Quantifying Reductions in Carbon Emissions at RAD Bikes

Bella Whyte, Janice Leung, Jo Lourens, and Iona Wood

Department of Geography, University of Canterbury

GEOG309: Research for Resilient Environments and Communities.

17 October 2025

Cite as "Whyte B, Leung J, Lourens J and Wood I, 2025, *Quantifying carbon emissions reduction at RAD Bikes*. *A* report produced as part of the GEOG309 Research for Resilient Communities and Environments course, University of Canterbury, 2025."

Table of Contents

Executive Summary

- Context: RAD (Recycle a Dunger) Bikes is a non-for-profit cycling workshop located in the central city of Ōtautahi Christchurch. RAD's goal is to reduce the barriers to cycling through providing low-cost bikes and services to the community and promoting an environmentally sustainable transport mode.

- Research Question: How can a method be developed and applied to quantify RAD bikes carbon emissions in Christchurch?

- Methods: A quantitative approach through the distribution of an online travel habits survey was employed to contribute to the carbon emission reduction calculations. This was supported by a qualitative method of on-site interviews conducted during RAD's opening hours to understand the community's perspectives on RAD as a service.

- Key Findings: We estimated that RAD Bikes has enabled approximately 129 to 324 tonnes of CO_2-equivalent reductions per year. This is equivalent to the emissions from approximately 895 to 2,238 one-way flights between Auckland and Christchurch per passenger.

- Future Research: Researchers could consider installing GPS tracking on participants' mobile devices to record their cycling trips more precisely, and gather a more representative and larger sample.

Introduction

This report will cover the research conducted with community partner RAD (Recycle a Dunger) Bikes. The aim of the research was to understand RAD's contribution to carbon emission reduction while also looking into topics surrounding the social impacts of RAD as a community service. This will include an overview of the relevant literature, methodology of the research conducted, ethical considerations, as well as the results of the surveys and interviews with a discussion on their relevance to RAD Bikes and greater scale.

RAD Bikes is a community bike workshop located in Christchurch's central city area. Bike workshops like RAD aim to provide people with access to bicycles that are affordable for the purpose of contributing to both individual and community wellbeing (Yu et al., 2024). RAD does this through offering second hand bikes for a lower cost, accepting and selling donated bikes and parts, as well as holding workshops to teach repair skills. Besides the community aspect, they work towards diverting second-hand parts from waste streams and getting people onto the zero-carbon transport mode of cycling (RAD Bikes, 2025).

This research was conducted with the request from Jess Smale, coordinator at RAD Bikes. She expressed a need for quantitative information surrounding carbon and waste emission reductions from RAD. As RAD becomes a more established organisation, funding granted for novelty becomes harder to apply for. Their current workshop space at 160 Lichfield Street is right by the new in-progress stadium, Te Kaha, and will not be a viable long-term option as demand for this area rapidly increases. Our research would be to support their funding applications for Christchurch City Council grants.

Additionally, Christchurch City Council (2025a) has a goal for Net zero emissions by 2045. Transport represented 54% of gross emissions between 2019 and 2023. The cycle counters are one of the council's indicators for carbon emissions. Cycling culture and infrastructure has been on the rise in Christchurch contributing to a healthy environment by reducing air and carbon pollution (Christchurch City Council, 2025b). Quantitative evidence, particularly related to the Christchurch City Council emission reduction plan, is a secure way to ensure their financial and operational sustainability.

From here the research question 'How can a method be developed and applied to quantify RAD bikes carbon emissions in Christchurch?' was developed. This covered quantifying current data provided by RAD as well as looking into future methods for RAD to be able to do this independently.

Research Question: How can a method be developed and applied to quantify RAD bikes carbon emissions in Christchurch?

Literature Review

To understand the context of our research, we conducted a literature review across four key areas: the environmental impacts of cycling, the health benefits of cycling, its social implications, and international case studies. This helped us situate RAD Bikes' work within broader global and local discussions on sustainable transport and community well-being.

1. Quantifying greenhouse gas (GHG) emissions

We conducted a literature review on methods used to quantify carbon emissions, which directly informs our research question. Across the literature, GHG emission reductions from cycling are commonly calculated by substituting the kilometres travelled by bike with those that would have otherwise been made using a non-active transport mode. However, the specific substitution methods vary. Kou et al. (2020) developed a regression model combining bike-share trip data, historical travel surveys, public transport availability, and emission factors to estimate city-wide reductions. Guo et al. (2025) used regression and propensity-score matching to compare active and inactive travellers with similar characteristics. In contrast, Neves & Brand (2019) and Zhang et al. (2018) applied travel diaries and GPS tracking to substitute commuting cycle trips for car trips, basing results on actual traveller behaviour rather than predictions. Despite methodological differences, all studies rely on similar inputs: trip distance, travel mode, and trip purpose (Guo et al., 2025; Neves & Brand, 2019; Kou et al., 2020; Zhang et al., 2018). Surveys have proven effective in obtaining these inputs, as shown by Mathez et al. (2012), who quantified the transport-related emissions of university students.

All reviewed studies convert substituted kilometres into GHG reductions using emission factors, yet the factor type significantly influences results. Most applied direct vehicle emissions (Mathez et al., 2012; Neves & Brand, 2019; Zhang et al., 2018), while Guo et al. (2025) incorporated marginal emission factors and Kou et al. (2020) adopted life-cycle emissions to include bicycle production. These methodological choices affect comparability, with life-cycle estimates reducing reported net benefits by around 30% (Kou et al., 2020), highlighting the importance of consistent emission factor selection.

2. Health Benefits of cycling

Several direct health benefits of cycling were identified from Green et al.'s (2021) review of the health benefits of cycling in medical literature, including clinical trials and systematic reviews: Improvement of physical well-being due to allowing for prolonged independence; reducing chances of acquiring chronic diseases such as diabetes; and decreases in all-cause mortality. There are also benefits of cycling on mental health, as shown by Berrie et al.'s (2024) study, only 9% of cyclists had a prescription for mental health compared with 14% amongst non-cyclists. Specifically in New Zealand, Bassett

et al. (2020) estimated cycling produces a health benefit of $0.50 (in New Zealand dollars) per kilometre for those aged 15-64 years, but even more benefit at $2.90 per kilometre for those aged 65-74 years old. Woodcock et al.'s (2021) study found that the health benefits from cycling in flat areas are roughly three times greater than those from hilly areas. Christchurch's flat terrain makes it a suitable place for promoting cycling and conducting relevant research.

Contrary to health benefits, cycling can also pose risks to the cyclists. Green et al.'s (2021) found negative health outcomes of cycling, such as exposure to air pollution and injury, but the literature has shown that health benefits outweigh such risks. Braun et al. (2021) found that cycling health risks are greater among marginalised populations, ie. neighbourhoods with lower income, lower educational attainment, and higher shares of ethnic minority populations, as they have worse outdoor air quality and facilities for preventing crashes. This highlights the critical importance of RAD for providing low-cost bike repairs, as proper equipment maintenance is essential to prevent injury risks.

3. Social implications of cycling

The research surrounding diversity in cycling shows that overall, there is a large disparity between ethnic groups with Aldred et al. (2015) talking about how despite an uptake in cycle rates there is not an increase in diversity. Using UK survey data, the research demonstrated that cycling participation remains predominantly white, male, and affluent. Steinbach et al. (2011) investigates how class, gender and ethnicity shape cycling identities in London which suggest that cultural associations of cycling discourage participation among marginalised groups.

Kokayi et al. (2023) provide quantitative evidence that ethnic minorities in England are significantly underrepresented in cycling. Using a GIS-based analysis they found that uptake is influenced by socio-economic and spatial factors such as income and terrain. Bopp et al. (2021) builds on this in a US setting, where they explored how exclusionary cycling cultures, racial profiling, and safety concerns discourage participation among minority cyclists. They discuss how community cycling groups help foster empowerment and safety to counter systemic exclusion.

Māori mobility in Auckland is connected to connected to cultural identity and wellbeing in research conducted by Raerino et al. (2013). While not specific to cycling, their work looks at how transport systems shape cultural participation and must reflect indigenous values to promote equity. Collectively the literature reflects that barriers to cycling extend beyond infrastructure and that cultural, social, and economic inequalities determine who participates, showing that transport equity requires both inclusive policy and cultural recognition. This links to the mission of RAD, which is to provide access to cycling for all and the data found further in this report shows how heavily a service like RAD can contribute to Māori access to cycling.

Based on the literature we reviewed about health benefits and diversity in cycling, we examined survey respondents' age, gender, and ethnicity to explore how RAD users from different demographic groups engaged with their services.

4. International Case Studies

Research related to international bike kitchens has largely focused on qualitative studies, which provide strong evidence for social cohesion, empowerment, and equitable mobility access (Bradley, 2016; Batterbury et al., 2025). These studies also highlight the contribution of bike kitchens to a circular economy by encouraging repair, reuse, and shared resources (Singh et al., 2019; Singh, 2022). The insights gained from qualitative data are particularly valuable for understanding social and behavioural change, such as community building and increased cycling (Crutzen et al., 2024). Incorporating this type of data collection could strengthen persuasiveness with a live voice in RAD's funding applications (Singh, 2022).

A main limitation of the current literature is the lack of quantified environmental data and methods, so addressing this research gap is the aim of our research question. Carbon emission reductions are mentioned mainly in theoretical terms, particularly in relation to degrowth and sustainable principles (Bradley, 2016; Singh et al., 2019; Batterbury et al., 2025). Our research seeks to demonstrate these impacts with robust, quantifiable data rather than relying on subjective or opinion-based evidence.

The literature also highlights the need for further investigation into the environmental contributions of bike kitchens. Potential approaches include calculating carbon emission reductions, life-cycle assessments, and material flow analysis (Singh et al., 2019; Singh, 2022). Several studies propose research frameworks that emphasise the importance of measuring environmental impacts alongside social outcomes (Singh, 2022; Crutzen et al., 2024). Our research also contributes additional evidence regarding the social impact of RAD's bike kitchen, with a specific focus on its role within the Christchurch community.

Methods

Survey Design

Appendix A shows the full questionnaire of our survey. The survey questionnaire included demographic questions covering age group, gender, and ethnicity. Age groups began at 18–24 and increased in 10-year intervals up to 65 and over. Gender options included female, male, and nonbinary/gender diverse. Ethnicity categories followed those used in the 2023 New Zealand Census , and respondents could select multiple options (StatsNZ, 2025). All demographic questions were optional to respect respondents' autonomy in sharing personal information.

To better understand respondents' cycling behaviours, the survey asked how their car usage had changed since visiting RAD, with five response options ranging from 'much less' to 'much more'. Respondents were also asked whether they had visited RAD before and could select one or more reasons for their visit. An open-ended question at the end of the survey invited respondents to share any additional thoughts about RAD's services.

A key challenge across the literature is the usage data of a bike after it leave a workshop (Singh et al., 2019, Crutzen et al., 2024). For RAD, this is the way their work can be directly linked to carbon emission reductions. Information needed was how long and how often a bike from RAD is used, and would this replace car trips or a different mode of transport. To determine the alternative mode of transport, respondents were asked to provide details for up to five trips in the past seven days, including the starting point and destination by naming the nearest intersection (e.g., Riccarton Road & Ilam Road). For each trip, they indicated the mode of transport used and what mode they would have used if they did not have access to a bike.

Emission Reduction Quantification Method

For this research, emission factors from *Measuring Emissions: A guide for organisations* (Ministry for the Environment, 2024) was used, as shown in Table 1. These factors show direct emissions and were chosen over marginal or life cycle factors because the Ministry for the Environment (MfE) guide is considered the industry standard for New Zealand organisations. This ensures results are comparable across organisations and can be referenced reliably in grant applications.

Table 1. MfE emission factors used for alternative travel modes (Ministry for the Environment, 2024)

Survey Alternative Travel Mode	MfE Emission Source	kg CO_2-e/km
Car (driver)	Default private petrol car	0.243
Car (passenger)	Regular taxi	0.160
Bus	Bus Passenger (National Average)	0.155
Moped	Moped	0.023

Emission reductions were calculated by multiplying the distance that would have been travelled by each alternative mode (had the respondent not cycled) with the corresponding emission factor:

Emission Reduction (kg CO_2-eq) = *Alternative Travel Mode (km) × Emission Factor*

Only bike trips by respondents who had used RAD's services were included in this calculation. Reductions for each mode were then summed to determine the total reduction captured in the survey. Dividing this total by the total kilometres travelled by bike provided average emission savings per kilometre, which was used to scale results to an organisational level. To estimate annual emission reductions, the following equation was applied:

Annual Emissions Saved (kg CO_2-e) =
Distance travelled (km) × Emissions Savings per km × Number of RAD Customers × 52 Weeks.

The number of RAD customers in FY2025 (approx. 2,570) was provided directly by the organisation. A similar equation was used to calculate emission reductions associated specifically with bikes sold, based only on trips recorded by respondents who had purchased a bike:

Sold Bikes Annual Emission Savings (kg CO_2-e) =
Average Sold Bike Trip Distance (km) × Emissions Savings per km × Number of Bikes Sold × 52 Weeks

The number of bikes sold was also provided by RAD Bikes (approx. 510) This result can also be expressed as a per-bike emission saving, providing a practical emission factor for future reporting or benchmarking.

Survey Sampling and Conduction

The identified population was people following RAD's social media, who were figured to be returning community members. This is where the survey was posted to best access their community. There were also people who came into the workshop on their weekend repair drop-in sessions participate through paper surveys and being directed to the online survey. It is recognised that this is not a random sample and may have a self-selection bias towards people who want to see RAD continue (and probably bike more than the average) (Nikolopoulou, 2022). Unfortunately, there was no other viable way of contacting their customer base, and this is considered in the results and analysis.

Advice from RAD's coordinator and the project supervisor meant getting adequate response numbers was considered. A bike lock and lights were donated from RAD, as an incentive for participating in the survey. The community aspect was also promoted, stating that taking part in this research will help keep RAD going so they can keep providing quality services and community.

Our survey was published through Qualtrics in September, 2025. A QR code and link to the survey were posted to RAD social media. Appendix C shows the poster with the QR code that were put up around RAD, as well as smaller paper copies for people to take for later use. In person paper surveys were conducted at RAD, this was to target the demographic who did not have access to a phone. After deleting responses from people who helped us pretest the questionnaire, who did not complete the whole questionnaire, and who were aged under 18, we collected 45 valid responses from the survey.

Interview Design and Conduction

As a second method of research, interviews were conducted to use as a proxy for broader travel emission assumptions of RAD's customers. Qualitative data from in person research makes this research more meaningful on a personal level. A key purpose of RAD's is developing community wellbeing, which is directly improved by providing a welcoming space for anyone that comes through their doors. This is also improved by their contribution to environmental health through reducing carbon emissions.

Interviewees were asked about their attitudes towards bikes, including what encourages them to cycle and what sorts of trips and destinations they make by bike compared to other transport (which is mostly car). To understand underlying attitudes around cycling, the question what the furthest distance is of a trip for you to not bike, was asked. Appendix B shows the interview questions we asked.

Interviews were conducted on two separate occasions on site during RAD's opening hours in September, 2025. There were 5 total interviews conducted, and these were done through audio recording and transcription.

Ethics considerations

Social Risk

Participants may have chosen to provide identifiable information for future contact. Informed consent was obtained, and the use of any personal information was clearly explained to minimise potential risk.

Service User Risk

Participants could potentially be identified by RAD Bikes service providers during interviews conducted at the workshop. To mitigate this risk, informed consent was obtained prior to participation in any interviews.

Recompense Costs

A prize draw for a high-quality bike lock and lights or a $10 gift card was offered as an incentive for survey participation. As the incentive was awarded by chance rather than guaranteed, it was not expected to introduce bias and was considered appropriate for the RAD customer population.

Data Analysis

The data was collected through Qualtrics which gave us percentage tables and bar charts, this was particularly helpful for our demographics. Quantitative information (e.g. distances travelled) was explored through excel. Calculations were done to find the average trip distance of RAD customers before being plugged in with the emissions factor.

Results and Discussion

Survey Results

Respondents' demographics

Age

Table 2.1 shows the distribution of age groups in the sample. For age groups, young people aged 18 to 24 are the largest group in the sample, around 30% of the total respondents. Then, from 25 to 54, the percentages of the age groups are almost evenly distributed. There are only 2% aged 55 to 64, while 7% of respondents are aged 65 or above. It might imply that older people pick up cycling again when they retire after 65. As Bassett et al. (2020) suggests, people aged over 65 might enjoy greater benefits from cycling.

Gender

Table 2.2 shows the gender distribution of the sample. For the gender distribution, in the sample, 56% are males and 42% are females, and there are 2% of non-binary and gender-diverse respondents. While the gender distribution is slightly skewed toward males, we still reckon it is within an acceptable range, and our sample is valid.

Ethnicity

Table 2.3 shows the distribution of ethnic groups in the sample. For ethnicity, the majority of the respondents are New Zealand European, 64%, but there are also 16% Māori and 13% Asian respondents. In particular, 16% Māori among our respondents is higher than the percentage of the Māori population in Christchurch, which is 11.2% in the 2023 census (StatsNZ, 2025). It indicates RADS work is important for the Māori

community. The literature shows ethnic minorities are usually underrepresented (eg. Raerino et al., 2013), but RAD has been very helpful to the ethnic minority groups.

Table 2.1. Distribution of age groups among respondents

Age Group	Percentage
18 - 24	29%
25-34	22%
35-44	20%
45-54	21%
55-64	2%
65+	7%

Table 2.2. Distribution of gender among respondents

Gender	Percentage
Male	56%
Female	42%
Non-binary/Gender diverse	2%

Table 2.3. Distribution of ethnic groups among respondents

Age Group	Percentage
NZ European	64%
Māori	16%
Pasifika	2%
Asian	13%
Latin America	2%

Reasons for visiting RAD

A total of 35 respondents (79.5%) indicated that they had visited RAD prior to completing the survey. When asked about their reasons for visiting, the most common response was bike repairs, selected by 58.3% of participants. This was followed by obtaining a second-hand bike (36.1%) and attending workshops (27.8%). Additionally, 16.7% reported volunteering, and 5.6% mentioned donating bikes or parts—both of which are vital to keeping RAD operational. Fig. 1 shows all reasons selected for visiting RAD (multiple selections enabled).

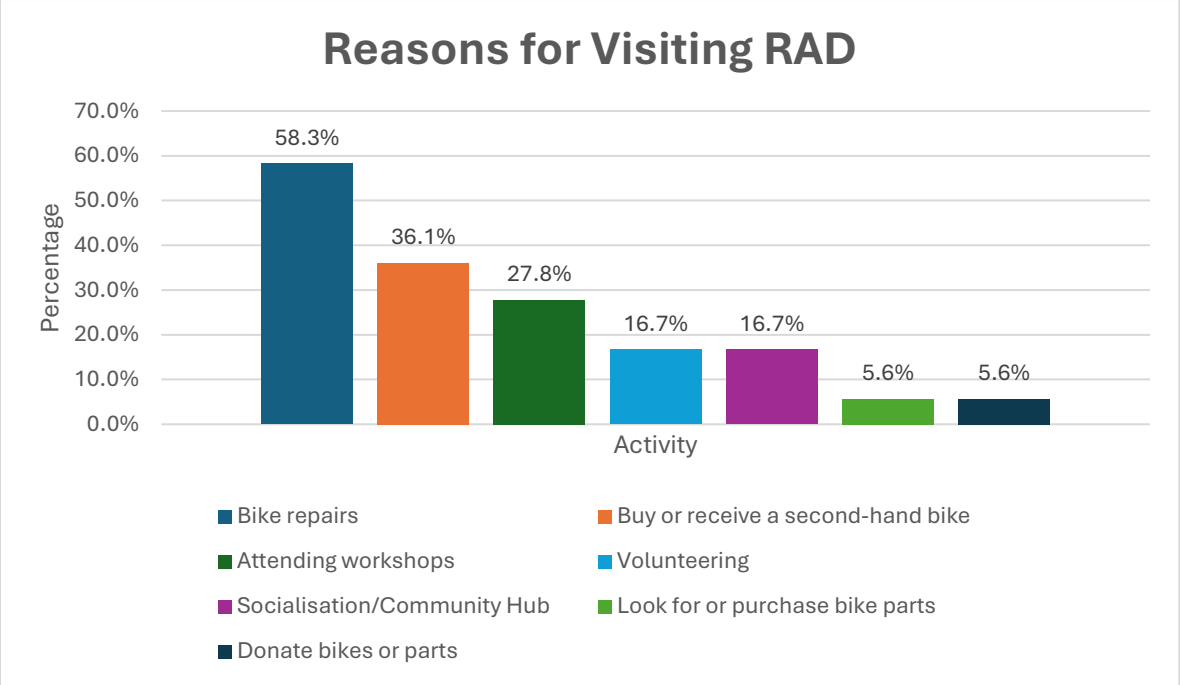

Figure 1. Reasons for visiting RAD among respondents

Mode of transport

We asked respondents what types of transport they had used in the past seven days, allowing for multiple selections. Fig.2 illustrates the distribution of transport modes. A significant majority—88%—reported using a bike, highlighting the importance of bike maintenance for RAD users, as most rely on cycling at least once a week. However, 60% also reported using a car during the same period. This suggests an opportunity for RAD to engage these users and encourage more frequent bike use over car travel, contributing to reduced carbon emissions.

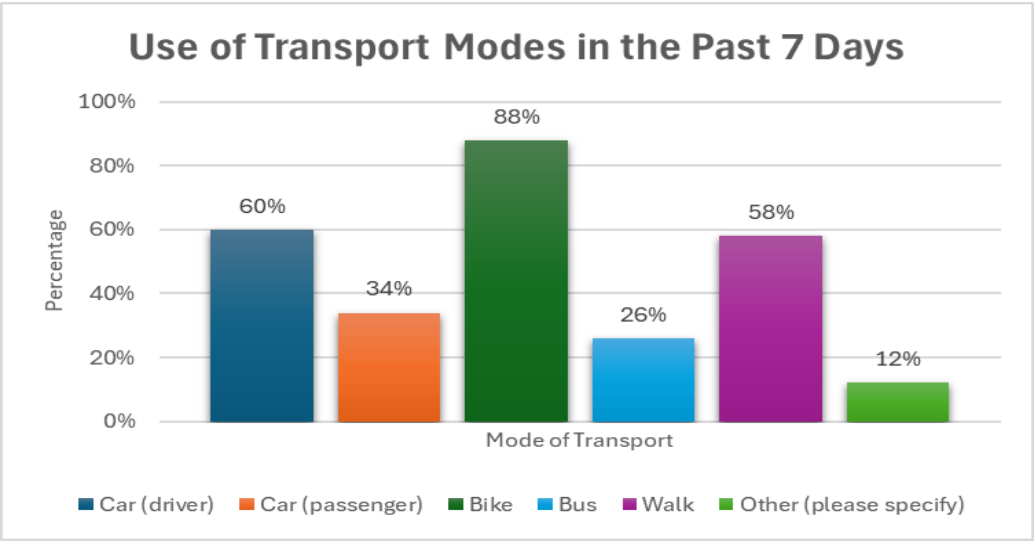

Figure 2. Respondents' use of transport modes in the past 7 days

Fig.3 indicates the respondents' self-reported frequency of using their cars compared to before they visited RAD (if they had visited RAD before). 78% of RAD visitors still used cars, but 37% of the respondents said they used cars either much less (22%) or somewhat less (17%) often compared to before they visited RAD. This is an encouraging finding, showing how people switched from cars to bikes with RAD's work.

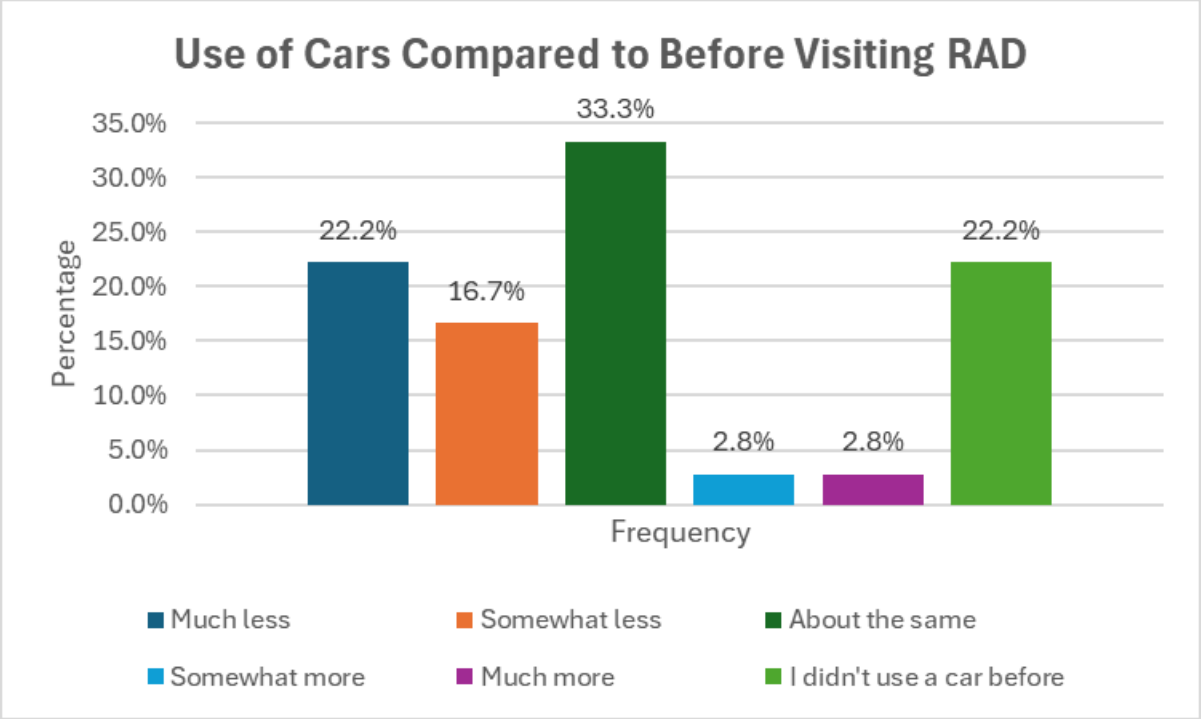

Figure 3. RAD visitors' car usage compared to before visiting RAD

Emission Reduction Results

Table 3.1. Emission reductions by alternative travel mode

Alternative Mode	Trip Distance	Emission Reduction (kg CO2-eq)
Bus	161	24.955
Car (driver)	149.5	36.3285
Car (passenger)	17.2	2.752
Moped	5.4	0.1242
Walk	74	0

The survey recorded 53 bike trips, totalling to 407km. The average bike trip distance was 7.68km. A total of 78km of bike trips were excluded, as these were taken solely for leisure or exercise purposes and therefore did not have an alternative mode. Table 3.1 presents the kilometres that would have been travelled by each alternative mode and their associated emission reductions. Walking was assigned a value of zero

because it is an active travel mode and does not contribute to emission reductions. Summing the alternative modes gives a total reduction of 64.16kg CO_2-eq from survey respondents travel habits over the 7-day period (equivalent to a 300km drive in a petrol car), with an average saving of 0.1576 kg CO_2-eq per kilometre travelled.

Using the per kilometre emission factor, the results were scaled to estimate annual organisational impact. Since not all customers will ride consistently, three scenarios were modelled to reflect different weekly trip frequencies and adoption rates (different percentages of RAD Bikes' 2,570 customers completing weekly trips consistently) (Table 3.2). These scenarios show that annual reductions could range between ~64.7 tonnes and ~485.3 tonnes CO_2-eq.

Table 3.2. Estimated annual emission reductions under varying adoption and trip-frequency scenarios

	Approximate Tonnes CO2-eq Reduction		
Adoption Rate	**Scenario A:** *1 avg trip/week*	**Scenario B:** *2 avg trips/week*	**Scenario C:** *3 avg trips/week*
40%	64.7	129.4	194.1
60%	97.1	194.1	291.2
80%	129.4	258.8	388.2
100%	161.7	323.5	485.3

Respondents, on average, reported between 1-2 trips per week which varied in distance. This is supported by comments from respondents stating they cycle for short errands, which may not have been included in the survey due to respondents only being able to record maximum five trips and being told to record their longest trips. Given that 57% of recorded bike trips were for work or study, it is likely that many riders cycle more than once per week. On this basis, Scenario A presents a more conservative estimate and Scenario C a more ambitious. Thus, the most realistic range of total reductions is represented by Scenario B, with two average trips per week. This shows that RAD Bikes has enabled approximately 129-324 tonnes CO_2-eq reductions per year, which is equivalent to 895-2,238 Auckland to Christchurch flights (per passenger equivalents).

A key service offered by RAD Bikes is the sale of donated bikes. From the survey data, 116.9km of cycling was recorded on bikes purchased from RAD, with an average trip distance of 6.5km. Multiplying the total distance by reductions per kilometre gives a total reduction of 18 kg CO_2-eq from survey respondents with a purchased bike. These participants averaged two trips per week, and applying this frequency to the 510 bikes sold in 2025 (following Scenario B from earlier analysis) results in an estimated 21.7-54.3 tonnes CO_2-eq saved annually. These reductions can be more directly attributed to

RAD Bikes than the broader customer estimate, as the provision of bikes directly enables emission-saving travel that would not have occurred otherwise.

Interviews

There was an overwhelmingly positive response in attitudes towards RAD. Quotes from the qualitative research are given in Table 4.

Table 4. Quotes and consistent themes from the qualitative part of the research

Quote	Themes
"I really like how it's run. I think if more people have access to bikes and have the knowledge to maintain the bike then maybe that could offer more opportunities for people to go biking."	Accessibility, Education
"awesome workshops, great to provide low cost alternatives to get people on bikes"	Accessibility
"it's really cool because it's run by volunteers and offers people an opportunity to learn new skills and to sell bikes that aren't too expensive. So, it gives that option too for people."	Education, Accessibility
"RAD bikes is an awesome community initiative to provide a wider access to biking for people."	Community, Accessibility
"First time visiting RAD and was very warmly welcomed."	Community
"It [RAD] got me interested in fixing the parts myself and looking more into how to improve my cycle knowledge."	Education
"RAD bikes offer a great service that bikeshops can't. A public gem."	Community
"Yeah, I think by donating bikes and things like that, it [RAD] has certainly encouraged people biking. I mean, RAD's been around for quite a few years now, and I'd say definitely through education and awareness."	Accessibility, Education
"Everyone at RAD is so helpful and lovely, getting a bike through them was such a good decision. I used to walk to uni everyday which took 30 mins and now I	Community

The consistent themes were the appreciation of community, their wide scope of demographics making their services more accessible, and the value of their workshop towards education.

These themes relate back to the literature on international bike workshops, which had the strongest evidence towards their importance for social cohesion and contribution to a circular economy (Singh et al., 2019; Bradley, 2016; Valentini & Butler, 2023). This qualitative data will help to strengthen persuasiveness in funding applications giving a live voice to RAD's community (O'Cathain et al., 2014).

Practical Implications on CCC Community Outcomes

To discuss the practical implications of our findings, we relate our findings to the Christchurch City Council (CCC) Community Outcomes. The Community Outcomes are goals provided by the CCC to promote the social, economic, environmental and cultural well-being of Christchurch (Christchurch City Council, 2025). Our findings demonstrate how RAD's done in terms of meeting these outcomes, which can help them create their fund applications in future.

1. A Collaborative, Confident City

This outcome emphasises being a collaborative, confident city by socially and actively engaging residents and groups in the wider community (Christchurch City Council, 2025c). Christchurch's flat terrain makes it ideal for enjoying benefits from cycling (Woodcock et al., 2021). As many respondents in the survey and the interview suggest, RAD Bikes enables community members to actively engage with cycling without significant financial concerns.

2. A Green, Liveable City

This outcome focuses on becoming a green, liveable city by achieving goals to reduce emissions, build climate resilience and protect and regenerate the environment (Christchurch City Council, 2025c). This is the most relevant community outcome from our research. Our findings indicate that RAD Bikes encourages increased bike usage, with a potential reduction of approximately 129 to 324 tonnes of CO_2 annually. This helps Christchurch become greener and more liveable.

3. A Cultural Powerhouse City

This outcome includes fostering inclusivity, multiculturalism, multilingualism, and a strong sporting culture (Christchurch City Council, 2025c). In our surveys and interviews, users consistently share their strong appreciation for how RAD has helped them with their cycling, showing RAD's central role in Christchurch's bike community, and how it is culturally an accessible space for people interested in cycling in Christchurch. Additionally, there is relatively high engagement from Māori users and a broad age range of participants in our survey. This indicates that RAD is an inclusive space that people from any ethnicity, culture and age can enjoy.

4. A Thriving, Prosperous City

This outcome is reflected in increased productivity and reduced emissions (Christchurch City Council, 2025c). In our survey, many RAD users reported using their bicycles for commuting to work or study, suggesting that cycling supports economic activity while minimising environmental impact. RAD's services help maintain these bicycles, significantly reducing cycling health risks that are greater among marginalised

populations (Braun et al., 2021), indirectly contributing to workforce mobility and local economic resilience.

Conclusions

Limitations and future research

Due to constraints in time and resources, our research has several limitations. First, we only asked the respondents to recall their transport usage in the past 7 days, so their answers might not accurately reflect their typical habits. There might also be recall errors in the self-report data when respondents recalled transport in the past 7 days. This could lead to inaccurate estimations of carbon emissions. Second, as we didn't have the resources to do a random sampling, there might be selection bias in the sample. With a relatively small sample size, our findings might not be able to generalise to the broader RAD user base.

To improve accuracy in future studies, researchers could consider installing GPS tracking on participants' mobile devices to record their cycling trips more precisely. However, this approach requires additional resources to obtain informed consent, and ethical concerns in collecting sensitive location data need to be addressed. Future research can also aim to gather a more representative and larger sample to enable the calculation of the specific emission factor for RAD. This would allow RAD to better quantify its environmental impact and support strategic planning to further reduce carbon emissions.

Concluding remarks

In conclusion, we developed a survey to quantify RAD Bikes' contribution to reducing carbon emissions in Christchurch, addressing our central research question and filling the research gap of bike kitchens' benefits in literature. Based on how RAD users substituted bike trips for higher-emission transport modes, we estimated that RAD Bikes has enabled approximately 129 to 324 tonnes of CO_2-equivalent reductions per year—assuming an average of two trips per week. We also found 37% of the respondents said they used cars either much less or somewhat less often compared to before they visited RAD.

To complement this, we incorporated qualitative approaches through interviews and an open-ended survey question, which provided a deeper understanding of RAD Bikes' impact on the local community. There was an overwhelmingly positive response in attitudes towards RAD. The consistent themes were the appreciation of RAD's bike community, their wide scope of demographics making their services more accessible, and the value of their workshop towards education.

Based on our findings, we recommend RAD consider the following actions:

1. Apply for funding based on their environmental impact
   RAD can use the data on carbon reduction to support applications for sustainability funding opportunities.
2. Celebrate and Communicate Environmental Contributions
   As shown by our survey responses and interviews, while most users are aware of RAD's community impact, fewer recognise its environmental benefits. RAD could enhance awareness by sharing these findings with users through their social media or other communication channels.
3. Set Future Emission Reduction Targets
   Our findings offer a baseline from which RAD can establish realistic carbon emission reduction targets, helping guide future initiatives and measure progress.

Acknowledgements

We would like to thank the different groups who supported our research. Firstly, to our supervisor Dr. Jillian Frater for overseeing our study. Followed by Jess Smale and the team at RAD Bikes for their time, knowledge, and use of space. Finally, we appreciate the advice from our course coordinators Professor Simon Kingham and Dr. Sophie Horton.

References

Aldred, R., Woodcock, J., & Goodman, A. (2015). Does More Cycling Mean More Diversity in Cycling? *Transport Reviews*, *36*(1), 28–44.

Bassett, D., Hosking, J., Ameratunga, S., & Woodward, A. (2020). Variations in the health benefit valuations of active transport modes by age and ethnicity: A case study from New Zealand. *Journal of Transport & Health*, *19*, 100953.

Batterbury, S., Uxo, C., De Chatillon, M. A., & Nurse, S. (2025). Community Bike Workshops in Australia: Increasing demand for cycling through mutual aid. *Transactions on Transport Sciences*, *2*.

Berrie, L., Feng, Z., Rice, D., Clemens, T., Williamson, L., & Dibben, C. (2024). Does cycle commuting reduce the risk of mental ill-health? An instrumental variable analysis using distance to nearest cycle path. *International journal of epidemiology*, *53*(1), dyad153.

Bopp, M., Mama, S. K., Wilson, O. W. A., & Elliott, L. D. (2021). Breaking down race-related barriers to recreational cycling: experiences from diverse cycling groups. *World Leisure Journal*, 1–14.

Bradley, K. (2016). Bike Kitchens – Spaces for convivial tools. *Journal of Cleaner Production*, *197*, 1676–1683.

Braun, L. M., Le, H. T., Voulgaris, C. T., & Nethery, R. C. (2021). Healthy for whom? Equity in the spatial distribution of cycling risks in Los Angeles, CA. *Journal of Transport & Health*, *23*, 101227.

Christchurch City Council (2025a). *We like to bike*. https://smartview.ccc.govt.nz/apps/emissions/?bike

Christchurch City Council (2025b). *The way we are going*. https://smartview.ccc.govt.nz/apps/emissions/?

Christchurch City Council (2025c). *Community outcomes monitoring*. https://ccc.govt.nz/culture-and-community/statistics-and-facts/community-outcomes-monitoring

Crutzen, M., Draaijer, S., Henstra, R., Veelenturf, T., & Zins, S. (2024). *The Bike Board: A Practice-Oriented Design Research Approach to Understand and Design for Social Practices at The Bike Kitchen*. https://www.susandraaijer.nl/wp-content/uploads/2024/05/TBK_Article_Group01_Field_Final_PDF.pdf

Green, S., Sakuls, P., & Levitt, S. (2021). Cycling for health: Improving health and mitigating the climate crisis. *Canadian family physician*, *67*(10), 739-742.

Guo, Y., Bigazzi, A. Y., & Chen, X. (2025). Potential greenhouse gas emission reduction from active transportation: Comparing travel behavior patterns. *Transportation Research Part D Transport and Environment*, *145*, 104835–104835.

Kokayi, A., Shiode, S., & Shiode, N. (2023). Geographical Exploration of the Underrepresentation of Ethnic Minority Cyclists in England. *Sustainability*, *15*(7), 5677.

Kou, Z., Wang, X., Chiu, S. F. (Anthony), & Cai, H. (2020). Quantifying greenhouse gas emissions reduction from bike share systems: a model considering real-world trips and transportation mode choice patterns. *Resources, Conservation and Recycling*, *153*, 104534.

Mathez, A., Manaugh, K., Chakour, V., El-Geneidy, A., & Hatzopoulou, M. (2012). How can we alter our carbon footprint? Estimating GHG emissions based on travel survey information. *Transportation*, *40*(1), 131–149.

Neves, A., & Brand, C. (2019). Assessing the potential for carbon emissions savings from replacing short car trips with walking and cycling using a mixed GPS-travel diary approach. *Transportation Research Part A: Policy and Practice*, *123*, 130–146.

Nikolopoulou, K. (2022). *What is self-selection bias? | Definition & example*. Scribbr. https://www.scribbr.com/research-bias/self-selection-bias/

O'Cathain, A., Goode, J., Drabble, S. J., et al. (2014). Getting added value from using qualitative research with randomized controlled trials: a qualitative interview study. *Trials, 15*, Article 215. https://doi.org/10.1186/1745-6215-15-215

RAD Bikes (2025). *RAD Bikes: Christchurch's community bike workshop*. https://www.radbikes.co.nz/

Raerino (Ngāti Awa, Te Arawa), K., Macmillan, A. K., & Jones (Ngāti Kahungunu), R. G. (2013). Indigenous Māori perspectives on urban transport patterns linked to health and wellbeing. *Health & Place*, *23*, 54–62.

Steinbach, R., Green, J., Datta, J., & Edwards, P. (2011). Cycling and the city: A case study of how gendered, ethnic and class identities can shape healthy transport choices. *Social Science & Medicine*, *72*(7), 1123–1130.

Singh, J. (2022). The sustainability potential of upcycling. *Sustainability*, *14*(10), 5989.

Singh, J., Mont, O., Winslow, J., Lehner, M., & Voytenko Palgan, Y. (2019). *Exploring social, economic and environmental consequences of collaborative production: The case of bike repair maker spaces in three European countries*. Paper presented at 3rd PLATE Conference, Berlin, Germany.

StatsNZ (2025). *Place and ethnic group summaries – Christchurch City*. https://tools.summaries.stats.govt.nz/places/TA/christchurch-city

Valentini, D., & Butler, A. (2023). *Bike kitchens and the sociomateriality of practice change: Exploring cycling-repair relations*. Urban, Planning and Transport Research, 11(1), Article 2259235.

Woodcock, J., Aldred, R., Lovelace, R., Strain, T., & Goodman, A. (2021). Health, environmental and distributional impacts of cycling uptake: The model underlying the Propensity to Cycle tool for England and Wales. *Journal of Transport & Health*, *22*, 101066.

Yu, S., Teixeira, C., & Kostiuk, S. (2024). What do community bike shops mean to the community? Exploring the patrons' perspective. Journal of Transport & Health, 39, 101926. https://doi.org/10.1016/j.jth.2024.101926

Zhang, Y., & Mi, Z. (2018). Environmental benefits of bike sharing: A big data-based analysis. *Applied Energy*, *220*(0306-2619), 296–301.

Appendices

Appendix A: Survey Questionnaire

Survey Information

Kia ora,
You are invited to participate in a research study on RAD Bikes and their environmental impact.
This study is being conducted by Iona Wood, Bella Whyte, Janice Leung, and Jo Lourens from the University of Canterbury | Te Whare Wānanga o Waitaha. Other research team members include Dr. Jillian Frater. The study is being carried out as a requirement for GEOG309 Research for Resilient Environments and Communities.

What is the purpose of this research? This research aims to determine the environmental impact of bikes. We are interested in finding out about your attitudes and behaviours related to bikes. The information from this study will help to improve the work of RAD Bikes.

Why have you received this invitation? You are invited to participate in this research because you are one of RAD's users. Your participation is voluntary (your choice). If you decide not to participate, there are no consequences. Your decision will not affect your relationship with me, the University of Canterbury or any member of the research team.
What is involved in participating? If you choose to take part in this research, please complete the online survey that follows this information page. The survey involves answering approximately 28 questions. Completing the survey should take around 10 minutes.

What if you change your mind during or after the study? You are free to withdraw at any time. To do this, simply close your browser window or the application (App) the survey is presented on. Any information you have entered up to that point will be deleted from the data set. As this is an anonymous survey it will not be possible to withdraw your information after you have completed the survey.

What is the prize draw? After completing the survey, you can choose to enter a random prize draw for one of good quality bike lock and lights, or a $10 gift card. This will involve clicking a link after completing the survey which will take you to another form to enter your details.

What will happen to the information you provide? All data will be anonymous. We will not be able to identify you or link your identity with any responses you provide. All data will be stored on the University of Canterbury's computer network in password-protected files. All data will be destroyed five years after completion of the study/publication of study findings [Name of person] will be responsible for making sure that only members of the research team use your data for the purposes mentioned in this information sheet

Will the results of the study be published? The results of this research will be published in a student report and a report by RAD Bikes. Results will also be presented during conferences or seminars to wider professional and academic communities. You will not be identifiable in any publication.

We will send a summary of the research to you at the end of the study, if you request this. If you provide an email address for this purpose, it will not be linked with your survey responses.

If you have any questions about the research, please contact: Iona Wood: Iwo21@uclive.ac.nz

This study has been reviewed and approved by the University of Canterbury Human Research Ethics Committee (HREC). If you have concerns or complaints about this research, please contact the Chair of the HREC at human-ethics@canterbury.ac.nz .

What happens next? If you would like a PDF version of this information sheet, please email Iona Wood at the email address above. Please read the following statement of consent and start the survey below.

Statement of Consent: I have read the study information and understand what is involved in participating. By completing the survey and submitting my responses, I consent to participate.

○ Yes (1)

End of Block: Block 1: General Info

Start of Block: Start

Have you ever visited RAD Bikes (160 Lichfield Street)

- ○ Yes (1)
- ○ No (2)
- ○ Unsure (3)

Display this question:

If Have you ever visited RAD Bikes (160 Lichfield Street) = Yes

What was your reason for visiting RAD Bikes? (Select all that apply)

- ☐ Buy or receive a second-hand bike (1)
- ☐ Bike repairs (2)
- ☐ Attending workshops (3)
- ☐ Volunteering (4)
- ☐ Socialisation/Community Hub (5)
- ☐ Other (6) _____

Display this question:

If Have you ever visited RAD Bikes (160 Lichfield Street) = Yes

Compared to before you used RAD Bikes' services, how often do you use a car now?

- ○ Much less (1)
- ○ Somewhat less (2)
- ○ About the same (3)
- ○ Somewhat more (4)
- ○ Much more (5)
- ○ I didn't use a car before (6)

End of Block: Start

Start of Block: Trip Overview Information

To calculate RAD's environmental impact please recall your travel habits from the **past 7 days** to the best of your ability.

Which modes of transport have you used in the last 7 days

- ☐ Car (driver) (1)
- ☐ Car (passenger) (2)
- ☐ Bike (3)
- ☐ Bus (4)
- ☐ Walk (5)
- ☐ Other (please specify) (6) _____
- ☐ I have not travelled (7)

Please describe **up to** five-one-way trips from the **last 7 days** (most frequent first; include your longest if it was different). Please select a box for every trip you want to describe (e.g. **tick Trip 1 AND Trip 2 if you have had 2 trips from the last 7 days**; **tick all 5 boxes if you have had 5 trips or more**)

- ☐ Trip 1 (1)
- ☐ Trip 2 (2)
- ☐ Trip 3 (3)
- ☐ Trip 4 (4)
- ☐ Trip 5 (5)

End of Block: Trip Overview Information

Start of Block: Main Trip

Display this question:

If Loop current: What was the main mode of transport you used for this trip? = Bike

If you didn't have access to a bike, how would you have made this trip?

- ○ Car (driver) (1)
- ○ Car (passenger) (2)
- ○ Bus (3)
- ○ Walk (4)
- ○ Other (specify) (5) _____

You're describing Trip ${lm://CurrentLoopNumber}. What was the **main purpose** of this trip?

- ○ Work/Study (1)
- ○ Social/Leisure (2)
- ○ Shops/Errands (3)
- ○ Exercise (4)
- ○ Other (5) _____

What was the starting point of the trip? (Name closest intersection e.g. Riccarton Road & Ilam Road)

_____

*

What was the destination of the trip? (Name closest intersection e.g. Riccarton Road & Ilam Road)

_____

What was the main mode of transport you used for this trip?

- ○ Car (driver) (1)
- ○ Car (passenger) (2)
- ○ Bike (3)
- ○ Bus (4)
- ○ Walk (5)
- ○ Other (specify) (6) _____

*

About how long did this trip usually take one-way, in **minutes**

_____

Was this trip one-way or return?

- ○ One-way (1)
- ○ Return (2)
- ○ Other (3) _____

How many times did you make this trip one-way in the last 7 days?

- ○ 1 (1)
- ○ 2-4 (2)
- ○ 5-7 (3)
- ○ 8+ (4)

Display this question:

If Loop current: What was the main mode of transport you used for this trip? = Bike

If you didn't have access to a bike, how would you have made this trip?

- ○ Car (driver) (1)
- ○ Car (passenger) (2)
- ○ Bus (3)
- ○ Walk (4)
- ○ Other (specify) (5) _____

End of Block: Main Trip

Start of Block: Demographics

Please select your age range

- ○ Under 18 (1)
- ○ 18 - 24 (2)
- ○ 25 - 34 (3)
- ○ 35 - 44 (4)
- ○ 45 - 54 (5)
- ○ 55 - 64 (6)
- ○ 65+ (7)

What ethnicities do you identify with? (Select all that apply)

- [ ] NZ European (1)
- [ ] Māori (2)
- [ ] Pasifika (3)
- [ ] Asian (4)
- [ ] Middle Eastern (5)
- [ ] Latin American (6)
- [ ] African (7)
- [ ] Other (8) _____
- [ ] Prefer not to say (9)

What gender do you identify with?

- ○ Male (1)
- ○ Female (2)
- ○ Non-binary / Gender Diverse (3)
- ○ Prefer not to say (4)

Do you have any additional comments about your travel habits and RAD Bikes?

_____

End of Block: Demographics

Start of Block: Block 5

We thank you for your time spent taking this survey! Your response has been recorded. If you would like to join the lucky draw for prizes, please move to the next page

End of Block: Block 5

RAD Bikes Survey Prize Draw

Thank you for filling out our survey!

Please enter your details below to be in the draw to win the following prizes!
- Bike Lock
- Bike Lights
- $10 Gift Card
(Only one prize can be won per person)

This page is detached from the survey so your survey response is still anonymised without recording any of your details.

First Name

_____

Last Name

_____

Please enter your preferred way for us to contact you. You will not be contacted for anything else, all details given will be deleted after names are drawn.

Email Address

_____

Phone Number

_____

Appendix B: Interview questions

INTRODUCING THE RESEARCH

- Introduce research
- Explain research objectives and interview format:

This research aims to determine *the environmental impact of bikes*. We are interested in finding out about your attitudes and behaviours related to bikes. The information from this study will help to *improve the work of RAD Bikes*. We have also conducted a survey which aims to provide us with quantitative information (numbers) about RAD bikes environmental impact. This part of the project is adding qualitative data through a series of interviews of people at RAD.

- Discuss confidentiality, and timing of the interview
- Complete consent form

ATTITUDES AND BEHAVIOURS RELATED TO BIKES

- What was your reason for visiting RAD today?
- What mode of transport have you used in the last 7 days? Number of trips
- Ask about their history of biking e.g. did they bike as a child.
- Ask about their cycling now.
- How often, frequency, time of days, length of trips
- Where e.g. what sort of journeys, destinations
- Ask what encouraged them to cycle e.g. Christchurch bike culture, peers, new job etc
- If RAD bikes workshop not mentioned, ask specifically about it
- What benefits do you see in using bikes for transportation?

FINISHING UP

- Ask if there are any other comments or questions.
- Explain process after this and ask if they want a copy of the notes.
- Ask if they want to be notified about publications.

Appendix C: Survey Poster