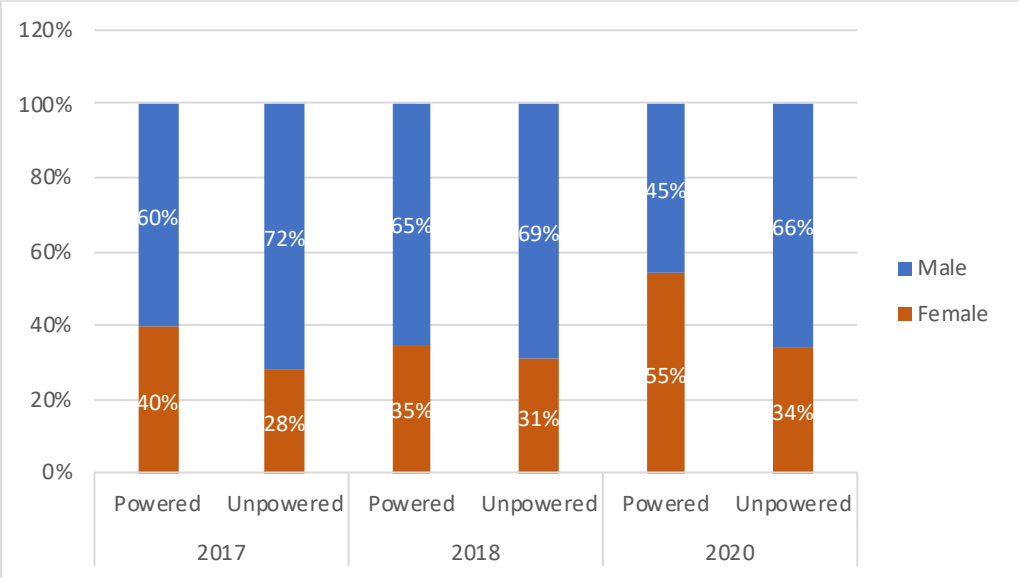

Figure 5-5: proportion of female and male use per year - Christchurch

5.2 Wellington trends over time

Hutt Road data was collected in 2017 and 2020. The survey conducted in 2017 had a duration of 45 minutes while the survey in 2020 took 90 minutes.[6] To make a comparison between facility use, the data of the observations in 2017 is extrapolated.[7] Results are listed in Table 5-2 and visualised in Figure 5-6 through Figure 5-10.

Table 5-2: overview results 2017 – 2020 – Hutt Road, Wellington

	2017	2017 extrapolated	2020
Numbers of observations			
# e-bikes	13	26	94
# e-mobility	13	26	98
# Unpowered bicycles	112	224	291
# Total users	125	250	389
% Increase in facility use since 2017			56%
Relative to total			
% e-bikes	10%	.	24%
% e-mobility	10%	.	25%
% Female all riders	33%	.	32%
% Female e-bike riders	12%	.	20%
Speed (km/h)			
All bicycles			
Average speed – All riders	28.5	.	29.7
St. Dev. speed – All riders	4.9	.	4.7
85th percentile speed – All riders	33.0	.	35.0
e-bikes			
Average. speed – e-bike riders	30.8	.	32.2
St. Dev. speed – e-bike riders	5.7	.	4.3
85th percentile speed – e-bike riders	36.8	.	37.0
Unpowered bicycles			
Average speed – Unpowered riders	28.2	.	28.9
St. Dev. speed – Unpowered riders	4.7	.	4.5
85th percentile speed – Unpowered riders	33.0	.	33.0
Difference			
Average speed e-bike riders – Unpowered riders	2.6	.	3.3
T-test	0.06417		5.79E-10

[6] The measurements did not take place in the same month each year. In 2017 measurements were in April and in 2020 in August. As there may be seasonal variation, this increase should be considered indicative only.

[7] If cycle traffic ebbs and flows during the 90-minute AM travel period, but roughly half is before 7:45 and half after (based on timestamps from the 2020 count, this is about right), then the extrapolated 2017 count would be about 250 riders.

Trends in e-mobility

Between 2017 and 2020 the use the Hutt Road facility during morning peak hour is estimated to have increased by 56%. The use of e-mobility devices is estimated to have increased from 10% to 24%. This is a higher proportion than measured in Christchurch, where e-mobility use was 3% in 2017 and 14% in 2020. This can be explained by the fact that there were more unpowered riders in Christchurch before the e-mobility trend started, and this group is also still growing.

E-mobility use on Hutt Road almost totally consists of e-bikes. Only four e-scooters were observed on Hutt Road in 2020, perhaps due to the distance from the city centre where most shared e-scooters are based.

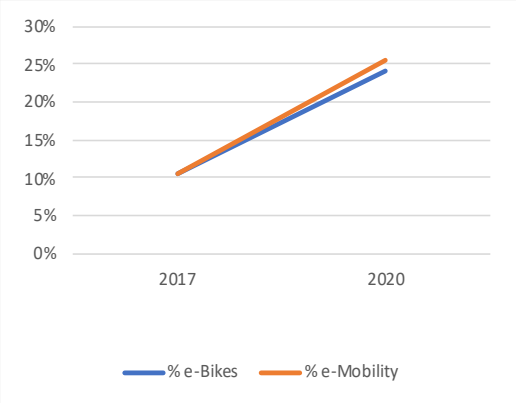

Figure 5-6: trend of e-mobility use

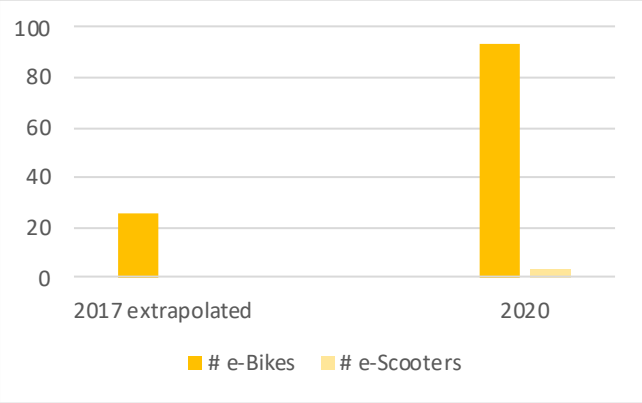

Figure 5-7: number of e-mobility devices observed

Trends in speed

Figure 5-8 and Figure 5-9 visualise the trend of average cycle speed and 85th percentile speed in 2018 and 2020. All speeds have increased on Hutt Road over the period of three years. The total average speed on Hutt Road has increased slightly by 1.2 km/h (Table 5-2). The increase in average speed of e-bike riders rose by 1.4 km/h, while the riders using unpowered bicycles the increase was only 0.7 km/h. The higher total average speed in 2020 may be explained by the higher proportion and the higher average speeds of e-bike riders on the facility.

The results of the 85th percentile speeds for all bikes shows a rising trend from 33 km/h in 2017 to 35 km/h in 2020, although for unpowered riders the value is stable and the change for e-bike riders is only 0.2 km/h faster. Again this is explained by a growing proportion of e-bike riders.

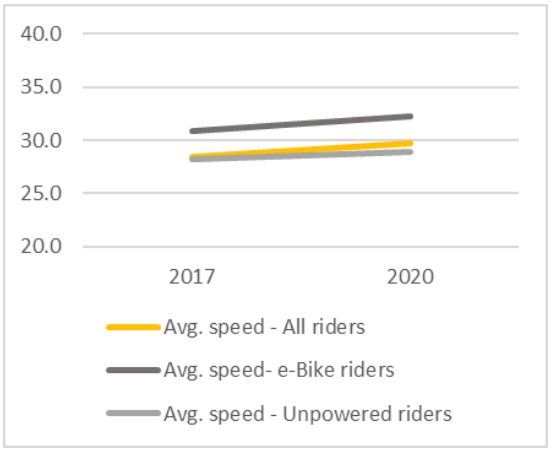

Figure 5-8: trend average cycle speed

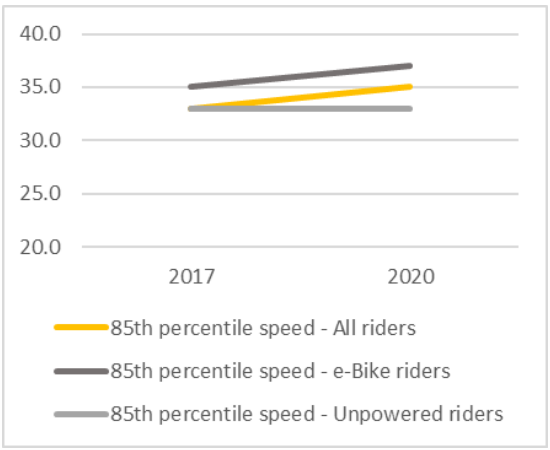

Figure 5-9: trend 85th percentile speed

Trends in gender differences

The proportion of female riders on Hutt Road increased for both powered and unpowered riders from 2017 to 2020, but more so for the latter group (Figure 5-10). The proportion of female e-bike riders remained almost the same, 31% in 2017 and 32% in 2020. As the total number of e-bike riders grew from 13 to 94, this means that the number of men and women on an e-bike is increasing at the same rate on Hutt Road.

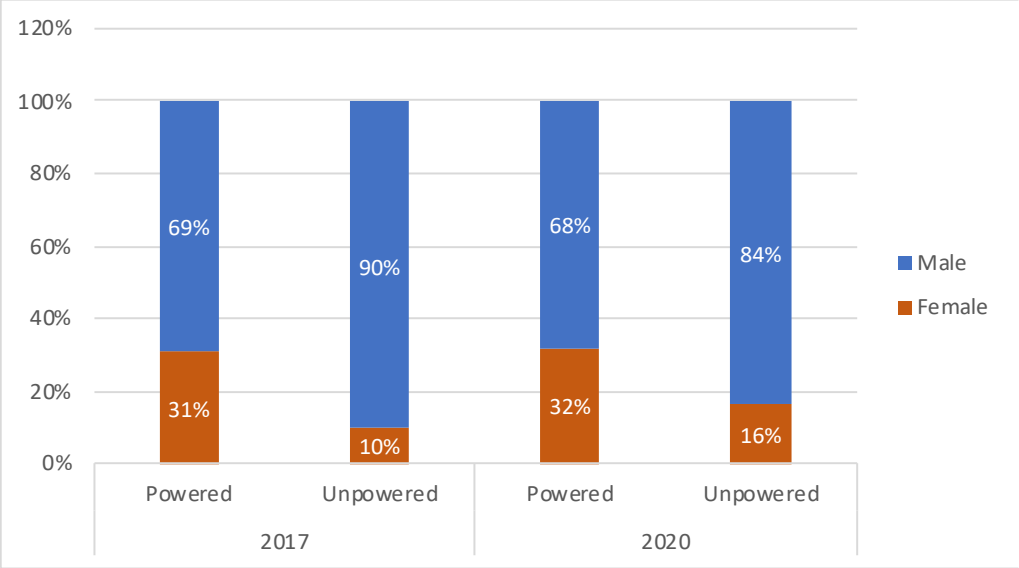

Figure 5-10: proportion of female and male facility use per year - Wellington

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