Impacts of e-rideables on the transport task in WA

Final report

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Impacts of e-rideables on the transport task in WA

[Comments]**Prepared by**

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About PATREC

The Planning and Transport Research Centre (PATREC) is a collaboration between the Government of Western Australia and local universities, constituted to conduct collaborative, applied research and teaching in support of policy in the connected spaces of transport and land use planning. The collaborating parties are: The University of Western Australia, Curtin University, Edith Cowan University, Department of Transport and Major Infrastructure, Main Roads Western Australia, Western Australian Planning Commission and the Western Australian Local Government Association.

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Summary

This research aims to build upon and contribute to the growing body of evidence on how the use of e-rideables impact transport in Perth, providing insights into their use and integration with other transport modes. The project evaluates e-rideable usage patterns in Perth through two data collection stages: an intercept survey (completed on the 9th of May, 2024, with the results described here) and an experiential survey completed in April 2025.

With the aim of contextualising Perth's experience in relation to international experiences, a review of the literature was undertaken and is presented in this report as background to the intercept survey results and wider project. The literature review and the results of two data collection exercises, an intercept survey and an experiential survey, presented in this report, represent Milestone 4 of the project.

The literature revealed a complex landscape where potential benefits are balanced against significant challenges. Four main themes emerged: focus on sustainability and impacts; travel behaviour and adoption preferences; safety aspects; and freight applications, covering papers that addressed the use of e-rideables at the macro/city level or at the micro/individual level. The overall conclusion is that use of shared and privately owned e-rideables is distinct and future research and policy efforts should be on developing integrated approaches that maximise the positive impacts of e-rideables (micromobility), while mitigating their risks, through improved infrastructure, regulation and the coordination of different transport modes.

As indicated, this report integrates the results of two complementary data collection components: an intercept survey, with a subsequent online follow-up and an experiential survey designed to capture the spatial and temporal patterns of e-rideable (e-scooters, e-skateboards, hoverboards, e-unicycles, etc.) use within individuals' daily travel in Perth, WA. The intercept survey focused on motivations for travel and the perceived benefits and drawbacks of e-rideable use, both at the personal level (e.g., satisfaction, multimodality, safety) and in relation to the broader transport system (e.g., infrastructure use, integration with other modes). The experiential survey sought to deepen this understanding by recruiting participants from the intercept sample, supplemented by targeted outreach through social media, user clubs and university networks. Despite these multiple recruitment strategies, the number of completions for the experiential survey fell well below expectations. Two main factors likely contributed to this outcome:

- Contextual barriers: A series of accidents involving rented e-scooters presented in the media affected fieldwork by creating heightened concerns about safety;
- Perception of monitoring: Some potential respondents expressed hesitation, fearing that their data could be used to track or penalise riding behaviour (e.g., monitoring speeds).

Taken together, these issues help explain the modest response rates. While the experiential dataset still provides valuable insights, the limitations in sample size should be acknowledged when interpreting the results.

While during the intercept survey a substantial number of shared/rented devices were noticed, the research is investigating solely patterns of use for privately owned e-rideables, which represent a smaller and more difficult-to-reach population segment.

The survey was conducted between the 2nd and 9th of May, 2024. Data on trip frequencies, purposes and motivations, timing, origins and destinations, as well as perceived enablers and barriers for uptake, were collected. Additionally, observations on levels of compliance and socio-demographic information were recorded. These factors were interrogated in more detail in a follow-up online survey.

The experiential survey was conducted between November 2024 and April 2025. A week of data on daily travel (confirming travel motivation and the mode of transport) and a short survey capturing socio-demographics were included in this survey. The recruitment included two steps: 1) participants downloading the ERES app and registering using a unique code provided; and 2) completing a week of travel movements and personal data profile on the app. While more than 600 participants completed step 1, only 35 completed the second step of data collection.

The information from both surveys helped identify potential trends in usage and likely changes in patterns associated with various program and/or infrastructure changes, although these need to be corroborated with observed data from other sources.

Results from the intercept survey

The intercept survey elicited 249 responses (a 26% response rate), primarily from males using e-rideables for commuting. Response rates were lowest in the AM Peak (between 8:00 AM and 9:00 AM), due to riders rushing to work, especially at “high-speed” locations like Narrows Bridge and the Kwinana Freeway PSP. About 25% of respondents exhibited repeated commuting patterns. 105 responses were obtained from the follow-up online survey. The socio-demographic pattern of non-respondents mirrored that of respondents. Online survey participants received a $10 e-voucher, but the impact of this incentive on response rates is unclear.

The survey identified associations between e-rideable use (such as purpose and time-of-day), and individual circumstances and life aspects. Respondents primarily used e-rideables for convenience, environmental friendliness, and enjoyment. Most trips were door-to-door, limiting travel distances. More separated paths and the ability to carry e-rideables on PT could encourage usage. Attitudes and environmental values influence the adoption of sustainable transport behaviours, such as observed e-rideable use. Speed differences between e-riders and other path users were a concern, with e-riders preferring higher speeds and pedestrians noting excessive speed.

E-rideables represent a small fraction of active travel, including other active travel modes such as cyclists and e-bikes. Beam and Neuron (shared) e-riders were observed in modest numbers during the weekdays, but their use substantially increased on weekends.

Meeting WA Police representatives during fieldwork highlighted the potential benefits of sharing data and collaborating with other agencies. Involving WA Police in future studies could enhance response rates, although fear of punitive actions could also have the opposite effect.

Results from the experiential survey

The experiential survey elicited 35 responses, primarily from males using e-rideables for commuting. Response rates were very low, consistent with other recent surveys using similar software tools (Tabasi et al., 2024). The socio-demographic pattern of non-respondents seems to be similar to that of respondents, although the incentive (a $70 e-voucher at the end of the participation) triggered substantial online fraud for survey participation during the last round of recruitment during May-July 2025.

The survey identified associations between e-rideable use, time-of-day and socio-demographics. Respondents primarily used e-rideables for shorter distances, suggesting their preference for convenience. Speed profiles of e-riders indicate a preference for higher speeds, and more than a quarter of the e-rideable trips were over 25km/h, although this may be explained by multi-modal trips, meaning that some trips were actually made at least partly on another mode such as a train, bus or car.

Trips using e-rideables represent less than 5% of travel (count of trips) and their reported frequency was much lower than other active travel modes (walking, riding a bike/e-bike). We suspect that the recent negative publicity of the e-rideables, also associated with irresponsible behaviour and tragic accidents, contributed to a reluctance of the e-riders to share their mobility patterns, particularly tracking the speeds of their trips. Almost one in seven trips was not 'labelled' in the app, which appears to be related to the use of e-rideables. Two distinct classes of users were identified: those using e-rideables primarily for commuting and those using e-rideables for other purposes, notably over weekends, mainly for recreation.

Limitations of the data collection

Limitations were encountered with data collection in both the intercept and experiential surveys. Due to the numerous issues with the experiential survey, the data could not be used as originally intended, to further explore insights from the intercept survey.

In terms of the intercept survey, limitations surrounded refusals, the focus on privately owned devices, the time and location of survey and the use of an incentive. Participation refusals were high for riders of e-rideables other than e-scooters, limiting knowledge of the behaviour and attitudes of riders of these devices. While not dominating in terms of e-rideable use, the researchers noted many shared (rented – Beam and Neuron) devices in use, which were not considered in this survey as they were out of scope. Surveying users of these devices may yield additional and different insights. The time and location of surveying also impacted response rates, with users rushing during morning peak to work less likely to stop and the same occurring at locations where high speeds could be achieved. It is also noted that the influence of the $10 incentive for completing the follow-up online survey is unclear.

In terms of the experiential survey, limitations surrounded conversion and recruitment, monitoring fears, incentive fraud and data limitations. While over 600 participants registered their interest for the ERES app-based survey, only 35 participants fully completed data collection. It is noted that of 493 people registering interest based upon posted flyers, none of these completed any further tasks, including downloading the app. Negative media coverage of e-rideable use (or other factors) led to some participants' refusal to utilise the app in the belief that the monitoring of speed or location may be used for enforcement of penalties. The size of the $70 incentive led to substantial online fraud, including interest from many non-genuine participants, which was reported to the Ethics committee. As the App's internal algorithm can only broadly discriminate between modes, it was essential that users tag each trip with the mode utilised and purpose as directed, which was not completed in all cases (with 14% of trips remaining unlabelled). Other trips were excluded due to being too short, too long or non-representative (such as those completed by kayak) and hence the overall dataset was deemed to be insufficient in size and detail to be used for robust statistical or route-based GIS analysis.

In response to the numerous data collection issues and low participation rates, the research team pivoted to add value to the final output by conducting an in-depth content analysis of 239 submissions to the concurrent Parliamentary Inquiry on e-rideable use. This strategic shift in study parameters allowed the researchers to better understand the underlying factors behind their own recruitment challenges, while providing contextual insights into public attitudes and the regulatory environment in WA and other jurisdictions that could otherwise not be captured.

Parliamentary inquiry

The Parliamentary 'Inquiry into the Safety, Regulation and Penalties Associated with the Use of eRideables' (commenced June 2025) corroborated and provided additional information to the study. The 239 submissions received by the Inquiry from individuals, organisations, and government bodies, reflect a wide range of views on the role and future of e-rideables, e-bikes and electric dirt bikes in Western Australia.

The submissions were split into three categories, based on their tone or general view. Submissions expressing safety concerns highlighted issues such as pedestrian conflicts, underage use, speeding and weak enforcement, calling for clearer legislation, stronger regulation and dedicated infrastructure. Neutral submissions emphasised balanced, evidence-based reforms, including adaptive governance, better path design, public education and integration with public transport. Positive submissions focused on the environmental, economic and lifestyle benefits of e-rideables, supporting proportionate regulation, rider training and collaborative policymaking.

Despite differing emphases, there was a strong consensus on the need for modernised laws, safer infrastructure, user education, and inclusive planning. Together, these insights provide a roadmap for embedding e-rideables within a safer, more sustainable, and integrated transport system for Perth and WA.

On the 4th of December, 2025, the Community Development and Justice Standing Committee reported on its inquiry [1] to the Legislative Assembly of Western Australia. Findings and recommendations centred around improving governance, mandating greater data collection on device use, addressing safety issues through e-rideable vehicle design and accessory requirements, trauma counselling, improvement of infrastructure, nationally harmonised standards, consultation on usage, classification of devices and its impact on legal and insured usage, education and enforcement. It is noted by the research team that the Government of Western Australia accepted either fully or in-principle all but one of the recommendations of the inquiry[2] on the 10th of March, 2026.

[1] https://www.parliament.wa.gov.au/Parliament/commit.nsf/(Report+Lookup+by+Com+ID)/43493D47E62284BC48258D550030E903/$file/02328458.pdf
[2] https://www.wa.gov.au/government/media-statements/Cook%20Labor%20Government/WA-leads-national-push-for-stronger-eRideable-laws-20260310

Table of Contents

1. Introduction

Electric rideable devices (e-rideables) represent an emerging transport mode that enhances the sustainability of transport and supports the health of users. They can positively contribute to transport systems by improving connectivity and accessibility to public transport (PT) networks, potentially serving as first-mile last-mile solutions. They require less parking space than cars and can help reduce traffic congestion in urban areas, particularly for short trips. E-rideables also provide opportunities to reduce sedentary behaviour, especially for those who may not engage in regular exercise and can contribute to improved air quality and noise pollution.

However, ensuring the safe use of e-rideables is paramount. As the use of scooters and other e-rideables has grown, concerns about accidents involving riders and pedestrians have also increased. Many cities lack appropriate infrastructure, such as dedicated 'cycle' lanes, forcing the riders to share the road with cars or sidewalks with pedestrians and cyclists, which increases the risk of crashes.

The purpose of this research is to benchmark the use of e-rideables in Perth, Western Australia, starting with a fundamental understanding of the circumstances and motivations for their use. Specifically, the study identifies frequent routes and times for riding, trip purposes, and perceived enablers and barriers.

This final report provides a review of the literature (Section 2) and presents findings from the intercept and online survey. The detailed literature review is provided in Appendix A; the main report includes a concise overview and an integrated content analysis, highlighting key themes and relationships. Section 3 describes the data collection process and results of the intercept survey conducted at 14 metropolitan sites. Section 4 presented the online survey results, drawn from respondents who agreed to participate in the follow-on online survey. Section 5 reports the findings of the experiential survey and discusses data collection challenges. In light of the timely *Parliamentary Inquiry into the Safety, Regulation and Penalties Associated with the Use of eRideables*, Section 6 includes a content analysis of the 239 submissions. The report concludes with recommendations for policy, practice, and future data collection efforts.

Before proceeding, it is important to clarify the definition of e-rideables adopted in this research. According to the Western Australian Road Safety Commission classification[3], e-rideables include e-scooters, e-skateboards, hoverboards, e-unicycle, e-wheels and e-skates. They do not include e-bikes and correspond broadly to the Type A of micromobility devices as defined by the International Transport Forum (ITF, 2024).

2. Literature review

2.1. Approach

In late 2023, more than 500 relevant papers, book chapters, consultant and industry reports were identified, using a systematic search of four databases: Web of Science, ScienceDirect, ABI-Inform, Dissertations and Google Scholar. The choice of databases was guided by the need to capture both academic and grey literature sources, such as technical or industry reports, and white papers, given the rapid technological evolution and practice-based nature of the topic.

The search keywords used were: ("e-rideables" OR "micromobility" OR "e-scooters" OR "personal mobility devices") AND ("urban transport" OR "city transport" OR "metropolitan transport" OR

[3] Classification available at https://www.wa.gov.au/organisation/road-safety-commission/erideables.

"urban mobility" OR "urban transit") AND (sustainability OR "sustainable transport" OR "green transport" OR "eco-friendly transport" OR "low-carbon transport") AND ("travel behavio*" OR "travel habits" OR "commuting patterns" OR "mobility patterns" OR "travel preferences")

These terms were consistent with those used by Bretones et al. (2023) but excluded health and wellbeing related outcomes that were the focus of their study.

Exclusion criteria removed publications prior to 2010, publications focused on e-bikes, and highly theoretical works (Q1, scholarly works). This process resulted in 457 publications from 1,498 initial records.

Two literature updates (May-July 2024 and May-Jul 2025) added 46 publications, although studies based on private e-rideables remain scarce (only 20 since December 2024, including new contributions in the *Journal of Cycling and Micromobility Research*).

Papers were ranked for relevance using an AI-assisted abstracts analysis, enabling prioritisation of the 60 most pertinent sources. All were tabulated in Excel with notes on data type, methodology, and findings. This was then used for drafting the themes of the literature review. The sources were broadly classified as, e-rideable research focused on:

- Integration with the transport system and built environment to achieve sustainability impacts and outcomes;
- Travel behaviour and adoption, including individual preferences;
- Safety concerns; and
- *Use for deliveries (not reviewed as part of this project since it is included in the literature review as part of a concurrent study into micromobility and freight).*

Papers supported by robust empirical evidence were intentionally prioritised to focus on the most relevant contributions. The detailed synthesis is in Appendix A, a high-level overview and thematic content analysis are summarised below.

2.2. Overview

Collectively, studies addressing the ***integration of e-rideables with transport system and built environment*** adopt systematic review approach and emphasise the need for an integrated framework combining environmental sustainability, urban infrastructure planning, and user perceptions and safety. This perspective argues that micro-mobility should be treated as a network-level component of transport systems to optimise sustainability and equity outcomes. Research on ***travel behaviour, user preferences and adoption of e-rideables***, deepens our understanding of how micromobility fits into broader urban transport networks and highlights demographic differences shaping user choices. Some studies note possible competition with public transport, suggesting policymakers must balance these modes to promote a cohesive, sustainable transport ecosystem. ***Safety-focused*** literature, drawing on crash data, emergency department records, and user surveys, identifies inadequate infrastructure and pedestrian-vehicle conflicts as key barriers to safe integration of e-rideables into urban transport systems. The papers discussed provide detailed analyses of the safety implications of micromobility and recommended specific infrastructure improvements and regulatory measures to enhance the safety of these micromobility systems.

The collection of papers (top 60 most relevant publications) highlights both the potential and the challenges of integrating micromobility within contemporary urban transport systems. Common themes include micromobility's capacity to reduce car dependency, particularly for short urban trips and its role in improving public transport (PT) connectivity through first- and last-mile linkages. The success of these modes depends strongly on the availability of safe, connected infrastructure and on regulatory frameworks that support their integration into existing transport networks. Safety concerns, particularly related to e-scooters, remain a critical challenge that requires targeted infrastructure upgrades and clearer regulation.

Variations across the studies are evident in both focus and methodology: demand and market potential analyses (Nigro et al., 2022; Zarif et al., 2019); safety and operational research (Bennett et al., 2021; Mitra & Hess, 2021; Felix et al., 2023); and environmental-impact assessments (Felipe-Falgas et al., 2022; Calan et al., 2024). Despite differences in geographic context, from Rome and Singapore to Austin, all studies converge on the need for holistic integration of micromobility within sustainable urban-transport strategies.

Collectively, these diverse perspectives reinforce the multifaceted nature of micromobility research and the ongoing need for interdisciplinary investigation.

Notably, only a few studies have examined data-collection methods for e-rideables. As Lee and Sener (2020) indicated, most existing counting systems struggle to distinguish e-rideables from bicycles, limiting the spatial and temporal evaluation of their use. Traditional travel surveys, while comprehensive, often omit details about trip purpose and user characteristics. Combining complementary techniques, such as inductive loops with infrared sensors or applying machine-learning analysis to video data, could greatly improve detection accuracy and the consistency of future micromobility datasets.

Building on these thematic findings, the following section visualises these relationships from all three streams of literature through content analysis.

2.3. Integrated content analysis

A content analysis of all papers selected for review, using the Leximancer tool, has shown (Figure 1) that connections with the central theme (e-rideables/e-scooters) are with the transport systems as a whole (top of the conceptual map), other vehicles (including other micromobility vehicles, see top left of the map), the users and their behaviour (bottom left of the conceptual map), and the analytical frameworks used to understand behaviours and impacts of e-rideables (‘analysis’ at the right of the map). This diagram resembles the main themes noted in the discussion in the previous section, although it does not highlight ‘safety’ as a standalone theme. This may be explained by the fewer publications selected in this stream, compared to their role within the transport system, their impacts and user preferences. Another notable feature is that regulation is distributed across themes, rather than appearing as a separate theme. While e-scooters offer significant potential as sustainable transport solutions, their rapid deployment has outpaced the development of necessary infrastructure and regulatory frameworks, which have to be strengthened.

The central theme ‘e-scooters’ includes not only the devices, but also the users (intersection with the ‘riding or rider’ theme) and trips. The ‘Transport’ theme has concepts such as travel, micromobility, planning, services, and impacts, the latter at the intersection with ‘analysis’. “Vehicles’ theme is particularly focused on interactions with other modes and also features the ‘cities’, at the intersection between ‘transport’ system and ‘vehicles’. The ‘model or models’ theme encompasses qualitative and quantitative methods, data, variables, results, while ‘analysis’ also emphasises approaches and impacts as relevant concepts.

Across the body of knowledge reviewed, rider demographics play a significant role in both the frequency of e-rideable use and the likelihood of accidents. The majority of users tend to be younger and predominantly male. The gender disparity extends to injury severity, with males often being overrepresented in hospital admissions and ED data. Conversely, women expressed greater safety concerns regarding interactions with vehicles and road hazards.

The interaction between e-scooter riders and other road users, especially motor vehicles, calls for better planning to ensure efficient and safe operation. The risk of incidents is heightened in environments where there is insufficient infrastructure separating motorised traffic from micromobility users. Studies suggest that better integration of bike lanes and dedicated spaces for e-scooters could reduce these incidents.

A recurring theme in the literature is poor road infrastructure, which is a barrier to the adoption of e-rideables and a major contributing factor to accidents. This underscores the need for urban planning that better accommodates micromobility by improving road maintenance and creating separate, safer routes for e-scooter riders, especially in congested urban areas.

Many studies recognise e-rideables as part of a wider shift towards multimodal transport systems. E-scooters are seen as last-mile solutions, often connecting riders to PT hubs. However, their integration into the broader transport system remains uneven.

About methods of analysis (multivariate techniques, machine learning, GIS-based spatial analysis, choice modelling), they are directly related to e-rideables and transport network and modes, but not to the users. This is consistent with the number of papers examining individual behaviour, in comparison with system-level papers addressing e-rideables.

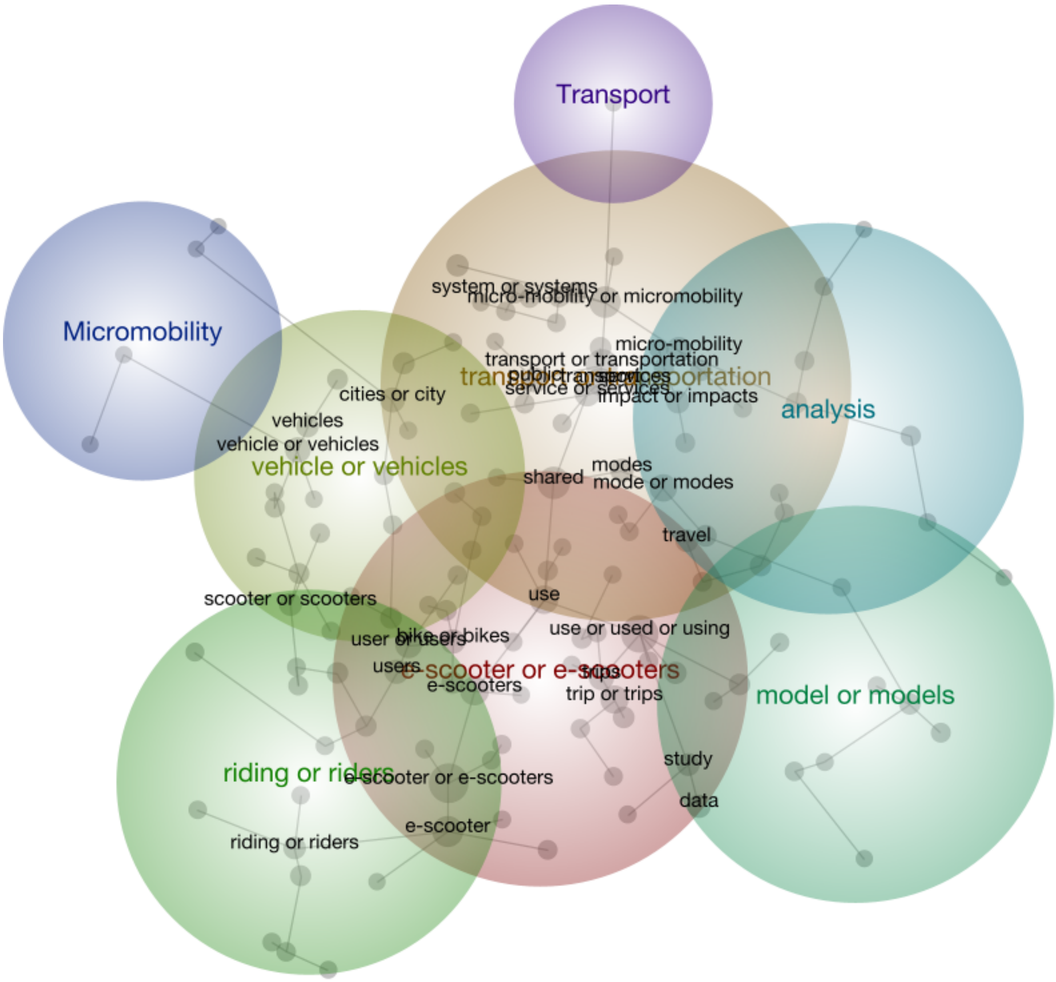


Figure 1: Conceptual map showing the key themes in the literature

When separating the body of literature by those themes, there are some relevant differences in the use of the concepts as illustrated in the Insights Dashboard (Figure 2).

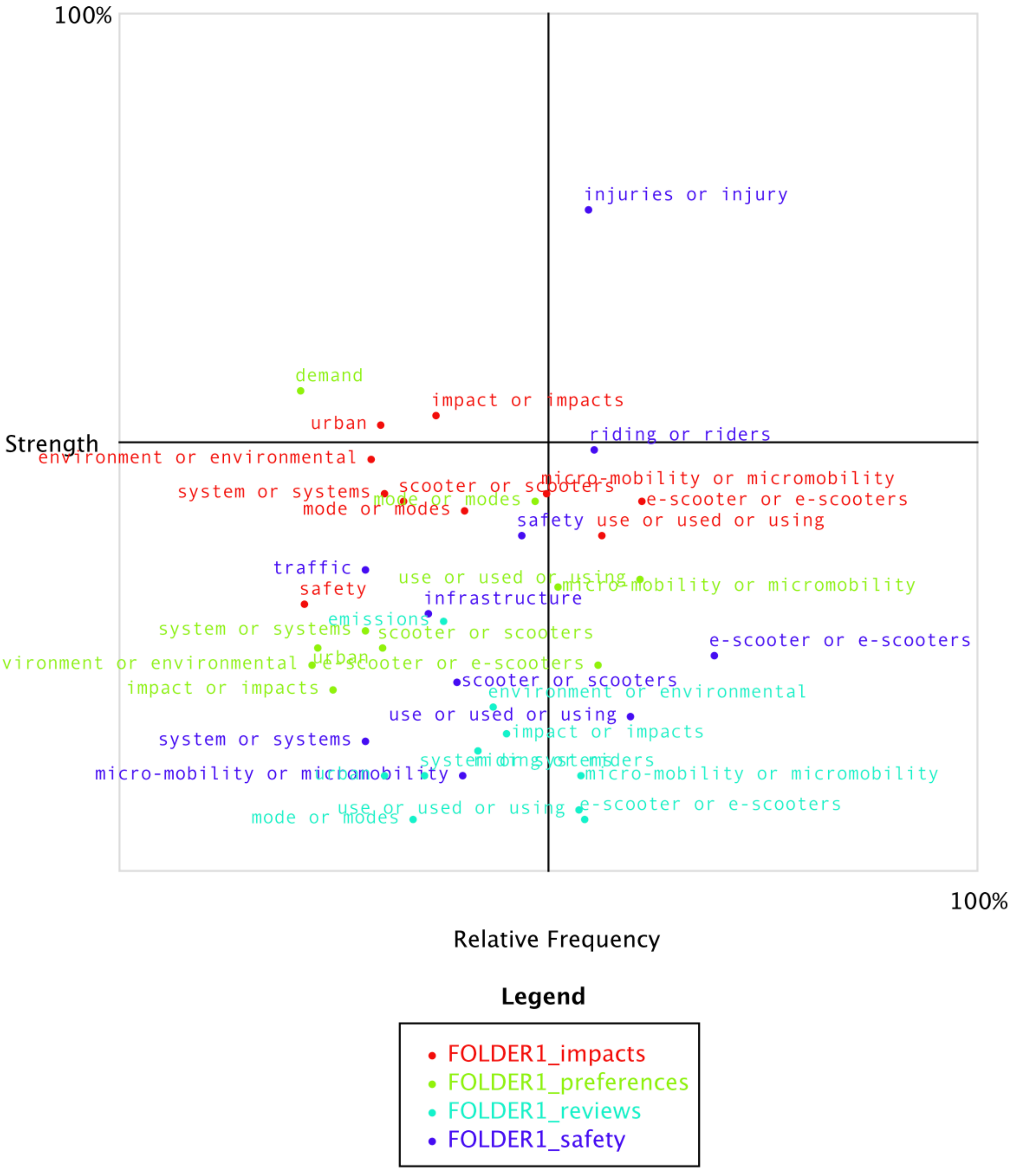


Figure 2: Insights dashboard comparing the literature by main themes

The most striking aspect of the dashboard is the strength of the injuries and the riders in the papers addressing the safety issues, and the focus on impacts and urban areas in the papers aimed at addressing the sustainability impacts of the use of e-rideables.

3. Intercept survey

3.1. Site selection and fieldwork preparation

The intercept survey was designed to capture on-site insights into e-rideable use and user characteristics across a representative range of shared path environments. To ensure the survey captured both spatial and behavioural diversity, 14 sites were selected based on their location, function, and level of activity. The intercept survey took place over a one-week period, with data collection at sites with limited e-rideable activity ending once sufficient evidence on the site activity were collected. The intercept survey was complemented by an observational component, allowing the research team to record traffic volumes, modes of travel, and behavioural interactions among users. These combined approaches ensured that data could be integrated to provide a comprehensive understanding of e-rideable activity patterns across the Perth metropolitan area.

3.1.1. Site selection

The 14 sites around Perth were selected based on the team's knowledge of e-rideable usage (such as use on particular routes and around transport hubs), prior reports from the WA Department of Transport, recommendations from the Steering Committee and path locations with over 600 bicycle counts from the Main Roads WA monitoring network. The sites included: Riverside Drive, Matagarup Bridge, East Perth, Claisebrook, South Perth, Narrows Bridge (north and south entries/exits), Canning Bridge (both near the Kwinana Freeway and the Raffles Hotel), Murdoch (the Kwinana Freeway exit and Murdoch University entry), Fremantle (near Marine Terrace and the city centre), the Scarborough-Trigg PSP and Moorland Street in Doubleview-Scarborough.

Team members inspected the sites, mapping locations deemed safe for the interview team to be stationed for fieldwork. Based on these locations, we initiated the process for obtaining approvals to conduct intercept surveys from the relevant organisations. Fieldwork revealed that three sites had minimal e-rideable traffic (Murdoch, Canning Bridge and Fremantle), which is an important finding for understanding the spatial distribution of e-rideable use across the Perth metro area, given that these sites had substantial bike counts.

3.1.2. Fieldwork preparation

Twenty-six students were trained for the fieldwork in two sessions conducted at UWA and Curtin University, covering data collection methods, safety protocols and site-specific procedures. The data collection was initially organised into three daily shifts (6:30AM-10:30AM, 10:30AM-2:30PM and 2:30PM-6:30PM) on weekdays and two shifts (7:30AM-10:30AM and 3:00PM-6:00PM) on weekends. Teams of two students were assigned to each site, under the supervision of an academic supervisor responsible for overseeing data collection at the site.

At each site, the intercept survey was complemented by an observational component, allowing the research team to record traffic volumes, modes of travel, and behavioural interactions among users. These combined approaches ensured that both quantitative (observational) and qualitative (intercept-based) data could be integrated to provide a comprehensive understanding of e-rideable activity patterns across the Perth metropolitan area.

3.2. Intercept survey results

3.2.1. Response rate

The survey included questions regarding general travel information, motivations and perceived enablers and barriers for further use of e-rideables. Basic socio-demographic attributes were noted by the field assistant on the form (as shown in the questionnaire provided in Appendix B).

The intercept survey, undertaken over 6 days in May 2024, elicited 249 responses from e-riders, with an overall response rate of 26% (Table 1 and Figure 3). Response rates varied by location and time of day, with the lowest rates observed during the AM Peak between 8:00AM and 9:00AM when riders were rushing to reach their workplaces.

Approximately a quarter of respondents exhibited repetitive behaviour, using the same routes more than once a week. There was no distinctive pattern differentiating non-respondents from respondents. Most respondents identified themselves as commuters, typically working in the office or at their workplace 3-4 days a week.

The participants were informed that their participation is incentivised with a $10 e-voucher upon completion of the online survey, however it is unclear to what extent this has influenced the response rate.

Table 1: Intercept survey activities

Date	Day	Location and time	Completions	Refusals	Repeats
2/5/24	W'day	Fremantle – Marine Tce (6:30am-6:30pm)	6	36	0
2/5/24	W'day	Murdoch (6:30-10:30am)	4	16	0
2/5/24	W'day	Perth – Narrows (2:30-6:30pm)	11	68	0
2/5/24	W'day	Perth – Riverside (6:30am-6:30pm)	30	104	7
3/5/24	W'day	Canning Bridge (6:30am-6:30pm)	14	58	0
3/5/24	W'day	East Perth – Matagarup (6:30am-6:30pm)	17	31	5
3/5/24	W'day	Fremantle – Adelaide / Parry / Queens (6:30am-6:30pm)	9	17	0
3/5/24	W'day	Perth – Riverside (6:30am-6:30pm)	22	95	17
4/5/24	W'end	Canning Bridge (7:30-10:30am, 2:30-5:30pm)	0	12	0
4/5/24	W'end	East Perth – Matagarup (7:30-10:30am, 2:30-5:30pm)	7	16	0
4/5/24	W'end	Perth – Narrows (David Carr) (7:30-10:30am, 2:30-5:30pm)	2	5	0
4/5/24	W'end	Perth – Riverside (7:30-10:30am, 2:30-5:30pm)	5	28	2
5/5/24	W'end	East Perth – Matagarup (2:30-5:30pm)	0	6	2
5/5/24	W'end	Fremantle (7:30-10:30am)	0	8	0
5/5/24	W'end	PSP – Claisebrook (7:30-10:30am)	0	22	0
5/5/24	W'end	Scarborough – North Beach (2:30-5:30pm)	0	13	0
5/5/24	W'end	South Perth (7:30-10:30am, 2:30-5:30pm)	9	26	2
6/5/24	W'day	East Perth – Claisebrook (6:30-10:30am, 2:30-6:30pm)	13	57	7
7/5/24	W'day	Matilda/Mounts Bay (6:30-10:30am, 2:30-6:30pm)	12	16	3
6/5/24	W'day	Scarborough – Moorland (6:30-10:30am)	1	13	0

Date	Day	Location and time	Completions	Refusals	Repeats
6/5/24	W'day	South Perth – Mends St (6:30-10:30am, 2:30-6:30pm)	14	39	?
6/5/24	W'day	Narrows – North (Leederville) (6:30-10:30am, 2:30-6:30pm)	9		
7/5/24	W'day	Foreshore – Vic Park (6:30-10:30am, 2:30-6:30pm)	10	65	14
7/5/24	W'day	Narrows – North (Leederville) (6:30-10:30am, 2:30-6:30pm)	42	108	14
8/5/24	W'day	Narrows – South (Mill Point) (6:30-10:30am)	13	30	2
8/5/25	W'day	Burswood (6:30-10:30am)	0	10	2
Total			**249**	**728**	**63**

The highest response rates were obtained on Matilda Bay, Fremantle, Matagarup, and South Perth (Mends St), and the lowest response rates were more prevalent at locations where e-riders could achieve higher speeds, such as the entry/exit points of the Narrows Bridge or the Kwinana Freeway PSP, near Canning Bridge.

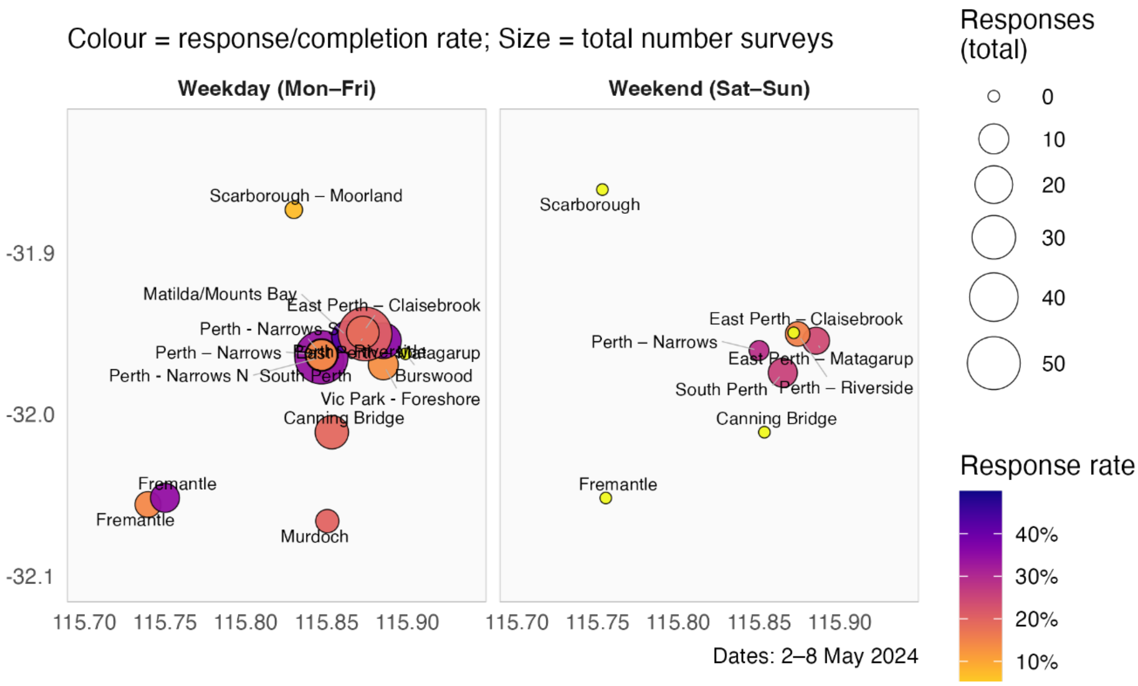


Figure 3: Response rate by location – Weekday vs Weekend days

3.2.2. Sample description

Information from 249 riders was collected, as well as observed patterns and behaviours for those who refused to participate. As indicated, response rates were lowest between 8:00AM and 9:00AM, due to riders rushing to work, especially at "high-speed" locations like Narrows Bridge and Kwinana PSP.

No statistically significant differences (Chi-square tests) were found between respondents and non-respondents in terms of gender, age-group or wearing a helmet.

Most e-riders were mature-age males (80%, 27% between 30-35 years), primarily using their e-rideables for commuting (two-thirds) or all of their weekly travel. Figure 4 displays the age distribution of the riders.

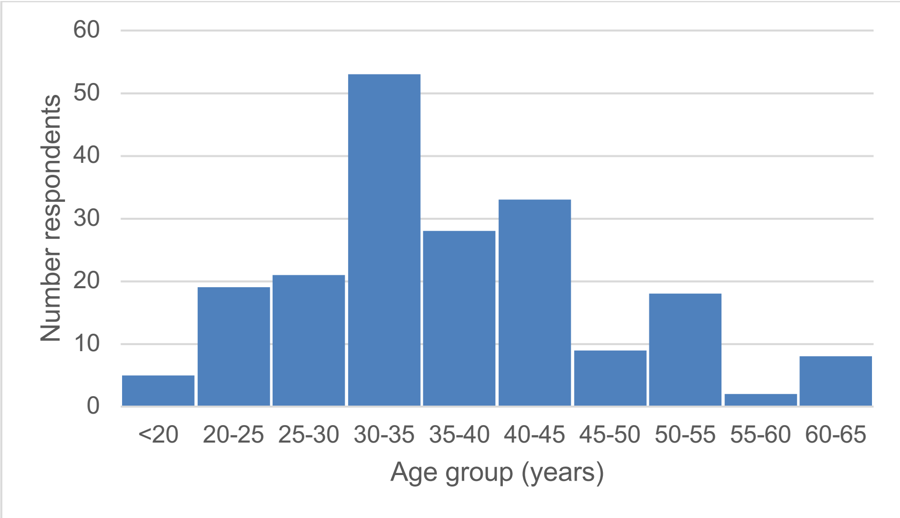


Figure 4: Age distribution of intercepted e-riders

The average age of the survey participants was 37 years, with a standard deviation of 10.5 years. The average age of male e-riders was marginally higher than for females (37.7 vs 33.9 years, p=0.045, see Figure 5).

However, the age profile is consistent with the reported use elsewhere (Mansourifar et al., 2025).

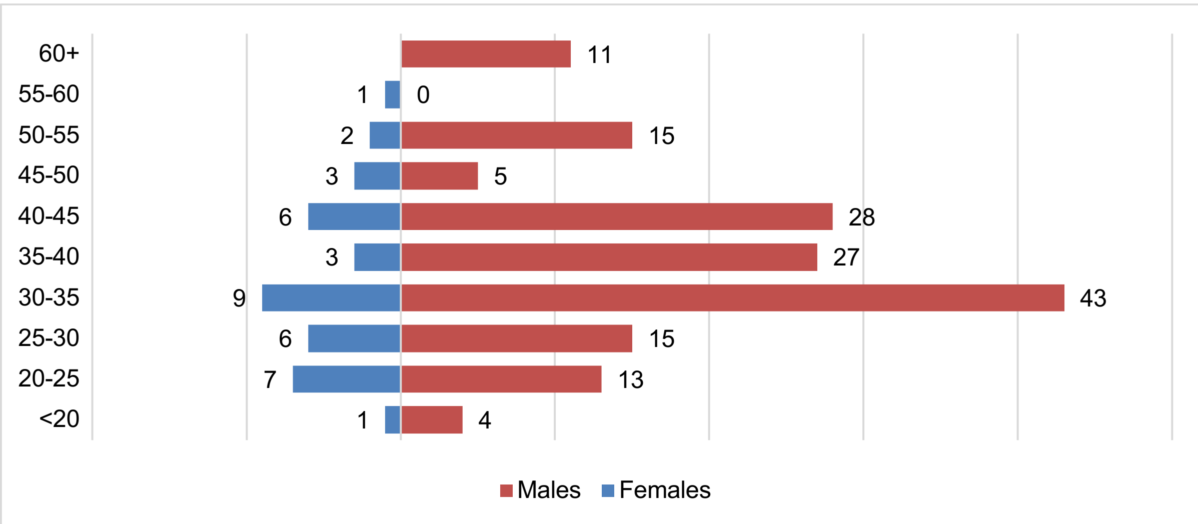


Figure 5: Age distribution by gender

Most riders regularly (at least 4-5 times per week) used e-rideables and less than 8% were infrequent users (Figure 6). This corroborates well with the commuting pattern, most e-riders using the e-rideable daily, to either avoid traffic, and/or to enjoy outdoors and benefits from incidental physical activity.

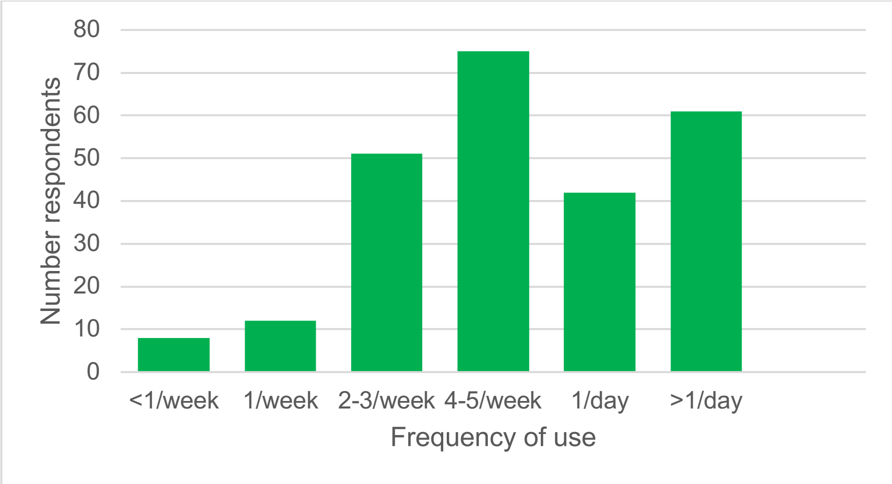


Figure 6: Frequency of using e-rideables

3.2.3. Travel behaviour findings

More than 90% of respondents reported they were using only e-scooters (Figure 7), although five participants indicated they own and use more than one type of e-rideable. No females indicated the use of more than one device, which was the e-scooter.

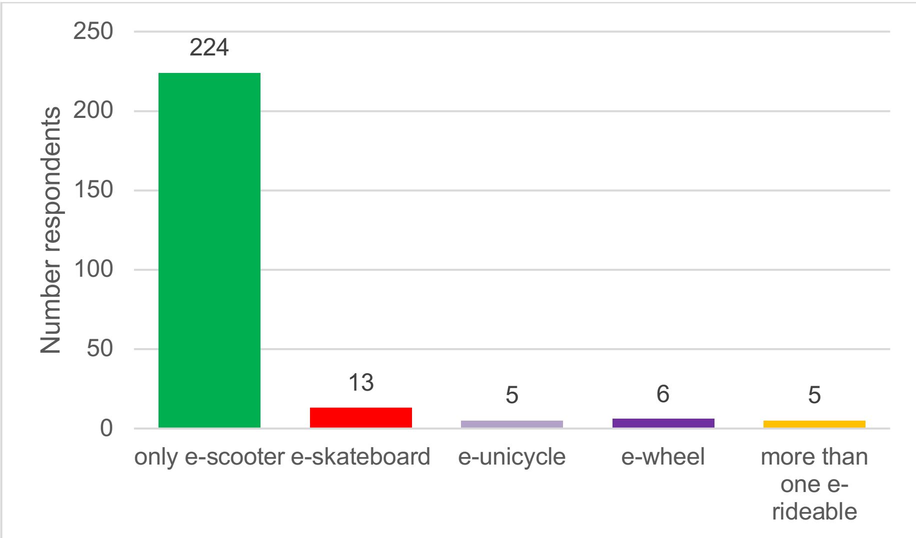


Figure 7: Distribution of e-rideable types

The average experience duration is over 1.5 years, although almost a quarter have used their e-rideable for less than six months (Figure 8). In terms of time-of-day, more than three-quarters used their e-rideables during the morning and afternoon peak, which is consistent with the commuting pattern reported.

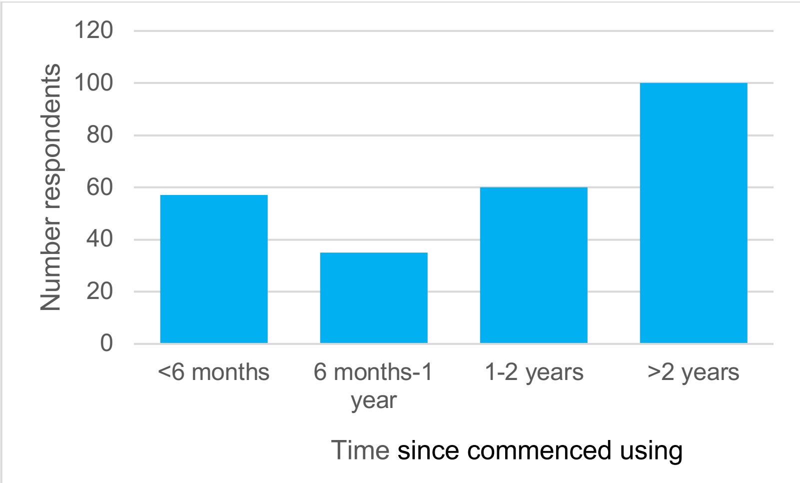


Figure 8: Experience in using an e-rideable

A quarter of e-riders use them during interpeak and about 15% after 6PM. Eleven participants reported use of the e-rideables at all times of day (Figure 9).

The average distance is under 8km, but this is an approximation and likely an over-estimation, given that the origins and destinations are mostly suburbs, and several participants reported the origin of the trip which may have included PT in the trip chain.

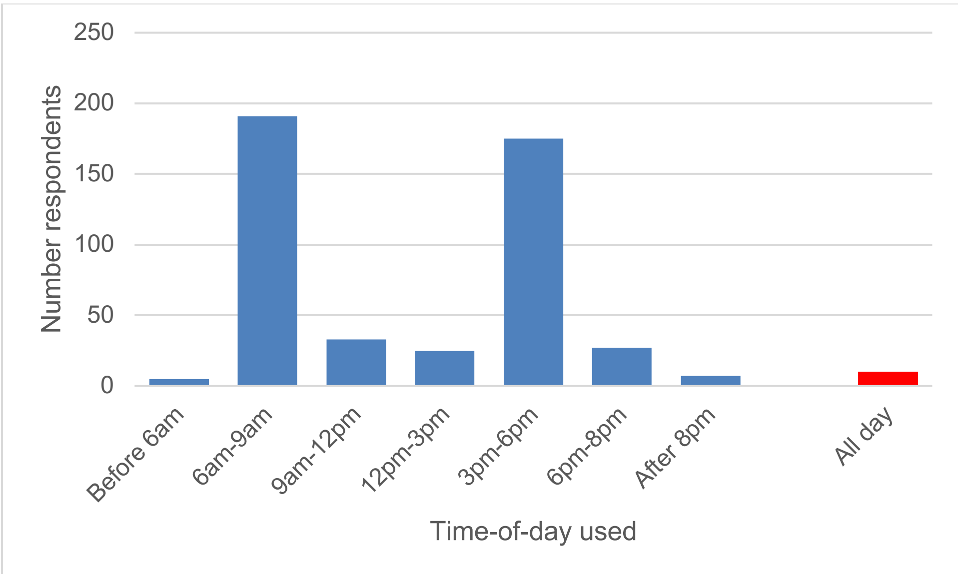


Figure 9: Time of day use of e-rideables

When comparing the sites (Table 2), there were no substantial differences in experience or use of e-scooters, however, despite the reduced subsample sizes, there are indications of differences in age, purpose, and distances travelled. The youngest demographic was, unsurprisingly, at Matilda Bay, capturing the students going to and from UWA. The oldest users of e-rideables were in Fremantle, and the shortest distances displayed by those riding in East Perth (Table 2), in general using their e-rideables door-to-door.

Table 2: Descriptive stats by site

Variable	Site	Canning Bridge, Murdoch	East Perth Matagarup, Vic Park	Fremantle	Leederville	South Perth	Matilda Bay	Riverside
	N	13	27	15	37	26	20	59
age (years)	Mean	36.7	35.7	**40.2**	34.8	**41.9**	*31.3*	37.8
	Std. Dev.	15.8	9.7	9.4	9.7	10.4	8.8	10.0
experience (years)	Mean	1.4	1.5	*1.0*	1.5	**1.7**	**1.7**	1.6
	Std. Dev.	1.0	0.9	0.8	0.8	0.9	0.8	0.8
distance O-D (km)	Mean	**15.9***	*7.0*	9.1	8.3	7.5	8.1	7.5
	Std. Dev.	11.7	4.6	8.6	5.7	4.2	4.3	6.4

* The inflated distance is due to multimodal trips using the train. If removing the train component, the distances are smaller, compared to those found in East and South Perth.

More commuting was recorded at the Riverside and Matilda Bay sites than the others (p<0.01); more morning peak trips were recorded at Leederville (p=0.024) than other sites; greater use of e-rideables after 6PM was recorded at Riverside and East Perth and none in Fremantle or Canning Bridge and Murdoch (p=0.008).

3.2.4. Spatial insights

Mapping O-D (origin to destination) trips (Figure 10), shows that most trips were for commuting purposes and some non-commuting North of the river, to Claremont and to Alfred Cove. Not surprisingly, the CBD area is the main destination.

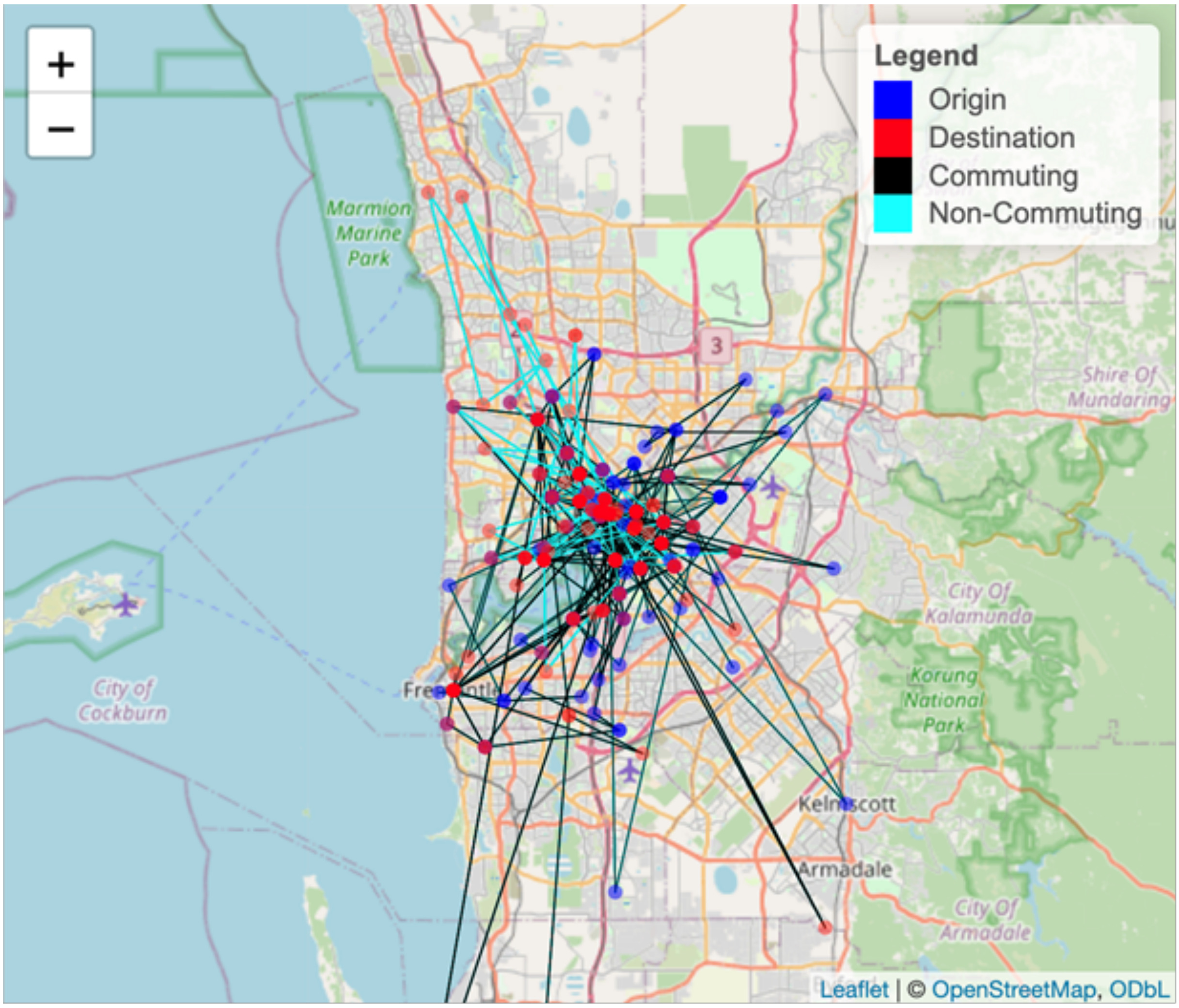


Figure 10: O-D commuting and non-commuting trips from the intercept survey

3.2.5. Qualitative insights

Qualitative comments suggest that an increased number of separated paths would incentivise more travellers to use e-rideables. Additionally, the ability to carry e-rideables on PT at all times would further enable their use. Attitudes and environmental values play a significant role in the formation of new habitual behaviours in favour of more sustainable transport options, including e-rideables.

The main reasons for using e-rideables include convenience and ease of use, enjoyment and fun and often beating the road traffic (Figure 11).

Figure 11: Word cloud for the reasons of using e-rideables.
Note: a threshold of 3 was applied for the word cloud.

When asked about the main barriers or suggestions to improve the uptake of the use of e-rideables, the most common concerns are about the infrastructure. This is consistent with the reported use of shared paths, followed by footpaths and roads (Figure 12).

Figure 12: Word cloud for perceived barriers for uptake.
Note: a threshold of 3 was applied for the word cloud.

Conversely, the most salient concern is the speed of e-riders compared to cyclists and pedestrians. While e-riders would prefer higher speed limits, pedestrians expressed concerns about the excessive speed of e-riders. Notably, the interviewed e-riders were compliant with helmet use. However, almost half of those who refused to participate failed to wear a helmet.

4. Online survey

4.1. Sample description

The 105 responses from the follow-up online survey display a similar profile: 78% of the e-riders were males, 30% between 25-35 years, 91% riding an e-scooter, more than half of them using e-rideables for commuting, and 30% of them were using e-rideables in combination with PT. More than 90% of the e-riders who completed the online survey declared that they are using their e-rideable at least 5 days/week.

In the online survey, 15% of the respondents were over 55 years of age, a surprising finding, however difficult to make any inferences, given the small sample. This has raised the average age of the online respondents to 40 years (Figure 13).

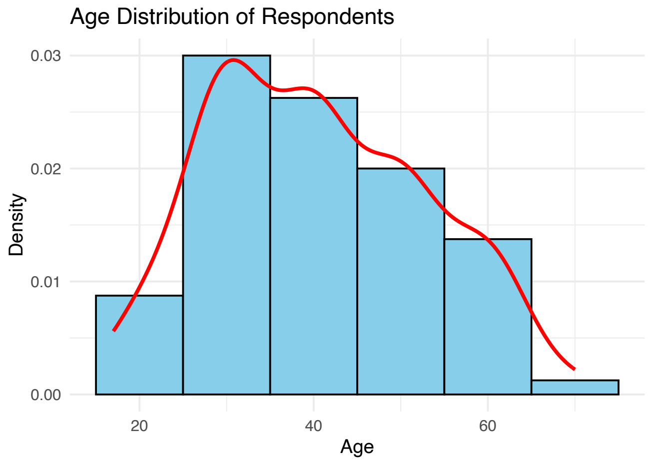


Figure 13: Age distribution for the online sample

Another interesting feature of the online survey sample is that 91% of the participants had a license for driving a motor vehicle and could choose to drive if they had access to a vehicle for that trip. Also, among the sample, 20% had multiple licenses (i.e. an additional motorcycle and/or truck licence). Only 9% of the sample substituted e-riding with public transport or other active modes.

As Figure 14 illustrates, almost 70% of the e-riders have completed a tertiary degree.

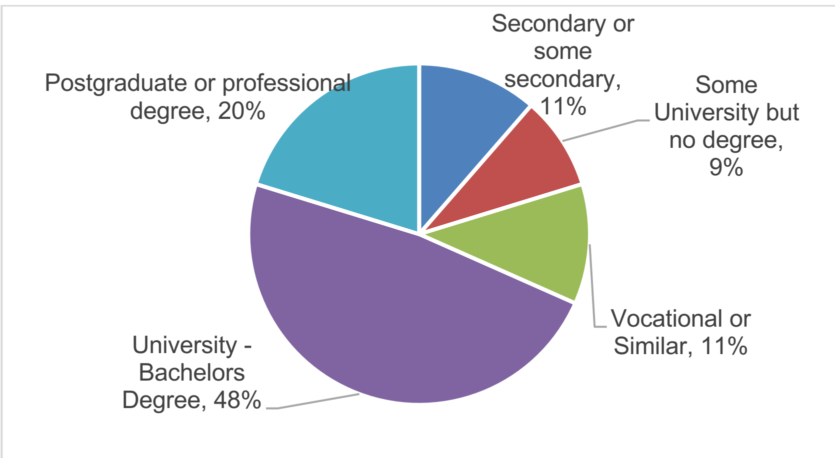


Figure 14: Level of education of respondents

They highlighted the positive environmental impact of e-rideables in their motivations, however, there are no differences in the level of awareness of the regulations applying to e-rideables, use of infrastructure, or perceived barriers from other respondents. Consistent with the intercept survey, the utilitarian benefits of using the e-rideables and the enjoyment represent the three main motivations for using them in daily travel (Figure 15).

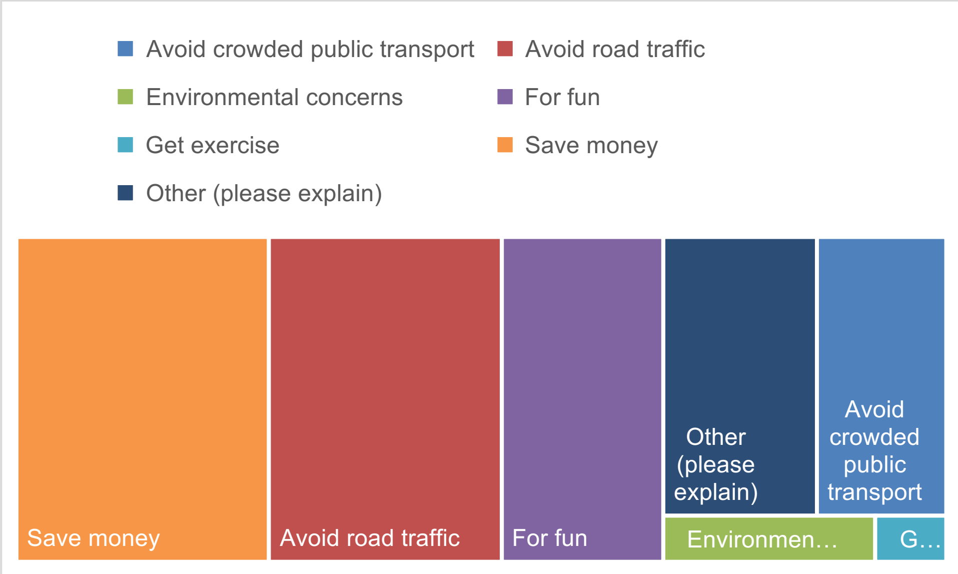


Figure 15: Main motivations for using e-rideables for travel

Rules for e-rideables, including allowable device dimensions and mass, maximum speed of travel and requirements for riders to wear a helmet, were included in WA's Road Traffic Code in 2021. While more than half of the e-riders are well aware of the relatively new rules, there is still one-in-seven riders ill-equipped in terms of knowledge of the rules (Figure 16). There are no significant associations between level of awareness and gender, level of education or motivation for using an e-rideable ($p>0.05$).

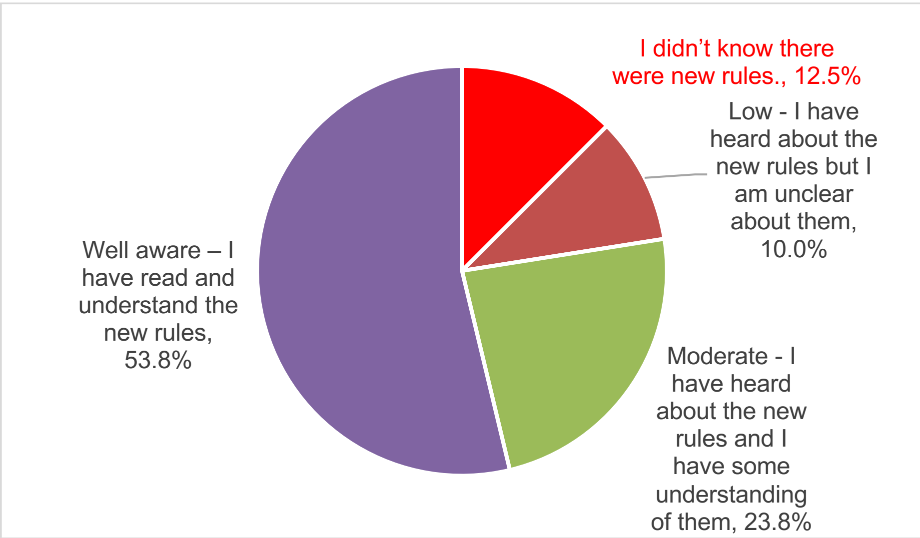


Figure 16: Awareness level of legislation

4.2. Travel Behaviour Findings

Following geo-coding of the origins (O) and destinations (D) and derivations of the distances and durations of the trips by e-rideable, an analysis of travel behaviour was undertaken.

By gender groups, there is no significant difference in the trip distance using the e-rideable (av.= 5.5 km), the daily travelled distances (av.= 10 km) or durations (av.= 48 min/day, s.d.= 29 min, range 20 to 180 min), on the number of motivations for using e-rideables (half of the respondents had more than 2), perception of changes in physical activity (increase by 0.7), or awareness of the regulations (an average of 2.2). All ANOVA and non-parametric tests had $p>0.05$. There are some differences in the trip distance and purpose, with commuting being shorter than for other purposes (Table 3). Females have shorter commutes, yet they used their e-rideables for longer non-commuting trips (e.g., shopping, recreational).

Table 3: Trip time and distances (online survey)

	Non-commute	Non-commute	Commute	Commute
	Trip duration (min)	Trip distance (km)	Trip duration (min)	Trip distance (km)
Male	24.22	5.54	24.19	5.27
Female	34.29	5.84	23.13	4.77
Overall	27.04	5.62	23.96	5.16

There are a few outliers in the trip duration (Figure 17), with five respondents indicating trips over one hour, all of them for non-commuting and four undertaken by female e-riders for recreation purposes.

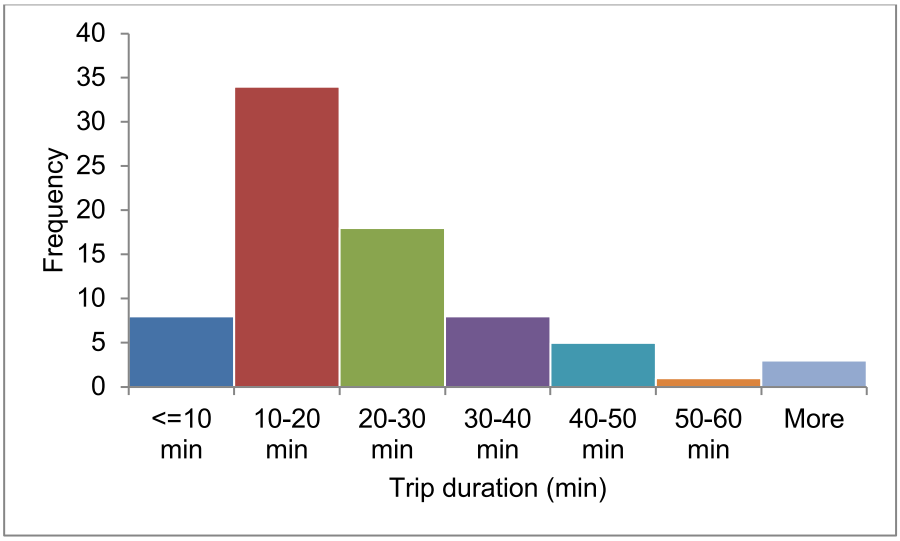


Figure 17: Distribution of trip time using an e-rideable

Unexpectedly, there was no significant association between the infrastructure used and gender, with shared path and within parks being the most frequent places for all trips (Figure 18).

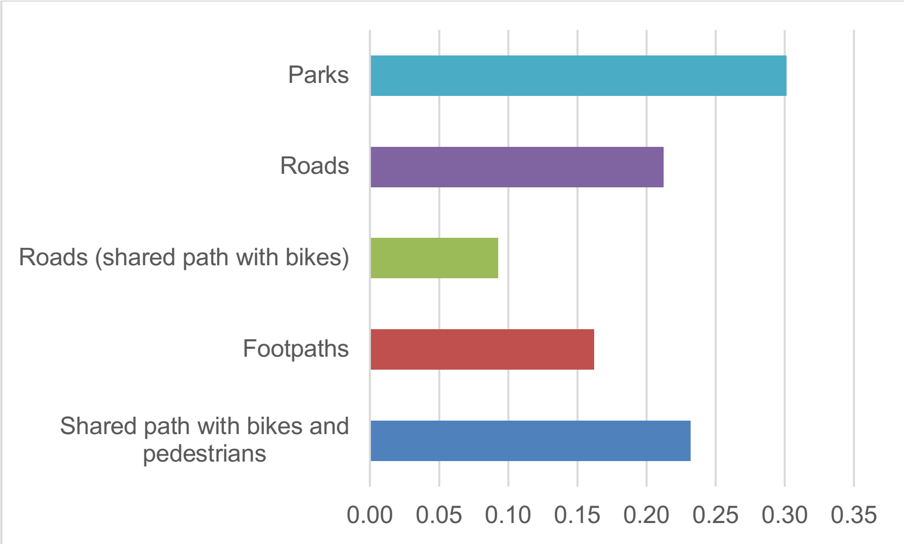


Figure 18: Infrastructure used for travel by e-rideables

When e-riders were asked about the impact of using e-rideables on their physical activity, it was seen that there was a net positive effect (average of 0.7), although almost a third did not think that it made a change (Figure 19).

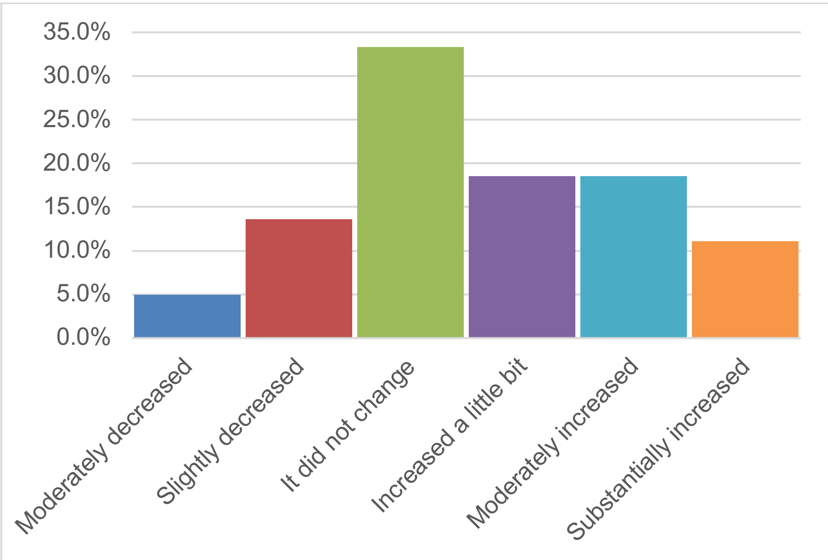


Figure 19: Impact of e-rideables on physical activity

While 30% respondents believed there are no major safety concerns (Figure 20), 60% considered that infrastructure is not adequate, 15% raised the problems of interaction with road traffic, 12% had concerns about pedestrians and dogs, 7% about the e-rideables themselves. One in five witnessed abuse or a near miss, and fewer a crash, with (15%) or without injury (6%). These are concerning statistics yet corroborated by the ranking of statements (Table 4), by the qualitative comments, and by the intercept survey results.

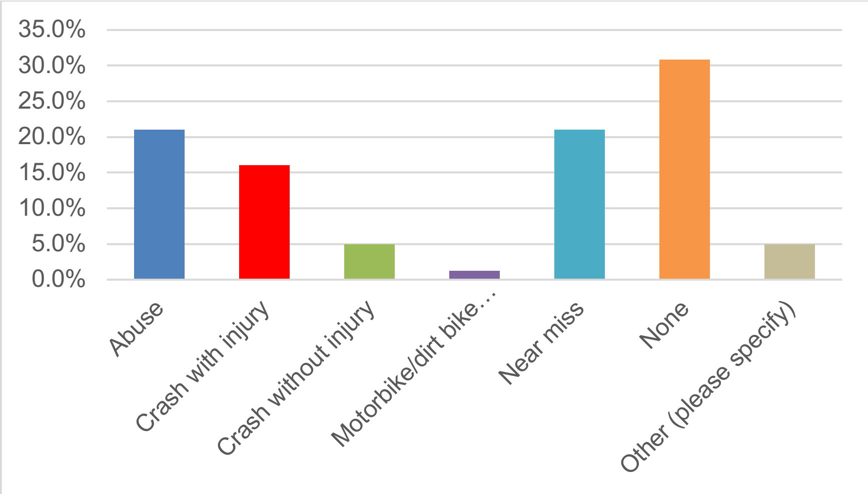


Figure 20: Safety concerns (witnessing accidents)

The number one concern is the speed of the e-rideables (2.96), followed by dangerous manoeuvres (3.06), and aggressive behaviours (3.12). The lack of skills was not seen as a major impediment in the interactions of e-riders with other participants to the traffic (4.81). As expected, speed is the primary concern for females, and the only statistically significantly different statistic found for these questions (p=0.015).

Table 4: Ranking of safety concerns (1 – the most concerning, 5 – the least concerning)

Concern (ranking)		Male	Female	Total	p
Aggression	Mean	3.09	3.19	3.12	0.841
	Std. Dev.	1.713	1.276	1.614	
Lack of awareness rules	Mean	3.3	3.25	3.29	0.917
	Std. Dev.	1.761	1.693	1.733	
Lack of courtesy	Mean	3.94	4.5	4.07	0.223
	Std. Dev.	1.549	1.713	1.593	
Dangerous manoeuvres	Mean	2.96	3.38	3.06	0.346
	Std. Dev.	1.493	1.628	1.523	
Speeding	Mean	3.19	**2.19**	2.96	0.015
	Std. Dev.	1.429	1.328	1.46	
Lack of skills	Mean	4.83	4.75	4.81	0.875
	Std. Dev.	1.805	1.693	1.768	

Compared to other modes of transport, female e-riders found e-rideables more environmentally friendly than cars and PT, but less than AT (albeit the differences were not statistically significantly different).

Among the whole sample, 30% thought that e-rideables are less environmentally friendly than cars and 14% that they are less environmentally friendly than PT. Also, 37% declared that e-rideables were more environmentally friendly than AT, a counterintuitive result that cannot be fully explained and requires further investigation. A potential reason could be that respondents consider the use of e-rideables as an enabler for AT trips, extending the range of what can be reached using AT and substituting these trips instead of other modes.

4.3. Spatial insights

Mapping O-D trips exclusively from the online data, there are fewer observations and they show that trips are predominantly commuting (Figure 21).

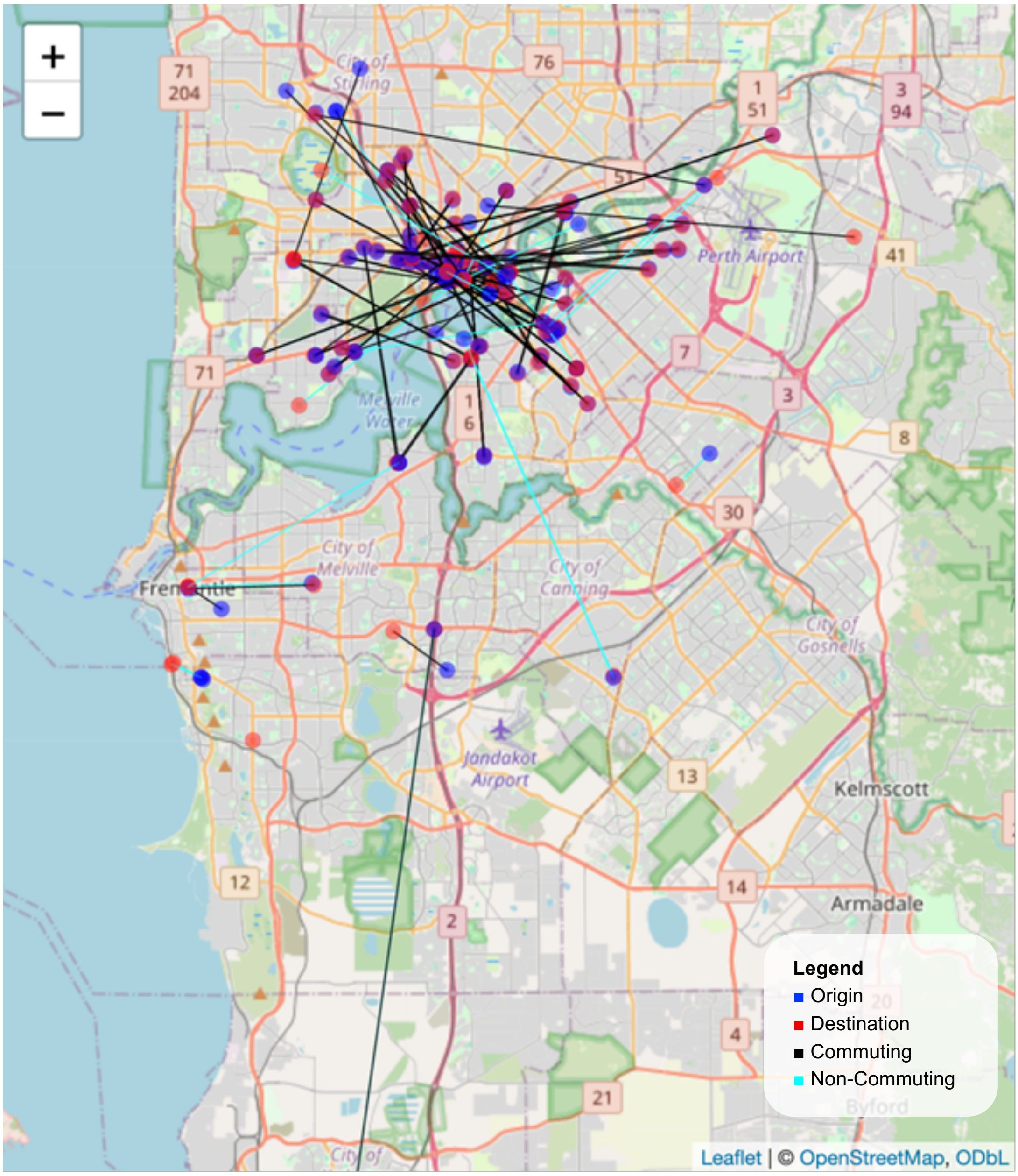


Figure 21: Commuting and non-commuting trips for the online respondents

4.4. Qualitative insights

Compared to the intercept survey, the word clouds from the online survey seem richer with many words/comments, however they are helpful in consolidating the findings from the intercept survey. It is important to note that, unlike the previous word clouds, there is no threshold applied for the comments made in the online survey.

Users considered e-rideables a competitive mode of transport, because they allow fast, conveninent, low cost of travel. They have also stated that e-rideables have a place in the transport system. Commuting is an important use for owners of e-rideables, although they are frequently using the devices for other purposes. Besides being convenient and cheap, they are fun to ride (Figure 22).

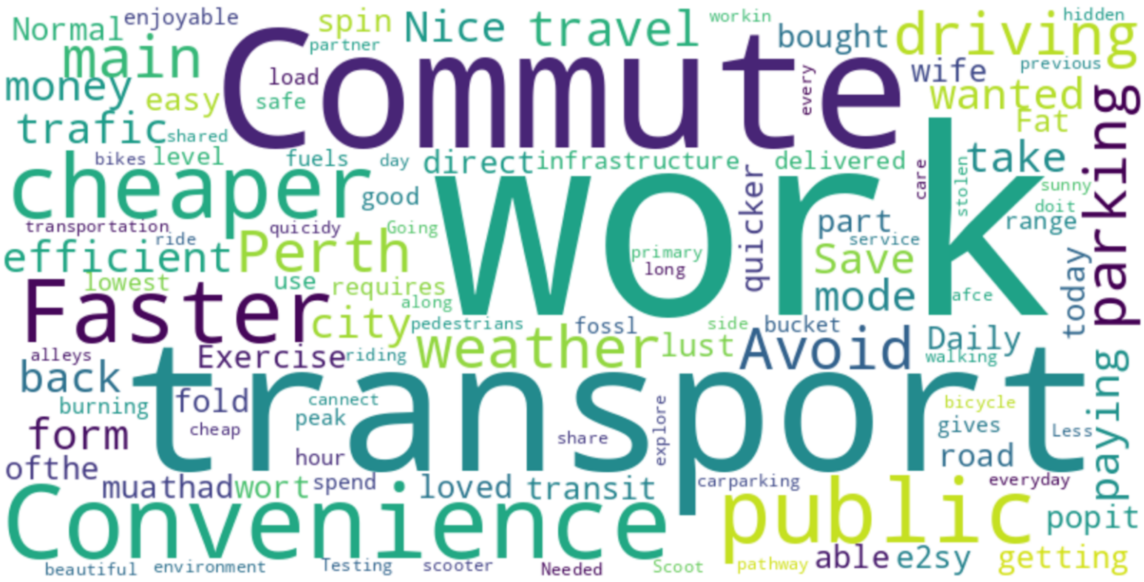


Figure 22: Word cloud for reasons for using e-rideables

The final comments emphasise their role in the transport network, as summarised by one of the participants: *"They need to be better promoted as a legitimate form of transport. They are quick, efficient, green and take little road and parking space. We already have excellent commuter paths to utilise and e-rideables are critical to decarbonising transport in inner city environments. e-rideables are already integrating well into the road and cycle networks."*

The prominent words in the word cloud include "need," "people," "safety," "paths," "riders," and "infrastructure," highlighting key messages related to e-rideables, echoed by the text excerpt provided above (Figure 23). To become a better integrated part of the transport system, changes are required in infrastructure, regulations and education. E-rideables respond to a genuine need in the community and e-riders see potential to increase their use, safety and efficiency.

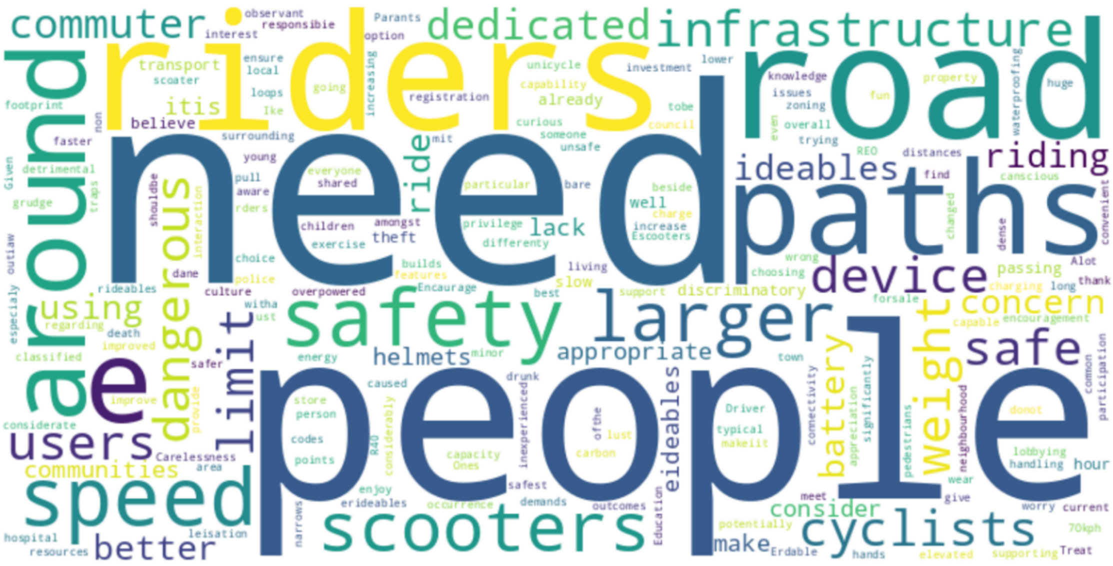


Figure 23: Word cloud from final comments in the online survey

4.5. Observational insights

Finally, our observational counts suggest that e-rideables represent a small fraction of ‘active travel’ modes, including cyclists and even e-bikes, varying between 8% to 15%, depending on the location. During the six days of the intercept survey we noted a higher proportion of bikes at Canning Bridge, Narrows Bridge, Matagarup Bridge, or South Perth, than on Riverside.

Of the 728 riders who refused the survey, 678 were on e-scooters, of which only a handful were using hired (Beam and Neuron) devices. However, we did note the use of hired scooters was more prevalent during the weekend. Thirty-three e-skateboarders were observed and the remaining 17 refusals were riding an e-unicycle, e-wheel or an e-hoverboard, indicating a strong dominance of e-scooters as e-rideables (93%).

Bikes represent the largest number of users of the PSP network, particularly Narrows Bridge, Canning Bridge, and South Perth. A total of 2,497 bikes and e-bikes were counted, with an average of 86/hour, varying between 7 to 298/hour, depending on the time of day and site.

5. Experiential survey

5.1. App description

For this research, we adapted the OpenPATH app, developed by the US National Renewable Energy Laboratory (NREL), used in other research projects to support sustainable mobility planning, travel demand modelling and behavioural studies (e.g., Tabasi et al., 2024). OpenPATH is an open-source platform designed to collect detailed travel behaviour data through passive smartphone sensing. It leverages GPS, accelerometer and other phone sensors to automatically detect trips, modes, and routes, providing a rich dataset on individual travel patterns without requiring extensive user input. To achieve this, the platform consists of a client app that is run on participant's mobile devices as well as a central server where the data is transmitted and aggregated to, amongst other elements.

The research team modified the app to meet the specific requirements of our survey and research objectives (highlighting the use of e-rideables, trip purpose and extra socio-demographics to improve compatibility with our research). This tailored version of the OpenPATH app, named Perth ERES, provides a robust foundation for examining emerging mobility trends, such as e-rideables and evaluating transport interventions (infrastructure and operational), while maintaining the app's original strengths in data accuracy, automation, and user privacy. The app is available for both Android and iOS operating systems and the users received a unique code to register and download the app. A screenshot of the registration screen is provided in Figure 24.

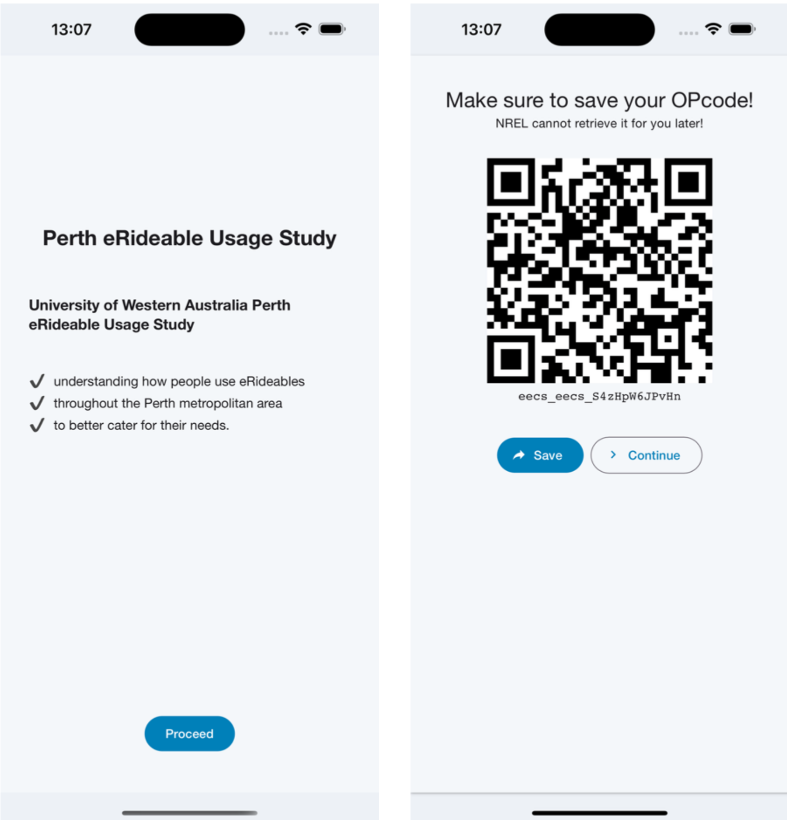


Figure 24: Screenshots from the registration component of Perth ERES (example from iOS / iPhone)

The socio-demographic information included not only age, gender, education, car ownership, but also personal circumstances (household composition) and also questions on availability of bikes and e-rideables (a sample of screenshots is available in Figure 25).

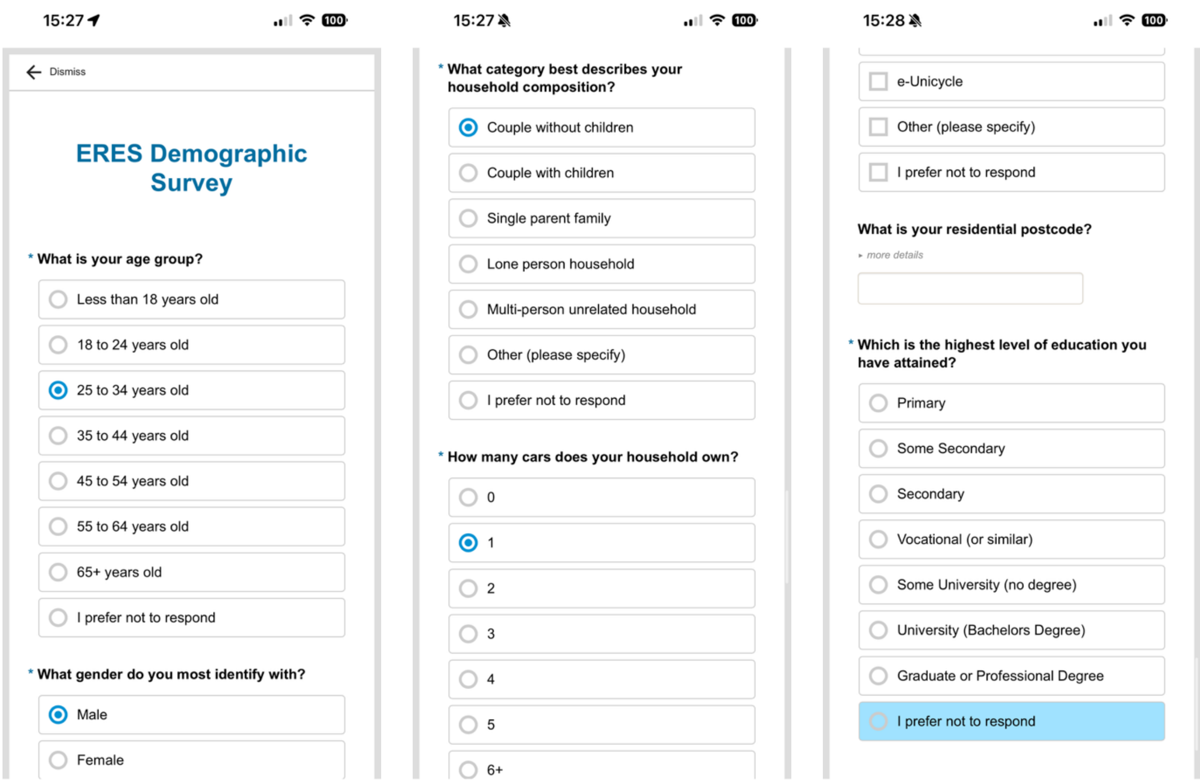


Figure 25: Screenshots from the socio-demographic survey

The Perth ERES app, similarly to OpenPATH app, generates detailed summaries of users' travel patterns over a selected time period (displayed in the 'Dashboard'), providing valuable insights into their mobility behaviour. The output includes key indicators such as the total distance travelled, travel time by different modes of transport, and the extent of active travel (e.g. walking, cycling, e-riding). It also estimates the energy and greenhouse gas (GHG) emissions associated with the recorded trips, enabling users to reflect on the environmental impact of their travel choices. These personalised summaries serve as direct feedback to participants, supporting greater awareness of their weekly travel behaviour. However, the accuracy and usefulness of these outputs depend on the user's active engagement in data collection, particularly their diligence in confirming the automatically inferred travel modes or correcting the inference and completing the trip purpose information. When users consistently complete these verification steps, the app provides a reliable and comprehensive picture of their travel activity. Figure 26 provides screenshots from the apps' dashboard.

This task is designed to be flexible and not onerous; users can confirm and edit their trip details at any convenient moment during the day, often in just 1-2min, or review all trips together at the end of the day or at their convenience (a reminder on 'unlabelled trips' is generated by the app). This step is especially critical for low-speed travel segments, where the app's automatic detection may be less accurate. As shown in Figure 27, the map with time-stamped trips and the two buttons for specifying trip purpose and transport mode are key to accurately capturing and interpreting travel patterns.

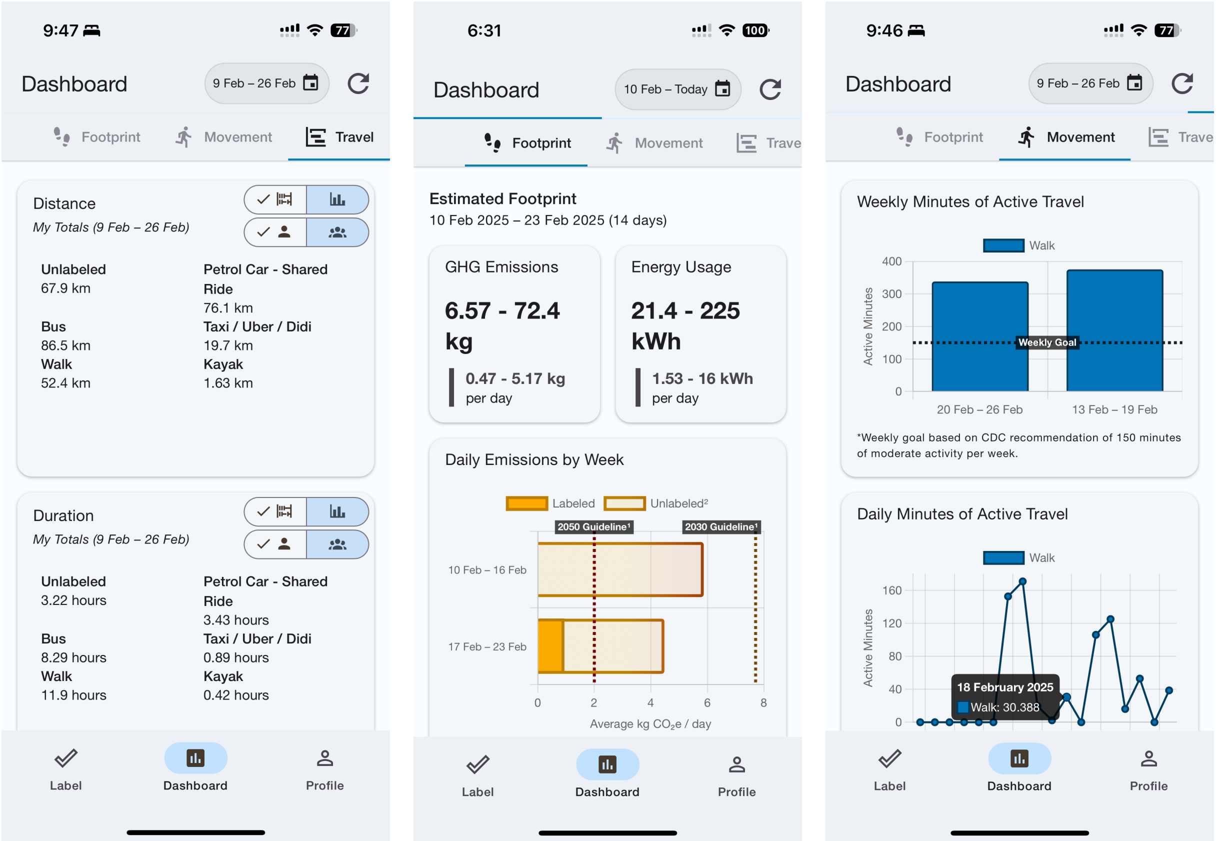


Figure 26: The dashboard of the Perth ERES app

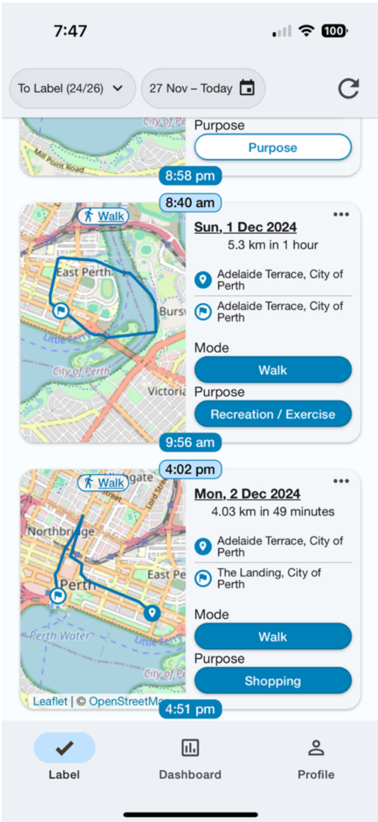


Figure 27: Labelling trips in the Perth ERES app

5.2. Data collection issues

The research team followed a diverse recruitment campaign, drawing on the previous intercepted users, promotion through the WA Department of Transport and universities, media postings on LinkedIn, as well as Facebook and Instagram accounts of e-rideable user groups or sellers of e-rideables (e.g., WestCycle, Perth Scooter Gang, E-scooter Club, Perth eride, Electric Racing League ERL, Perth unicyclists, Eriderz and Scooter Hut).

A diagram of the data collection efforts is provided in Figure 28, showing on the right (in pink) the steps followed to recruit participants for the experiential survey.

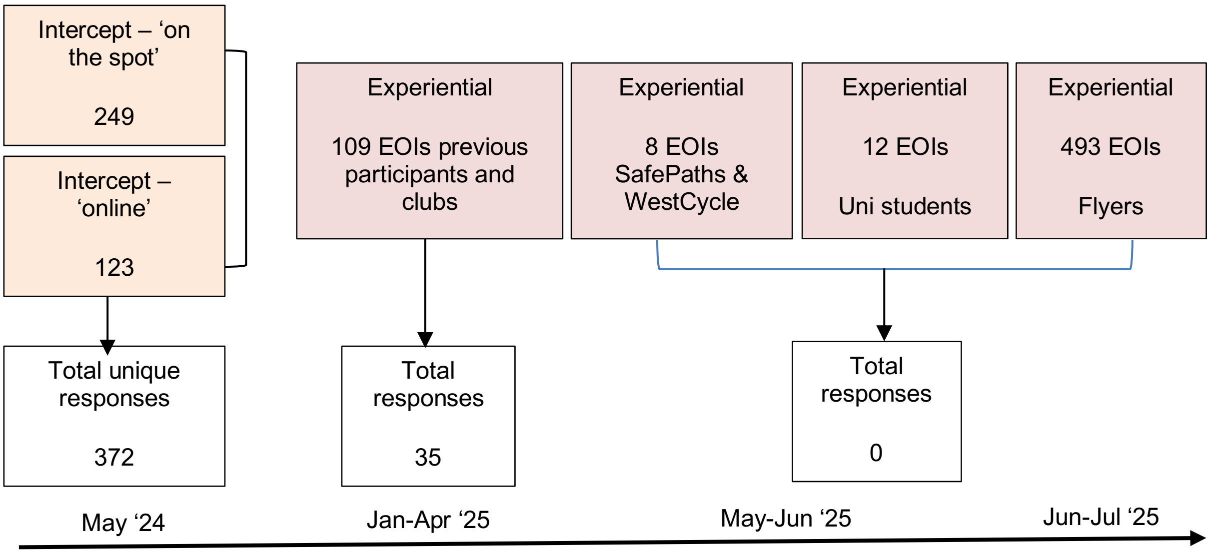


Figure 28: Data collection timeline

Despite a substantial number of individuals expressing initial interest in participating in the experiential study and signing up, the conversion rate from registration to active participation was very low. Follow-up attempts were largely unsuccessful in eliciting feedback on the reasons participants 'withdrew' or chose not to install the Perth ERES app and complete the travel tasks.

Several factors may have contributed to this low engagement. The $70 gift voucher offered at the end of the data collection week, while intended as an incentive, may not have been perceived as sufficient to offset the effort required to install the app, engage with its features, and validate trip data. Additionally, concerns about privacy and data sharing (as confirmed by two participants) may have discouraged continued participation. Recruitment challenges became more pronounced over time, and notably, no new participants were successfully recruited after April 2025, suggesting that additional strategies, such as enhanced personal communication with e-riders, improved onboarding through clubs or associations, or stronger incentives, may be necessary to support future data collection efforts. This may have been further complicated by contextual issues, with media discussion focusing on negative aspects of e-rideables becoming prominent at this time, due to an unfortunate accident involving a rented e-scooter (e.g. Bourke, 2025).

We highlight that, despite initial engagement from multiple sources, including 12 university students, 8 participants from the SafePaths & WestCycle workshop held in June, and 493 individuals who signed up through distributed flyers (double-sided A4 flyers also offering some insights from the intercept survey and describing the app, to entice the participant), none of these expressions of interest translated into actual app downloads or completion of the travel tasks. This outcome was unexpected and concerning, and the underlying motivations remain unclear. However, the pattern appears consistent with the growing issue of fraudulent responses in online research participation, particularly in studies linked to incentives or compensation, often associated with so-called ‘click farms’.

For instance, our team received hundreds of email messages from individuals claiming the $70 compensation, despite never completing the study. Figure 29 illustrates one such case, the 19th message received from the same sender within a single month, highlighting the scale of the problem. The incidents were reported to the UWA Human Research Ethics Committee (HREC) to alert them to the severity of the issue and to warn other researchers conducting similar studies.

Unfortunately, our experience is not unique. Similar challenges have been documented in recent literature addressing fraudulent participation in online research, including the Reflect, Expect, Analyse, Label framework proposed by Lawlor et al. (2021), as well as studies by Wang et al. (2023) and Johnson et al. (2024). This is a growing issue and therefore a consideration for recruitment in future studies, which should incorporate a face-to-face validation step with the participant.

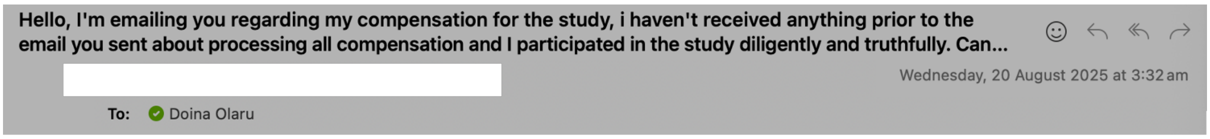


Figure 29: Example email header from a non-genuine participant

5.3. Descriptive statistics of participants

The sample (35 individuals) resembles the profile of the intercept survey, with two-thirds being males (23 out of 35), 28 (80%) being employed full-time and 71% being professionals (Figure 30) and with tertiary education completed. Most participants are between 30-40 years of age (Figure 31), possess at least one class of driver’s licence (only two without licences) and have access to more than one car (average car ownership = 1.85 cars).

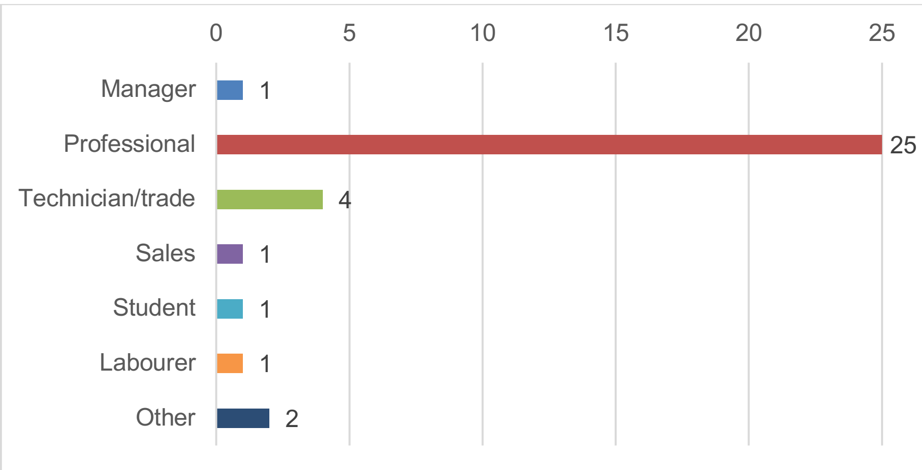


Figure 30: Socio-demographic breakdown by occupation

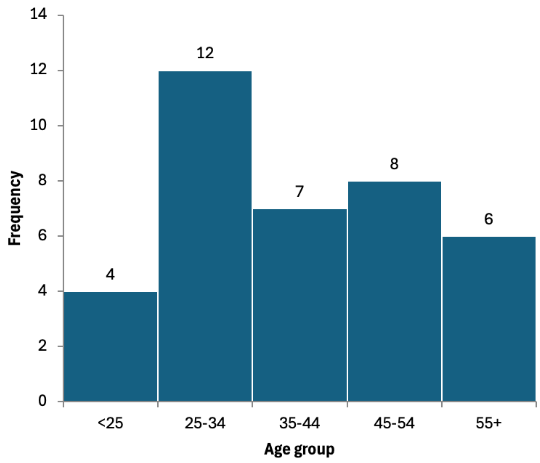


Figure 31: Socio-demographic breakdown by age

More than half work for large organisations (over 500 employees) and 10/35 work in education and training.

Twenty-two out of the 35 used an e-scooter, three an e-skateboard, two e-unicycle and one e-wheels.

In total, 3,922 trips by any mode were made over 458 user-days (as detected by the app). A total of 500 trips were excluded from the analysis for several reasons: 1) too short (455 trips at distances <300m, either by walking or not a trip); 2) too long (17 holiday, business and fly-in-fly-out trips, over 1,000km); 3) not representative for the objective of the project (24 trips by kayak or boat).

The analysis of the trips highlighted the importance of labelling/confirming the mode of transport and indicating the purpose. We compared the suggested/'sensed' mode and the labelled mode and noted that the internal algorithm correctly identified/detected car use in more than 70% of the cases, walking in about 50%, but e-rideables and bicycles in only 27% of the cases. This reinforces the need for participants to verify travel modes and provide trip information, which could be used to further inform the automated process to recognise these newer and less frequently used modes. Future research could explore imputing the travel mode based on factors such as the repeatability of the trip (e.g., similar origin–destination pair and time of day), the observed travel speed, and the modes used in the preceding and subsequent trips.

Figure 32 shows that the average speed of e-rideables is comparable to that of buses, significantly higher than that of bicycles, but lower than that of cars. The research team also developed individual-level speed distributions and found that approximately one quarter of e-rideable trips recorded speeds exceeding 25 km/h. These results are not reported here due to the limited number of participants and the associated risk of identifying individual travel patterns.

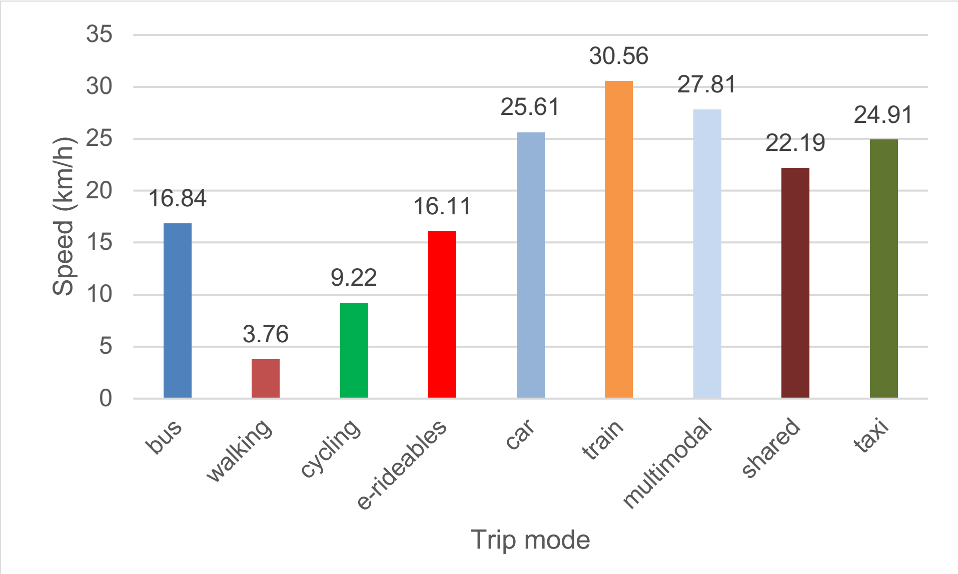


Figure 32: Mode breakdown by average speed

The dataset includes 334 trips made on e-rideables, with the mode confirmed by the user. It is important to note that many trips remained unlabelled (14%), and there is potential to impute the mode through careful consideration of speed, spatial characteristics of the trip, and the daily sequence of activities. In this report, we chose to include only the complete data without applying any estimations. Future work will focus on further modelling and validation.

Out of these trips, 102 were to the workplace (commute) & back home, 38 for recreation (primarily during weekend days), 37 for shopping, and 33 for personal business. The results confirm the two classes of users: mainly commuters and e-riders for a variety of reasons, mainly discretionary.

We also observed substantial variation between and within individuals, with activity spaces, representing the spatial extent of a person's routine mobility and activity participation[4] (measured as confidence ellipses, see Appendix D) ranging from 97 km² to over 8,600 km², with an average of 901 km² and median of 299 km^2. The average corresponds to a circle around the home with a radius of approximately 17 km, representing the urban area an individual typically uses over the course of a week. Although the dataset is insufficient for robust statistical analysis, a visible trend emerges: individuals who rely primarily on e-rideables tend to have smaller activity spaces than those who use them in combination with other modes of transport to meet their mobility needs. Across a week, participants spent a longer time travelling during weekend days (on average 86 min) than on weekdays (average 74 min), according to their routines. We note that the smallest activity space corresponds to an individual with a radius of about 5.6 km and the largest to an individual with a radius of over 50km, less likely to be representative for the e-rideable users.

Also, more trips were recorded/labelled during weekdays than weekend days. Figure 33 displays the distribution of reported trips by day of the week, with the largest number of trips recorded on Fridays, followed by Mondays and Thursdays.

Finally, the experiential survey, consistent with the findings from the intercept survey, suggests that e-rideables are more likely to replace car travel and some PT trips rather than active travel.

[4] The activity space covers the set of locations an individual regularly visits and the spatial area within which their daily activities occur, usually derived from travel diaries, GPS traces, or activity–travel surveys (Botte, 2015).

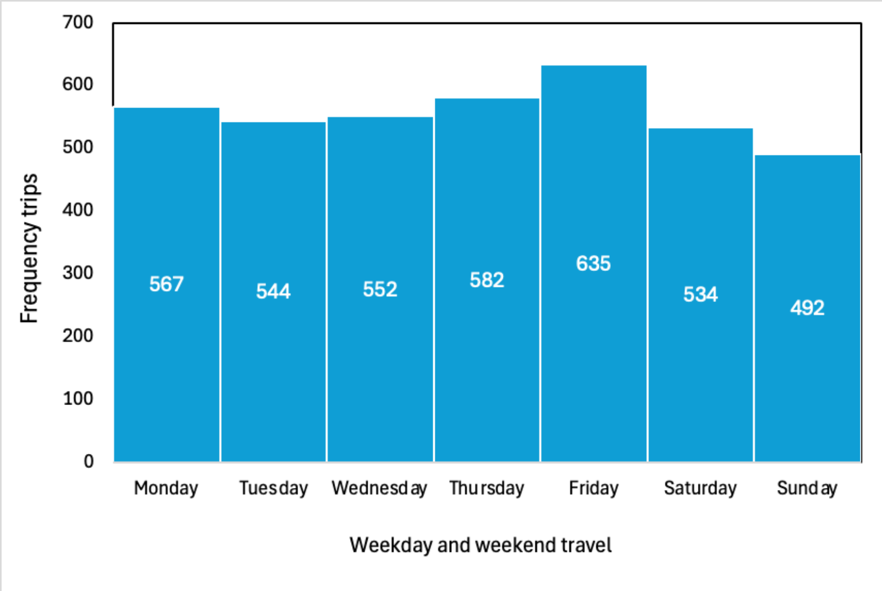


Figure 33: Distribution of trips by day of the week

This result differs from the findings of a recent meta-analysis by Fearnley and Vestein (2025), which reported different replacement ratios for Europe compared to the rest of the world (Table 5).

Table 5: Replacement trips by e-rideables (from Fearnley & Vestein, 2025)

	Private motor vehicle	**Public Transport (PT)**	**Active Travel (AT)**
Europe	20%	25%	**55%**
Non-Europe	37%	10%	**53%**

5.4. Spatial Analysis

Mapping the origins and destinations of trips recorded through the Perth ERES app revealed a wide spatial distribution and distinctive patterns of urban coverage, which are further reflected and summarised in the calculated activity spaces. Figures 34 and 35 illustrate examples of weekly mobility patterns: one participant shows a higher concentration of trips within the vicinity of their home, while another demonstrates a much broader travel range, extending both south and north of the CBD and Swan River.

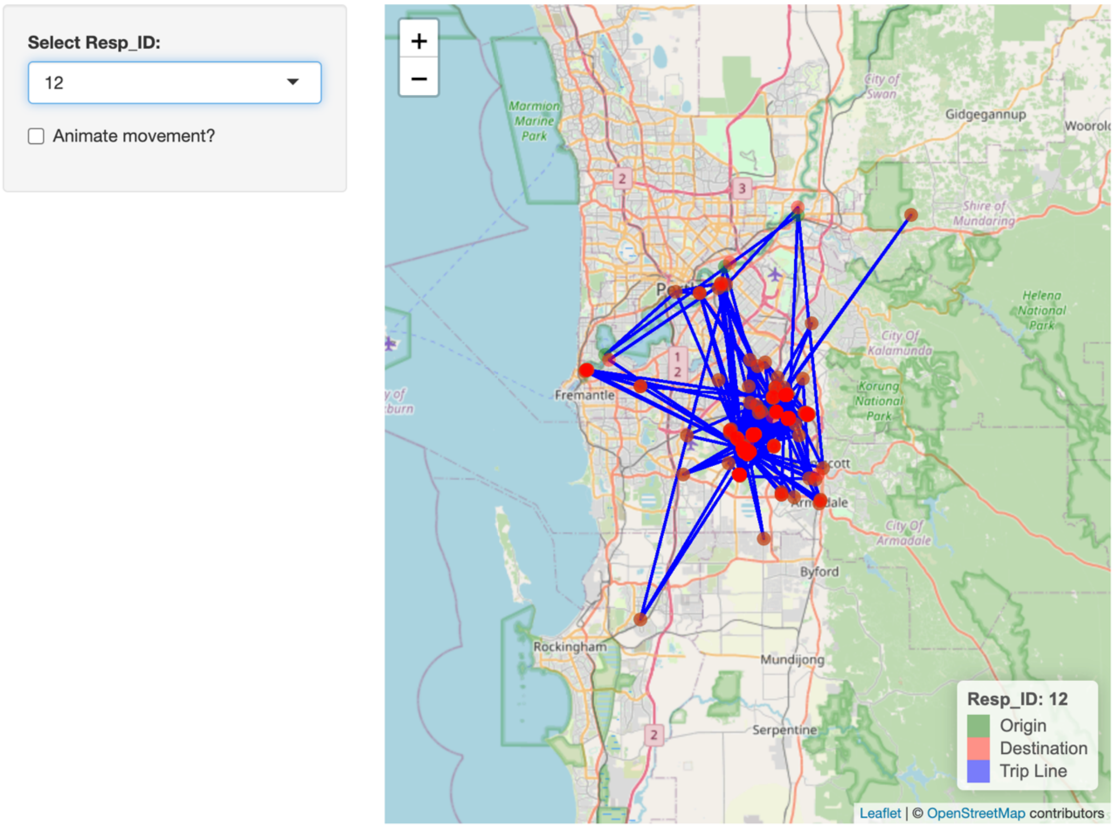


Figure 34: Example 1 of weekly trips for a participant in the experiential survey

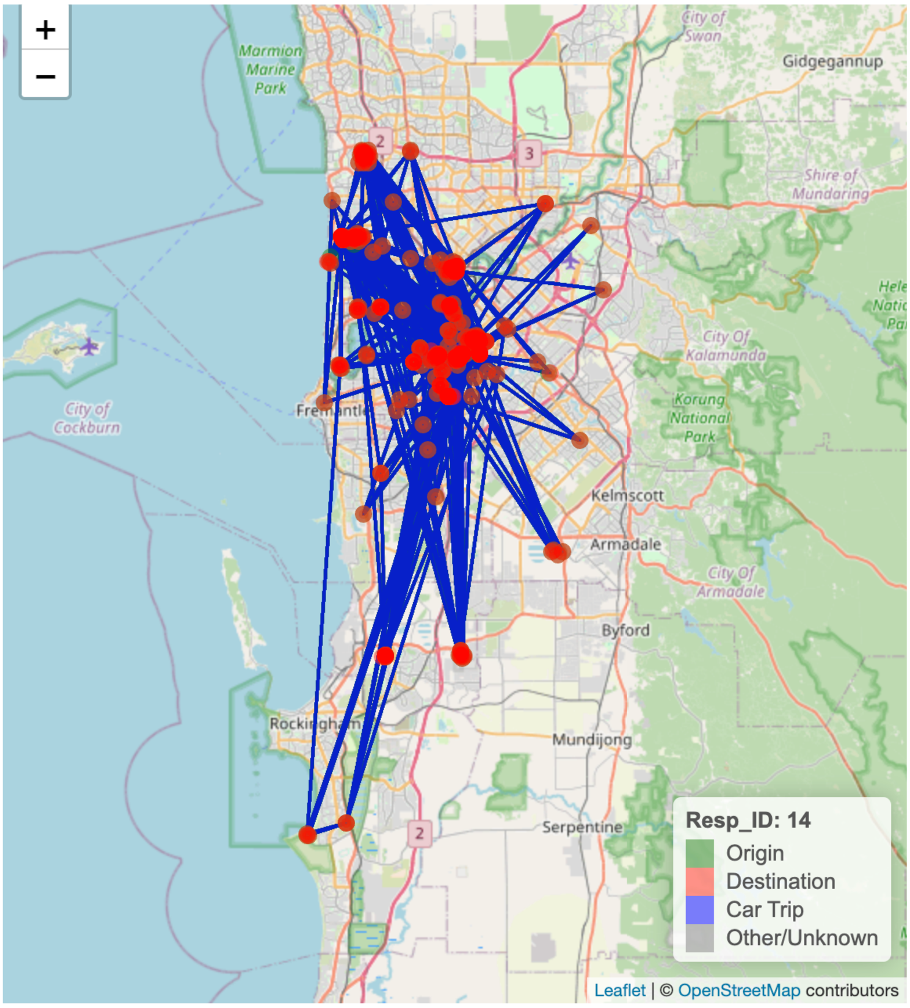


Figure 35: Example 2 of weekly trips for a participant in the experiential survey

These figures also bring to light one of the key challenges associated with app-based data collection and possibly explaining the low response rate, the privacy concerns. Some individuals may feel identifiable based on the spatial patterns of their mobility, raising questions about the confidentiality of location information. However, an even more sensitive issue, not illustrated above, relates to the recording of speed profiles. For e-rideable users, where devices are legally limited to 25 km/h, the capture of speed data appeared perceived as particularly intrusive. Participants expressed concerns that such information could potentially be used as evidence of non-compliance, even if higher speeds occurred in private settings. These anxieties were reflected in direct feedback from two participants:

"I did want to enquire though, it seems that the app runs in the background using GPS? Does this mean it is tracking my speed on my e-rideable? Of course, I would only do this on private property, but would it be able to detect if I am going above 25 km/h? I am worried what may be done with this information. Is it anonymous?"

and *"Is the app recording the speed?"*

Similar concerns have been reported in previous studies using the same base app, such as Tabasi et al. (2024), where low response rates were attributed in part to apprehensions over data use. These observations suggest that future studies should carefully address both spatial privacy and speed-related sensitivities, particularly when legal thresholds could make participants feel vulnerable to surveillance or sanction.

6. Parliamentary inquiry

On 18 June 2025, the Parliament of Western Australia launched the *Inquiry into the Safety, Regulation and Penalties Associated with the Use of eRideables*[5], inviting public submissions until 22 August 2025, with the final report expected to be tabled on 4 December 2025. While initially focused on e-rideables, the scope of the inquiry was expanded on 30 July 2025 to include the safety, regulation and penalties associated with e-bikes, and further broadened on 13 August 2025 to encompass electric dirt bikes. Given the limited experiential data available from our own research and with the aim of better understanding the factors underlying the low response rate and recruitment challenges, the research team undertook an in-depth analysis of the submissions received by this parliamentary inquiry. This analysis provided valuable contextual insights into public attitudes, concerns, and expectations around micro-mobility devices, as well as the broader policy and regulatory environment within which the study was conducted.

The research team downloaded all 239 submissions, redacted the personal information and repetition of the inquiry text to keep only the responses, and separated them into three categories: negative, neutral and positive, based on their general ‘sentiment’. Then content analysis of the three sets of submissions was performed, with the results provided next.

6.1. Descriptive analysis

The 239 submissions received by the inquiry represent a broad cross-section of stakeholders, including individual members of the public, community organisations, professional associations, advocacy groups, industry bodies, and government agencies. The submissions varied greatly in length, from less than 50 words to more than a hundred pages, often including supporting evidence, reports, or detailed recommendations from the submitters.

The submissions with mostly **negative** comments amounted to 45,699 words, and they were received primarily from the general public, community associations (e.g., Over 55 Cycling Club), insurance companies, councils/shires, the Pedestrian Council of Australia, the Australian Lawyers Alliance, and the Australian Medical Association. Those with predominantly **positive** perspectives (47,854 words) were received from many members of the public, users of e-rideables, as well as from the Electric Sports Racing Association, and e-scooter manufacturers. Finally, the **neutral** submissions, totalling 36,431 words, were provided mainly by institutional and sectoral stakeholders, including university researchers, the Road Safety Commission, the Association for Electric Vehicles (AEV) WA, the Australasian College for Emergency Medicine, eMobility, the Motor Trade Association of WA, WestCycle, RAC WA, and the WA Department of Transport and Major Infrastructure (DTMI).

The comparable size of the three categories/clusters enabled a robust content analysis, highlighting the similarities and distinctions across the submission clusters. Overall, ‘riders’ or ‘riding’ appeared 851 times in the submissions, followed by ‘safety’ and ‘safe’ (519 +220 times), ‘e-bikes’ and ‘e-scooters’ with a frequency of 570 and 505. The next most frequent words were ‘pedestrians’ and ‘enforcement’ (358 and 249).

[5] Inquiry website available at https://www.parliament.wa.gov.au/parliament/commit.nsf/(WebInquiries)/057E19FBFAC08CE748258CAC0028EA1D?opendocument

6.2. Content analysis

6.2.1. Thematic analysis of the three categories/clusters of submissions

Negative cluster of submissions

The overall sentiment of these submissions is a deep concern, often frustration of pedestrians and users, and erosion of trust or declining public confidence in how e-rideables, but also e-bikes and similar devices are currently managed. Respondents view the existing system as “broken” and “dangerous”, with rules that are poorly designed, inconsistently enforced and quickly outdated. There is a pervasive sense that both government and police have failed to anticipate or respond effectively to the risks posed by these devices, leading to avoidable harm, serious injuries and even fatalities. It is important to note that many members of the public do not distinguish between e-rideables and e-bikes.

The key concerns raised include:

1) **Public safety risks**: frequent accounts of unsafe behaviour with riding on footpaths, underage riders, intoxicated users, helmet non-compliance, speeding, and reckless stunts being cited as major threats, especially to vulnerable groups such as children and older pedestrians;
2) **Lack of enforcement**: many respondents expressed irritation at the inconsistent and insufficient policing of existing laws, with repeated reports going unaddressed and dangerous behaviour continuing unchecked;
3) **Regulatory gaps and outdated rules**: device specifications, classification systems, and legal definitions are seen as outdated and poorly aligned with current technology, allowing unsafe or illegal devices to proliferate;
4) **Cultural and behavioural issues**: some submissions highlight lower levels of ‘road culture’, referring to expected attitudes and behaviours when interacting with other participants to traffic on the road, mutual respect and safety awareness in Australia compared to European countries.

The submissions proposed a comprehensive set of reforms:

- Regulatory modernisation, moving from a rigid device definition to weight-based and speed-based classifications and removing outdated restrictions (e.g., 125 cm personal mobility device length limit, which is problematic for many adults);
- Introducing licensing requirements for all powered devices used on roads or footpaths, and considering liability measures (e.g. third-party insurance) for minors and their guardians;
- Increasing police capacity, integrating digital verification systems and equipping police officers with real-time compliance tools, to support enforcement of riding conditions;
- Creating ‘no-go’ and ‘low-speed zones’ in crowded urban precincts, banning footpath riding in crowded areas and regulating parking more strictly;
- Establishing national data-sharing standards and collaborating with academic institutions to refine risk frameworks and collect the relevant data for the use and impacts of e-rideables.

The main takeaway messages refer to enforcement and cross-sector collaboration. The public frustration seems to result not only from safety risks, but from a perception of institutional inaction. Visible enforcement and clear communication are essential. Legislation must evolve with technology changes, avoiding overly prescriptive rules that quickly become obsolete. Public acceptance of e-rideables will depend on credible safety measures and cultural adaptation strategies, including educational initiatives, especially in high schools. A coordinated approach involving state and local governments, law enforcement, industry, and researchers is crucial to closing regulatory gaps and building safer, more resilient mobility systems.

Neutral cluster of submissions

The overall tone across the neutral submissions is constructive and solution-oriented, seeking balance between public safety, accessibility and the need to promote active and sustainable transport modes. While acknowledging risks associated with e-rideables, the submissions consistently urge the inquiry to avoid overly restrictive regulations that might stifle innovation or hinder modal shift away from cars. There is a clear emphasis on systemic thinking, highlighting that the issues surrounding e-rideables are interconnected with broader urban mobility, infrastructure design and climate action goals.

The key themes and concerns include:

1) **Safety and innovation balance:** strong calls to modernise e-bike legislation, including raising the speed limit from 25 km/h to 32 km/h and allowing higher motor power (up to 750W), aligning WA with international standards; concerns that current restrictions may exclude people with disabilities due to throttle bans, limiting equitable access.
2) **Infrastructure gaps**: persistent need for protected cycling lanes, dedicated e-rideable paths and improved pedestrian crossings; infrastructure separation would reduce conflicts, enhance safety and support a “safety-in-numbers” effect as usage grows.
3) **Policy and regulation initiatives**: advocacy for a comprehensive regulatory framework, covering both private and hire devices, with practical and enforceable statewide rules. Here, regulating alcohol and drug impairment, setting clear penalties for unsafe behaviour and improving enforcement of existing laws, rather than introducing excessive new ones, are dominant themes. Related to this, support for geofencing, speed-limiting technology and even breath testing features on (primarily hireable) e-scooters to address unsafe behaviour.
4) **Behavioural changes:** the submissions call out “motonormativity”, the entrenched prioritisation of cars, as a barrier to reform, thus proposals advocate for shifting focus toward pedestrian and cyclist-friendly design, with broad education programs supporting this. Given that active travel modes are essential to meeting climate targets, repeated reminders and calls to increase active transport funding by an order of magnitude (e.g, from ~1% to 10%) and to integrate e-rideables into the public transport system.

Policymakers may consider the following:

- Shift to proactive regulation instead of focusing narrowly on incidents or punitive measures; policy should anticipate growth in micro-mobility and design frameworks that guide safe integration, both for hireable and private devices;
- Modernising e-bike and e-rideable regulations (speed, power, throttle use) to match international standards;
- Treating infrastructure as core safety policy, as many risks arise not from the devices themselves but from inadequate infrastructure;
- Addressing systemic car dominance, since broader policies reducing car dependency will indirectly improve safety and uptake of alternative transport;
- Leverage technology for compliance, using technological tools to help enforce speed, location, and drink and drug riding rules more effectively than current policing;
- Investing in public education and cultural change, such as more awareness campaigns (beyond what the user groups are providing) around safe and responsible use, infrastructure, and shared path etiquette, which are critical.

Positive cluster of submissions

The positive submissions to the parliamentary inquiry reflect a broadly supportive and optimistic stance toward e-rideables, portraying them as a transformative component of Perth and WA's transport ecosystem. The prevailing sentiment is constructive and future-oriented, with an emphasis on potential benefits, opportunities for integration and collaborative pathways for safe and sustainable adoption.

The main themes and insights include:

1) **e-rideables as integral to urban mobility**: these devices should be seen as flexible, affordable and sustainable transport options that reduce reliance on private cars, lower household costs and contribute to decarbonisation efforts. They're viewed as a genuine car replacement for short trips and an essential solution for first and last-mile connectivity, complementing public transport services;
2) **Community and cultural shifts:** the technology fosters community building through group rides, training events and social networks, promoting active lifestyles and shared mobility culture. This behavioural shift enables the reclaiming of road space and prioritisation of active travel; rather than relying solely on restrictive regulation, many submissions emphasise education, rider training and awareness campaigns as key to safe use. Electric Sports Racing Association (ESRA) and similar groups already run training facilities and workshops, enhancing rider skills, confidence and compliance;
3) **Data-driven risk perspective:** injury and usage data is needed; many of these submissions consider that 'serious incidents are rare' and mostly due to rider error and non-compliance, underscoring the value of training, helmet use and better infrastructure. Distinguishing between private and rental users is seen as critical for targeted interventions.

Their recommendations include:

- Further refinement and improvement of contextual regulation, allowing for higher speeds on shared paths (up to 35 km/h) while slowing in pedestrian-heavy areas and enabling e-rideable use on certain roads under 'bicycle-like rules';
- Proportionate classification, keeping 'standard' devices regulated similarly to bicycles, while introducing a separate class for heavier or more powerful devices;
- Investing in infrastructure, such as the extension of the PSP network, improving path quality, lighting and connectivity to support growing use and enhancing safety;
- Partnership approaches, such as collaborative co-design solutions with local councils and transport authorities to align policy with real-world use and community needs.

The positive submissions convey confidence in e-rideables as a vital part of a sustainable transport future. They advocate for balanced regulation, strong education and engagement programs, and collaborative policymaking that embraces innovation while safeguarding users and pedestrians. Rather than over-regulating, they call for supportive frameworks that harness the full potential of e-rideables to reshape mobility in Western Australia.

6.2.2. Leximancer analysis

Similar to the literature review synthesis, the content analysis of the three clusters of submissions was performed, to cross-validate the thematic analysis by the researchers. This objective analysis, using the abilities of large language models, further supports insights of manual coding by researchers.

The most striking feature of the conceptual map presented in Figure 36 is the distinct location of the red tags for the three clusters. Starting from the bottom of the conceptual map ('Negative' views of the submissions), we note the second most prominent theme of the map ‘E-rideables (in orange) connected to public safety, insurance, injuries, and compliance.

The largest themes are in the middle, ‘Use of e-rideables’ (in red and directly connected to the neutral submissions) and ‘E-scooters’ (in green). The ‘Use of e-rideables’ includes concepts such as: areas of use, infrastructure (paths, footpaths, roads), vehicles and their features (motor, power, speed), legal use, highlighting the distinction between devices and e-riders and the need to promote active and sustainable transport modes, while ensuring safe and compliant behaviour. The separate ‘E-scooters’ theme is notable, in recognition of their dominance in the e-rideables. Issues of public safety, usage by underage usage, regulation needs, data collection, and education are present. The theme is also directly connected to the ‘battery’ theme, where the storage and charging conditions are critical. Here we also note the concept of children, referring to both users of devices, as well as vulnerable pedestrians on the shared pathways. While acknowledging risks associated with e-rideables, the submissions consistently urge the inquiry to avoid restrictive regulations and to review standards.

At the top of the map, the positive submissions are directly connected to the ‘Cycling’ theme and then to ‘Transport’ and ‘E-bikes’. The main concepts are represented by the health, environmental, and economic benefits of active travel. Many of the later submissions, primarily referring to e-bikes, are associated with the positive perspectives. The “Transport” theme emphasises the safe, affordable, efficient (time), and sustainable transport options that increase access, reduce reliance on car mobility, and contribute to active travel and decarbonisation efforts. Standards and safety, as well as infrastructure investment and education, are required to support growing use and enhanced benefits.

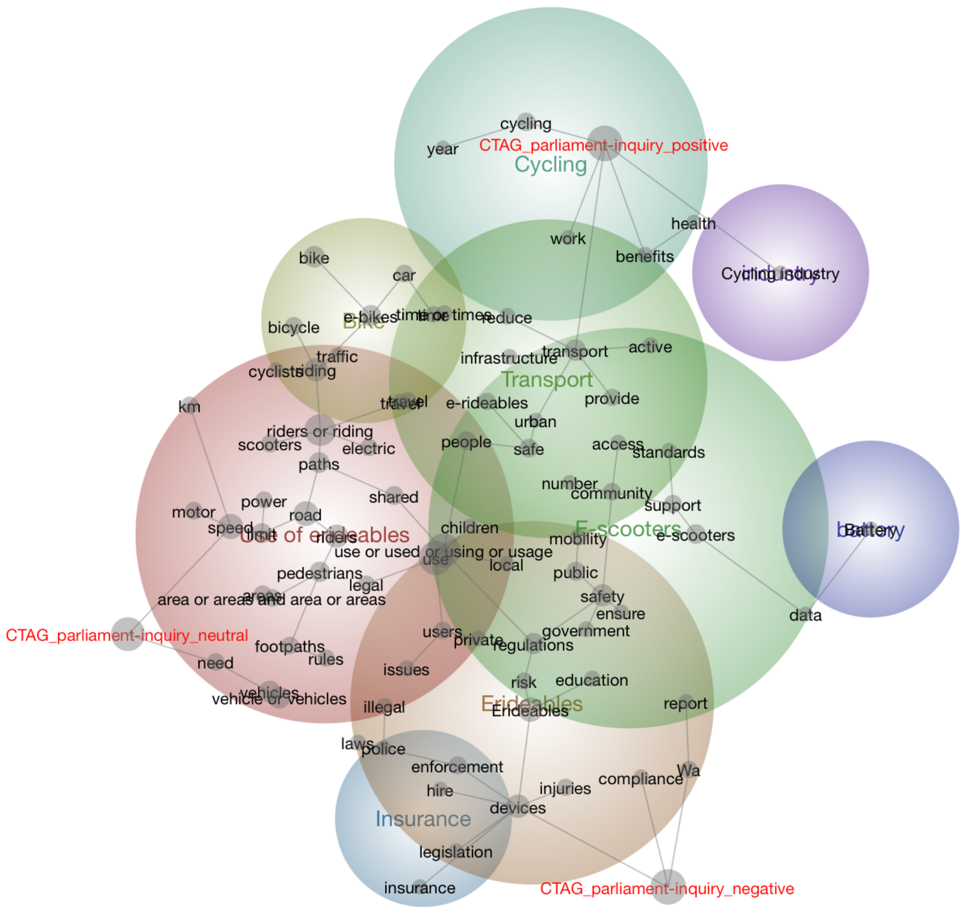


Figure 36: Leximancer conceptual map of the text analysis

These insights come to life in the additional analysis of the conditional probabilities of concepts in a cluster of submissions (see Figure 37).

The horizontal axis presents the Relative frequency, indicating the conditional probability of a concept, given the cluster. For example, if we are looking at the submissions with negative tone (displayed in red), how likely is that e-scooters or riders are mentioned? The quadrant diagram shows that ‘riders or riding’ are equally presented in the three categories of submissions, but e-bikes, pedestrians, and regulations are more frequently included in the neutral cluster (green) than positive (blue), or negative (blue).

On the vertical axis, the Strength represents the conditional probability of the cluster, given a particular concept. In other words, if we select footpaths, for example, it shows how often they are mentioned in the positive, neutral, or negative submissions. Again, Figure 37 illustrates that footpaths, e-scooters, and injuries have the strongest presence in the negative submissions (shown in red on the map), reflecting strong public concern about safety risks and pedestrian conflicts, whereas benefits, standards, and infrastructure represented the focal points in the positive submissions (in blue). This is consistent with the emphasis on the opportunities and enabling conditions associated with e-rideable use observed in the positive submissions. As indicated, e-bikes and regulations have the lowest incidence in the negative submissions, suggesting they were not perceived as major issues, and pedestrians received the lowest attention in the positive submissions. The quadrant map also shows that the concepts in green (from neutral submissions) are grouped in the lower half of the two-dimensional space, confirming the more balanced and integrative view of the submissions. In contrast, the red and blue concepts are more spread, highlighting the sharply different priorities of the negative and positive submitters.

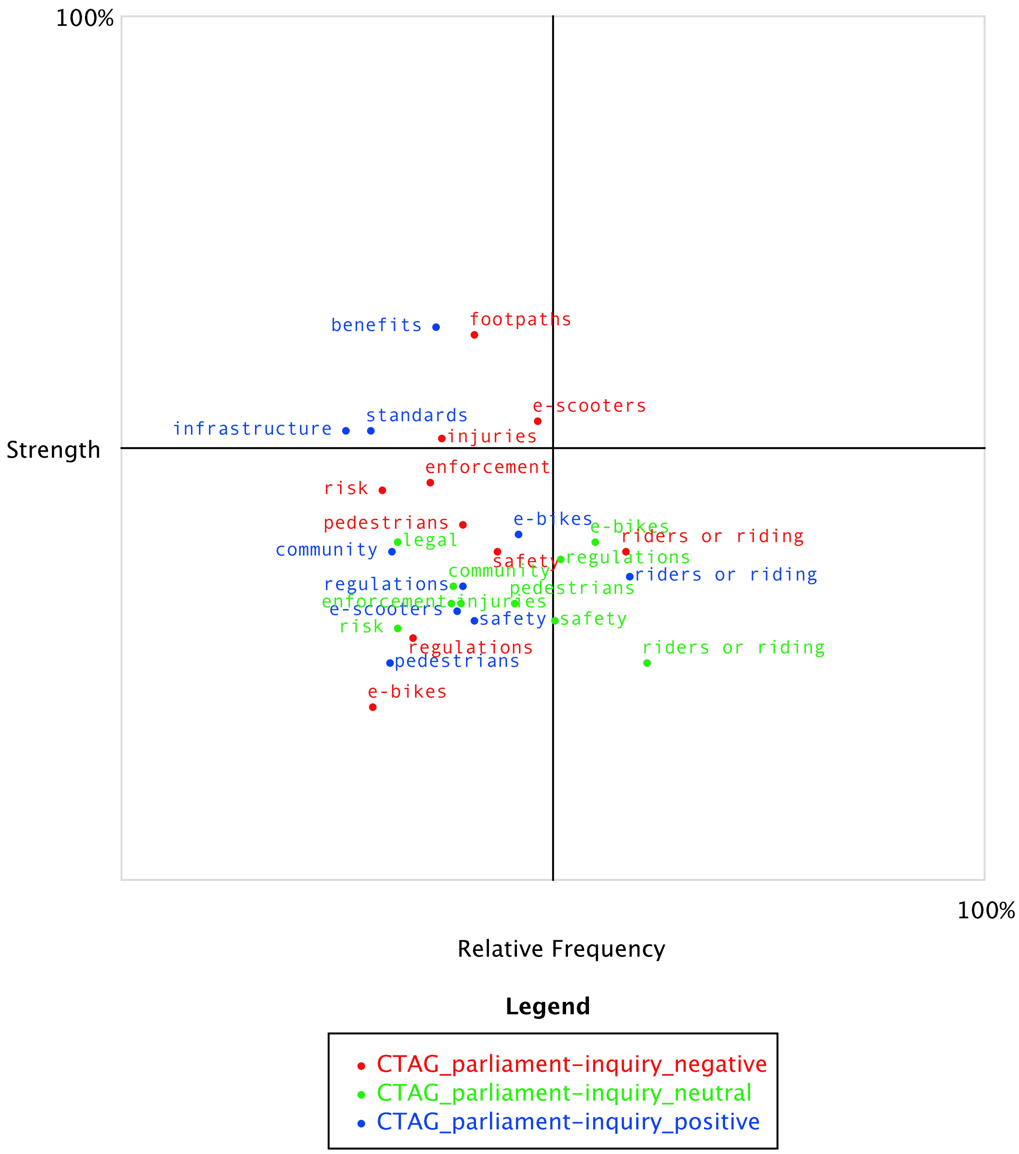


Figure 37: Quadrant report, by the three categories/clusters of submissions

Finally, the ranked concepts reflect the importance factors different concepts have in the various categories of submissions (Figure 38). ‘Footpaths’, ‘e-scooters’, and ‘injuries’ are at the forefront of the negative inquiries, ‘e-bikes’, regulations’ and ‘legal’ aspects, as well as ‘community’ for neutral submissions, and ‘benefits’, revision of ‘standards’ and ‘infrastructure’ improvements for positive view submissions (more details in Appendix D).

2. Ranked Concepts for Categories

Category: CTAG_parliament-inquiry_negative

Concept	Rel Freq (%)	Strength (%)	Prominence
footpaths	7	63	1.6
e-scooters	9	53	1.4
injuries	6	51	1.3
enforcement	5	46	1.2
risk	4	45	1.2
pedestrians	6	41	1.0
riders or riding	15	38	1.0
safety	7	38	1.0
regulations	5	28	0.7
e-bikes	4	20	0.5

Category: CTAG_parliament-inquiry_neutral

Concept	Rel Freq (%)	Strength (%)	Prominence
e-bikes	13	39	1.7
legal	4	39	1.6
regulations	10	37	1.6
community	6	34	1.5
pedestrians	8	32	1.4
enforcement	6	32	1.4
injuries	6	32	1.4
safety	10	30	1.3
risk	4	29	1.2
riders or riding	17	25	1.1

Category: CTAG_parliament-inquiry_positive

Concept	Rel Freq (%)	Strength (%)	Prominence
benefits	5	64	1.8
standards	4	52	1.4
infrastructure	3	52	1.4
e-bikes	8	40	1.1
community	4	38	1.0
riders or riding	15	35	1.0
regulations	6	34	0.9
e-scooters	6	31	0.9
safety	7	30	0.8
pedestrians	4	25	0.7

Figure 38: Ranked concepts in the three clusters of submissions

7. Conclusions and Recommendations

7.1. Conclusions

The combined evidence from the literature, user surveys, and the analysis of submissions to the Parliamentary Inquiry demonstrates that e-rideables have an established and growing role in urban mobility systems, offering a practical, sustainable, and increasingly popular mode of transport. Their appeal lies in convenience, cost-effectiveness, environmental benefits, and user experience, features repeatedly cited in both survey responses and published studies.

Both survey components of the research have unpacked associations between the use of e-rideables, including trip purpose and time-of-day, and individual circumstances and expressed attitudes about e-rideables and transport more broadly). Fieldwork revealed that in Perth, most of our interviewed respondents reported using their e-rideables because they are convenient, environmentally friendly, and fun to use. Users value e-rideables for short, door-to-door trips, typically under 7-8 km, and use them for commuting but also for other purposes such as leisure or errands, particularly on weekends. E-rideables offer quick access for short trips, allowing their users to navigate urban environments without the hassle of driving in congested networks, parking their cars or using complicated transit schedules. They represent a cheaper alternative to cars, reducing operational costs but also contributing to a lower carbon footprint and reduced air pollution compared to fossil fuel-powered transport. E-rideables encourage spending time outdoors, even if their effect on physical activity is inconclusive. Riding e-rideables is often considered more enjoyable than traditional commuting methods.

There are no substantial differences in behaviours and attitudes by the site survey and the same concerns were raised by users, with female riders highlighting the issue of speeding. Most current users are younger males, often early adopters and more likely to take risks in traffic or engage in higher-speed travel behaviour compared with other demographic groups. However, there is a notable and growing adoption among people aged over 50, highlighting their potential to serve a broader demographic over time.

The surveys highlight two main groups of users: commuters and users of e-rideables for discretionary trips. The length of trips constrains the broader use of e-rideables, resulting in their predominant use for shorter journeys. Respondents also noted that e-rideables are not a viable option for long commutes, particularly in the absence of effective integration with public transport.

However, the findings also reveal a set of consistent challenges and critical enablers that must be addressed if e-rideables are to realise their full potential as part of Perth's sustainable mobility mix. Across all three sources of evidence, several themes emerge, as displayed in Table 6.

Table 6: Summary themes from integrating literature, survey data analysis and submissions to the parliamentary inquiry

No	Topic	Comments
1	Safety and Infrastructure as core priorities	Safety concerns, for both riders and pedestrians, dominate the discourse. Users, stakeholders, and policymakers emphasise the urgent need for dedicated, well-connected infrastructure to minimise conflict between e-rideables, pedestrians, and motor vehicles. The separation of lanes, improved path design and targeted infrastructure deployment in areas underserved by public transport are repeatedly highlighted as essential interventions.

No	Topic	Comments
2	Modernising legislation and strengthening enforcement	There is a broad consensus that existing legislation is outdated and inadequate. Clearer classification systems for devices, updated speed and power regulations, and more stringent enforcement are required to address safety risks, close legal gaps, and align with international best practice. The submissions particularly stress the importance of aligning the conditions under which e-rideables and e-bikes operate, ensuring regulatory consistency and equity.
3	Education and behavioural changes	A recurring recommendation is the need for comprehensive education campaigns to inform users about safety protocols, responsible riding practices, and the capabilities and limitations of their devices. Such initiatives can address common risk behaviours (e.g. speeding, reckless riding) and support cultural shifts needed for safer integration of micro-mobility into the transport network.
4	Integration with PT and urban systems	Currently, many e-rideables are used as stand-alone modes rather than as part of multi-modal journeys. Enhancing integration with public transport, including compatible storage and charging infrastructure, could significantly extend their utility and support broader mode shift goals. These aspects were strongly included in the surveys, with feedback from riders indicating they desire a more seamless experience when using e-rideables, with a focus on convenience, integration with PT and accessibility to suitable routes.
5	Equity and access considerations	Both the literature and stakeholder feedback underline the importance of ensuring that e-rideables serve diverse user groups, including older adults and people with mobility constraints. Policies that address affordability, accessibility and inclusive design will be essential for equitable adoption.
6	Ongoing research and evidence-based policy	There is a recognised need for further research and innovation to improve device safety, assess health and environmental impacts, and evaluate the effectiveness of policies and infrastructure investments, particularly in the submissions for the Parliamentary Inquiry. Continuous monitoring and adaptive governance will be key to managing evolving technologies and behaviours.

7.2. Conclusion and recommendations

7.2.1. Policy and practice

In conclusion, the integration of e-rideables into Perth's urban transport systems presents a viable contribution to resolving mobility challenges. By addressing safety, community infrastructure, and user education, cities can enhance the overall effectiveness and acceptance of e-rideables as a mainstream transport option.

Integrating e-rideables into Perth's urban transport system requires a coordinated approach across legislation, infrastructure, education, and innovation. This is clear from the literature, the comments from the survey participants and the Parliamentary inquiry submissions. First, the regulatory framework must be modernised to reflect evolving technologies and usage patterns. This includes updating legislation with clear classifications based on speed, weight, and power, aligning the operating conditions for e-rideables and e-bikes to ensure consistency and equity, and strengthening enforcement through targeted policing and technological tools such as geofencing and speed limiters.

Infrastructure investment is equally critical. The development of dedicated and well-connected networks that separate e-rideables and motor vehicles should be prioritised, reducing conflict and enhancing safety. Consideration should be given to how to manage path user behaviour to support safety for all path users - including pedestrians, in areas of high path use.. Survey participants highlighted the new Boorloo Bridge as an exemplar to follow in managing different modes. In addition, secure parking and charging facilities at key destinations, such as transport hubs, workplaces, and activity centres, would support seamless integration into daily travel.

Improving integration with public transport is another essential step. Targeting new infrastructure in areas underserved by buses and trains could further extend the reach of and accessibility to Perth's public transport network. Policies could enable the carriage of e-rideables on PT, while multimodal hubs and clear signage can facilitate easy transfers between walking, cycling, e-rideables and PT. Ensuring suitable storage and charging infrastructure at these hubs can further facilitate this.

Besides physical infrastructure, education and awareness initiatives are highly recommended. Comprehensive campaigns can inform users about safety protocols, device capabilities, responsible riding behaviour, and legal obligations, while broader messaging on sharing the space/path can foster mutual understanding and safer interactions between people, whether driving, walking, or riding. Understanding the underlying environmental, health and economic benefits of e-rideables can also encourage broader uptake and behavioural change.

Equity and inclusion should form the foundation of all policies. With nearly one in five riders aged over 50 (suggesting that use is not limited to younger populations), e-rideables should be promoted as a viable transport option for people across all life stages, including older adults and those with mobility constraints. At present, however, their use is legally restricted to people aged 16 and over, although there are indications of younger people using e-rideables. It is expected that the infrastructure design, regulatory decisions, and educational materials reflect this diversity of users. Embedding e-rideables within broader strategies for sustainable transport, climate action and urban liveability can help deliver safer, more connected and more inclusive future urban mobility in Perth and WA.

Finally, continued investment in research and development (R&D) will be vital for advancing device safety, battery technologies and charging systems, as well as exploring innovative solutions for urban integration and real-time monitoring of the use of e-rideables. This may allay some fears and drive greater uptake. Establishing mechanisms for ongoing data collection and evaluation will allow policies to adapt as technologies and behaviours evolve. DTMI is considering its monitoring of activity on the AT network. Currently piezoelectric counters provide a measure of activity on major shared paths, covering but not distinguishing between bikes and e-rideables. Video surveys have been used for specific projects. The longer-term goal is an approach to monitoring that covers all modes and can inform policy and practice.

7.2.2. Implications for research

Future research on e-rideables should focus on addressing the current evidence gaps, improving engagement with users of e-rideables, and deepening understanding their behavioural patterns and motivations. The limited uptake of the experiential survey highlights the need to rethink recruitment strategies and strengthen connections with relevant community groups, advocacy organisations and user networks. Building partnerships with local councils, cycling and micro-mobility associations (such as WestCycle) and rider communities could improve trust, participation and the representativeness of future studies.

Co-designed research approaches, including participatory workshops, targeted outreach and pilot projects, may also increase involvement of e-riders and generate richer experiential data. These approaches could involve people who walk and ride bicycles as well as e-riders in various locations across the city, engaging local government and community groups, looking at how to share space and address safety issues. This will alleviate some of the negative media comments and the anxiety of being around e-riders, bringing more trust by and towards e-riders, and limiting the effects of the ‘moral panic’. Another important aspect that co-designed research could address is alleviating the ‘fear of being tracked’. While we could not directly measure participant reasons for declining participation, the possibility of mistrust or fear of being monitored, particularly in relation to speeding, cannot be ruled out. In designing the recruitment materials, we emphasised confidentiality and the ethical approval of the study; however, it is possible that these assurances were insufficient to overcome concerns about location tracking. This is consistent with findings from other studies using passive or GPS-based data collection, where perceived surveillance and data security concerns can reduce participation despite financial incentives (e.g., Tabasi et al., 2024; Svaboe et al., 2025).

Also, the presence of fraudulent responses, highlights the need for stronger participant verification procedures in online surveys offering financial incentives. Future studies should consider incorporating additional safeguards at the recruitment stage, such as moderated recruitment, participant verification (e.g., phone/video confirmation), or follow-up validation with the participants (e.g., interviews in face-to-face settings) to further reduce the risk of automated or fraudulent participation.

A key area for further investigation is the diversity of e-rideable users and their travel purposes. Our collected evidence suggests the existence of two distinct user groups: those who use e-rideables primarily for commuting and those who use them for recreation, particularly on weekends. These groups differ not only in the frequency and regularity of their use, but also in their expectations, behaviours and infrastructure needs. Future research should aim to explore these distinctions in greater depth, including how motivations, safety perceptions and usage contexts shape travel decisions. Understanding these differences will enable more targeted policy responses, infrastructure planning and educational campaigns.

It is also important to investigate the factors influencing adoption and non-adoption, particularly among groups underrepresented in current datasets. This includes examining barriers related to cost, infrastructure availability, safety concerns, regulatory uncertainty and perceptions of risk. Longitudinal and mixed-method studies could offer valuable insights into how attitudes and behaviours evolve over time as technology, regulation, and infrastructure change.

Investigation of multi-modal use of e-rideables and PT, together with the use of e-rideables as mode substitution for private vehicle, should be furthered, not only to cater for riders who travel in this manner, but the effects this will have on the PT and road networks, as well as their users. Utilising the tracks gathered by the app developed for this project, interactions with the road network and with PT hubs could be inferred through the use of spatial analysis. This could help target interventions to areas of high utilisation for these purposes by e-rideables, for the benefit of those who ride and those who do not. This could also be augmented through analysis of the inferred and stated (confirmed) mode and purpose tags within the Perth ERES app. We agree that the current sample size and its composition limit the extent to which the existing dataset could support detailed GIS-based route analysis. However, a GIS-enabled application such as the Perth ERES, combined with validated participation (e.g., moderated recruitment or participant verification to encourage uptake and limit fraudulent participation) would therefore provide a more robust basis for collecting route-level information and analysing how e-rideables interact with transport networks and public transport hubs.

Further research should also focus on the integration of e-rideables into the broader transport ecosystem, including their interaction with PT and land use. Understanding how users combine e-rideables with other modes and how infrastructure and policy can support seamless multimodal journeys will be critical for planning future mobility systems. Finally, impact-focused research on safety outcomes, environmental benefits and public health implications will be essential to build the evidence base needed for effective policy and investment decisions.

7.3. Final words

In summary, the evidence points to a clear trajectory that e-rideables are not a passing trend, but a significant element of future urban transport systems. Realising their full potential requires a coordinated, multi-disciplinary approach, combining updated legislation, targeted infrastructure, education, enforcement, integration with public transport and continued research. Done well, these measures can enhance safety, support behavioural change and enable e-rideables to contribute meaningfully to more sustainable, connected and people-centred cities in Western Australia. Perth and WA are well-positioned to be at the forefront of these emerging mobility transformations, supported by the active engagement of government agencies, industry organisations, community groups and the wider public. Future DTMI initiatives should pilot integrated data collection and infrastructure audits to monitor e-rideable uptake.

On the 4th of December, 2025, the Community Development and Justice Standing Committee reported on its inquiry [6] to the Legislative Assembly of Western Australia. Findings and recommendations centred around improving governance, mandating greater data collection on device use, addressing safety issues through e-rideable vehicle design and accessory requirements, trauma counselling, improvement of infrastructure, nationally harmonised standards, consultation on usage, classification of devices and its impact on legal and insured usage, education and enforcement.

Specifically, this project contributes towards Recommendation 4 (in terms of capturing data on e-rideable usage) and Recommendation 10 (capturing data on trip origins, destinations, peak times, device and user profiles). The results from the research surveys support Recommendation 9 (to develop dedicated e-rideable infrastructure). It is noted by the research team that the Government of Western Australia accepted either fully or in-principle all but one of the recommendations of the inquiry[7] on the 10th of March, 2026.

[6] https://www.parliament.wa.gov.au/Parliament/commit.nsf/(Report+Lookup+by+Com+ID)/43493D47E62284BC48258D550030E903/$file/02328458.pdf
[7] https://www.wa.gov.au/government/media-statements/Cook%20Labor%20Government/WA-leads-national-push-for-stronger-eRideable-laws-20260310

Appendix A: Detailed Summaries of Literature

A1 Achieving Sustainability Impacts and Outcomes

A1.1 Integration of micromobility with the transport system

A number of systematic review studies focused on the integration of micromobility as part of the transport system to achieve a range of related outcomes including sustainable transport goals, enhanced PT accessibility, alleviation of congestion and reduced emissions. Five studies, by Oeschger et al. (2020), Sengul & Mostofi (2021), Abduljabbar et al. (2021), Zhang Cheng et al. (2023), and Zhang Yushan et al. (2023), emphasise the importance of integrating micromobility into urban planning frameworks to achieve sustainable transport goals. They highlight the need for well-designed infrastructure and policies that support the coexistence of various transport modes. Furthermore, each study identifies the significant potential of micromobility to reduce urban congestion and emissions, aligning with broader sustainability objectives.

Oeschger et al. (2020) used a systematic review of existing literature and case studies to evaluate the effectiveness of various micromobility solutions in enhancing PT accessibility. The review covered 48 papers, combining studies on shared micro-vehicles and studies that focused on private micro-vehicles in combination with PT, thus focusing on the first-mile last-mile problem. The reviewed studies use various data sources, including big data from micromobility and PT providers, stated preference surveys, and spatial data analyses, and apply various methodologies ranging from regression models and GIS-based spatial analyses to qualitative methods like stakeholder interviews and focus groups. The findings suggest that micromobility could significantly improve PT usage by bridging the gap between transit stations and final destinations, but this requires coordinated efforts between city planners, transport authorities, and micromobility providers. The paper contributes to theory by exploring the synergies between different modes of transport, and to policy by recommending integrated planning approaches that combine micromobility with PT.

Sengul & Mostofi (2021) synthesised data from 29 studies to evaluate the environmental, social, and economic effects of e-rideables (including e-scooters and e-bikes). The findings suggest that e-rideables offer significant potential for reducing GHG emissions and alleviating congestion, yet, their widespread adoption is hindered by safety concerns, lack of infrastructure, and regulatory challenges. According to the authors, micromobility can be used for all trips with different travel purposes shorter than 8 km, which represents 50 to 60% of total trips in China, Europe and the US. Yet the review shows a wide range of trip distances and purposes, for e-scooters mostly up to 2km and many being used for recreational purposes. These results are primarily due to the prevalence of studies on rented/shared e-scooters. The authors highlight the benefits of riding in the open air, having a sense of freedom, being in control of the device, and having flexibility to plan the trips, however, it is unclear if there are differences between the personal use and use of shared devices. Another concerning aspect is the 'displaced' mode of transport. It is shown that at least 25% of trips replace walking, while the main benefit would be to replace car trips. About safety, Sengul & Mostofi (2021) concluded that issues mostly result from confusion about the right-of-way, negligent parking, and lack of compliance with the use of helmet. Inconsistent regulations in terms of speed and where the devices are allowed have become priority in many jurisdictions (Europe, US, Canada, Japan).

A1.2 Interaction between micromobility and the built environment

Abduljabbar et al. (2021) analysed 328 journal publications to explore micromobility through the lens of sustainable urban development, emphasising the integration of micromobility into existing transport networks and its potential to enhance urban sustainability. Given the timespan they covered (2000-2020), most attention was paid to bikes and their (shared) use, parking and policies. Through citation analysis, they identified four clusters of publications: benefits of micromobility (efficiency, time savings, accessibility, reduced congestion, impact on physical activity and emissions), its determinants, technology and policies.

While Abduljabbar et al. (2021) focused primarily on the environmental benefits of micromobility and enhanced accessibility, Zhang Yushan et al. (2023) emphasised the bi-directional interaction between micromobility and the built environment. Without distinguishing between e-bikes and e-scooters or other e-rideables or their ownership (private or rented/shared) their findings suggest that infrastructure is crucial, yet it must be complemented by policies that encourage sustainable practices. Their identification of the node, link, and network levels of interaction between the built environment and micromobility, provides a nuanced understanding of the spatial implications of micromobility. Their review also noted positive impacts (e.g., increased accessibility to metro stations, potential for reducing urban sprawl) and negative consequences (e.g., conflicts in public space usage, need for electronic fencing) of (rented) e-rideables. Their review included 59 papers, with 48 describing micromobility in Europe, North America and Asia.

In their review of 87 papers, Zhang Cheng et al. (2023) focused on the challenges of space sharing between pedestrians and micromobility devices (by placing them into a “slow speed” road environment, which reduces riders’ safety risk posed by road vehicles), highlighting safety and behavioural issues. These are critical aspects, often overlooked in the broader discourse on micromobility. They found that many conflicts between pedestrians and riders are due to the insufficient (narrow width) share of road and pedestrian/cycling paths, and the low proportion of separated paths in areas with high traffic volumes. Their recommendations included: multi-source and real-time data, the use of diverse scenarios to examine vulnerable road users’ behaviour and interactions and examining parking issues and long-term impacts of micromobility.

A1.3 Measuring environmental impacts of shared micromobility

Recently, Calan et al. (2024) took a different approach by applying Life Cycle Assessment (LCA) to evaluate the environmental performance of shared micromobility vehicles, including e-scooters and e-bikes. The study critically examines the sustainability of these vehicles by considering their entire life cycle, from production to disposal. The findings from 20 reviewed studies reveal that while shared micromobility can reduce greenhouse gas (GHG) emissions in some cases, the environmental benefits are not as significant as previously assumed, especially when accounting for the full lifecycle of the vehicles (shared e-scooters have the highest GHG/pkm, but shared e-mopeds and shared e-bikes tend to have lower GHG). The emissions for shared e-scooters and e-bikes are also increased because of losses due to theft or vandalism (approximately 20%). This paper fills a research gap by providing a comprehensive assessment of the environmental impacts of shared micromobility, highlighting the need for more sustainable vehicle designs and efficient operational practices.

A2 Need for Planning, Policy, Regulation and Design

Here we discuss 23 papers and a Master’s dissertation, focusing on the role of micromobility in achieving sustainable urban transport. They are mainly system-level studies, addressing the supply and use of e-rideables, their interactions and integration challenges with other modes (Kothawala et al., 2023). The main conclusion is that their success in supporting the transport function depends on careful planning, regulation, and design.

Bennett et al. (2021) explored the role of micromobility in urban transport, emphasising the safety and operational challenges that arise from the integration of shared micromobility vehicles, such as e-scooters, into existing transport systems. The study used empirical data from 24 semi-structured interviews (including disabled interviewees) to assess the risk factors associated with micromobility and provided recommendations for improving safety standards. The authors highlight the need for better infrastructure and regulatory frameworks to accommodate the growing use of micromobility vehicles and the risks associated with lack of compliance, addressing a significant research gap in understanding the safety implications of these emerging transport modes.

Using life cycle analysis, Hollingsworth et al. (2019) quantified the total environmental impacts of shared/rented e-scooters on global warming, acidification, eutrophication, and respiratory impacts and highlighted the prevalence of manufacturing and charging of e-scooters (transporting them to the charging stations) in the total emissions. The life of the scooter plays a substantial role in the emissions (it is preferred to be extended over two years), regardless, their impact is smaller when compared to car use. Still using LCA, but combined with self-reported modal changes, a study by Felipe-Falgas et al. (2022) focused on the environmental impact of different micromobility modes in Barcelona. The results revealed that while personal e-scooters significantly reduce GHG emissions, shared e-bikes and e-mopeds may increase emissions, depending on the modes they replace. This was echoed by Abouelela et al. (2023), also noting the reduced parking space of a scooter (0.3-0.6m^2 vs 20m^2 for cars). By integrating LCA with real-world data on modal shifts (a survey of 902 users of metro and rail before the introduction of bikes, e-bikes, e-scooters, and mopeds), Felipe-Falgas et al. (2022) offered a nuanced view of how different micromobility modes contribute to urban sustainability. Another important point made by the authors is that the LCA emissions per pkm may be higher for PM2.5 and NOx, but they are not contributing to exposure in urban areas. Consequently, strategic deployment (logistics and areas with low accessibility) and design improvements may be beneficial and maximise the environmental benefits of micromobility.

Ecer et al. (2023) provided a broader framework (Delphi, Logarithmic Percentage Change-Driven Objective Weighting, and Combined Compromise Solution methods with interval-valued fuzzy neutrosophic number (IVFNN) information), defined by the authors as a reconciliation tool to set criteria for assessing the sustainability of micromobility, considering social, economic, and environmental dimensions. Their multi-criteria decision-making approach to evaluate different micromobility options does not present the 69 chosen sub-criteria, nor the final 24 sub-criteria (Table 4), but identified that overall social criteria (0.621) is prevailing, with the economic and environmental criteria following, with much smaller relative importance values (0.253 and 0.127). The authors highlight the complexity of integrating micromobility into urban transport systems, emphasising the need for policies that balance environmental benefits with social equity and economic viability. They recommended the mini-electric vehicle, then the standing e-scooter, seated e-scooter, self-balancing e-board, e-bicycles, e-skates, and finally the non-self-balancing e-board as mobility solutions.

Gössling (2020) shifted the focus to the integration of micromobility with PT, exploring how shared e-scooters can complement existing urban transport systems in 10 major cities. The author applied content analysis of local media reports, before and after the introduction of micromobility. Despite the enthusiasm for their potential benefits, there are challenges associated with the use of e-rideables. The study identified key factors that influence the success of such integration, including infrastructure, pricing, and user behaviour. The findings suggest that while shared e-scooters have the potential to enhance PT systems, their impact is highly context-dependent and requires careful planning and regulation. Many cities have struggled with unforeseen outcomes such as forms of irresponsible riding, cluttering, or vandalism, which led to new rules and/or restrictions on their use. This paper contributes to the research field by offering insights into the synergies between micromobility and PT, emphasising again the need for integrated transport policies.

Gkartzonikas & Dimitriou (2023) examined the adoption of shared micromobility among university students, focusing on the factors that influence their decision to use these services. The study used a survey-based approach to gather data on students' attitudes and behaviours and an ordered probit model for intensity of use, revealing that convenience, cost, and environmental concerns are the primary drivers of micromobility adoption. The authors highlight the potential of micromobility to reduce car use among young adults, but also note the challenges related to safety and infrastructure. Their analysis suggested that a variety of variables affect the behavioural intention to use shared micromobility services: employment situation, household size, gender, travel patterns, level of awareness, and attitudinal variables in the form of perceptions on incentives and infrastructure, and they should be considered when planning new shared e-rideable programs.

Felix et al. (2023) assessed the safety and operational challenges associated with shared e-scooters in Lisbon, focusing on the conflicts between pedestrians and micromobility users in shared spaces. The study uses a survey with 919 responses and “use data” (1.4 million trips from a local operator) to analyse the interactions between different road users. The study showed that shared e-scooters can pose significant risks in densely populated urban areas and that the environmental benefits may be outweighed by the negative health impacts associated with a high number of crashes and injuries, thus raising questions about their contribution to more sustainable transport. The authors call for more stringent safety regulations and infrastructure improvements to mitigate these risks, addressing a critical gap in the literature on the safety implications of shared micromobility.

Still in Europe, Guan et al. (2024) reported on the experiences in three cities: Utrecht, Malmo, and Grand Manchester, which differ in terms of transport infrastructure and shared micromobility services implemented. They estimated 24 distinct models (OLS regressions and binary logistic regressions) on the perceived adequacy of the services and their use. They found that current shared micromobility services in European cities do not fully address the challenges of transport equity. Residents in low-density and marginalised areas seem to experience a lower chance of benefiting from shared e-rideables, which played a limited role in improving perceived accessibility and travel affordability: for example, in Manchester, the shared e-bikes are frequently used by individuals with increased perceived mobility levels only and by the high-income group. Nonetheless, shared e-scooters/e-mopeds showed a greater potential in facilitating transport equity than shared bikes/e-bikes.

Nigro et al. (2022) focused on the potential demand for electric micromobility in Rome, Italy, using Floating Car Data (FCD) to assess which trips could be shifted from private cars to e-scooters or e-bikes. They analysed trip characteristics and infrastructure compatibility to determine the feasibility of the modal shift. The findings revealed a significant potential for reducing car use (between 10.2 and 14.1% for e-scooters on weekdays), particularly for short trips, though this potential is heavily dependent on the availability of suitable infrastructure. The paper’s contribution lies in its innovative use of FCD to predict micromobility demand, while its practical implications underscore the need for targeted infrastructure improvements to support the growth of e-micromobility in urban areas.

Yet, the views on e-rideables and their impacts are not shared in all cities. Mitra and Hess (2021) investigated the potential market for shared e-scooters in Ontario, Canada. Data collected online in June and September 2019 from 1,640 residents living in 17 neighbourhoods was used to analyse the willingness to consider using shared e-scooters on a pay-per-use basis. Mitra and Hess (2021) found only 21% of residents would consider e-scooters, with no significant difference between urban and suburban residents. While in urban neighbourhoods, shared e-scooters would likely replace transit trips and walking, in suburban communities, shared e-scooters can potentially substitute short car trips and provide the first-mile last-mile solution to PT ridership. The weighted logistic regression showed that those who valued efficient, environmentally friendly, and cost-effective transport were more likely to consider e-scooters, with no significant socio-demographic effects. Given that perceived street safety was positively associated with shared e-scooter systems, policies should consider the attitudinal profiles of potential users, focusing on areas with a strong culture of active transport and adequate infrastructure.

Recently, Saha et al. (2024) used a Fermatean fuzzy set combined with a MULTIMOORA decision-making model (integrating a Delphi technique) to assess the importance of seven criteria for selection of e-scooters: price and maintenance cost, length and weight, battery capacity, speed, charging time. Their results highlight that despite the focus on sustainability, cost considerations still dominate decision-making processes for e-scooters. There is also a need to consider operational and technical features to ensure the long-term sustainability of e-scooter systems.

Although the proposed model is robust and applicable, the study acknowledges that the approach could be further enhanced by incorporating more diverse data sources and exploring more criteria impacting e-scooter selection.

A paper from Deloitte (Zarif et al., 2019) discusses the evolution and potential of micromobility to disrupt urban transport systems. The authors use a combination of market analysis and case studies to examine the economic and operational viability of micromobility solutions like e-scooters and shared bikes. They define micromobility as a *"form of transport that can occupy space alongside bicycles"* (p.2). They highlight that while micromobility can significantly reduce reliance on private cars and enhance first-mile last-mile connectivity, its success depends on overcoming challenges related to infrastructure, regulation, and integration with PT. For the rented model, vandalism and theft are the main issues, and retrieving, charging, and balancing the fleet overnight has been a costly and labour-intensive exercise, which increases GHG emissions, an aspect noted in many papers addressing environmental aspects. Compliance with helmet use and speeds has also been problematic, which increased the number of injuries and led to many trials being ceased (e.g., Paris, Melbourne). The document highlights the need for adaptive regulation and public-private partnerships to foster the growth of micromobility services, aspect also raised by Minorgan (2022) in his literature review (Chp.2). Community concerns were also raised in Portland in 2018, but the PBOT response in 2019 accounted for the feedback, implementing geofencing, dedicated parking areas, seated e-scooters, offering education programs, monitoring compliance and applying penalties. The report provides statistics of use (trip duration, distance, main O-D relations), but also environmental and health impacts (e.g., over 415k car miles replaced or 2.5 injuries per 10,000 trips).

Wang et al. (2023) investigated whether e-scooters displace PT or car trips in urban areas. The authors used a review of survey data and statistical analysis to examine the modal shift patterns associated with e-scooter use. Their findings indicate that e-scooters are more likely to replace walking (30 to 60% of the trips) and cycling trips (much lower rates) rather than car or PT trips (commonly 3-18% and where PT is more common, e.g., in Europe, up to 30-34%), raising concerns about their overall contribution to sustainable urban mobility (ibid, Table 3). As an aside, short trips, about 10 min and not exceeding 30 min were also found by Latinopoulos et al. (2021) in France. Sandt et al. (2022) however, found a % higher of scooter trips that can replace car trips (33 to 49%), more optimistic than Wang et al. (2023).

In terms of infrastructure used, most e-scooter riders use shared paths, although in other cases, they prefer the sidewalk (Fitt & Curl, 2019). Wang et al. (2023) challenged the assumption that e-scooters inherently promote sustainable transport and the evaluation of policies by suggesting that e-scooter deployment strategies should be carefully managed to avoid negative impacts on more sustainable modes of transport. Although e-scooters have a smaller physical footprint than cars and bicycles (as they need very little space for storage and parking, allowing them to function as an efficient transport service in the public right-of-way), their integration requires careful planning and promotion to become efficient and safe (access and egress) modes.

The environmental impact of micromobility depends on the ownership model. Reck et al. (2022) alerted to the fact that while personal e-scooters and e-bikes have a net positive effect in GHG terms, shared devices emit more than the modes they replaced, primarily because of their reduced lifetime and substitution patterns (short-distance PT and walking trips). Their research is based on a large dataset collected in Zurich, involving GPS tracking (using MyWay app), booking data, and survey responses from 540 participants over three months. The data included 65,716 trips and covered eight transport modes: shared or personal e-scooters and e-bikes, along with PT, cars, bikes, and walking. Most of these trips were by PT, closely followed by car and walking, with trips by e-bike and e-scooter representing only 4.4%. A mixed logit model was used to estimate mode choice, considering factors including trip distance, precipitation, access distance, and user characteristics and preferences. The paper highlighted the importance of distinguishing between shared and personal modes when evaluating their environmental benefits. The authors recommended that cities prioritise the use of personal micromobility modes and introduce more efficient shared services that minimise operational emissions.

Hosseinzadeh et al. (2021) investigated factors influencing the spatial distribution of shared e-scooter trips in Louisville, US, using Geographically Weighted Regression (GWR), based on trip data from over 400,000 e-scooter trips across 159 Traffic Analysis Zones (TAZs), collected between Aug 2018 and Nov 2019. Age distribution, gender, land use, and walk score were included in the final GWR model, accounting for spatial heterogeneity, producing location-specific coefficients and identifying localised influences on e-scooter trip density, offering guidance for improving e-scooter service deployment and urban mobility: males, younger people aged 18-29, students are more likely to use shared e-scooters; commercial land use and public/semi-public spaces (such as universities) significantly influence e-scooter usage; walk and park score showed strong positive relationships with e-scooter trip density, reinforcing the importance of walkability in promoting micromobility and the use of e-scooters for recreational trips. However, their analysis has not captured the temporal dynamics of e-scooter trips or the influence of external variables, such as e-scooter distribution patterns or socioeconomic factors beyond demographics.

Using the same context and data, Ziedan et al. (2021) examined the impact of e-scooters on bus ridership by applying fixed effects regression techniques and comparing trip data before and after the introduction of shared e-scooters in 2018-2019. The authors found that e-scooters have a mixed impact on bus ridership, with some displacement of short bus trips, but also an increase in overall mobility for certain demographics. The minimal effect on bus ridership is due to the distinct purposes of transit and shared e-scooters, as well as the longer distance of the transit trips (4.2 miles, compared to 1.2 miles for e-scooters). This further reinforces results elsewhere that e-scooters have a place as first-mile last-mile connectors. The authors recommended strategies to better integrate e-scooters with existing PT networks: e.g., MaaS and analysis of catchment areas.

A study specifically dedicated to the use of infrastructure and route choice was reported by Zhang et al. (2021) on a trial at Virginia Tech Blacksburg Campus in Sep-Oct 2019. The study used GPS observations of 76,652 e-scooter trips using Spin e-scooters (Ford subsidiary mobility provider). The study included an in-app survey at the end of each ride inviting riders to contribute their data for research purposes. Unsurprisingly, their recursive logit models showed that e-scooter riders tend to favour pathways shared with bikes and multi-use paths (but not pedestrian-exclusive ways), as well as local road segments on campus, given their reduced speed. They also prefer simpler routes, with fewer left turns, avoiding U-turns and winding routes, consistent with existing bicycle route choice model results. Similar findings on GPS data in Austin, Texas were provided by Zuniga-Garcia et al. (2021), with most trips under 0.25 miles being on bike lanes and sidewalks, and longer trips on the roadways. They emphasised the importance of geolocation information accuracy, with the width of 3.6m (as opposed to 1.5m) for these pathways reducing the % of unclassified infrastructure for trips by 15% (compared to 45% for 1.5m lanes). The authors also found significant differences between speeds during different times of the day and days of the week. Riders tended to ride faster during weekdays and AM peak, with the bike lanes presenting the highest e-scooter speeds, followed by roads and then pedestrian paths. They followed up on this research, modelling the use of e-scooters as a last-mile solution (Zuniga-Garcia et al., 2022), using a survey of users of e-scooters at the university. They applied a two-stage regression procedure to isolate the effects of confounding variables on transit trips. The first stage aimed to isolate confounding variables using a gradient-boosting regression to account for factors like location, weather, and time of day. The second stage applied a negative binomial (NB) or zero-inflated NB model to measure the relationship between e-scooter trip origins and transit alighting locations. The survey indicated that 12% of the e-scooter riders used transit to complement their trips. Although small in magnitude, the data modelling results show a statistically significant relationship between the university campus and Austin's downtown area, supporting the survey results and extending the analysis to other areas of the city.

A3 Preferences and Adoption

In the area of perceived performance and satisfaction, there are several papers, using various methods, from technology adoption (e.g., Chahine et al., 2024) to stated preferences and stated choice experiments (Cao et al., 2021; Jaber et al., 2023; Hensher et al., 2024). They belong to the group of consumer-level studies, as described by Kothawala et al. (2023).

Using a study in Singapore, Cao et al. (2021) investigated the potential for e-scooter sharing to replace short-distance PT trips, particularly in situations where the transit system (MRT) involves excessive indirectness, multiple transfers, and long walking distances. The research employed a stated preference survey and a mixed logit model to assess user choices between e-scooters and PT and estimated how many short-distance trips could shift to e-scooters under various conditions. The data collection relied on a survey distributed to 758 Neuron e-scooter users, complemented by trip data provided by the e-scooter company. The mixed logit models incorporated variables such as transit fares, the number of transfers, walking distances, and travel times. One significant finding was that male, young, and high-income individuals exhibited more diverse preferences for e-scooters over transit compared to other demographic groups. Fare, walking distance, and the number of transfers were found to have significantly negative impacts on the utility of using transit (especially the ‘excessive indirectness’), making e-scooters a more attractive option for short-distance trips under these conditions.

The study found that up to 23.7% of MRT trips longer than 3.5 km could be replaced by e-scooters, particularly in high-density areas with a higher number of transfers and indirect transit routes. However, the authors also highlighted the trade-off for e-scooter companies between maximising ridership and revenue (considering five stages of e-scooter services A1-A5, based on fare adjustments). Their analysis suggests that pricing strategies need careful consideration to strike a balance between these two objectives. The study makes a notable contribution to the field by quantifying the specific scenarios where e-scooters could replace short-distance transit trips and by analysing the trade-offs that operators face in optimising their services. It emphasised the importance of targeted deployment of e-scooter infrastructure in areas underserved by PT and highlighted the role of pricing strategies in achieving broader urban mobility goals.

Abouelela et al. (2023) examined shared e-scooter usage patterns across five North American cities – Austin, TX, Chicago, IL, Louisville, KY, and Minneapolis, MN (USA), and Calgary, AB (Canada), using a comprehensive dataset of approximately nine million scooter trips from publicly available data sources. Citing Santacreu et al. (2020), the study included a distinct definition of micromobility, as vehicles lighter than 350kg with a max speed of 45km/h. Consequently, this class of vehicles includes much more than e-bikes and e-scooters, which IFT (2024) labels as Type C and D of micromobility. However, the other use features of e-mobility are common to other studies: trip distance of about 1 mile (10% of the daily trips in USA), energy consumption (1 kWh/100km). The datasets for the cities included trip duration, speed, and distance, along with temporal and spatial data like start and end times, and the associated land-use at census tract level. Additional external datasets including meteorological data, infrastructure details (bike lanes, sidewalks), sociodemographic information (age, gender, income), and PT accessibility (measured through the Local Index of Transit Availability, LITA) were fused as part of data augmentation. The authors employed a zero-inflated negative binomial (ZINB) regression model to account for the excess zeros in low-demand areas and identify the factors that influence scooter demand (number of daily trips per census tract).

The analysis revealed consistent spatiotemporal patterns across the five cities. Key findings include:

- daily and seasonal variability with two peaks during weekdays (AM and PM), suggesting potential commuting use, and demand concentrated in the afternoons during weekends, aligning with leisure trips. Special events (e.g., SXSW festival) significantly boosted scooter usage, and inclement weather reduced it.

- from the spatial viewpoint, weekday demand was higher around educational institutions and commercial areas, while weekend trips were concentrated in downtown regions and areas with POIs such as restaurants and parks.
- the average scooter trip distance was approx. 1.7km, and trip speeds were higher during early morning when traffic was lighter. Pilot periods saw longer trips with higher speeds compared to later stages of regular use.
- transit accessibility, infrastructure (e.g., bike lanes), and socio-demographics (e.g., younger populations) were positively correlated with higher demand.

The results seem to apply widely and have been confirmed in Perth, 2024 as well. They support the integration of shared e-scooters as part of the first-mile last-mile PT solution, offering valuable policy insights for urban planning.

It is worth pointing out that most studies, presented before, rely on data for shared e-rideables, with a minority examining the use of privately-owned devices. Kothawala et al. (2023) is one of these exceptions. They used data collected through an online survey of e-scooter users in Washington, DC, administered during COVID, between Sep 2021 and Dec 2022 and compared the use patterns and purpose of shared and privately owned e-scooters. The authors advocate for jointly analysing the overall suite of purposes for which an e-scooter is used (as opposed to the purpose of a single trip) and frequency, incorporating motivations in the analysis. Their argument is that individuals with strong intrinsic inclinations towards environmental consciousness may not only choose e-scooters frequently, but also specifically for making routine transit connections. Similarly, those who intrinsically have a positive perception of e-scooters may not only have a high frequency of use but also tend to use them specifically for time-constrained pursuits. *"If such significant jointness exists between use frequency and use purpose, and use purpose is treated as an exogenous variable to predict use frequency, it would incorrectly overestimate transit connections and social/tourism as important drivers of e-scooter use."* (p.2).

Consequently, Kothawala et al. (2023) applied a Generalised Heterogeneous Data Model (GHDM) to jointly assess e-scooter use frequency and purposes. The sample consists of 904 respondents, including 87 who own personal e-scooters. Respondents provided data on their e-scooter usage frequency (categorised as infrequent, monthly, or weekly) and the purposes for their trips (leisure, shopping, work, or transit connections). Three latent psycho-social constructs were integrated into the model: Green Lifestyle Propensity (GLP); Variety-Seeking Lifestyle Propensity (VSLP); Positive Perception of E-Scooters (PPS), capturing favourable views on the convenience and fun of e-scooters. Unfortunately, the reliability of the VSLP construct was limited (followed by PPS), which may explain the fitness of the model and the lack of significance of some associations. The study found that younger men, from lower-income households, and with limited access to private vehicles, are frequent users (for utilitarian trips), as well as those with higher green lifestyle propensity and positive perception of e-scooters. Conversely, higher income and vehicle availability were negatively associated with e-scooter use frequency. E-scooter trips for leisure were most common among high-income users, particularly those with easy access to cars and higher VSLP. Women were less likely to use e-scooters frequently, particularly for utilitarian trips such as commuting or transit connections. Safety concerns were highlighted as a potential factor for this discrepancy. The study also found that use frequency correlates with the likelihood of using e-scooters for routine purposes like commuting and shopping and that use frequency influences trip purposes, particularly for routine trips, suggesting that increasing use frequency leads to wider adoption of e-scooters for daily travel. These results highlight the need for improving safety infrastructure and addressing perceptions of e-scooter safety, particularly among women. Policies targeting routine use (such as for work or PT connections) can thus further promote e-scooter adoption. Improving access and safety and integrating e-rideables with PT can help expand their role in urban mobility. Additionally, public education campaigns about safe e-scooter riding could increase adoption, particularly among demographic groups currently underrepresented among frequent users.

Still in the USA, Chahine et al. (2024) examined perceptions/attitudes of individuals towards shared micromobility usage patterns following the COVID-19 pandemic in three US cities (Chicago, Minneapolis, and Indianapolis), with 1,534 responses. They applied a multigroup structural equation modelling (SEM, Figure 2) approach based on the Theory of Planned Behaviour (TPB). The study found that while attitudes towards micromobility, perceived behavioural control, and subjective norms positively influenced intentions to adopt shared micromobility services, there were differences across cities:

- Subjective norms and attitudes (similar across cities) had the largest impact on intentions, suggesting that promotion and image are key. Perceived behavioural control increased users' sense of control over the service, thus enhancing accessibility and infrastructure, as well as educational programs, could boost ridership, especially in Indianapolis and Chicago.
- COVID-19 risk perception showed a unique trend, with a positive effect on intentions in Chicago, likely reflecting shifts towards more active, open-air active transport modes during the pandemic.
- Safety concerns remained a significant barrier to adoption, with users expressing hesitations due to road conditions and general safety during micromobility trips.
- Demographic factors did not have a significant impact on intentions to adopt micromobility, nor the attitudes towards sharing, environment, and technology.

Overall, the findings suggest that e-rideables will play a more substantial role in post-pandemic urban mobility, and this implies that city planners should invest in expanding cycling infrastructure, particularly dedicated bike lanes, and regulate shared micromobility operators to ensure safety and equitable access. This was also identified in Europe, by Filipe Teixera et al. (2023), who compared residents from five capital cities (Budapest, Lisbon, Rome, Vilnius, and Warsaw) in their reasons for not using e-mobility services (bikes and e-scooters): convenience, safety, infrastructure, and personal preferences. The main reported barrier was the lower convenience of micromobility compared to other modes of transport. The lack of a bike network was found to be more important for bike non-users, while traffic safety concerns were perceived as a more important barrier for e-scooter non-users. Distance to the destination was considered a minor barrier. The main message was that the barriers to adopting shared micromobility are external, rather than rooted in individual preferences, which indicates that increasing the adoption of micromobility relies heavily on urban planning and policy interventions. Unfortunately, the study relied on limited data: 657 respondents, of whom 487 had never used bike sharing and 579 had never used e-scooters. Notably, the preference for free-floating parking was an important consideration for users of e-rideables in Budapest (Jaber et al., 2023).

Moving to the Turkish market, Çalli and Çalli (2024) revealed what constitutes a customer value proposition for shared e-scooter services, based on emerging topics from user reviews extracted from the Google Play Store. They applied the Latent Dirichlet Allocation (LDA) algorithm to uncover eight topics that inform customer value propositions; this is a novel contribution within the domain. With nearly 25,000 reviews, the sample size is considerable, making the findings more robust and generalisable, particularly in the Turkish context, underrepresented in the literature. The analysis found that 'Funny, Easy, and Practical' (positive user experiences) was the strongest feature (0.186), followed by 'Short-distance users and discount requests' (0.063), and 'Payment challenges and card transaction difficulties' (0.053). Pricing concerns, parking dilemmas, and routine maintenance issues and technical complications displayed similar importance factors (0.033-0.045), much higher than service inadequacy or battery insufficiency (0.021). The study confirmed the importance of emotional values for user experiences and offered recommendations, especially in the realm of infrastructure and service improvement. The authors identified key user concerns, including service coverage, pricing, parking, and vehicle maintenance, which can inform better policy and operational decisions, and reiterated the need for understanding behavioural motivations for use of e-rideables.

This was echoed in Australia by Hensher et al. (2024), who investigated the potential future role of e-rideables in urban transport, emphasising their impact on first-mile last-mile connectivity and complete journey options. The study employed both revealed preference (RP) and SP surveys to capture current and potential future travel behaviours. The RP component collected data on trip frequencies, travel modes, and travel patterns over a typical week, to serve as a baseline for understanding existing travel behaviour. Then, the SP component presented 2,268 different trip scenarios covering nine main transport modes, such as walking, cycling, and electric vehicles, together with various access/egress modes and infrastructure conditions. Respondents were asked to indicate their likelihood of adopting these modal combinations for different trip purposes. The authors employed negative binomial (NB) models, well-suited for count data, also accounting for overdispersion (capturing the variability in users' trip frequencies and preferences). They found that:

- walking trips (either standalone journeys or in combination with car travel) have the highest probability of being chosen for short, medium, and long trips.
- micromobility options (including e-bikes) ranked lower, when they represented the main mode for longer trips, but did gain traction when used for shorter trips or as access/egress modes combined with PT.
- deterrents to wider adoption of micromobility include concerns about traffic volume, infrastructure (such as cycle paths and shared roads), steepness of roads, particularly for older individuals and those less experienced with cycling or e-scooters.
- WFH and hybrid work models have influenced travel behaviours, leading to fewer commutes and an increased emphasis on local trips and active travel options for shorter distances.
- there are gender and age differences, with women more likely to adopt PT and active travel modes, while older individuals are less inclined to use micromobility or active travel options compared to younger respondents.

Overall, the findings of the RP and SP analyses suggest a growing interest in integrating active and micromobility options into urban transport, but this interest is conditional on improving the supporting infrastructure. The approach adopted aligns with Oeschger et al. (2020) who emphasised the importance of developing systematic studies on active travel in the overall transport system. For policymakers, the study emphasises the importance of developing cycle paths, pedestrian-friendly roads, and shared infrastructure to make active modes safer and more attractive. Additionally, the study highlights the need for targeted initiatives to encourage older populations and women to adopt these modes, which could include subsidies for e-bikes, improved cycle safety, or tailored PT solutions.

An interesting perspective on the use of micromobility was provided by Guan et al. (2024), who show a positive association between travel satisfaction and further use of micromobility in Malmo, Manchester, and Utrecht during 2022. The sample consisted of 1,596 users and non-users of shared micromobility services. For users of shared micromobility, travel satisfaction was measured in terms of how using the services impacted their overall travel satisfaction. For non-users, general satisfaction with daily travel was recorded. The findings suggest that improving the travel experience, thus satisfaction, could significantly increase user loyalty and adoption rates. As previously indicated, the study also points to important policy implications: enhancing the accessibility and satisfaction of shared micromobility services may encourage adoption, especially for first-mile and last-mile connectivity. However, more efforts are needed to target non-users who are least satisfied with their current travel options, especially those facing structural barriers such as distance or lack of skills to use mobility apps.

To identify, compare, and rank criteria applied when making decisions about the location of shared e-rideables stations, Jaber et al. (2024) used an Analytic Hierarchy Process with data from 35 professionals, academics and HDR students in Hungary. They found that proximity to PT, access to key destinations, and infrastructure prevail, before demographics, safety, and land-use.

A4 Safety

In the appraisal of the benefits of e-rideables, there is evidence of environmental and health benefits. Yet, they are heavily dependent on legislation and compliance with safety regulations.

Both ITF reports (Santacreu et al., 2020 and ITF, 2024) analysed safety trends and risks related to micromobility, particularly e-scooters and e-bikes, and provided recommendations for improving safety standards. As helmet use remains low, contributing to injury severity, especially in head-related incidents, this is a priority for enforcement. The report found that most e-scooter accidents are single-vehicle crashes, often resulting in minor injuries, with collisions with larger vehicles leading to more severe outcomes. E-scooter injuries frequently involve head, face, and neck trauma, with a significant portion of injuries occurring due to falls and loss of control.

The report emphasised the need for improved data collection on e-scooter usage and accidents, particularly for privately-owned devices, and suggested that the current risk is often underreported. In terms of infrastructure, separated bike lanes are found to significantly reduce crash risk, while poorly maintained road surfaces and the absence of dedicated micromobility lanes increase the likelihood of accidents. Powered micro-vehicles with a maximum speed of 45 km/h should be regulated as mopeds. They recommended: regular infrastructure maintenance, creation of dedicated micromobility networks, speed limit reductions (max speed control and lowering to 30km/h the speed in areas with high micromobility use), and stricter enforcement of risky behaviours (failure to wear helmet, alcohol-impaired riding, speeding). For operators, the report emphasised the importance of good maintenance, context-based speed controls, incentives for safe behaviours, and using telematics data to offer safety feedback to riders. The 2024 report also includes mobility training within the curriculum of secondary schools (p.9).

Besides grey literature, a large body of research highlighted the challenges of e-rideables adoption in relation to inconsistent or non-existent legislative actions. Latinopoulos et al. (2021), referring to the case of Paris, presents a good argument in this sense, adding specifically to their evaluation framework system impacts and policy and regulation, besides the typical user characteristics and spatio-temporal use patterns: *“Planning for the deployment of new e-scooter schemes or for regulatory changes in existing ones is a multidimensional problem. So far cities and operators have followed a trial-and-error approach, and we now observe an accelerated learning curve.”* (p.2). Their framework is broader than the more focused analyses found in previous studies, which often examined individual aspects like safety or demographics without integrating them into a cohesive policy toolkit. What also sets this paper apart is the use of multiple methodologies: online surveys (albeit a small sample of 102 respondents), stakeholder interviews, and microsimulation. Most prior studies relied primarily on survey data or spatial analysis alone. The inclusion of traffic microsimulation helps assess the impact of e-scooters on congestion, a less-explored aspect in previous literature. This methodological diversity allows for a more holistic evaluation of e-scooter systems. A key contribution of this study is its detailed analysis of regulatory approaches and the interaction between cities and operators. It reviews the code of conduct implemented in Paris, addressing common regulatory challenges, such as parking issues and rider safety and offering concrete recommendations for policy improvements:

- reinforcing the use of bike lanes when available, to reduce interactions with pedestrians on sidewalks and with motor vehicles on roads. In the absence of bike lanes, e-scooters should be restricted to roads with speed limits below 50 km/h to minimise the risk of collisions with faster-moving vehicles;
- expanding dedicated infrastructure for e-scooters, such as wider and more accessible bike lanes;

- enforcing speed limits for e-scooters and promoting helmet usage. In Paris, e-scooters are limited to a maximum speed of 20 km/h and helmets are not mandatory. Ensuring that these speed limits are enforced and that non-compliant riders are penalised could reduce accidents;
- mandating that e-scooters are equipped with front and rear lights and that riders wear reflective items at night, for visibility;
- enforce parking regulations in designated areas, as poorly parked e-scooters can create hazards for pedestrians, particularly those with disabilities;
- running public education campaigns focused on safe riding practices, proper parking, and respecting other road users. This would help foster a culture of responsible e-scooter use, which is essential for long-term safety improvements.

This was echoed in the work presented by Bretones et al. (2023), who conducted a scoping review of 67 studies to assess the determinants of electric micromobility (EMM) adoption, focusing, from a public health perspective, on e-bikes and e-scooters. They identified contextual enablers such as cost savings, improved accessibility, and reduced travel times, while barriers included inadequate infrastructure, weather conditions, and safety concerns. Individual motivations included travel time savings, avoiding congestion, thrill/fun/enjoyment, overcoming car-dependence or cost-savings. The paper emphasised that a nuanced understanding of both individual and contextual determinants is critical to promoting EMM as a sustainable and healthy transport option in European cities (where 65% of the studies were undertaken).

In terms of injuries, Trivedi et al. (2019) investigated the types, severity, and clinical outcomes of injuries related to e-scooter use based on emergency department (ED) visits over one year in Southern California. They provided an early glimpse into the public health impact of the rapidly growing use of e-scooters in the US. The study analysed 249 patients, of whom 91.6% were riders and 8.4% were pedestrians involved in accidents with e-scooters. They were of middle age (33.7 years), and 58.2% were male. Notably, 10.8% of patients were under 18, which was below the age requirement set by scooter companies. The most common injuries involved head trauma (40.2%), fractures (31.7%), and soft tissue injuries (27.7%). Despite a state law requiring helmet use, less than 5% of riders were documented as wearing helmets at the time of injury. A small subset (4.8%) of the patients was intoxicated, and some were in tandem riding (7.8%).

Most injuries (80.2%) were caused by falls, followed by collisions with objects (11.0%) and moving vehicles (8.8%). The majority of patients (94.0%) were discharged from the ED, with 6.0% requiring hospitalisation. Despite the detailed description, the study does not apply any multivariate technique, making difficult any inferential intent on the determinants of accidents (e.g., spatial or environmental factors that may influence injury rates, such as the availability of bike lanes or road conditions). Raubenheimer et al. (2023) also identified that most patients were male (80%) and only 43% had helmet. A third (35%) were intoxicated with either alcohol or drugs and 54% required surgery (WA).

The authors called attention that self-regulation by e-scooter companies may not be sufficient to prevent injuries, particularly among minors. Also, improved urban infrastructure is needed to accommodate e-scooters and enhance rider safety. Public health policies that enforce helmet use, regulate rider age, and limit intoxicated riding may reduce the incidence and severity of injuries associated with e-scooter use. These conclusions were later found by Sandt et al. (2022), which provided a more detailed analysis of safety challenges associated with e-scooter use and the various mitigation strategies currently employed by 20 cities across the US. Their work was particularly important given the rapid expansion of shared e-scooter programs and the lack of comprehensive data to guide policymakers on safety management practices.

Using a mixed-methods approach, Sandt et al. (2022) offered a detailed examination of the injuries. The web-based surveys targeting key stakeholders involved in e-scooter programs also allowed the authors to explore qualitative insights into how cities are handling safety issues. The report specifically excluded the bikeshare references, unless they were part of comparisons with e-scooters. A final number of 268 reports were included in the analysis.

The report alerted to the increase in injuries (in 2019 the incidence in USA was 9.22 per 100,000 population, much higher than before) and showed that inexperienced or distracted e-riders frequently suffer from injuries, head trauma and fractures being among the most common. Many of these accidents were linked to poor infrastructure, such as the lack of dedicated bike lanes or the presence of potholes and curbs, especially dangerous for e-scooter riders. In terms of demographics, men and younger people were the most frequent users, with females and older adults expressing more safety concerns, particularly regarding collisions with pedestrians or vehicles. One major issue identified was the improper use of sidewalks and parking, which increases the risk of accidents involving pedestrians and creates additional hazards, thus contributing to negative perceptions of micromobility.

Similar to previous sources, the report emphasised the need for enhanced safety regulations and better infrastructure planning to support e-scooter use. A unique feature of the report was its focus on stakeholder practices and gaps in safety management. By identifying where cities are succeeding or falling short in regulating e-scooter use, the report offered a roadmap for developing more effective policies, ensuring that e-scooter use complements other modes of transport rather than conflicts with them.

Some specific studies, at the individual level, examined reasons for using sidewalks, factors that can contribute to accidents and how they can be mitigated. Using observations at six sites (recording 738 e-scooter riders) and on-site surveys (129 responses) in two German cities in Aug-Sep 2020, Anke et al. (2023) found a preference for sidewalk riding, particularly when shared infrastructure is not available. The motivations might be related to comfort or convenience, comprising up to 40% of instances of sidewalk riding. The study, focusing on the safety of these devices, noted that a considerable number of incidents are accompanied (or even caused) by the rider's incorrect use of the road infrastructure or sidewalks. However, e-riders may hurt users on the sidewalk, which has increased the negative perception of e-scooters by vulnerable users (also reported by Mayer et al., 2020). Although a quarter of the users incorrectly believed that the use of sidewalks was legal, no significant association was found between the lack of knowledge and the use of pedestrian infrastructure. The results of the study support the need to invest in cycling infrastructure and a coherent network of facilities.

Azimian and Jiao (2022) aimed to identify the factors associated with e-scooter injury accidents using 2018 dockless e-scooter accident data in Austin, Texas. The study employed zero-inflated Poisson (ZIP) and zero-inflated negative binomial (ZINB) models to address the features of the data (excess of zeros). Key factors influencing accident rates included: demographics (e.g., the proportion of males aged 18-34), socioeconomic factors (median household income), and built environment features (land-use entropy, % sidewalks, proximity to restaurants and educational centres). The findings suggest that e-scooter accidents are more likely in dense urban areas with a high concentration of points of interest (POIs), while higher-income areas and those with better sidewalk infrastructure experience fewer accidents. The authors recommend enhancing infrastructure, such as expanding bike lanes and sidewalks, and implementing safety initiatives like a demerit point system for unsafe behaviours, coupled with educational campaigns on helmet use. The study underscored the importance of urban planning and regulatory interventions to reduce these risks.

There are similarities between the USA experience and the European cities. Bodansky et al. (2022) examined the musculoskeletal injury rate resulting from the use of e-scooters in Liverpool, following the launch of an e-scooter rideshare pilot scheme. Data were collected retrospectively from hospital records and compared to bicycle injuries in the same region. The authors calculated an orthopaedic injury rate of 26.1 per million km for e-scooters and 24.1 per million km for bicycles. Most injuries involved the upper limbs, with 15.7% of patients requiring surgery. Eighteen out of

39 injuries occurred on pavement and 16 on the road. The study concluded that while injury rates for e-scooters are comparable to bicycles, enhanced regulation and safety measures (e.g., helmet, no alcohol use) are necessary to mitigate injury risks. The conclusions are consistent with Zhang Cheng et al. (2023), who indicated that although most deaths and hospitalisations of e-riders resulted from collisions with motor vehicles, there are also serious injuries from collisions with pedestrians.

According to Stigson et al. (2021), most e-scooter accidents in Stockholm, Sweden (over 80%) involved single crashes, with no other vehicles involved. Accidents commonly occurred on weekends (54%) and at night (46%), with a higher proportion of head and face injuries occurring during night-time crashes. Helmet use was low, with only 13% of ED patients wearing helmets. The study also found a high incidence of injuries caused by hazardous surfaces (20-22% of accidents). Lacerations and contusions were the most frequent types of injuries (38%), followed by fractures (28%). Dental injuries were particularly prevalent in the insurance data, accounting for 18% of injuries, but were not reflected in the hospital data, which emphasises the value of combining multiple data sources to obtain a comprehensive view of accident-related injuries.

The paper called for improved infrastructure maintenance, particularly in urban areas, as surface conditions play a critical role in e-scooter accidents. Local authorities are urged to take greater responsibility for ensuring safer road conditions. The authors also recommended initiatives to increase helmet use. Furthermore, stricter regulations on e-scooter parking could prevent accidents involving pedestrians tripping over parked e-scooters, which accounted for 5% of the reported incidents. The robust analysis by leveraging two data sets, allowed for a more comprehensive understanding of e-scooter accidents. The comparison between insurance claims and emergency department data highlights important gaps in each source, such as the underrepresentation of dental injuries in hospital data. However, the study is limited by the reliance on retrospective data, which may not capture all incidents, particularly minor accidents that do not result in medical or insurance claims.

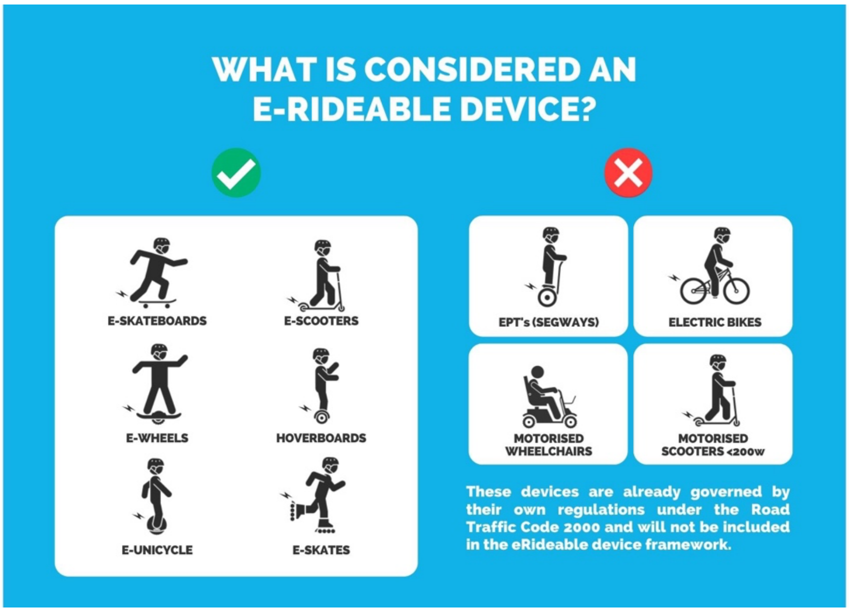
Appendix B – Survey Questions

Introduction

(text for field assistant or first page of online survey)

Hello! We're glad you're here. Thank you for agreeing to share with us how you use your e-rideable devices. If you're not sure what these are, please allow us to clarify (read on).

This survey aims to understand how WA people use some form of personal e-rideables during the week. E-rideables are defined according to the Western Australian Road Safety Commission classification and include e-scooters, e-skateboards, hoverboards, e-unicycle, e-wheels and e-skates (see below). They do not include e-bikes. This study is also not investigating temporary use of shared e-rideables (e.g., Beam, Neuron, Lime). Upon participation, you will receive a $10 Coles/Myer gift voucher. To ensure anonymity, the emails for incentive is kept separately from the responses to the survey.



Source: https://www.wa.gov.au/organisation/road-safety-commission/erideables

The study is concerned with understanding how these forms of transport are used in Perth, and the opinions and experiences of the users. Your participation in this research is voluntary. Failing to complete the questionnaire will be taken as withdrawal from the study. Withdrawing will carry no negative consequences. Any information collected before withdrawal will not be used in the study and will be deleted.

Your participation is completely anonymous. No personally identifiable information is collected. The data will be kept in a password-protected computer or a secure server for a minimum of seven years.

This research has received approval from the Human Research Ethics Committee at The University of Western Australia no 2024_ET000042, following its ethics review and approval procedures. Any person considering participation in this research project, or agreeing to participate, may raise any questions or issues with the researchers at any time. In addition, any person not satisfied with the response of researchers may raise ethics issues or concerns and may make any complaints about this research project by contacting the Human Ethics Office at the University of Western Australia on (08) 6488 3703 or by emailing hreo-research@uwa.edu.au.

For further information on this survey or any aspect of this study, please contact Doina Olaru at 08 6488 3908 or by email: doina.olaru@uwa.edu.au.

Consent

Are you over 16 years of age?

□ Yes □ No - Exit survey

Do you agree to participate in this study?

□ Yes □ No - Exit survey

Yes to both:

PLEASE CONTINUE TO THE SURVEY

Questions Intercept Survey (Apr-May)

Completed by field assistant, recording the time of intercept, location, type of rideable, providing a unique ID for completion of online survey (only after screening participants 16 or younger).

1. Where did you just come from today? Address/suburb/postcode.
2. Where are you going to next? Address/suburb/postcode
3. Why did you decide to travel by e-rideable today?
4. How often do you use e-rideables for your travel needs? (A few times a day, once a day, 4-5 times a week, 2-3 times a week, Once a week, Less than once a week)
5. What type of e-rideable do you [most often] use? (e-scooter, e-skate board, e-wheel, hoverboard, e-unicycle, e-skate)
6. How long have you been using this e-rideable? (Less than 6 months, 6 months to 1 year, 1 -2 years, more than 2 years)
7. At what times of the day do you typically use e-rideables? (before 6am, morning peak 6-9am, 9-12pm, 12-3pm, afternoon peak 3-6pm, 6-8pm, night after 8pm). Again, going to and from a destination will result in two trips, potentially in distinct time periods.

Thank you for your time. Please use this QR code to complete our short online survey (about 10 min).

Questions Online Survey (Apr-May)

Patterns of Use

8. Did you use your e-rideable today? Yes/No
9. Why did you decide to travel by e-rideable today?
10. How often do you use e-rideables for your travel needs? We are referring here to trips (i.e., Going to and from a destination is two trips.) (A few times a day, once a day, 4-5 times a week, 2-3 times a week, Once a week, Less than once a week)
11. What type of e-rideable do you [most often] use? (e-scooter, e-skate board, e-wheel, hoverboard, e-unicycle, e-skate)
12. How long have you been using this e-rideable? (Less than 6 months, 6 months to 1 year, 1 -2 years, more than 2 years)
13. What are the main reasons you use an e-rideable? (e.g., Commuting to work/school, Leisure, Running errands, Making a delivery, Other, please elaborate.) (grid of frequency and purpose)
14. What is the main reason that you started using e-rideables? (Avoid road traffic, Avoid crowded public transport, Save money, Environmental concerns, Get exercise, Fun, Other, please explain.)
15. Where do you most often travel on a typical journey with your e-rideable? (Road, Bike path, Footpath, Other, please explain. [.....])
16. What type of rideable? (e-scooter, e-skate board, e-wheel, hoverboard, e-unicycle, e-skate)
17. Trip 1 today: Origin and departure time; destination and arrival time;

    Trip 2 today: Origin and departure time; destination and arrival time;

    Trip 3 today: Origin and departure time; destination and arrival time;

18. How many kilometres do you think you travel (all trips added together, i.e. going to and from a destination is two trips) on your e-rideable in an average week? If you are not sure, please give your best estimate.
19. What other modes do you use for your daily travel and how often? (car, public transport, bicycle/ebike, walking)
20. What type of public transport do you most often use in combination with this e-rideable? (train, bus, ferry, other [……], I do not use this device with PT)
21. Has the use of e-rideables replaced any other mode of transport in your routine? If yes, which one(s)? (car, train, bus, ferry, bike, walking, other [……])
22. Has the use of e-rideables reduced your reliance on a privately owned car? Yes/No/Unsure

Perceptions and Preferences

23. Do you have any safety concerns while using e-rideables? (Yes, No). Please explain (Open answer).
24. How would you rate the safety of the roads, footpaths, bike paths, shared paths that you use for users of your device? Grid for all categories (Roads [very good, acceptable, poor], Footpaths [very good, acceptable, poor], Bike paths [very good, acceptable, poor])
25. Please indicate any negative events you have personally witnessed or experienced while using your e-rideable. (none, abuse, near miss, crash without injury, crash with injury, motorbike/dirt bike interaction, other […..])
26. In your view, what is the most frequent cause of these negative events? (lack of skill, going too fast, dangerous maneuvers, lack of courtesy, lack of awareness, aggression, other [……])
27. Do you prefer e-rideables over other modes of transport? If yes, why? Open answer.
28. Do you consider e-rideables as a more environmentally friendly mode of transport than car/Public Transport/Active Transport (walking & cycling)…? (Very friendly, Moderately friendly, Equally friendly as …, Less friendly than …, Much less friendly.)
29. How has the e-rideable changed your level of physical activity? (Substantially increased, Moderately increased, Increased a little bit, It did not change, It reduced my physical activity, It substantially reduced my physical activity)

Challenges and Improvements

28. What are the main challenges you face while using e-rideables (e.g., lack of dedicated lanes, confusion about road rules, lack of secure end of trip facilities)? Open answer.
29. What improvements would you like to see to better accommodate e-rideables? Open answer.

Socio-demographics

30. Which age group do you belong to? Please indicate the appropriate range: (16-18, 18-24, 25-34, 35-44, 45-54, 55-64, 65-74, 75+)
31. Gender: How do you identify? (Woman, Man, Non-binary, Prefer to self-describe [………])
32. What is the highest level of education you completed: (year 10 or less, year 12, vocational education, bachelor degree, postgraduate studies (Master, PhD))

33. What is your occupation? Please select from the list below: (using ABS list of occupations)
34. Do you own a vehicle? Yes - one/Yes – multiple/ No
35. How much do you know about the new e-rideable rules introduced in Dec 2021 and updated in 2023? (Well aware – I have read and understand the new rules, Moderate - I have heard about the new rules and I have some understanding of them, Low - I have heard about the new rules but I am unclear about them, I didn't know there were new rules.)
36. What is the postcode where you reside:
37. This concludes our survey and we thank you for your participation. We acknowledge that we may have not covered all relevant aspects to all users or population at large. Is there anything else you would like to add about e-rideables that might be of interest to the researchers? […..]

To receive your gift voucher, please include your email address. This information is kept separately from the survey data, to ensure anonymity.

THANK YOU FOR YOUR PARTICIPATION

Link: https://uwa.qualtrics.com/jfe/form/SV_82HUZxCqYKfj76u

Appendix C – Additional Insight Dashboard Output and Text Summary

Parliamentary_Inquiry_Sep25
Insight Dashboard

Total Context blocks: 4895, Concepts: 27, Categories: 3

This is an automated Report that can be generated using the settings in the Concept Location phase, as follows:

- Set the level of granularity (i.e. number of Concepts required)
- Select the 'Categories' of interest (e.g. Tags)
- Select which 'Concepts' to investigate

The Report is in 5 Sections - described below. The description is based on data that has been 'categorised' ('tagged') in the technology to analyse positive and negative sentiment; however the Report can be produced across any combination of Categories of Concepts.

Section 1 - Quadrant Overview

This is a high-level, visual chart displayed in a 'magic quadrant' format. The axes are:

- Relative Frequency: a measure of the conditional probability of the Concept, given the Category (in this case positive/negative sentiment)
  - e.g. given we are looking at occurrences of positive (or negative) sentiment, how likely is it that the Concept 'service' is mentioned

- Strength: a measure of the conditional probability of the Category (in this case positive/negative sentiment) given the particular Concept
  - e.g. given we are looking at occurrences of the Concept 'service', how often is it mentioned in a positive (or negative) sentiment, i.e. the 'strength' of the association

There are four pertinent areas to the Quadrant; the differing colours of the Concepts denoting their association with the particular Category.

Concepts in Quadrant 1 are weak and less prevalent or likely within the Category - a good place for any negative sentiment to manifest. Concepts in Quadrant 4 are strong, prominent and more likely to co-occur with the Category - a good place for positive sentiment to manifest [Given the Category in this description is based on positive/negative sentiment].

Section 2 - Ranked Concepts for Categories Overview

This is a more quantitative analysis in ranked barchart format of the most prominent Concepts within the particular Category - defined via a measure of the combination of their strength and frequency characteristics.

Prominence is given by joint probability / product of marginal probabilities. e.g. given the Attribute A and Category C, prominence is equal to (the co-occurrence count for A and C / total number of context blocks in data set) / (occurrence of A / number of context blocks) x (occurrence of C / number of context blocks)

It also contains hyperlinks to the appropriate reference in Section 4 of the Report - see below.

Section 3 - Ranked Compound Concepts for Categories Overview

This is similar to Section 2, providing a ranked list of the most prominent Concept pairs for the Category.

Section 4 - Supporting Text Overview

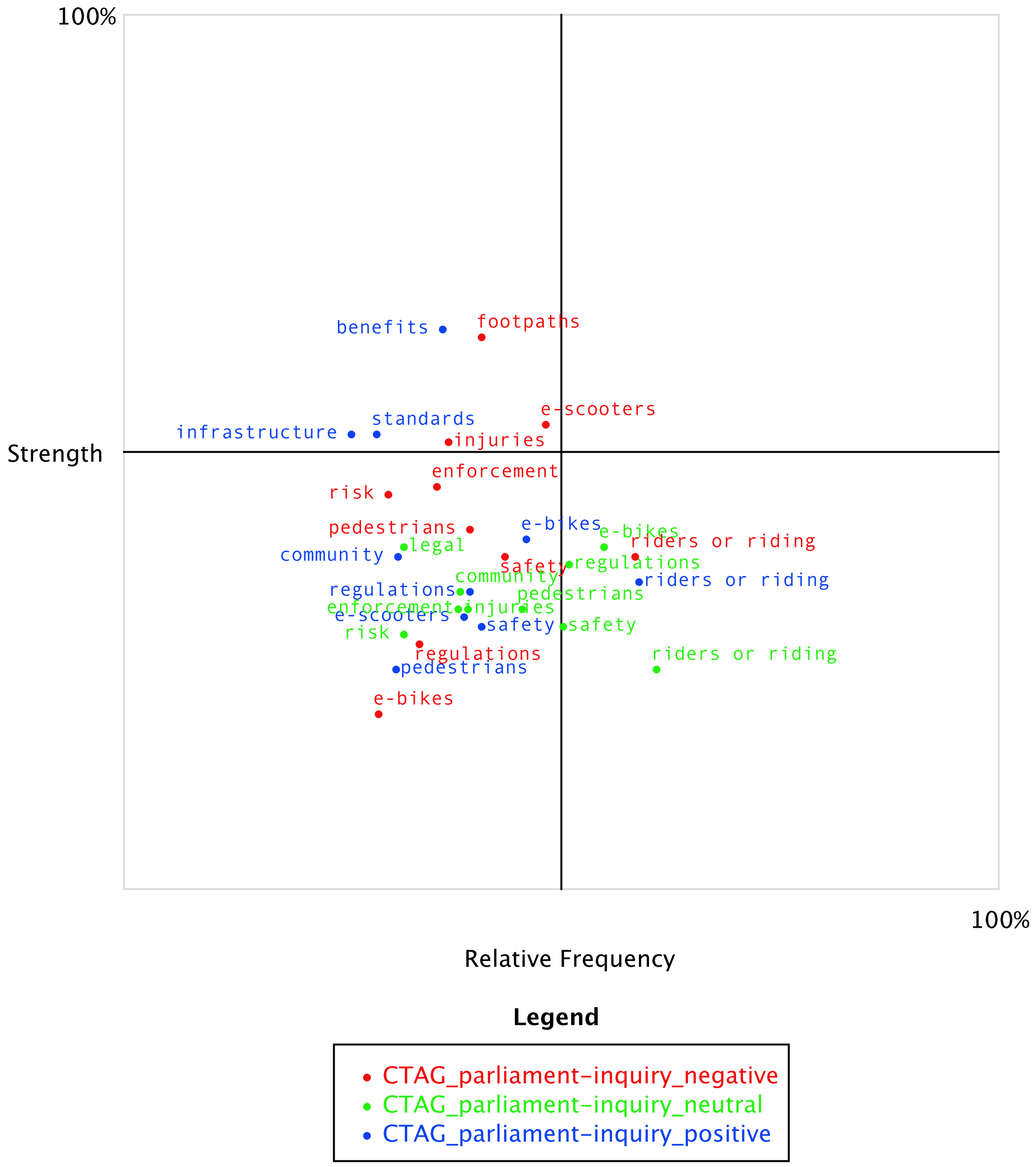
This provides a good supporting text excerpt, and real evidence, for the top related Concepts - for each of the Concepts identified and ranked in Section 2.

Section 5 - Ranked Concept Count

This provides the actual ranked list of ALL Concepts and their associated reference count from the original base data.

Table of Contents

1. Quadrant Report



2. Ranked Concepts for Categories

Category: CTAG_parliament-inquiry_negative

Concept	Rel Freq (%)	Strength (%)	Prominence
footpaths	7	63	1.6
e-scooters	9	53	1.4
injuries	6	51	1.3
enforcement	5	46	1.2
risk	4	45	1.2
pedestrians	6	41	1.0
riders or riding	15	38	1.0
safety	7	38	1.0
regulations	5	28	0.7
e-bikes	4	20	0.5

Category: CTAG_parliament-inquiry_neutral

Concept	Rel Freq (%)	Strength (%)	Prominence
e-bikes	13	39	1.7
legal	4	39	1.6
regulations	10	37	1.6
community	6	34	1.5
pedestrians	8	32	1.4
enforcement	6	32	1.4
injuries	6	32	1.4
safety	10	30	1.3
risk	4	29	1.2
riders or riding	17	25	1.1

Category: CTAG_parliament-inquiry_positive

Concept	Rel Freq (%)	Strength (%)	Prominence
benefits	5	64	1.8
standards	4	52	1.4
infrastructure	3	52	1.4
e-bikes	8	40	1.1
community	4	38	1.0
riders or riding	15	35	1.0
regulations	6	34	0.9
e-scooters	6	31	0.9
safety	7	30	0.8
pedestrians	4	25	0.7

3. Ranked Compound Concepts for Categories

Category: CTAG_parliament-inquiry_negative

Concept	Rel Freq (%)	Strength (%)	Prominence
footpaths & pedestrians	2	74	8.3
enforcement & police	< 1	63	7.3
footpaths & e-scooters	2	95	6.6
enforcement & compliance	< 1	58	6.5
footpaths & cyclists	< 1	69	6.4
injuries & risk	< 1	48	5.4
pedestrians & cyclists	< 1	31	5.3
footpaths & children	< 1	80	4.7
injuries & data	< 1	35	4.6
regulations & compliance	< 1	33	4.4
risk & safety	1	42	4.3
risk & community	< 1	69	4.0
footpaths & police	< 1	100	3.9
footpaths & hire	< 1	50	3.8
risk & battery	< 1	46	3.7
risk & illegal	< 1	46	3.6
footpaths & enforcement	< 1	76	3.6
e-scooters & riders or riding	4	74	3.5
footpaths & risk	< 1	67	3.5
risk & children	< 1	83	3.5

Category: CTAG_parliament-inquiry_neutral

Concept	Rel Freq (%)	Strength (%)	Prominence
legal & illegal	< 1	50	14.7
injuries & data	1	46	10.2
injuries & insurance	1	52	9.4

regulations & hire	1	62	8.6
e-bikes & cyclists	1	78	7.4
pedestrians & cyclists	< 1	26	7.4
regulations & compliance	1	33	7.3
community & infrastructure	< 1	50	7.3
e-bikes & standards	1	50	6.8
injuries & risk	1	36	6.8
enforcement & education	< 1	39	6.4
enforcement & police	< 1	32	6.1
legal & education	< 1	50	6.0
enforcement & infrastructure	< 1	54	5.8
safety & risk	2	33	5.6
enforcement & illegal	< 1	54	5.6
community & benefits	< 1	36	5.5
community & education	< 1	25	5.5
regulations & community	1	43	5.4
pedestrians & police	< 1	64	5.3

Category: CTAG_parliament-inquiry_positive

Concept	Rel Freq (%)	Strength (%)	Prominence
benefits & health	< 1	74	18.2
standards & battery	< 1	86	10.8
pedestrians & cyclists	1	43	8.0
standards & compliance	< 1	82	7.2
community & education	< 1	50	7.2
infrastructure & health	< 1	80	5.7
benefits & infrastructure	< 1	64	5.6
benefits & community	< 1	55	5.4
standards & regulations	< 1	73	5.1

regulations & compliance	< 1	33	4.8
infrastructure & education	< 1	42	4.5
e-bikes & legal	< 1	52	4.5
standards & e-bikes	< 1	50	4.5
infrastructure & community	< 1	44	4.2
standards & safety	< 1	50	4.1
benefits & e-scooters	< 1	94	4.0
standards & legal	< 1	63	4.0
regulations & safety	2	39	3.7
infrastructure & regulations	< 1	50	3.7
benefits & cyclists	< 1	67	3.5

4. Supporting Text Summary

Category: CTAG_parliament-inquiry_negative

Concept	Related Concept	Supporting Text
footpaths	children	Pedestrians at Risk: The footpath, once a sanctuary for children, the elderly,
	cyclists	I use footpaths daily when walking my dog, and walking is also an essential part of my exercise routine. It is very stressful and dangerous when e-scooters (and cyclists) zoom from behind without ringing a bell.
	e-scooters	Two come to mind: 1: An e-scooter being driven by a child approximately 10 or 11 years old came up from behind my husband, dog and I silently and very quickly on a footpath near our dog park, just as we were changing direction to enter the park. We avoided a collision by jumping out of the way quickly.
	enforcement	I would like to propose that e-scooters not be allowed on pedestrian footpaths. Speeding is not enforced and neither are helmets.
	hire	Most of the riders are doing something unlawful - no helmets, riding two up, speeding, looking at their phones, going against traffic on Karrinyup Road and one young girl was shorter than the hire e-scooter she rode. I now treat the footpath like a road and look both ways before entering from my driveway and I am continually scanning for vehicles on the road and footpath when I mow and trim the verge.
	pedestrians	They were close to the shop front because they were trying to avoid pedestrians on the footpath. A few seconds later, the little girl ran out from the door.
	police	The worst location is the 'dual-use' footpath from Scarborough to Trigg, where I have seen speeds around 60-80kph. No one including the council or police appear to be monitoring this location and its getting worse, not to mention E-scooters.
	risk	Never consistently Children and teens do not have the capacity to understand risk, or operate fast moving machinery on public roads and footpaths.
e-scooters	riders or riding	Figure 3: Tall man riding e-scooter
injuries	data	French study2 comparing injury data from 2019-2022 found eScooter related crashes resulted
	risk	Collaborate with academic institutions to review fatality/injury data and update risk frameworks accordingly.
enforcement	compliance	Integrate digital verification systems (e.g. CREDZ) into WA compliance and enforcement
	police	police. If they can't enforce the rules, the rules are meaningless.
risk	battery	To better manage the issues and risks related to lithium-ion battery fires and to assess the efficacy of mitigation and response measures, FRNSW, on behalf of other fire and emergency services in Australia is leading a collaborative research program into the Safety of

		Alternative and Renewable Energy Technologies (SARET). The research and testing program is currently focused on fire service response to LiB fires and intends to investigate the operational impact of the end-of-life LiB hazard.
	children	Older adults, people with disabilities and children are at a greater risk of non-rider harm. Significant injuries can occur due to:
	community	The Strategic Directions are: 1. Supporting resilient communities through risk reduction 2.
	illegal	III. COMPLIANCE AND CLASSIFICATION OF DEVICES, INCLUDING ILLEGAL MODIFICATIONS AND IMPORTATION Unregulated or illegally modified eRideables significantly heighten safety risks for both users and bystanders.
	safety	AFAC representatives also lead the development on many Australian and International Standards Committees. AFAC and Standards Australia are signatories to a Memorandum of Understanding in the development and revision of standards relating to the management of fire related risks, fire protection and fire safety.
pedestrians	cyclists	Zigzagging between pedestrians, cyclists, and cars
riders or riding		Riders in Singapore are much more courteous and respectful than the average Australian rider.
safety		Istrongly believe eRideables should be banned entirely on Rottnest Island to preserve its safety and family-friendly environment.
regulations	compliance	But Good Devices Exist – and So Do Real Standards We don’t have a technology problem. We have a compliance and regulatory problem.
e-bikes		Update Department of Fire and Emergency Services (DFES) guidance to include e-bikes in

Category: CTAG_parliament-inquiry_neutral

Concept	Related Concept	Supporting Text
e-bikes	cyclists	Context I have lived in Northbridge for the past three years and so am aware of the difficulty of getting around our city by any means. I have been an enthusiastic cyclist for over 30 years and do use an e-bike to commute occasionally.
	standards	1.6 Issues with current Australian E-bike Policies and Perceived Safety. The European Standard EN 15194 design standard for e-bikes was adopted in Australia in 2012 and WA followed suit in 2015.
legal	education	Expand current Road Safety Commission and Department of Transport programs to include targeted campaigns for Extend education in schools, youth groups, and first-time purchasers. Leverage Consumer campaigns across digital social media, online advertising, and in-store point-of-sale Education and school-based materials to promote legal requirements, safe ridingplatforms practices, and protective equipment use.
	illegal	The current rules have made most self balancing devices illegal. Those that are legal, are not capable of being ridden by an average sized adult at the prescribed speed limits safely.
regulations	community	I slowed down and moved on when the children went back onto a driveway. The committee should consider community education requirements, not just additional regulation or penalties.
	compliance	Overall compliance and enforcement of the regulatory framework is therefore challenging. Operation of ‘for hire’ eRideables was restricted by geofencing technology in key CBD locations, including Murray Street Mall, Forrest Place and Hay Street Mall.
	hire	For commercial hire operations, additional restrictions such as geofencing and night curfews are also evident in many countries. WA’s current regulatory framework already incorporates most of these elements.
community	benefits	Income stream (paid by riders) to fund development and initiatives that benefit riders and keep the community safe.
	education	1/ Education. School children and the wider community must be better educated regarding the responsibilities and dangers of these devices.
	infrastructure	Conclusion: eRideables require dedicated quality infrastructure for an acceptable level of safety for the community.
pedestrians	cyclists	But all these cities do more than that in order to provide a context for the use of these e- Ridables. They design ways to integrate pedestrians, cyclists and e-Ridables into traffic through traffic calming key streets.
	police	Online purchases may be difficult to police. · Encouraging pedestrians walking dogs to shorten leads and be more aware of others.
enforcement	education	This is an education and awareness issue and needs attention along with enforcement

	illegal	The penalties for these illegal modifications, if they can be adequately enforced, do not appear to be serving as much of a deterrent. Infringement fines for exceeding regulated speed cut offs for these devices would be typically $100.
	infrastructure	In the case of penalties ; the already placed infringements are already good, its like stated before enforcement is the main task as this is a more menial topic law enforcement being tasked on enforcing these laws is on the bottom of their list and aren't present nor is there infrastructure like cameras we have on roads that capture drivers breaking the law. As such continuous enforcement for word of mouth to spread of obeying the eRideable laws to occur is important.
	police	4/ Completely outlaw an e rideable capable of unassisted speeds over 25 kmh and enforce this with police seizing modified and illegal scooters and bikes.
injuries	data	This includes a call for a state-managed, standardised, and technology-enabled approach to collecting and analysing incident data, including eRideable-related injuries. Such improvements would enhance understanding of trends and inform safety strategies.
	insurance	Statewide Injury Reporting System: Establish a centralised database for eRideable-related injuries (frequency, severity, and causation), linked to WA Police, hospital emergency departments, and insurers.
	risk	Emerging research has shown that injuries resulting from an e-bike crash are comparable to injuries incurred on a traditional bicycle. Accidents involving pedestrians and e-bikes have garnered negative attention in the media which is distorting the perceived risk of e-bikes within the community.
safety	risk	Key Recommendations 1. Prohibit the sale of non-compliant e-rideables and conversion kits Non-compliant devices and modification kits undermine WA's regulatory framework, posing unacceptable safety risks.
risk		e. back streets at night), the risk of collisions could be heightened.
riders or riding		riders, commuters or enthusiasts. Since 1973, our organisation has advanced the case for

Category: CTAG_parliament-inquiry_positive

Concept	Related Concept	Supporting Text
benefits	community	Focus on education, safety, and community benefits rather than blanket restrictions. Thank you for considering my submission and for your efforts in creating a safer and more sustainable transport future for Western Australia.
	cyclists	They are a danger not just to themselves, but to us and anyone trying to use a footpath/cycleway It is horrendous that these footpath menaces have caused so much harm and I would like to see regulation of motorised e-rideables. Would you please pass on my concern that if pedal-assisted bikes, such as those ridden by our members, are caught up in any new regulations, they may deprive our senior cyclists of the pleasure of cycling, the exercise benefits and the social amenity of our Club.
	e-scooters	Economic, social and environmental benefits of cycling and e-scooters in Australia. We Ride Australia (‘WeRide’) is the national independent voice for cycling in Australia.
	health	Cycling generated an estimated $954m in health and social benefits. Including…
	infrastructure	WeRide’s mission is to build a healthy, sustainable future through advocacy, program development and research around the bicycle’s role in environment, health, infrastructure and safety. WeRide has engaged Ernst & Young (“EY”) to conduct an assessment of the economic, social and environmental contribution of cycling and an assessment of the economic contribution of e-scooters in Australia in 2022 (the “Study”).
standards	battery	Battery standards The NSW Office of Fair Trading has introduced an ebike battery certi cation process that is unique from any other jurisdiction in the world. The implementation process has been an unmitigated failure.
	compliance	Foster consistency with national standards, including aligning WA’s framework with the NTC’s updated PMD classi cations and enabling national import and compliance controls.
	e-bikes	The number of e-bikes imported in 2022 grew to almost 200,000 units 3 and the number of ebikes imported continues to grow. In 2016 Standards Australia released the standard for a pedalec AS 15194:2016 as a modi ed adoption of the European standard EN15194:2009 (we are still operating from the EU 2009 standard which is now 15 years old).
	legal	Federal lobbying The Federal Minister for Infrastructure and Transport, along with the Federal Office of Infrastructure Vehicle Safety Policy and Partnerships, Road and Vehicle Safety Division indicted that as e-bikes, whether road legal or not, have been removed from the Vehicle Standards (Australian Design Rules) under the Road Vehicle Standards Act due to the previously-mentioned amendment, the department no longer has a role in the management of e-Bike imports (correspondence. from the office of the Federal Minister for Infrastructure and Transport August 2024).
	regulations	EN17860 European standard for electrically-assisted cargo bikes. Include in regulations.

	safety	Battery fires have largely involved poorly manufactured or modified devices—not those meeting EN15194. A more targeted approach would be to strengthen import and safety standards, so only compliant devices are available.
infrastructure	community	A warehouses, or experience our operations in our consistent approach with clear rules, proper current markets. infrastructure, and strong enforcement will make these services safer, easier to use, and more reliable. It will also help reduce congestion, support more connected communities and make public transport more convenient by improving first and last mile options.
	education	ESRA supports policies that enable the benefits of eRideables while maintaining safety and fairness. This includes infrastructure upgrades, education campaigns, and regulatory frameworks that encourage responsible use without overburdening private riders.
	health	WeRide's mission is to build a healthy, sustainable future through advocacy, program development and research around the bicycle's role in environment, health, infrastructure and safety. WeRide has engaged Ernst & Young ("EY") to conduct an assessment of the economic, social and environmental contribution of cycling and an assessment of the economic contribution of e-scooters in Australia in 2022 (the "Study").
	regulations	I believe more stringent regulations will hamper the adoption of E-ridables which will create greater issues for people in the form of driving cars and car dependant infrastructure. I believe these issues both indirectly and directly cause much more problems (pollution, automobile collisions, impact on global warming, etc...) but are ignored due to the culture surrounding driving.
e-bikes	legal	Should such a ban come into effect, I'm not sure that our club would remain viable. We are very respectful of pedestrians, all of our e-bikes are compliant legally, i.
community	education	Rider training and education should be offered via community groups, such as ESRA.
riders or riding		Optional or required licensing for frequent riders.
regulations	compliance	1 Risky behaviour and regulation compliance in eRiders and cyclists in metropolitan Perth Western Australia, 12th June,2025. https://research-repository.uwa.edu.au/en/publications/risky-behaviour-and-regulation-compliance-in-eriders-and-cyclists
	safety	Conclusion I urge the Committee to adopt a balanced approach: improve safety and regulation, but do not ban eRideables. Instead, embrace them as part of a broader strategy to create a healthier, more connected, and more sustainable Perth.
e-scooters		Universities Key e-scooter and related E-scooter
safety		Encourage proper usage and improve safety. 2. Designated Parking Zones
pedestrians	cyclists	Rather than bigger motorised killing machines on our roads we need to explore how we can enable more cyclists (ebike included), pedestrians, joggers, runners etc.

Appendix D – Activity Space

The concept of activity spaces (AS) originates from biological research on habitat use, territorial behaviour, and mammalian home range studies dating back to the mid-20th century (Burt, 1943; Jennrich & Turner, 1969). It has since been adapted to diverse fields, including crime analysis, healthcare accessibility, transit-oriented development (Botte & Olaru, 2012), and the study of food deserts (Cervigni et al., 2020).

AS capture the interaction between individuals and their environment, incorporating travel demand and supply, time constraints, and institutional conditions. They represent the spatial extent within which daily activities such as work, recreation, healthcare, and food acquisition occur, shaped by the transport services that enable access. AS can describe either realised spatial behaviour (Axhausen et al., 2004; Kamruzzaman & Hine, 2012) or perceived spatial awareness (Casas, 2007), at both individual and aggregate levels.

By reflecting the areas people traverse and occupy, AS offer insights into exposure to different environments and the accessibility of opportunities. Improvements in transport services can expand activity spaces or yield time savings, while changes in the built environment may also reshape them—expanding access to distant activities or contracting around local opportunities.

Methodological approaches have evolved from simple elliptical measures to more sophisticated techniques such as kernel density estimation, minimum spanning trees (Axhausen et al., 2004; Schönfelder & Axhausen, 2010), and alternative geometries (Rai et al., 2007; Botte & Olaru, 2010). When detailed data, particularly GPS traces, are available, confidence ellipses and bivariate kernel density estimators are often preferred for their conceptual clarity and ease of application.

A confidence ellipse is then calculated to be the smallest area within which a person's trip location is expected to fall with a specific probability (e.g., 95%). It is derived from the variance–covariance structure of the coordinates of observed locations expressed as (x, y) pairs. Given a set of (n) activity points (x_i, y_i), the sample means $\bar{x}$ and $\bar{y}$, and the variance–covariance matrix S= $\begin{pmatrix} s_{xx} & s_{xy} \\ s_{yx} & s_{yy} \end{pmatrix}$

where $s_{xx} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})^2$; $s_{yy} = \frac{1}{n-1}\sum_{i=1}^{n}(y_i - \bar{y})^2$; and $s_{xy} = \frac{1}{n-1}\sum_{i=1}^{n}(x_i - \bar{x})(\, y_i - \bar{y})$.

The area of the confidence ellipse is then calculated as $35.9\pi\sqrt{|S|}$: where S is the determinant of the covariance matrix.

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