

Evaluating the impacts of personal mobility devices (e-scooters) in Central Brisbane

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Abstract

The popularity and demand for e-scooters in Brisbane, Australia has continued to grow since their adoption in 2018. This paper presents the findings to date of a research project which aims to evaluate the impacts associated with these devices in Central Brisbane. So far, it is evident that there is a lack of research surrounding the impacts of e-scooters across Australia, from both a safety and an operational perspective. Recently there has been an increase in crash data analysis relating to e-scooters in Brisbane but there is still limited research on these devices, specifically research that considers both safety and operation together. The State of Queensland has classified e-scooters as personal mobility devices and hence riders are considered as pedestrians. This limits the infrastructure on which they can be used and currently they are not legally permitted in Queensland to be ridden on on-road cycle lanes or roads other than local roads with speed limits less than 50km/h. The adoption of these devices varies substantially between Australian states, from New South Wales which has banned these devices on public land, to Queensland which has the least restrictive laws. While only the state has regulatory authority over whether/how devices are operated by the rider, local government may restrict or support the presence of devices on its land and/or infrastructure. Consequently, uptake of e-scooters has created a user class whose implementation and management are dependent on both levels of government working together. It has also been evident that crash data relating to e-scooters is difficult to ascertain, with much of the existing e-scooter crash research informed by hospital admissions data. Based on the information found so far, we have developed a questionnaire and observational survey to further understand existing opinions on the devices, and the existing safety and operational impacts of the devices respectively. At the time of submission, survey data is still being collected.

1. Introduction

Electric scooters (e-scooters) are becoming increasingly popular within society. Brisbane is an example of a metropolitan area where there has been rapid uptake in both private and shared e-scooters. With the increasing use of this modern transport mode, safety and operation of electric scooters need to be further explored. This paper will discuss our research on the safety and operation of e-scooters within the Brisbane Central Business District (CBD). It will first summarise a review of existing academic literature on the topic and outline the gaps in research that need to be addressed. The current environment in which e-scooters are operating in Brisbane will then be explained, followed by an evaluation of policy, planning and safety considerations. Based on various meetings and discussions in this research, the perspectives of actors in the system will be described. The paper will then cover the rationale of some key

activities that we propose to undertake as part of this research in the near future. Lastly, some recommendations will be provided with respect to e-scooter use, its safety and operation, based on what is understood this far.

2. Literature review

It is necessary to understand the current research on safety and operation of electric scooters. The most useful academic resources were in the form of journal articles and conference proceedings, most of which were international studies. The research identified a number of safety concerns and operational issues associated with electric scooter use around the world. International studies identify that riding on footpaths and riding on-road both impose safety risks on different road users; e-scooter regulations differ between different countries; misuse of e-scooters has contributed to the number of crashes and crash severity and weak law enforcement and lack of awareness of laws are a key part of the issue (Yang et al. 2020; Oh and Kim 2021). International studies also identify the need for improved public awareness and new safety measures to reduce crashes. Some studies have also suggested that using e-scooters on physically separated cycleways, as opposed to on footpaths or roads, could improve safety for all road users (Oh and Kim 2021). Research previously conducted in other countries was predominantly based on policy review or crash data developed by hospital injury data or media news reports. A number of the issues identified and solutions proposed have not yet been explored in Australia.

Whilst existing academic literature on the research topic is predominantly set overseas, a limited number of Australian studies exists. Haworth, Schramm and Twisk (2021) examined the misuse of electric scooters and bicycles, as well as their interaction with pedestrians. They recorded observations at six different sites within the Brisbane CBD and found that a number of e-scooter riders broke the regulations due to either not wearing a helmet, riding on the road instead of the footpath, carrying a passenger or a combination of these. They observed fewer instances of these regulations being broken by cyclists.

Jamieson Trauma Institute (JTI) is currently investigating the safety of electric personal mobility devices (e-PMDs). They identified the need for key stakeholders to further develop safety strategies, injury and safety data to be better captured, and incentives for e-scooter users to comply with regulations. They also recommend that hours of operation for e-scooters are restricted to avoid high risk periods, and a portion of revenue from shared schemes be dedicated to injury surveillance system development and increased enforcement funding. JTI continues to chart reviews to better understand characteristics associated with e-scooter crashes and injuries (Ozanne-Smith and Vallmurr 2021).

With limited research surrounding electric scooters within Queensland and more specifically within the Brisbane CBD, the factors influencing e-scooter safety and operation within this location are not yet well understood. Our research fills this gap in knowledge by investigating the existing safety and operational implications of e-scooter use within the Brisbane CBD and evaluating potential solutions to these issues which have not yet been explored in depth, or at all. Whilst existing research is predominantly based on policy review or analysis of injury/hospital data, we will use a mixture of four techniques to investigate the impacts of e-scooters, providing a more holistic perspective on e-scooter issues and potential solutions.

3. Existing Brisbane e-scooter operating environment

Shared e-scooters were first introduced in Brisbane in November 2018 when the Queensland Road Rules were amended in December 2018 to allow devices up to 25km/h and up to a mass of 60kg to operate (O’Keeffe 2019). Following an extended trial period in 2019, Brisbane City Council moved to call tenders from shared scheme operators to enter into operating agreements in Brisbane with an original cap of 1,000 devices (White 2019). In the second round of operating agreements entered into in July 2021, this cap was increased to 2,000 shared devices throughout the city.

Since the introduction of these devices, it has been observed that personal devices have become more accessible as they become cheaper and more widely available whilst increased shared device availability has made them more utilised. This increase in popularity was presented in Brisbane City Council’s (BCC) *Brisbane’s e-mobility strategy 2021-2023*, reproduced herein for ease of reference in Figure 1, and shows that excluding the impact of coronavirus, shared demand has remained at around 5300 daily trips (Brisbane City Council 2021).

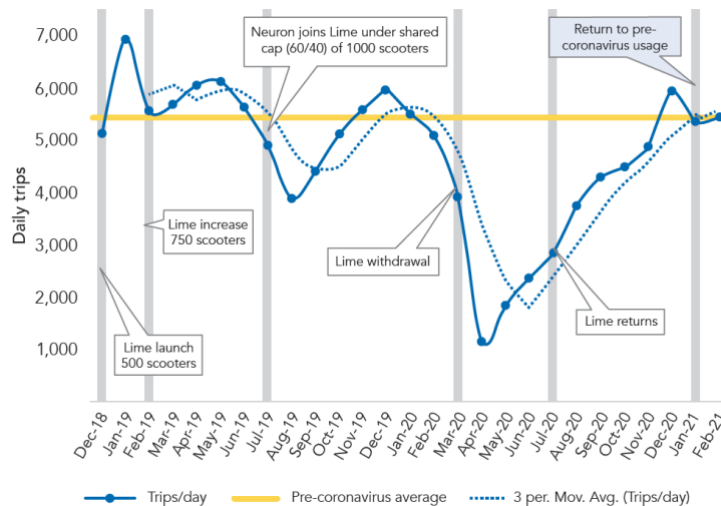


Figure 1: Average e-scooter trips per day 2018–2021 (Brisbane City Council 2021)

Industry advice is that the optimum daily utilisation is when devices are seeing 5 trips per day (pers. comm. 2021). This is based upon the balance of maximising returns and ensuring availability and convenience. It is important to note that unmet demand may exist due to caps on devices for hire, therefore latent growth in demand for hire e-scooters may not be evident in Figure 1.

As devices become more accessible, local and state governments and the Commonwealth Government require more information and analysis to guide the development of harmonised policies and regulations that address safety and operational effectiveness.

4. Policy, planning, and safety considerations

4.1. Powers and responsibilities of governments

The use of shared and private e-scooters and the regulations surrounding these devices differs between countries, states within Australia, and local government areas within these states. To understand why this occurs, the responsibilities of different levels of government and their level of power on e-scooter laws, regulations and policies need to be established. This is summarised for Australia in Table 1. For information, laws can be implemented at all levels of government and specify the legal expectations of society. Regulations and rules are put in place to

implement these laws. Laws, regulations and rules are legally-binding and enforceable by different authorities (federal police, state / territory police and Council officers). By comparison, policies are the principles or actions proposed to be undertaken by a particular level of government.

Table 1: Responsibilities and powers by level of government in Australia concerning e-scooters

Level of Government	Responsibilities	Powers
Commonwealth Government	Responsible for the classification of e-scooters for importation purposes and for ensuring imported devices fit within a specific size and power wattage.	Power to enforce importation laws.
State/ Territory Governments	Responsible for road rules and regulations which must be adhered to and are enforceable by Queensland Police Service. Responsible for state classification of devices for the purpose of state regulations and rules. State governments are also responsible for developing appropriate infrastructure on the portion of the network that they control.	Power to decide whether e-scooters are permitted and with what restrictions (speed, helmet use, age, transport facilities which riders are permitted to use etc).
Local Government	Responsible for permitting shared e-scooter schemes to operate and to what capacity. Responsible for improving safety/operation of e-scooters within local area through local policies and laws. Also responsible for developing appropriate infrastructure for these devices to operate.	Have the power to designate low speed zones and areas in which these devices are prohibited from being ridden. Have the power to implement incentives and build infrastructure for road users.

The Commonwealth Government is not heavily involved with e-scooter use beyond importation laws. By comparison, state/ territory governments carry the greatest responsibilities and powers with respect to the safety and operation of e-scooters, through setting and implementing state regulations and rules. Local governments have some powers with respect to the safety and operation of e-scooters, through implementing local policies and laws. These are particularly around limiting parking, use of devices in certain areas and on certain infrastructure, however these local laws and policies cannot contradict state regulations.

4.2. State regulations

We reviewed existing e-scooter regulations and rules within Queensland and other states and territories of Australia to understand how state regulations vary. Table 2 compares e-scooter rules between states/ territories.

Table 2: Comparison of state/ territory rules and regulations

State / Territory	Private E-scooters	Shared E-scooters	Speed Limit	Rider Age Limit	Operating Hours
Queensland	Yes	Yes	25km/h	16, or 12 with adult supervision	All hours
Australian Capital Territory	Yes	Yes	Varies ¹	12, or any age with adult supervision	All hours
Western Australia	Yes	Yes	10km/h	-	Daylight hours only
Victoria	Yes	Future trials proposed	10km/h	-	Daylight hours only
Tasmania	Yes	Future trials proposed	10km/h	-	All hours
New South Wales	No	No	-	-	-
Northern Territory	No	Undergoing trials	15km/h (trial)	18 (for trial)	All hours

State / Territory	Private E-scooters	Shared E-scooters	Speed Limit	Rider Age Limit	Operating Hours
South Australia	No	Undergoing trials	15km/h (trial)	18 (for trial)	All hours

¹15km/h on footpath, 25 km/h on bike/shared paths & 10km/h when using a crossing

Some states allow both shared and private e-scooters to operate in public, whilst others do not permit them in public at all. For all states where e-scooters are permitted (shared or private), they must give way to pedestrians, keep left on paths, the rider must wear a helmet and cannot be under the influence of alcohol, cannot use a mobile device whilst riding, and only one person is permitted per device. Regulations also differ about where the e-scooters are permitted to be ridden. Within Queensland, Western Australia, Victoria and Tasmania, e-scooters are permitted on footpaths, shared paths and roads with a speed limit less than 50km/h, no dividing line or centre median and no more than one lane if the street is one-way. It therefore follows that within Queensland, since e-scooters are not permitted to be ridden on any other roads, they are therefore not permitted on CBD multi-lane roads; of which most CBD streets are (The State of Queensland 2019; Department of Transport 2019; Victoria State Government 2021; Department of State Growth 2021; Road Rules 2019 (Tasmania)).

In the Australian Capital Territory (ACT), riders must use bike paths, shared paths or separated paths and footpaths. E-scooters are not permitted to be ridden on the road, unless no footpath or nature strip is available or if these facilities are impractical to use (Transport Canberra n.d.). In the Northern Territory, e-scooters involved in the trial must be ridden on footpath or shared path except for certain circumstances where these facilities are not provided or it is impractical to use them. Interestingly, e-scooters are permitted in bicycle lanes on the road (Northern Territory Government of Australia 2020). South Australia is adopting the same regulations as the Northern Territory for their trials, with the exception that e-scooters are not permitted to be ridden on bicycle lanes (Government of South Australia 2021). In New South Wales, no e-scooters are permitted in public. E-scooters may be purchased but only used on private property (Transport for New South Wales 2018).

4.3. Brisbane City Council policies

Within Queensland, e-scooters are permitted on the footpath and on separated cycleways. This includes a number of recently constructed on-road cycleways such as the CityLink Cycleway and Woolloongabba Bikeway, which are classed as separated cycleways due to marked, raised solid barrier physically that separate the cycleway facility from the traffic lane/s. Figure 2 illustrates a section of the CityLink Cycleway.



Figure 2: Section of CityLink Cycleway, Edward Street, Brisbane CBD

Brisbane City Council has also designated a number of prohibited areas within public space that it controls, including Queen Street Mall, Reddacliff Place, Brunswick Street Mall, Chinatown Mall and some pedestrian-only footpaths (Brisbane City Council 2019). There are also a number of low speed zones in or around the CBD. Whilst technological measures in place to ensure that shared e-scooters riders abide by these policies (due to the devices automatically slowing down in geofenced slow speed areas and alerting the driver when in a prohibited zone), these can be difficult to enforce for private e-scooter riders.

Considering the existing issues surrounding e-scooter use, Brisbane City Council recently published Brisbane's e-mobility strategy to share their perspective on existing issues and outline a roadmap for improving e-scooter use moving forward. Council worked closely with JTI and used their research and recommendations to help inform the strategy and identify solutions for BCC to explore (Ozanne-Smith and Vallmurr 2021). This strategy highlights that Council is very much in support of e-scooters and sharing schemes and recognises them as a key component for the future of active and sustainable transport in Brisbane. BCC is currently looking into future incentives, infrastructure, policies & enforcement for e-scooters (Brisbane City Council 2021). Given that e-scooters are currently being explored by various state and local governments throughout Australia, are a controversial topic among the public, and that potential exists for policy change in the near future, further research on this topic needs to be undertaken to inform decision making.

4.4. Safety considerations

With respect to the safety of e-scooters, it is important to consider them from both an historical perspective (historical crash data) and a future perspective (safety of the device and applicable infrastructure). Although there some research exists concerning historical e-scooter related crashes in Brisbane, it is limited in scope to crash events only. Although this approach appears to be typical for similar research conducted internationally, it does not consider typical Australian industry approaches to these sorts of assessments, i.e. considering the system holistically (safe systems approach).

As such, we consider it appropriate and necessary to review the impacts of e-scooters by analysing both historical crash data and the environment and infrastructure in which they operate. As part of this project, appropriate crash data will be sourced and assessed as has been done previously, with an intention to relate the crash data back to typical industry standard crash reporting rates such as crashes per vehicle-kilometres-travelled (VKT). This engineering approach will address the volume and rate of crashes rather than just reviewing individual crashes and their severity.

With respect to the infrastructure and facilities used currently by e-scooter riders, it appears that the current assumption is that cycling infrastructure or cycling design standards are appropriate to be applied to e-scooters. However, there is no research which has been identified about whether this assumption is correct, nor if any safety assessments for existing road infrastructure appropriately consider specific e-scooter needs.

Given this, we consider it worthwhile to investigate the extent to which the Road Safety Guidelines (*Austrroads Guide to Road Safety Part 6, Managing Road Safety Audits*) (Morgan et al. 2019) would appropriately consider e-scooters when auditing existing cycle infrastructure for e-scooter use, or whether additional factors need to be considered. Similarly, it is important to understand whether the infrastructure types upon which these devices are permitted to be ridden are appropriate and whether there are any inherent safety risks associated with a device by infrastructure type, such as a specific maximum gradient. In combination with the proposed

observational survey discussed in Section 6.2, we propose to undertake a Road Safety Audit under the supervision of a qualified Road Safety Auditor at one of the chosen survey locations as a case study to investigate key design factors which should be investigated further.

We will also review the *Cycling Aspects of Austroads Guides* (Taylor et al. 2017) to identify potential future research focuses on which design elements may or may not in fact be appropriate for application to e-scooters. For example, it will be important to consider whether the cyclist design envelope, which is commonly utilised in the design of cycle lanes or infrastructure, is applicable to e-scooters. Similarly, it is important to identify the aspects of these guides which should be a key focus when designing infrastructure for both e-scooters and cyclists.

Although design principles are being considered predominantly for the use of e-scooters in inner city environments, given the rapid adoption of these devices, it follows that in future design standards and guidelines it may be required to be applied in less dense urban environments. Development of guiding engineering principles for e-scooter adoption would be advantageous now whilst in the early stages of adoption before e-scooter are prevalent in more areas of Brisbane and other places in Queensland.

5. Perspectives of actors in the system

Over the course of the project to date, we have identified five (5) key actors with respect to the safety and operation of e-scooters in the Brisbane CBD. These key actors identified are Brisbane City Council (BCC), Queensland Department of Transport and Main Roads (QTMR), Queensland Police Service (QPS), shared e-scooter operators such as Neuron and Lime, and the Australian medical industry.

As was highlighted in the previous section, QTMR is responsible for the general oversight and implementation of these devices at the state level through state policy and legislation. It therefore has a more general responsibility to maintain the safety of all road users, whether they be pedestrians (including e-scooter users), cyclists, or drivers. QTMR ensures that the introduction of these devices will not pose significant additional safety risks to existing road users. QTMR engineering and data representatives have identified that the department's principal priority is road user safety and that several challenges exist when considering the safety concerns or impacts which these devices may pose to either riders or other road users (pers. comm. 2021).

Challenges exist concerning availability of device related crash data for purposes of analysis. QTMR's vehicle crash database is informed by QPS Incident Reports, which by our understanding are predominantly composed of vehicular related crashes (bicycles included given their legislative definition). Given that in Queensland e-scooters are classified as pedestrians, it is likely that a number of e-scooter/pedestrian or single device crashes are not reported to this database. Further, QTMR's database only captures crashes that occur within the road reserve. For e-scooters, we expect that many crashes would occur off road or would not be reported to police, and therefore not contained in the available crash data. As with any device or vehicle, this database would also not capture any near miss events.

We found through discussion with QTMR representatives that should e-scooters be reclassified to more accurately capture crash events, it would not likely yield statistically significant results. Beyond the significant system changes that would be required from both QPS and QTMR, it is understood that people are generally hesitant to contact QPS in the event of more minor crashes not relating to vehicles and so this change would not likely yield any more crash data. The

opinion of these representatives was that the most effective way to evaluate crashes for these devices going forward was to work with the health industry through hospital admission records.

BCC has limited jurisdiction regarding operation of e-scooters, however has control over the implementation of shared schemes through business plans with vendors. The introduction and growth of new technologies like geofencing has allowed BCC to enforce reduced speed zones in high pedestrian areas such as South Bank. A representative from BCC (pers. comm. 2021) noted that these speed zones are effective for shared device users, which automatically slow in these zones, but difficult to enforce for private e-scooters because personal devices are not speed limited via geofencing, and the reduced speed areas are set by BCC policy, which is not intrinsically enforceable by QPS.

The representative identified that enforcement of laws with respect to e-scooters was an issue BCC that is looking to improve with QPS. BCC is looking to improve enforcement around helmet use but is also looking to work with vendors to actively encourage helmet use. BCC is aware of the importance of e-scooter safety and the difficulties surrounding the analysis of appropriate and current crash data. As such, the representative identified that BCC is working with vendors to gain a more holistic view of crash events by reviewing and analysing vendor crash reports from the public and any other crash data they may have.

In 2021 BCC increased the cap of shared e-scooters from 1,000 devices to 2,000 devices. The BCC representative noted that they are anticipating continued growth in this market and that infrastructure and policy will need to be reviewed continually over the coming years. This raises the key role that BCC plays in the implementation and operation of these devices; balancing the needs of the vendors with community interests.

They noted BCC needs to ensure that they are providing the infrastructure and policy appropriate for the volume of devices that have been approved so that community interests are protected and to avoid street clutter. However, BCC must also ensure enough shared devices are permitted for the schemes to be financially viable for vendors, otherwise they may withdraw from the market. This is viewed as a poor outcome given that BCC perceives e-scooters to be an overall positive transport mode, providing an alternative last kilometre trip mode, which reduces inner city congestion (Brisbane City Council 2021).

It was ultimately evident that BCC is aware of where they need to undertake further research and are looking to conduct ongoing surveys to better understand e-scooter usage in the CBD and improve the way these devices are incorporated under their jurisdiction. The representative identified that BCC may investigate the potential for e-scooters to use on-road cycle lanes, to allow more e-scooter users to move off the footpath and provide a better environment for other pedestrians in the future. It was however noted that QTMR maybe reluctant to this proposition, possibly due to concerns of more severe crash injuries following the introduction of these devices on the road.

Our discussions with these actors have identified that a cumulative engineering research effort is required, combining a review of policy, legislation, and crash data. It is important, from a safe systems approach, to consider the exposure and likelihood of crash events involving e-scooters both on the road and on the footpath. Although it would be almost certain in the absence of significant historical data that an e-scooter/vehicle crash would result in more severe injuries than a pedestrian/e-scooter crash, the likelihood of each of these events should also be considered. These are aspects which to date, from the information available, have not been considered or reviewed in Brisbane or Australia, with most analyses of hospital admissions data considering the frequency of events without relating it to existing industry comparisons for scale.

It is evident from discussions with representatives from both BCC and QTMR that they are working together to arrive at solutions which are safe, benefit the community, and benefit vendors. The CityLink Cycleway trial is an example of new infrastructure developed in partnership so that it could be used by e-scooters by designing it to a separated cycleway standard. Regardless, it is evident that further research is required given the demand increase expected, with future research efforts needing to focus on holistic reviews of the situation rather than isolated elements of the e-scooter system in Brisbane.

In addition to discussions with government representatives, a number of medical institutes have been contacted to discuss injury data and also gather some insight into their role in the decision making for e-scooters. Discussions with representatives from Queensland Health and the Jamieson Trauma Institute (JTI) identified that they are supportive of our research and it could be useful for comparing to their findings (pers. comm. 2021). JTI is also currently investigating e-scooter crashes and factors associated with these crashes, to provide recommendations for improving the safety of these devices. Throughout this research, JTI has been in contact with BCC and JTI's research and recommendations to date have informed the Brisbane e-mobility strategy. This highlights the key role that current research is playing in establishing Council policies and strategies.

The Queensland Injury Surveillance Unit (QISU) was also contacted and we are currently in discussions with them to obtain some detailed injury data to use for analysis. Based on these discussions, it is understood that whilst injury data can be used to understand e-scooter crash characteristics, and safety issues more broadly, this data needs to be analysed carefully as it is not 100% accurate and is inconsistent with what is recorded for different incidents (pers. comm. 2021). This supports JTI's findings and recommendations that reliable crash data is not readily or easily available and there is a need for better systems to be implemented to capture this more accurately. This will allow a better understanding of the safety of these devices and how this has changed over time. In analysing the injury data for this research, we will need to work closely with JTI and QISU to ensure it is interpreted and evaluated correctly.

6. Rationale for questionnaire and observational survey

Based upon the information gathered and reviewed to date, we have developed a questionnaire and observational survey to gain a better understanding of existing user opinions and concerns surrounding e-scooters, and to observe the safety and operational impacts of e-scooters in Brisbane respectively.

6.1. Questionnaire

The purpose of this questionnaire is to gain an understanding of the existing use of e-scooters, awareness of regulations, perceived issues and potential solutions to these issues. It will take approximately six minutes to complete and include demographic questions, questions around how participants currently use e-scooters and bicycles, perceived issues associated with e-scooter use, and where participants believe the safest location for riding this device is, given different scenarios and considering different road users.

Two different groups of research participants will be involved: QUT students, and local cycle groups. QUT's Gardens Point Campus is located in Brisbane's CBD (Mianjin) while its Kelvin Grove Campus is located immediately to the north (Barrambin) of Brisbane's CBD. QUT students from any degree and any year of study can participate and all members from the local cycle groups approached can also participate. Involving these two different groups is aimed to provide insight on the topic from the perspective of different road users. For both groups, the questionnaire will be electronic and answered online via Qualtrics, the software on which the

questionnaire was created. To gather some meaningful data for analysis, the questionnaire will aim to capture responses from at least 100 QUT students and 100 cyclists from local cycle groups in Brisbane.

Given that this project is being undertaken by researchers from QUT, all activities using human participants require an ethical clearance from QUT's Ethics Committee. The questionnaire was classed as a negligible risk activity as it does not ask for any identifiable or sensitive information and is not expected to result in any risks above those imposed by day-to-day living (approval number 2021000406).

The questionnaire was published 6th July 2021, and the participants proposed to be involved have been approached. The questionnaire will be open for participation for a 2-month period. After this, it will be closed to allow sufficient time for results to be analysed. The findings of this questionnaire will be useful to compare how the community perceives e-scooters with what is observed through the other components of this research.

6.2. Observational survey

In order to gain an understanding of the existing operational impacts of e-scooters and potentially observe any obscure or noteworthy interactions, an observational survey was proposed at key active transport corridors in the Brisbane CBD. Specifically, it was proposed that surveys be conducted along South Bank, Woolloongabba Bikeway, and CityLink Cycleway. These locations have been identified as both key active transport corridors and key e-scooter routes. This would allow for the observation of e-scooters with both pedestrians and cyclists and allow for a holistic review.

So that more periods could be reviewed, we originally proposed this survey as a video survey allowing for a more efficient review of peak periods across a longer survey period. Whilst video surveys are conducted regularly within the public road reserve in industry for various reasons, this proposed video survey was not approved by QUT's Ethics Committee due to concerns regarding videoing in the public realm for research purposes. As such, the observational survey was re-proposed as an in-person survey where the project team would spend time at the survey locations recording events in-person. Given the length of the project, it is likely this type of survey will be approved but will be significantly limited in scope. As such, further observational surveys in other research settings would certainly be required to gain a firm understanding of the existing impacts and interactions between road users and e-scooters.

We hope that this survey will identify a potential spread between shared e-scooters and private e-scooters. Although BCC has identified that it records overall trip data on key cycleway corridors, it is not currently known how many private e-scooters are being used in Brisbane. Again, this survey will have a limited scope due to the in-person data collection, however will still provide an indication of how many e-scooters are using the corridors surveyed. Should vendor trip data be supplied by BCC, there is also the potential to scale the weekly total trips accordingly to gain a more holistic view of private e-scooter use in the city.

The intent of this survey is to also assess whether the infrastructure currently being utilised by e-scooters is appropriate through the identification of any potential challenges observed. Currently, e-scooters can utilise existing cycle facilities (excluding on-road cycle lanes) without any adaptations needed, however, we have not found research to determine whether this is appropriate. Although this is not the major focus of the observational survey, it will be valuable to observe how e-scooters navigate the infrastructure in each of the survey locations and if there are any trends in challenging obstacles. This will also feed into elements of the literature review surrounding Road Safety Audits and whether the auditing process and manual appropriately considers e-scooters.

Ultimately, the observational survey will investigate areas for future research whilst giving a brief insight into current operations and critical concerns for the immediate future. The observational survey, in combination with the other components of this research, will provide a more holistic review of e-scooters in Brisbane.

7. Conclusions and recommendations

Considerable progress has been made to date to further evaluate the impact of e-scooters in the Brisbane CBD. Predominantly, this progress relates to having a detailed understanding of the current e-scooter climate in Brisbane in addition to understanding broadly where future research should be guided. The key conclusions are:

- There is a lack of existing research relating to e-scooter use in Brisbane.
- E-scooter demand is expected to continue to increase over the coming years and warrants further detailed reviews to ensure the adoption and implementation of these devices is safe and appropriate.
- E-scooter legislation varies substantially between states across Australia.
- Brisbane City Council and Queensland Department of Transport and Main Roads must continue to work together to implement effective and safe legislation and infrastructure.
- Future research will be undertaken into appropriate e-scooter infrastructure, whilst also considering crash rates within accepted industry standard forms.
- Brisbane City Council has very clear objectives about further implementation of e-scooters in Brisbane.
- A questionnaire and observational survey will be undertaken to further understand existing opinions on and the impacts of e-scooters in Brisbane.

Based on these conclusions, the following recommendations can be made with respect to future research on e-scooters beyond this study:

- Due to limited research on e-scooters currently, additional research is needed to validate the findings of previous research and this study, to increase accuracy and confidence of what has been found.
- Once better systems for data collection have been implemented, more in depth and accurate research needs to be undertaken and monitoring of injuries and safety hazards needs to be ongoing.
- Further research is required to be undertaken from an engineering perspective, so that safety measures implemented are not only based on historical crashes but also provide preventative measures, reducing the risk of future crashes from occurring.
- Future research into e-scooters should consider the safest operating speed for these devices, whilst considering the other road users they are operating around, given the vastly different speed limits between states.

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