Submission
No 182

INQUIRY INTO USE OF E-SCOOTERS, E-BIKES AND RELATED MOBILITY OPTIONS

Organisation: Centre for Accident Research and Road Safety – Queensland

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CARRS-Q SUBMISSION TO NSW LEGISLATIVE COUNCIL INQUIRY INTO THE USE OF E-SCOOTERS, E-BIKES AND RELATED MOBILITY OPTIONS

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TABLE OF CONTENTS

1. INTRODUCTION

This submission has been prepared in response to the Portfolio Committee No. 6 – Transport and the Arts of the Legislative Council of the NSW Parliament Inquiry into Use of e-scooters, e-bikes and related mobility options. As a leading nationally and internationally recognised research institution in road safety, the vision of Centre for Accident Research and Road Safety - Queensland (CARRS-Q) is for a safer world in which injury-related harm is uncommon and unacceptable. CARRS-Q was established in 1996 as a joint initiative of Queensland University of Technology (QUT) and the Motor Accident Insurance Commission (MAIC).

CARRS-Q builds new scientific understanding that enables regulatory authorities, policy makers, educators and communities to frame strategic choices about applied future actions. Clear proactive input to relevant national research priorities is a key element of the research strategy, which has been assisted by staff membership of all major road safety policy groups including at the state and federal level.

One of the Centre's core research themes is Vulnerable Road User Safety which traditionally encompassed pedestrian, bicycle and motorcycle safety. CARRS-Q is now one of the most active organisations in Australia in relation to research into the safety of e-scooter use. Our e-scooter research includes:

- An international review of the safety of e-micromobility including comparisons between e-scooters (and other new forms) and electric bicycles.
- A series of observational studies of e-scooter and bicycle use in the Brisbane CBD ranging from the commencement of shared e-bikes in 2010 to October 2021. These studies compared locations of riding (footpath, road), safety behaviours and interactions with pedestrians by users of shared and private e-scooters and bicycles.
- An observational study of risky behaviours of delivery and non-delivery bicycle and e-bike riders in inner Brisbane suburbs in 2021.
- An international survey comparing shared and private e-scooter user and non-user knowledge of laws, attitudes and safety behaviours in Brisbane, Belgium, the Czech Republic, Norway and Sweden in 2020.
- A repeat of the international survey in the Australian Capital Territory in 2022 and 2023.
- The Safer Scooting Study, an ongoing longitudinal study of how the safety and patterns of e-scooter riding changes with experience.

Our submission to the current Inquiry draws on previous CARRS-Q responses to similar government consultations, including:

- The National Transport Commission (NTC) Consultation Regulation Impact Statement on *Barriers to the safe use of personal mobility devices*
- The Queensland Government Discussion Paper on *Personal Mobility Devices Access to On-Road Bike Lanes*

Our submission is based on the e-scooter, bicycle and pedestrian safety research that we have conducted at CARRS-Q. We have not conducted any specific research regarding related mobility options such as hoverboards and electric skateboards.

For any further information on any material presented in our response or have any questions, please contact:

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2. THE CURRENT AND ANTICIPATED ROLE OF ALL THREE LEVELS OF GOVERNMENT IN ENABLING AND ENCOURAGING SAFE ELECTRIFIED ACTIVE TRANSPORT OPTIONS (a)

2.1. General approach to regulation of e-micromobility

The regulations regarding the use of e-scooters differ across the world and according to specific geographic locations (Gössling, 2020) but the regulation of e-scooters generally occurs at multiple levels. National regulations mainly deal with standards and requirements for the vehicles themselves. State regulations primarily focus on road rules and traffic laws. Local governments, such as city councils, may enact additional rules specific to their jurisdiction and address local concerns. In this case, it may involve regulations related to shared e-scooters. Companies operating in the transportation sector, such as e-scooter rental companies, may also establish their own rules and guidelines. These rules may cover user eligibility, rental terms, safety protocols, maintenance requirements, and penalties for misuse.

Local governments frequently engage in discussions about which laws and regulations should be applicable to e-scooters (BBC News, 2022; Carville, 2018; Marshall, 2018; National Association of City Transportation Officials (NACTO), 2019; Portland Bureau of Transportation, 2020).

The questions regulators grapple with across the world include:

- Should electric scooters be treated in the same way as motorised vehicles, bicycles, or pedestrians?
- What speeds should they be operated at?
- Which sets of rules and regulations should be followed in different situations such as footpaths, bicycle paths, roadways, and park trails? (Rivara, 2019; Sokolowski, 2020; Störmann et al., 2020)

2.2. Australia

In their international review of e-scooter regulations, Zhang et al. (2024) not that even within a country, the regulations may vary. This is certainly true for Australia. Table 1 summarises the e-scooter regulations in Australian states and territories as at 30 June 2024. The most notable difference in regulations among various states is regarding whether shared and/or private e-scooters are allowed, whether they are allowed to be ridden on the footpath and, at what speed. For example, the use of private e-scooters on roads and road-related areas (including footpaths, shared paths and bicycle lanes) is illegal in NSW but not in Queensland. Often, the rules related to e-scooter use parallel those for bicycle use (e.g., in relation to riding on the footpath).

In Australia, state road rules constrain local government's approach to regulation of shared (and private) e-scooters - local government cannot permit any practice that is prohibited by the state rules. For example, local governments cannot allow higher speed limits for shared e-scooters than specified in the state road rules. While local governments cannot totally prohibit the use of private e-scooters if their use in legal in that state, local governments may choose to impose additional restrictions on shared (and possibly private) e-scooter use. Such restrictions could relate to not allowing e-scooter use in specific areas (by signage that is allowed under state road rules) or by parking requirements or prohibitions.

Table 1. E-scooter regulations in Australian states and territories as at 30 June 2024.

State/Territory	New South Wales	Tasmania	Victoria	Queensland	Western Australia	South Australia	Northern Territory
Private e-scooters	×	✓	✓	✓	✓	×	×
Shared e-scooters	✓ In trial areas only	✓	✓	✓	✓	✓ In trial areas only	✓ In trial areas only
Year of first shared e-scooter trial	2022	2021	2019	2018	2018	2019	2020
Max speed (km/h)	20 km/h on bicycle path/lanes and roads 10 km/h on shared paths	25 km/h on bicycle path/lanes, shared paths, and roads 15 km/h on footpaths	20	25 km/h on bicycle path and separated paths 12 km/h on footpaths and shared paths	25 km/h on bicycle path, shared path, and roads 10 km/h on footpaths	15	15
Minimum age (year)	16	16	16	12 years with supervision 16 years without supervision	16	18	18
To carry on public transport	×	Depends on the public transport driver/manager	×	Depends on the public transport driver/manager	×	×	×
Blood Alcohol Concentration (BAC) (grams)	0.05	-	-	-	0.05	0.05	0.05
Riding private e-scooters on public roads	×	✓	✓	✓	✓	×	×
Riding private e-scooters on private property	✓	✓	✓	✓	✓	✓	✓

Riding on footpath	×	✓	×	✓	✓	✓	✓
Riding on bike paths and shared paths	✓	✓	✓	✓	✓	✓	✓
Riding in on-road bike lanes	✓ Speed limit up to 50 km/h in trial areas only	Not stated	Not stated	✓ Speed limit up to 50 km/h	✓ Speed limit up to 50 km/h	×	✓
Riding in separated bike lanes	Not stated	Not stated	Not stated	✓	Not stated	Not stated	Not stated
Riding on-road	✓ Speed limit up to 50 km/h in trial areas only	✓ Local roads speed limit up to 50 km/h	✓ Speed limit up to 60 km/h	✓ Local roads speed limit up to 50 km/h	✓ Speed limit up to 50 km/h, no dividing line or median strip, not multi-lane one-way	✓ Speed limit up to 50 km/h	×
Helmet	Required for all states and territories						
Bell, horn, and lights	Required for all states and territories						
Driver's licence	Not required for all states and territories						
Insurance	Not required for all states and territories						
Mobile phone usage	Not allowed for all states and territories						
Carrying passengers	Not allowed for all states and territories						

2.3 International approaches to regulation

City administrations like those in New York City, Montreal, London, Auckland, Paris, San Francisco, Madrid, Brussels, Nashville and Seattle have discussed the possibility of allowing rideshare companies under specific regulations or prohibiting shared e-scooter services entirely (Bekhit et al., 2020; Felton, 2019; Irfan, 2018; Sikka et al., 2019; Yang et al., 2020). Depending on the location, e-scooters are allowed to be ridden in different areas. For example, many jurisdictions ban the use of e-scooters on the footpath. This variation has been linked to increased confusion when it comes to where e-scooters are permitted (James et al., 2019). Helmet regulations for e-scooters apply in only a small number of international jurisdictions (Gössling, 2020; Harbrecht et al., 2021). The regulations for helmet use vary in different parts of the US, with some mandating helmets for all ages, specific age groups (usually <14), or leaving it optional (Sikka et al., 2019).

In summary, there appears to be a lack of consistency in rules and regulations (e.g. speed limit, minimum user's age) which are mainly determined by individual operators and cities. The absence of standardized laws and unclear definitions regarding e-scooter legislation may lead to irresponsible riding behaviours (Yang et al., 2020). Table 2 provides an overview of e-scooter regulations across various cities globally. According to Table 2, in Santa Monica, California, e-scooters are allowed to be ridden in bike lanes with the exception of beachfront bicycle paths (City of Santa Monica, 2021). Santa Monica is a popular tourist destination where many visitors spend time exploring the coastal areas.

Table 2. Summary of e-scooter policies in different cities around the world

City, Country	Where is it allowed to ride			Speed limit (km/h)*	Minimum Age	Driver's licence	Helmet required
	Road-way	Bike lane	Footpath				
Santa Monica, USA	Yes (b)	Yes (a)	No	24.14	16	Yes	No
Miami, USA	Yes	Yes	Yes	24.14	18	No	No
Detroit, USA	Yes (b)	No	Yes	40.23	12	-	Yes (g)
Austin, USA	Yes (b)(c)	Yes	Yes	32.19	16	No	Yes (f)
Calgary, Canada	No	Yes	Yes	24	16	No	Yes (f)
Paris, France	Yes (d)	Yes	Yes	25	12	No	No
Madrid, Spain	Yes	Yes	No	20	15	No	No
Auckland, New Zealand	Yes	Yes	Yes	16	16	-	No
Santiago, Chile	Yes	Yes	No	25	14	No	Yes
Bogota, Colombia	Yes	Yes	No	20	14	No	Yes
Buenos Aires, Argentina	Yes	Yes	No	25	16	No	-

*Note: (a) Except in beach bicycle paths. (b) Only if the road speed limit is under 40.23 km/h. (c) Only if the road has 4 lanes or less. (d) Only if the road speed limit is under 50 km/h. (e) Only if there is not a bicycle lane. (f) Under 18 years old. (g) Under 19 years old. Source: Orozco-Fontalvo et al. (2023). * For those cities where footpath riding is allowed, It is unclear from sources whether lower speed limits apply on the footpath than on the road.*

2.4 Rider awareness of laws and regulations

A consequence of the variation in e-scooter laws and regulations is that some e-scooter riders have limited knowledge about the laws and regulations that apply in the cities where they are riding (Aman et al., 2021; Comer et al., 2020; Felton, 2019; Yang et al., 2020). For instance, our Canberra survey (Ssi Yan Kai et al., 2024) found that 12.1% of e-scooter riders thought that there was no helmet law or that it only applied to children. Further analyses showed that incorrect knowledge about the helmet law and lack of support for the law predicted not wearing helmets. Survey data from Brisbane (Haworth & Schramm, 2023) showed that all private e-scooter riders reported that helmet use was mandatory but among shared e-scooter riders, 2% thought that helmets were not mandatory and 2% thought they were only required for children. Surveys largely exclude tourists and therefore may underestimate the proportion of shared e-scooter riders who lack knowledge of the rules.

Similarly, research in Berlin found that riders lacked a clear understanding of the e-scooter laws and regulations relating to riding with a passenger (not allowed), travelling in the opposite direction of traffic flow (prohibited), designated riding areas (bike tracks and paths), necessity for a driver's licence (not required), and signalling turns by hand (mandatory) (International Transport Forum, 2020; Siebert et al., 2021a).

Some shared e-scooter companies require potential riders to confirm their understanding of local regulations governing e-scooter usage, including age requirements, helmet use, adherence to traffic laws and location restrictions as part of hiring. Interviews of riders have reported that most riders tend to quickly acknowledge these rules without fully comprehending them in order to proceed with riding their e-scooter.

Not only do rules differ among jurisdictions, but they have also changed over time within particular jurisdictions. The demand for governments to continuously review operational permits for ride-share companies has been prompted by unexpected launches, disruptive e-scooter users, public concerns, and a rise in crashes and fatalities. Government discussions have centred on creating policies and rules that adequately tackle the safety and health consequences of shared e-scooters. Various social media platforms also feature company and government videos conveying information about e-scooter regulations in specific cities as well as posts that may present outdated information.

3. OPPORTUNITIES TO REFORM THE REGULATORY FRAMEWORK TO ACHIEVE BETTER AND SAFE OUTCOMES FOR RIDERS AND THE COMMUNITY (b)

This section outlines several opportunities to reform the regulatory framework, ranging from standardising terminology and classification of powered micromobility devices, proposing an approach to regulation of speed based on the Safe System Approach, to opportunities at the Federal level.

3.1 Standardising terminology and classification of powered micromobility devices

Given the international market for powered micromobility and the continued emergence of new devices, terminology and classification in regulatory approaches need to be standardised and future-proof. Standards Australia has yet to undertake work in the area of powered micromobility.

Consistency with international standards is a relevant consideration in deciding on appropriate regulatory frameworks because of these standards will influence what is manufactured and thus available for importation to Australia. The Society of Automotive Engineers has developed a standard SAE J3194™ Taxonomy and classification of powered micromobility devices (SAE, 209) which defines a "powered micromobility vehicle" as a wheeled vehicle that must:

- Be fully or partially powered
- Have a kerb weight not exceeding 227kg
- Have a top speed not exceeding 48 km/h

This standard appears to cover a range of vehicles that are otherwise defined as electric bicycles, and potentially mopeds in Australia. It is also reasonably future-proof (except perhaps for the requirement to have wheels). Within the standard, there is a classification system that comprises characteristics such as kerb weight, vehicle width, top speed and power source. Under this standard, vehicles most current powered micromobility in Australia would be classified as:

> *Ultra lightweight or Lightweight or Midweight, Standard-width, Ultra low-speed or Low-speed, Electric vehicles*

This classification system allows a finer regulatory approach, which could be of value in relation to decisions about where (and by whom) vehicles could be operated. For example, it might be appropriate to allow only Ultra-low speed vehicles to be operated in pedestrian areas or, conversely, to prohibit their use on particular types of roads.

3.2 A proposed Safe System Approach to regulation

The CARRS-Q international safety review of e-micromobility concluded that the appropriateness of infrastructure and speed are inextricably linked. This should not have been surprising given that it is a fundamental tenet of the Safe System Approach to road safety.

The challenge is to identify operating environments that provide sufficient separation from higher-speed motor vehicles while minimising risks to bicycle riders and slower-speed pedestrians. It would seem appropriate to prohibit the operation of powered micromobility in locations where riding of bicycles is prohibited.

Where e-scooters are allowed to be used should really depend on the maximum speeds at which the e-scooters can (or allowed to) travel and the speeds of motorised vehicles and bicycles in those locations. In general, safe operation of e-scooters on footpaths requires low maximum speeds. Safer operation on low-speed, low traffic volume roads requires higher maximum speeds of e-scooters. Based on the fundamental safety principles of kinetic energy transfer and separation, **Table 3 is an attempt to indicate the relative degree of risk of e-mobility operations under different situations. It could form the basis of a best practice approach to regulation.**

The table assumes operation by adults and helmet wearing. It does not apply to footpaths or shared paths where many of the pedestrians are elderly. A potential modification in that situation is to increase the risk level to the next category. All use on roads with speed limits of greater than 50 km/h was considered high risk and so is not included in the diagram. The definition of local roads is quite important. It needs to be clear to users that it is not all roads with a speed limit of 50 km/h or less because some of these roads are heavily trafficked, multi-lane roads in cities.

The table concludes that low risk operation of e-micromobility devices is possible under the following conditions:

- Riding up to 10 km/h on footpaths with few pedestrians
- Riding up to 5 km/h on footpaths with many pedestrians
- Riding up to 25 km/h on shared paths
- Riding at 25 km/h (but not 10-12 km/h or less) on bike paths or protected bike lanes, or in bike lanes on roads with speed limits of 30 and 40 km/h
- Riding at 25 km/h (but not 10-12 km/h or less) in bike lanes on roads with speed limits of 50 km/h or lower

Table 3. Risk matrix for e-micromobility devices as a function of maximum riding speed and operating environment. P=risk to pedestrian, R=risk to rider, P+R=risk to both pedestrians and riders

Operating environment	Maximum riding speed			
	5 km/h	10-12 km/h	25 km/h	>25 km/h
Footpath with few pedestrians			P	P+R
Footpath with many pedestrians		P	P	P+R
Shared path				P+R
Bike path/protected bike lane	R	R		R
Bike lane on road 30-40 km/h	R	R		R
Road 30-40 km/h	R	R	R	R
Bike lane low volume Road 50 km/h	R	R		R
Road Low volume 50 km/h	R	R	R	R
Bike lane High volume Road 50 km/h	R	R		R
Road High volume 50 km/h	R	R	R	R

3.3 Opportunities at the Federal level

Given that there are likely to be compliance and enforcement challenges associated with PMDs, there should be a focus on maximising the extent to which undesired outcomes are prevented by the regulatory framework, rather than assuming that compliance and enforcement will be effective. For example, the maximum speed attainable as spelt out in the regulatory framework should not exceed the maximum speed of PMDs that can be brought into Australia.

Current discrepancies between vehicle standards and import regulations allow the import of vehicles/devices which are illegal to be used on public roads. For example, high-powered e-bikes are being imported and sold as "e-mountain bikes" which are not legal for use on roads and bicycle infrastructure. This is not clear to purchasers or to enforcement authorities. Australia should examine the suitability of approaches to this problem that are being developed internationally. The technical characteristics of cargo-bikes and small electric vehicles for delivery purposes need to be regulated well to allow them to achieve their potential in terms of congestion and environmental benefits.

4. OPPORTUNITIES TO IMPROVE SAFETY AND OUTCOMES FOR USERS AND THE COMMUNITY (d) and (g)

Our focus in this section is on opportunities to improve safety for users and the community. Given our research expertise, the focus is on e-scooters, rather than other forms of powered micromobility. We begin this section by providing a brief description of e-scooter safety issues, before examining the likely effectiveness of different approaches to mitigating the risk and severity of injury.

4.1 E-scooter safety issues for pedestrians

While there is widespread public concern about the risks that e-scooters pose to pedestrians, most published studies have focused solely on riders (e.g., Dhillon et al., 2020) or have failed to distinguish between riders and pedestrians (e.g., Aizpuru et al., 2019; Störmann et al., 2020; Vernon et al., 2020). Therefore, there is limited knowledge regarding how many pedestrians have been hit by e-scooters or have fallen over e-scooters on the footpath.

In Queensland, e-scooters and bicycles are allowed to be ridden on the footpath, unless there are signs prohibiting this practice. Many of the off-road paths are shared between individuals undertaking diverse activities, including walkers, cyclists, scooterists, and skateboarders. Observational research in Brisbane in February 2019 concluded that pedestrian perceptions of risk from e-scooters and bicycles being ridden on footpaths may outweigh the objective risks (Haworth et al., 2021b). We observed that about 70% of e-scooter and bicycle riders on the footpath travelled within 5 metres of at least one pedestrian, while around 40% rode within 1 metre of at least one pedestrian. Less than 2% of these interactions resulted in conflicts (braking, swerving, calling out). Out of six riders involved in these conflicts, four were using shared e-scooters and two were using private bicycles. All individuals involved were adults, and four conflicts occurred during the afternoon peak period.

Video data collected for TMR just prior to the introduction of the new rules in November 20222 (which allowed riding on roads and in bike lanes at a wider variety of locations) showed that more than 80% of e-scooter riding occurred on the footpath for CBD locations where the alternative was a general traffic lane or an on-road bicycle lane. However, when there was a protected bike lane, less than 10% of riding occurred on the footpath. Less than 25% of e-scooter riding occurred on the footpath in other urban and suburban areas with speed limits of between 40 and 60 km/h (except one site with a 40 km/h speed limit and on-road bicycle lane where about 40% rode on the footpath). Speeds on the footpath were consistently lower on footpaths than on roads. Mean footpath speeds across the sites ranged from 8 to about 18 km/h and mean speeds on roads ranged from 16 to 28 km/h. The TMR data are spot speeds and so it cannot be determined whether riders slow down on footpaths (which has been shown for bicycles) or whether on-road riders have different characteristics to footpath riders (e.g., relatively more private e-scooter riders on roads).

E-scooters have the potential to obstruct footpaths or building entrances, impeding access for pedestrians, especially those who rely on mobility aids such as walkers, canes, and wheelchairs. E-scooters may also obstruct pedestrian and cyclist movement, access to fire hydrants/valves, bike parking or bike-share stations, street furniture, and vehicle street parking. No Australian studies were available but international studies have examined the problem of e-scooter parking using methods such as surveys, observations, and database searches (Bai & Jiao, 2020; Comer et al., 2020; James et al., 2019; Portland Bureau of Transportation, 2018). A study conducted in Indianapolis, Indiana found that approximately 28% of both riders and non-riders reported witnessing a parked e-scooter blocking a disability access ramp (Comer et al., 2020). 2.8 % percent of photographed parked e-scooters in Portland Oregan, obstructed disability access (Portland Bureau of Transportation, 2018). Observational research shows that a large majority (72.8%-97%) of e-scooters were appropriately parked on footpaths and other areas without impeding access or flow (James et al., 2019; Portland Bureau of Transportation, 2018). Nevertheless, between 6 % and 10 % of parked e-scooters blocked pedestrian footpaths or flow (James et al., 2019). In an analysis of city complaints in Austin, Texas, e-scooters were left on footpaths (n = 1,705), on private property (303), in parks (215) or presented as a general obstruction (1,472) (Bai & Jiao, 2020). Tickets issued in Portland were primarily for improper parking (82 %) (Portland Bureau of Transportation, 2018).

4.2 E-scooter safety issues for riders

As the usage of electric scooters has risen, so has concern regarding crashes and injuries linked to them (Caldwell, 2019; Plummer, 2019).

Internationally, most injuries to e-scooter riders result from falls as a result of loss of balance (74%) rather than crashes with motor vehicles (Singh et al. 2022). These falls might be linked to instability from small wheels on uneven pavements (Ma et al. 2021).

4.2.1 Inexperience

There is evidence to suggest that inexperienced e-scooter riders are at higher crash risk. International research indicates that around one-third of riders who sustained injuries were riding an e-scooter for the first time (Austin Public Health, 2019; Cicchino et al., 2021; Störmann et al., 2020; Uluk et al., 2022). For example, Uluk et al. (2022) found that 41% of the injured riders in Berlin were visitors. The appeal of e-scooters to tourists may lead to an increase in inappropriate behaviours among users of these shared vehicles (Haworth et al., 2021b). As mentioned earlier, the most common risky behaviour among users of shared e-scooters was not wearing a correctly fastened helmet (Haworth et al., 2021b). Tourists who are not familiar with the helmet and road regulations may even have an increased likelihood of injuries while riding e-scooters.

4.2.2 Risky riding behaviours

Risky behaviour among e-scooter riders can be categorised into sex and age demographics, helmet use, alcohol and/or drug use, underage usage, double riding, speed, rider distraction and rider visibility. Tables summarising the published observational and hospital-based studies of helmet use, double riding and riding below the legal age are provided in Appendix 1 (from Janikian et al., 2024).

4.2.2.1 Non-use of helmets

The growth in e-scooter use has been accompanied by reports of increased e-scooter-related injuries including frequent head injuries. A review of 29 international studies of e-scooter injuries concluded that the head and/or face was the most common injury site, comprising 38.8% of emergency presentations (Rashed et al., 2022). Another review of 34 international studies showed that over 98% of the 5,705 injured e-scooter riders presenting to local Emergency departments were not wearing helmets and their most frequent mechanism of injury occurred as a result of loss of balance (74%) rather than crashes with motor vehicles (Singh et al. 2022). These falls might be linked to instability from small wheels on uneven pavements (Ma et al. 2021). In Brisbane, Australia, the head/face was the most commonly injured body part in 952 emergency presentations involving e-scooters between November 2018 and June 2021 (Vallmuur et al., 2023). In Western Australia, injured e-scooter riders who used helmets (43%) had significantly less head injuries (Raubenheimer et al., 2023), confirming the findings from an earlier Brisbane cohort (Mitchell et al., 2019).

Most countries do not require helmet wearing for e-scooters and observed wearing rates are generally below 10% (Serra et al., 2021). In Australia, helmet use when riding an e-scooter is mandatory in all states and territories. Observational studies in downtown Brisbane in October 2021 found that helmets were not worn by 36.8% of shared and 7.4% of private e-scooter riders (Haworth & Schramm, 2023).

4.2.2.2 Impaired riding

The use of alcohol and drugs while riding is common among injured e-scooter riders, as shown in Table A2. In hospital studies of injured riders, alcohol consumption was found for between 10 and 50% of injured riders in most studies (Janikian et al., 2024). It should be noted that most of these studies did not record whether the rider was on a shared or private e-scooter at the time of the crash.

An experimental study showed that as participants' blood alcohol concentration increased, their performance in riding an e-scooter through an obstacle course after consuming alcohol decreased (Zube et al., 2022). There are only a few experimental studies, and most of the studies that examine alcohol consumption utilise hospital data. Hospital studies showed that riders who were injured and tested positive for alcohol were five times more at risk of sustaining a traumatic brain injury (TBI) than those tested negative (Uluk et al., 2022). Studies on craniomaxillofacial (CMF) injuries have found that the proportion of affected individuals who had consumed alcohol varied from 53% to 91%. Intoxication was found to be closely linked with CMF injury (Shiffler et al., 2021). Several other studies also observed patients with cranial and maxillofacial injuries along with elevated blood alcohol levels (Brownson et al., 2019; Faraji et al., 2020; Kobayashi et al., 2019; Shiffler et al., 2021; Suominen et al., 2022; Wüster et al., 2021; Yarmohammadi et al., 2020).

Use of illegal drugs prior to the crash is also prevalent among e-scooter riders. In a study by Kobayashi et al. (2019), 60% of the patients were subjected to urine sample toxicology screening for drug use. Among those who underwent testing, 52% received positive results. The most frequently detected drugs in positive tests were tetrahydrocannabinol at 32%, and methamphetamine or amphetamines at 18%. Dhillon et al. (2020) conducted a study in which 17.2% of injured patients were tested for drug use, revealing that 13% had used cannabis (13.8%), amphetamine (4.6%), opiates (8%) and cocaine (1.1%). Several other studies have also examined drug usage among injured e-scooter riders (Bauer et al., 2020; Bloom et al., 2021; Faraji et al., 2020; Hennocq et al., 2020; Lavoie-Gagne et al., 2021; Shiffler et al., 2021; Suominen et al., 2022)

4.3 Improving safety outcomes for e-scooter riders and pedestrians

Table 4 sets out a range of short-term and long-term potential mitigation strategies to the e-scooter safety issues identified above and provides an assessment of their likely effectiveness. Most mitigation strategies address multiple characteristics and therefore are potentially more impactful. Several mitigation strategies have been shown in previous studies to be highly effective (e.g., apps to prevent renting at high-risk times, installation of protected bike lanes) but most have not been rigorously evaluated and are classified as “likely to be effective” or of “limited effectiveness”. In general, mitigation strategies that are hard-wired into shared e-scooters are more effective than those which are educational or advisory. The mitigation strategies are classified according to whether they can be implemented in the short term (ST) or over a longer time period (LT). Some mitigations are only relevant to shared e-scooters (SS).

4.3.1 Approaches to improve pedestrian safety

Short-term approaches to mitigate the risk associated with riding on shared paths include:

- Geofencing to prevent riding at high-risk locations
- Geofencing to impose a lower maximum speed at high-risk locations

However, these measures are only possible for shared, not private, e-scooters. Erecting signs or markings on paths to prohibit e-scooter riding or advise riders to travel more slowly would apply for private e-scooter riders but are likely to have limited effect for both groups.

Another aspect to be considered if it is decided to take steps to prevent e-scooters using busy sections of pathway is the availability and safety of alternative routes. Queensland law does not allow e-scooters to be ridden on roads with speed limits over 50 km/h, so these roads cannot be considered alternative routes. Internationally, most e-scooter fatalities have involved collisions with motor vehicles and so the extent to which forcing e-scooter riders to ride on roads to bypass busy sections of pathway would create a risk to these riders should be considered. If a risk assessment of alternative routes shows an unacceptable level of risk (e.g., heavy traffic, large numbers of parking and unparking manoeuvres), then imposing a lower speed limit would be preferred to preventing riding at that high-risk section of shared path.

E-scooter users may not always know where to park their vehicles (James et al., 2019). Many urban areas have established designated areas or zones for the parking of e-scooters and e-bikes, along with installing signage to indicate the appropriate parking locations (Governors Highway Safety Asociation, 2020). Riders can be encouraged to park shared e-scooters in designated areas through mobility app reminders or by submitting a picture of the parking location (Portland Bureau of Transportation, 2018). Paris developed a mobility app to report e-scooters that were improperly parked (Gössling, 2020). Brisbane City Council has installed more than 25 e-mobility parking hubs across the CBD and inner suburbs to provide designated areas to park and pick-up shared e-mobility devices. The operators also have a network of virtual e-mobility parking hubs available across Brisbane. The impact of city-implemented parking regulations on the decrease or increase of injuries to pedestrians and cyclists caused by parked e-scooters has not been adequately studied.

Provision of designated e-scooter parking areas (possibly accompanied by parking bans in other areas) has potential to reduce the risk of pedestrians falling over shared e-scooters left across footpaths. This could be a short-term measure introduced as virtual hubs for shared e-scooters or a somewhat longer-term if physical hubs were installed for private as well as shared e-scooters (although there is no strong evidence of a problem of dangerous parking of shared e-scooters).

Table 4. Summary of e-scooter safety issues and potential mitigations.

Safety issue	**Potential mitigations**										
	Apps to prevent renting at high-risk times (SS)	**Apps to prevent renting by intoxicated riders (SS)**	**Helmet locks (SS)**	**Geofence to stop riding at high-risk locations (SS)**	**Geofence lower speeds at high-risk locations (SS)**	**Signage to stop riding or lower speeds at high-risk locations**	**Widening or separation of shared paths**	**Install protected bike lanes**	**E-scooter parking areas**	**Require safer e-scooter designs (SS)**	**Educate users**
Injuries to pedestrians											
Collisions with pedestrians				E ST	E ST	LE ST	EE LT	EE LT			LE ST
Pedestrians falling over e-scooters on footpaths				E ST		LE ST	E LT		E ST		LE ST
Injuries to riders											
Inexperience	EE ST	EE ST		EE ST	EE ST	LE ST				E ST	LE ST
Lack of knowledge of rules	EE ST	EE ST	E ST ???	EE ST	EE ST	LE ST				E ST	LE ST
Speeding						LE ST					LE ST
Intoxicated riding	EE ST	EE ST		E ST	E ST					E ST	LE ST

Non-helmet wearing			E ST ???								LE ST

EE = proven highly effective E = likely highly effective LE = limited effectiveness ST = short-term LT = long-term SS = applicable to shared e-scooters only

In the long term, replacement of busy shared paths by separated paths should be undertaken wherever possible. If this is not possible, widening of paths should be considered. Use of footpaths by e-scooter riders (and bicycle riders) has been shown in Brisbane to be reduced by the installation of protected bike lanes. While these long-term measures are costly, they deliver a benefit to all active travel users, not just e-scooter riders.

4.3.2 Approaches to mitigate rider inexperience

The approach to mitigation should recognise that inexperienced riders will be largely riding shared e-scooters, not private ones, and that mitigation should focus on approaches which are designed into the hardware and software of shared e-scooters to maximise their effectiveness. These approaches include:

- Apps to prevent riding at high-risk times (e.g., midnight to 5am on weekends)
- Apps to prevent renting by intoxicated riders
- Geofencing to prevent riding at high-risk locations (e.g., busy shared paths, high-pedestrian areas)
- Geofencing to impose a lower maximum speed at high-risk locations

4.3.3 Approaches to reduce impaired riding

It is generally thought (though empirical research is lacking) that alcohol and drug use are higher among riders of shared than private e-scooters. Therefore the approach to mitigation should focus on approaches which are designed into the hardware and software of shared e-scooters (similar to the approaches taken to mitigate risk for inexperienced riders). These approaches include:

- Apps to prevent riding at high-risk times (e.g., midnight to 5am on weekends)
- Apps to prevent renting by intoxicated riders
- Geofencing to prevent riding at high-risk locations (e.g., high-pedestrian areas, busy or narrow shared paths)
- Geofencing to impose a lower maximum speed at high-risk locations

Typically, alcohol consumption tends to be higher on weekends than on weekdays (Sieri et al., 2002). In 2021, Brisbane City Council implemented a requirement that shared e-scooters were unavailable to hire from midnight to 5am on weekends in Brisbane's CBD and Fortitude Valley (Lucy Stone, 2021). No evaluation of the effectiveness of this measure has been published, but results from other parts of the world support this approach. E-scooters were prohibited from being used during nighttime hours in Atlanta, Georgia between 9 p.m. and 4 a.m. in August 2019 following four fatalities (Governors Highway Safety Association, 2020; Nisson et al., 2020). The nighttime restriction resulted in a decrease in the percentage of injuries reported at a major trauma centre in Atlanta from 32% to 22%, but this change was not found to be statistically significant (Anderson et al., 2021). In July 2021, new regulations were approved by the Oslo City Council to impose restrictions on e-scooters. The goal of these measures in the Norwegian capital was to minimize both accidents and inconvenience caused by e-scooters, particularly for individuals with impaired sight or mobility. Key measures included prohibiting e-scooter rentals between 11 p.m. and 5 a.m., as well as establishing a limit on the number of available e-scooters for hire within the city (European Commission, 2021). The introduction of these rules led to a very large reduction in the percentage of e-scooter riders attending the local hospital during weekend nights. Enforcing nighttime ride limitations also has potential to lower injuries among younger riders (Moftakhar et al., 2021) and individuals who consume excessive alcohol before riding (Oksanen et al., 2020; Suominen et al., 2022).

Local governments could also require any shared e-scooter operator to implement a procedure to discourage or prevent rentals by intoxicated persons. Beam e-scooters has developed a cognitive test they have name "Rider Check" which they state:

> *is a proactive measure aimed at discouraging riders from operating e-scooters under the influence of drugs or alcohol. This cognitive test is strategically deployed during peak travel hours on Friday and Saturday nights, targeting various high-traffic hotspots and nightlife areas. (Beam, 2024)*

The test requires rider to tap either to the left or right side of two images shown on the screen. Riders who do not pass the test after three attempts lose their access to Beam trips for several hours.

4.3.4 Approaches to improve levels of helmet use

Helmet use is mandatory for both private and shared e-scooters in Australian jurisdictions but that measure has not been completely effective. The focus of approaches to improve helmet use should focus on riders of shared e-scooters, since levels of helmet use by private riders (at least in Brisbane) are relatively high.

Relatively few measures proven effective in increasing helmet use by shared e-scooter riders. In Brisbane, helmet wearing rates on shared e-scooters were not higher after the introduction of helmet locks (Haworth & Schramm, 2023). Incentives for helmet wearing have been trialled by shared e-scooter companies in other countries, but their effects have been relatively modest, resulting in helmet wearing rates that are still much lower than found in Australia.

4.3.5 Approaches to improve knowledge of the rules

Regarding lack of knowledge of rules, education of users by including information that must be clicked through as part of hiring an e-scooter has been of little effectiveness because potential riders try to do this as quickly as possible because they are being charged for the time. Signage at hiring points regarding the rules or prohibiting riding or advising lower speeds at high-risk locations is likely to be of limited effectiveness.

4.3.6 Safer e-scooter designs

Most rider injuries are associated with individuals falling off electric scooters (Janikian et al., 2024). Requiring that shared e-scooter operators provide the safest possible e-scooter designs can help to alleviate this problem. This could include:

- Larger wheels for increased stability on rough or damaged surfaces
- Better lighting to detect rough surfaces or obstacles in time to safely brake
- Wider footplates
- Requiring or promoting seated, rather than standing, shared e-scooters
- Provision of a selectable or programmed "beginner" mode with lower acceleration.

There is a need to research whether lighting on e-scooters is appropriate to indicate their presence in on-road bicycle lanes to motor vehicle drivers. The rear lights on e-scooters are low to the ground and may be more likely to be obscured or not in the driver's line of sight (or normal scanning pattern).

Some electric scooters are equipped with features that enable riders to use them in a seated position. Figure 1 illustrates sitting and standing postures while using e-scooters. The relatively recent introduction of seated e-scooters means there were no available crash or injury publications regarding their safety compared to standing e-scooters but mathematical modelling has demonstrated that they are more stable under braking. Modelling demonstrated that shared e-scooters have a lower and further forward centre of gravity, providing increased stability and reducing the risk of falling or crashing (Paudel & Fah Yap, 2021). The authors point out that this is particularly advantageous for individuals with limited balance or less familiarity with two-wheeled vehicles.

The Beam shared e-scooter company offers seated options in cities such as Brisbane and Canberra. Both tourists and riders under the influence are at risk of falling off e-scooters due to lack of experience or intoxication. Using a seated e-scooter has the potential to reduce the occurrence and severity of injury, although further studies should examine whether the lower height may impair visibility of the e-scooter to motorists.

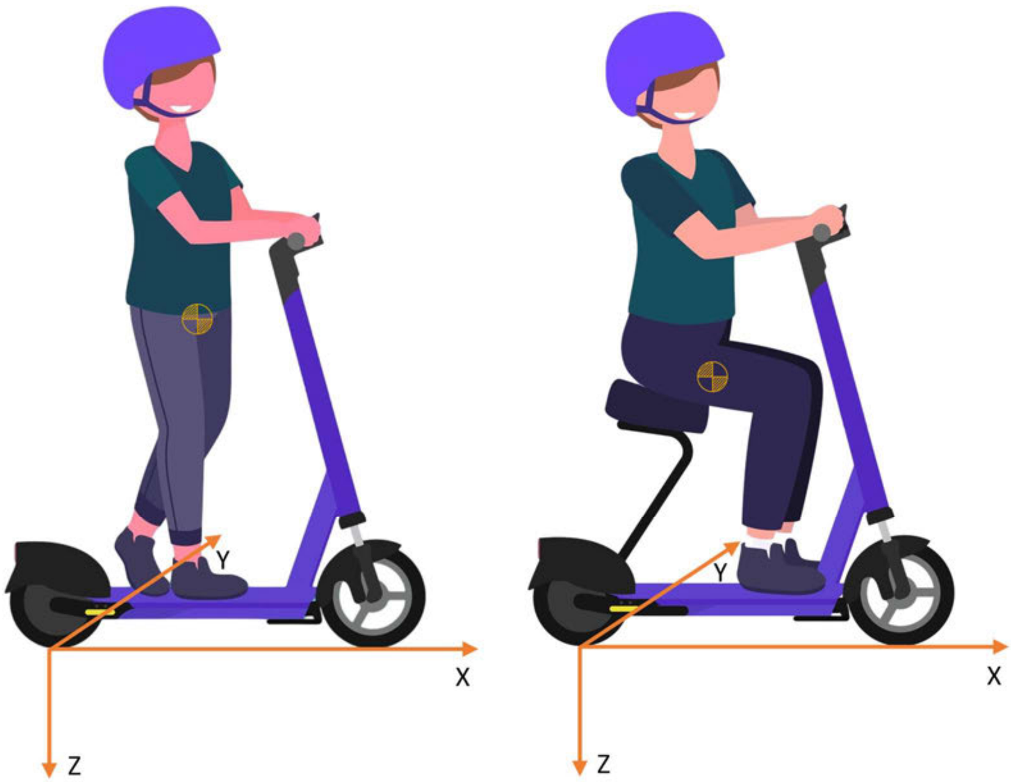

Figure 1. Standing and sitting postures on e-scooters (from Paudel & Fah Yap, 2021)

4.3.7 Infrastructure improvements

Improvements to the road surface quality and ensuring regular removal of debris which collect in on-road bike lanes will mitigate risk of falls from e-scooters. E-scooters have smaller wheels and are more subject to surface irregularities than bicycles. Falls in bike lanes can directly result in injury from hitting the road surface or the kerb, or potentially lead to falling into the path of motor vehicles. International research shows that falls are a greater contributor to injuries to e-scooter riders than collisions with motor vehicles, even in jurisdictions where on-road use is allowed. Cleaner, smoother on-road bike lanes would also encourage their use by PMD riders.

Risks to both PMD and bicycle riders in on-road bike lanes can also be mitigated by converting on-road bike lanes to protected bike lanes. Conversion of on-road bike lanes to protected bike lanes on roads with speed limits of higher than 50 km/h would also improve rider safety.

4.4 The need for better data

Regardless of which regulatory options are adopted, better data on the safety of PMDs for both riders and pedestrians is sorely needed. This requires the ability of police reporting systems to identify PMD riders involved in crashes and to identify those pedestrians who were struck by e-scooters.

For example, in Queensland, collisions between PMD riders and pedestrians were originally not “road crashes” because no vehicle was involved. In addition, crashes between PMD riders and vehicles could not be directly identified in road crash data because the PMD rider is coded as a pedestrian. The TMR Discussion Paper acknowledged that allowing PMDs to use on-road bike lanes will increase interactions with motor vehicles and therefore crashes. It stated that this will need to be balanced against increased perceptions and actual safety of pedestrians. To be able to establish the outcome of this trade-off will require an improved ability to routinely identify e-scooter crashes in the road crash data, without having to rely on special studies of hospital injuries (which generally lack detailed location information).

Given the current definitions of what constitutes a road crash, pedestrians falling over e-scooters parked on footpaths are not counted as road crashes. Therefore, to monitor trends in these incidents, they need to be able to be identified in hospital data collections.

5. THE EXTENT THAT E-MOBILITY DEVICES HAVE POSITIVE COMMUNITY BENEFITS SUCH AS ENCOURAGING MODE SHIFT, RELIEVING CONGESTION, ADDRESSING SOCIAL DISADVANTAGE AND TOURISM (f)

This section focuses on what research by CARRS-Q and others has demonstrated regarding the effects of e-scooter use on mode shift and they potential implications of those findings. It then provides some brief comments on the extent to which e-mobility devices may be impacting on social disadvantage. We have not discussed benefits for tourism because that is outside the scope of our expertise.

5.1 Mode shift

Powered micromobility has been proposed as a solution which can provide a 'first and last mile' mobility option to improve access to public transport and an 'only mile' option for replacing cars for short trips (European Environment Agency, 2020). The data provided by operators of shared e-scooter schemes supports the view that they are used mainly for short trips of about 1km in length. Our survey data from Canberra shows that 10.5% of trips were less than 10 minutes in duration, with 39% lasting between five and ten minutes.

The international evidence varies in terms of the extent to which e-scooters replace car trips. The percentages of e-scooter trips that replace car trips reported in evaluation studies from cities that have introduced shared e-scooter schemes have varied dramatically from less than 10% in European cities (Christoforou et al., 2021; Fearnley et al., 2020; Sellaouti et al., 2020) to between about a third and a half in US cities (City and County of Denver, 2021; City of Santa Monica, 2019; Portland Bureau of Transportation, 2018). Internationally, the opportunity for e-scooters to replace private car trips seems to be greater where more travel is by private car and less where public transport is readily available and popular.

In our Canberra survey, e-scooter riders were asked what modes of travel they would have used if the e-scooter was not available. About a third of e-scooter trips replaced driving (see Table 5) but this figure was greater for private than shared e-scooter trips (48% versus 28%). This pattern was also observed in our Brisbane survey, where 45% of private e-scooter trips replaced driving compared with only 15% of shared e-scooter trips.

A concerning finding internationally and in Australia is that e-scooter trips often replace public transport or walking and cycling, or generate new recreational trips, rather than reducing car travel (e.g., Christchurch City Council, 2019). Table 5 shows that about half ot Canberra e-scooter riders reported that their last e-scooter trip replaced a walking trip of at least 10 minutes, with this proportion being much greater for shared than private e-scooters (64.6% versus 28%). E-scooter trips also replaced cycling and public transport. In our Brisbane survey, 60% of shared e-scooter trips replaced walking, compared to 31% of private e-scooter trips.

Table 5. Mode replaced by e-scooter on last trip. Multiple responses allowed. Percent.

Mode replaced	Private	Shared	Total
Walking at least 10 minutes	28.0	64.6	53.1
Cycling	14.4	16.7	16.0
Driving	48.3	27.6	34.1
Public transport	17.8	15.6	16.3
Taxi/ ride share	12.7	16.0	14.9
None, I would not have travelled	11.9	7.8	9.1

Yellow highlight indicates significant difference between private and shared riders at p<.05

5.2 Implications of PMD use for the health of the community

Riding conventional bicycles provides physical and mental health benefits (Celis-Morales et al., 2017; Fraser & Lock, 2011). E-bike use has been shown to provide roughly half the physical activity of riding a conventional bicycle and thus also provides health benefits. E-scooters are generally considered to provide little or no physical activity, although little research has examined the effects of PMD use on physical activity and population health.

However, many studies around the world have demonstrated that many e-scooter trips replace walking and so may have negative effects on physical activity and, thus, physical health. The results of our international survey (see Šucha et al., 2023 for an outline) showed that e-scooters replaced walking for many trips and this was most evident for shared e-scooters and multimodal trips. Among multimodal shared e-scooter trips, 72% replaced walking for at least part of the trip, compared with 44% of private e-scooter trips. Both private and shared e-scooters also replaced cycling, particularly e-scooter only trips. In addition to the impact on environmental sustainability, several authors have expressed concern regarding the reduction in physical activity and therefore increased risk of chronic disease which may result (Fearnley, Berge, et al., 2020; Sanders et al., 2020).

In terms of motor vehicle use, we are not aware of any studies that compare any savings in motor vehicle use from shared PMD schemes with the use of motor vehicles to take the PMDs away for charging and then reposition them. However, a study of docked bicycle schemes (Fishman et al., 2014) showed that the extent of this use of motor vehicles was significant and outweighed the reduction motor vehicle use in some cities such as London.

Similarly, we are not aware of any research that measures the impacts on physical activity (and thus health) or substituting PMD use for walking and cycling for short trips.

From a broader policy perspective, the question arises: Should we make the same safety allowances for devices that have little or no health benefit as we do for the bicycle which has proven health benefits?

5.3 Addressing social disadvantage

Proponents of powered micromobility have claimed that it can "address social and economic disparities in mobility by providing reliable, inexpensive, and equitable transportation that links with transit and other modes" (McQueen et al., 2020). Nevertheless, concerns have been raised about the extent to which this is actually happening, with many US studies reporting that most users of shared e-scooters are white males. A recent review examined the extent to which US shared micromobility programs included equity requirements (Brown et al., 2024). Equity requirements can include:

- Alternatives to requiring a smartphone
- Possibility for cash payment compatibility
- Reduced rates for disadvantaged groups
- Multilingual services

- Adaptive vehicles for users with disabilities
- Requirements to service disadvantaged areas

The authors reported that 62% of shared micromobility programs had at least one equity requirement, although only 46% included more than one. They recommend that equity requirements be set out in operating agreements between shared e-scooter companies and local governments, that operational incentives be provided if companies attain specified equity outcomes and that undertaking and evaluating pilot programs could enable learnings and improved outcomes.

Another aspect related to social disadvantage is the high level of concern from people with sensory impairments regarding their fear of bit hit by or falling over e-scooters on footpaths.

While little independent research is available, e-scooters, particularly seated, may improve mobility for people with mobility impairments. As noted earlier, the Beam shared e-scooter company offers seated options in cities such as Brisbane and Canberra. The company has stated that seated e-scooters address the needs of diverse riders including seniors and those with limited mobility (Beam, 2024).

6. BEST PRACTICE IN OTHER AUSTRALIAN AND INTERNATIONAL JURISDICTIONS (h)

Our focus in this section is on best practice in terms of safety for users and the community.

The lack of evaluation of outcomes in a coherent manner across jurisdictions means that it is difficult to establish what is best practice from the perspective of safety. One barrier to evaluation has been simply the relatively short time since e-scooters were first introduced. Secondly, e-scooter regulations and the characteristics of e-scooters have changed. Thirdly, there has been poor capture of injury outcomes and relatively poor data on the amounts of riding that have prevented robust estimations of safety risks.

For example, the Queensland e-scooter regulations have evolved over time. Initially, e-scooters (then termed "e-rideables") were not allowed to be ridden on roads with any markings (which effectively prohibited their use on on-road bike lanes), or multi-laned roads or roads with a speed limit of over 50 km/h. Thus, there were very few situations where it was legal to ride on the road and so most riding had to occur on footpaths or off-road paths. Under the original rules, the speed limit for e-scooters was 25 km/h on both footpaths and roads. E-scooters (as e-rideables) were defined as "devices" rather than "vehicles" which meant that many road rules related to vehicles did not apply to them. Not being vehicles also meant that e-scooters were recorded as "pedestrians" in road crash data. A collision between a pedestrian and an e-scooter was not a "road crash" because there was no vehicle involved. Unfortunately, the effects of these changes on e-scooter and pedestrian safety have yet to be evaluated.

Unlike other devices or vehicles for transport and recreation, the major use of PMDs was initially as part of shared schemes. Thus, most of the limited data available about PMDs and their safety and usage relate to these shared schemes, rather than private use. Many pundits are predicting that private use will grow, and potentially overtake shared schemes. Therefore, it is important that any regulatory approach cater to both forms of use, and not be clouded by current knowledge that is biased toward shared models.

Best practice models should consider the potential differences between private and shared personal mobility devices. These relate to:

- The greater range of regulatory controls that might be possible for shared PMDs (e.g. geofencing)
- The degree of ruggedness required of the manufacture to ensure that safety standards continue to be met
- Possible differences in skills and motivations of users
- Ability to enforce compliance and apply penalties for noncompliance

Implementing strict rules for shared e-scooters in conjunction with private e-scooters being legal could have unwanted consequences. While the primary aim of strict regulations may be to enhance safety, there is a potential risk that such actions might unintentionally deter people from using shared e-scooters and steer them towards owning private ones, which can be more challenging for authorities to regulate successfully. Based on the experience in Brisbane, the introduction of shared e-scooters did not decrease the use of private e-scooters; in fact, it was associated with increases in their usage. In the Brisbane CBD, there were 7.7 shared e-scooters observed for every private e-scooter in Feb 2019, which fell to 1.8 in October 2019, and then to 1.3 in October 2021 (Haworth & Schramm, 2023). TMR observational data from October 2022 suggests that there are more private than shared e-scooter trips, particularly outside the CBD. There is little published research on why people might change from using a shared e-scooter to buying their own e-scooter. However, there is widespread speculation that the relatively high cost of regularly using a shared e-scooter, particularly for longer trips, may lead users to purchase their own e-scooter. Research underway at CARRS-Q is seeking to shed light on this issue.

Best practice approaches to e-scooter regulation should not incentivise e-scooter use over other forms of micromobility which may have better health or environmental outcomes. Introducing a scheme for sharing e-scooters in areas where shared bicycles or e-bikes, may lead some users to transition from using shared e-bikes to shared e-scooters. Research by Yang et al. (2021) conducted in Chicago revealed that the introduction of an e-scooter sharing program resulted in a 10.2% decline in bike sharing ridership within the same operational area, potentially causing financial losses for operators of shared e-bikes. Additionally, it is important to consider differences in helmet usage between users of these two modes. According to Haworth et al. (2023) non-use of helmets in Brisbane in October 2021 was more common among riders of shared e-scooters (40.9%) than shared e-bikes (31.1%). Thus, any transfer from shared e-bike to shared e-scooter use could result in a net increase in riders with head injuries.

There is a common view that e-bikes are safer than e-scooters but this is disputed by some (particularly operators of shared e-scooter schemes). Most published comparisons of their relative safety have had significant limitations (e.g., failing to correct for differences in trip lengths or the types of infrastructure used or shared or private use). Nevertheless, the likelihood that riders will have some previous experience and the stability of the vehicle is greater for e-bikes than e-scooters.

If significant growth in e-mobility occurs, particularly as a transport mode and not mainly recreation, then there will be a need to examine the future capacity of facilities and what types of uses should be prioritised. This may involve considering whether growth in e-mobility will require dedicated e-scooter lanes, or shared e-mobility lanes, or whether there will be a need to widen bike paths or shared paths to provide sufficient capacity. Some discussion is occurring regarding the potential for road space allocation to consider kinetic energy and dimensions of vehicles/devices rather than being prescriptive regarding the specific users of particular allocated areas.

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Appendix 1

Table A1. Observational studies that reported risky e-scooter behaviours

Study	Location	# of observed riders	Helmet use %	Double riding %	Underage %
Arellano and Fang (2019)	San Jose, CA	330	2		
Haworth and Schramm (2019)	Brisbane, Australia	785 *[1]	61.7 *[2]	2	1 *[3]
Haworth et al. (2021a)	Brisbane, Australia	1206 Shared 359 Private	64 *[4] 94.8	2.1	0.6 *[2]
Huemer et al. (2022)	Braunschweig, Germany	253 *[5]	1.6	2	
Portland Bureau of Transportation (2018)	Portland, OR	128	10		
Siebert, Hoffknecht, et al. (2021)	Berlin, Germany	777	0	5.1	
Siebert, Ringhand, et al. (2021)	Berlin, Germany	2972	0.8	3	
Sparks et al. (2019)	Los Angeles, CA (UCLA)	1390	1.8		
Todd et al. (2019)	West Los Angeles, CA	171	10.9	1.2	4 *[6]

**[1] 698 shared, 87 private e-scooters. *[2] 35% not wearing a helmet, 3.3% unfastened helmet.*
**[3] Must be 12 and supervised or 16 to ride. *[4] 10% unfastened or carrying helmet.*
**[5] 186 shared, 67 private e-scooters. *[6] 18 years, legal age.*
Source: Table 1 from Janikian et al. (2024).

Table A2. Hospital injury studies that reported percentages of e-scooter rider risky behaviours.

Authors	Location	# of patients	Males %	Helmet Use %	Alcohol %	Underage Riding %	Double Riding %
Alwani et al. (2020)	Indianapolis, IN	89	65.2	0	14.6	6	-
Anderson et al. (2021)	Atlanta, GA	227	65	2.9	19	-	-
Austin Public Health (2019)	Austin, TX	160	55	1	29	-	4.4
Badeau et al. (2019)	Salt Lake City, UT	50	50	0	16	-	-
Bauer et al. (2020)	Scottsdale, AZ	61	57	-	28	-	-
Beck et al. (2019)	Dunedin, New Zealand	55	61	2	13	13	7
Bekhit et al. (2020)	Auckland, New Zealand	770	56.1	-	26.8	3.3	-
Blomberg et al. (2019)	Copenhagen, Denmark	130	42.9	3.6	36.6	5.4	-
Bloom et al. (2021)	Los Angeles, CA	248	57	3	9	2	-
Cicchino et al. (2021)	Washington, D.C.	105	52	2	12	-	4
Cruz et al. (2022)	London, UK	83	83.1	34.1	7.6	16.9	-
Dhillon et al. (2020)	San Diego, CA	87	71.3	18.4	17.2	-	-
English et al. (2020)	Austin, TX	124	59.7	1.6	14.5	-	-
Faraji et al. (2020)	San Diego, CA	203	58.6	-	45.8	3.4	-
Harbrecht et al. (2021)	Cologne, Germany	59	40.7	0	15.25	-	-
Hennocq et al. (2020)	Paris, France	125	63	12	49	2.4	14
Ishmael et al. (2020)	Santa Monica, CA	73	50.7	-	-	5.5	-
Kim et al. (2021)	Korea	284	65.1	1.4	11.3	-	0.7
Kobayashi et al. (2019)	San Diego, CA	103	65	2	48	-	-
Lavoie-Gagne et al. (2021)	San Diego, CA	442	61.3	2.5	27.1	-	-
Liew et al. (2020)	Singapore	36	66.7	5.6	-	-	-
Mayhew and Bergin (2019)	Auckland, New Zealand	63	57.1	6.3	-	-	-
Mitchell et al. (2019)	Brisbane, Australia	54	51.9	46	27	-	-
Moftakhar et al. (2021)	Vienna, Austria	175	65.7	-	4	-	-
Oksanen et al. (2020)	Turku, Finland	23	70	0	91	-	-
Portland Bureau of Transportation (2018)	Portland, OR	176	60	3	16	-	-
Portland Bureau of Transportation (2020)	Portland, OR	66	62	-	7	-	-
Puzio et al. (2020)	Indianapolis, IN	92	57	-	33	-	-
Shah et al. (2021)	Nashville, TN	52	69	-	4	13	-
Shiffler et al. (2021)	Los Angeles, CA	165	73.9	1.2	12.1	-	-
Siow et al. (2020)	San Diego, CA	485	61.9	2.9	29.1	4	-
Stigson et al. (2021)	Sweden, Stockholm	321	57	13	-	-	-
Störmann et al. (2020)	Frankfurt, Germany	76	69.7	1.3	-	2.6	-
Suominen et al. (2022)	Turku, Finland	104	61	3.8	71	-	-
B. Trivedi et al. (2019)	Dallas, TX	90	62.2	0	17.8	7.7	-
T. K. Trivedi et al. (2019)	Los Angeles, CA	249	58.9	4.4	4.8	10.8	7.8
Uluk et al. (2022)	Berlin, Germany	248	52	1	20	-	2
Wüster et al. (2021)	Berlin, Germany	43	74	2	28	-	2
Yarmohammadi et al. (2020)	San Diego, CA	34	74	0	74	-	-

Source: Table 2 from Janikian et al. (2024). Studies where more than 50% of data are missing for each of the risky behaviours have been removed.