West of England E-scooter Trial Evaluation Final Report

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EXECUTIVE SUMMARY

The trial and its evaluation

The e-scooter rental trial in the West of England started in October 2020 and is part of an England-wide programme of e-scooter trials in cities and towns overseen by the Department for Transport (DfT).

There are two operating areas in the West of England. One covers a combined area within Bristol City and South Gloucestershire (referred to as Bristol). The other covers Bath city centre. The trial provides two rental options: Hop-on Hop-Off (HOHO) and Long-Term Rental (LTR). For the HOHO option, users pick up and drop off a scooter from parking locations. For the LTR option, users rent an e-scooter for their individual use for a longer period, available for one month on a rolling basis. Users of the LTR scheme can ride anywhere in the West of England Combined Authority area.

The Department for Transport has completed a national evaluation to understand the operation and impact of the e-scooter trials across all 32 trial locations. It is based on data collected between July 2020 and December 2021. The evaluation has shown the West of England trial has had the most rides by a significant margin. Based on December 2021 trip totals, the West of England has had broadly three times more trip making than the next most popular trial area. In the same month it accounted for approaching a third of the trip making within all the trial areas combined.

The national evaluation provides useful insights to national trends with some comparisons provided between areas. Given the significance of the e-scooter operations in the West of England, and a desire to learn from the trial to inform longer term policy, the Combined Authority commissioned a local evaluation within Bristol and Bath. It adds significantly to insights over and above those emerging from the national evaluation. Trial operator data and other datasets have been analysed in-depth. Several primary data sets have also been collected.

In the West of England, a significant number of users have adopted e-scooters into their way of life. People are using them to get to work/college/university and they support leisure and shopping. A high proportion of users are between the ages of 18 and 35, and the majority of users are male. Take-up has been high due to their ease of use and time saving around Bristol and Bath. E-scooters are replacing trips from all types of transport. The trial has reduced travel related carbon emissions. Data on e-scooter safety is not robust enough to draw firm conclusions, but e-scooter riding may be riskier than cycling. E-scooter users thought that better infrastructure is needed. A lower proportion of e-scooter riders wear a cycle helmet than cycle riders. People dislike e-scooters obstructing the footway and some people fear e-scooters being ridden. These two issues particularly impact blind or partially sighted people. Those responsible for running the trial recognise the importance of well parked e-scooters. The trial has benefitted from strong collaboration between the e-scooter operator, local councils, police, fire service, and the Combined Authority.

The remainder of this summary elaborates on these key findings based on the following themes: journeys, users and user benefits; transport mode choice and accessibility; impacts on health, wellbeing and carbon; safety; impacts on non-users; and implementation and management.

Journeys, users and user benefits

Number of trips and their distance. There have been over ten million trips made on rental e-scooters in the West of England since the start of the trial in October 2020 to the end of May 2023.

In February 2023, 371,916 trips were made in Bristol using a fleet of 3,070 e-scooters. These trips were made by 58,435 different users, representing the equivalent of 8% of the residents of the Bristol and South Gloucestershire local authority areas. 19,552 trips were made in Bath using a fleet of 363 e-scooters. These trips were made by 5,325 different users, representing the equivalent of 3% of the residents of the Bath and North East Somerset local authority area. The contribution to travel is highlighted by one e-scooter being observed for every 1.66 cycles based on traffic surveys carried out at eight sites in central Bristol in July 2022.

Trips using the rental e-scooters are largely short distance with three-quarters of trips less than 3.3 km in Bristol and three-quarters of trips less than 2.5 km in Bath. Morning and afternoon peak periods of use are clearly apparent on weekdays with the afternoon peak more intense with 28% of all rides occurring between 4pm and 7pm, as compared with 14% between 7am and 10am.

User characteristics and frequency of use. The users are predominantly younger adults with 85% of all trips across the trial areas up to April 2022 made by 18-35 year olds and 49% made by 18-24 year-olds. Only 1% of trips were made by those 55 and above. There are 1.8 times more males than females signed up to use the system, and 2.8 times more trips have been made by males than females.

About 15% of registered e-scooter users are active users who use the e-scooters at least once per week – this was 42,200 people in April 2022. Long-Term Rental (LTR) users made 5% of total trips and distance travelled in the trial area even though they only made up 1% of total users. Most Hop-on Hop-Off (HOHO) rides have been paid for on a pay-as-you-go basis (56%). Daily and monthly passes represented respectively 18% and 26% of the HOHO rides.

Motivations for use. Most users choose to use e-scooters due to their advantages over other modes (speed, convenience, cost and flexibility). Other users rent e-scooters due to a lack of alternative modes (poor public transport service, inability to walk to destination, not having a car or bicycle).

Journey purpose. The rental e-scooters have been used to a similar extent for work/education purposes and for social/leisure purposes (about four in ten trips for each). Personal business such as shopping, errands and medical appointments account for about two in ten trips.

Transport mode choices and accessibility

Modes e-scooters are replacing. Data from the trial operator surveys suggests that about two-thirds (range of 59%-70%, based on surveys at different times of year) of e-scooter trips are replacing walking, cycling and bus use with about one-third (range of 27%-37%) replacing car, taxi and ride-hailing. The most recent data for Bristol identifies modes replaced by an e-scooter in Bristol in descending order as walking (35%), bus (19%), car (17%), bicycle (15%) and taxi/ ride-hail (10%). 1% of trips would not have been made if an e-scooter was not available.

The trial operator’s Winter and Summer surveys had an under-representation of young (<35 years) e-scooter users and frequent users compared to total ride data. Both of these groups are less likely to have used a car instead of an e-scooter. Car replacement is greater amongst older users and less frequent users while bus replacement is more common among 18–34-year-olds and more frequent users.

Modal integration. The data available suggests that e-scooters are being used as part of a longer journey involving bus or rail for between 10% and 20% of journeys. In-depth interviews revealed circumstances where e-scooters are used to get to and from a railway station because this avoids the stress of an unreliable bus service or having to leave a bicycle at the station where it may not be secure.

Impact on travel routines. In-depth interviews of e-scooter users highlight that it has become the first mode of choice for travel within Bristol for some users and an option selectively chosen by others for particular situations. Rental e-scooters have been added to people's urban transport menu of options with the relative amount they are used varying from person to person. One user noted they might have considered getting a car if it was not for the availability of the e-scooters.

Ease of access to e-scooters. Initially, suburban and peripheral areas of Bristol were relatively less well served by the rental scheme, but expansion of the operating zone to the north-west in March 2022 and south in December 2022 resulted in a wider distribution of e-scooter parking zones across the city. An assessment of how e-scooter provision varies with neighbourhood-based deprivation in Bristol showed there was no clear pattern. In Bath the operating zone initially covered a central part of the city but was expanded to cover most of the city from summer 2022. Most users perceive access to e-scooters as being easy (87% of responses), but younger users (aged 18-29) find access easier than older users and non-disabled users find access easier than disabled users.

Access to destinations. 37% of all e-scooters users do not have access to a car. This figure is 66% for 18-24 year old users. 39% of Bristol users and 31% of Bath users said that e-scooters enabled travel to places not previously possible. Interviews highlighted that e-scooters facilitated exploration of the city, made it easier to visit family and friends and enabled some users to take on jobs which would not have been possible otherwise.

Health, wellbeing and carbon

Health and wellbeing impacts. E-scooter users recognised that using an e-scooter provides less exercise than walking and cycling, but some said e-scooters encouraged them to go out when they might not otherwise have done so. Nearly a half (45%) of e-scooter users considered that they contribute to wellbeing. Enhanced wellbeing was attributed to the 'fun' factor of riding e-scooters, the increased ease of reaching destinations and the pleasure of being outside.

Carbon emissions. The trial has resulted in a net reduction of lifecycle carbon emissions. For the 4.15 million rides in Bristol during 2021 the range of the estimate for the reduction is 6 to 238 tonnes of carbon dioxide equivalent. For the 206,000 rides in Bath the range is 5 to 7 tonnes. The range of the estimated reduction is wide mainly because of variability in estimates of the proportions of main modes replaced by e-scooter rides from the different survey data available. The size of the reduction is influenced strongly by the proportion of walk trips the e-scooter replaces.

The analysis used an e-scooter lifecycle carbon emissions rate of 65.2 gCO_2eq per passenger kilometre. A range of estimates was used for lifecycle carbon emissions for the modes the e-scooter replaces, and estimates were also made for direct (rather than lifecycle) emissions. Additional variability which cannot be accounted for with the data available includes travellers changing mode and destination at the same time. E-scooter journey lengths for the same trip may be shorter than, for example, car journeys they replace.

Safety

Perceptions of safety. One in ten riders say they feel unsafe riding an e-scooter and nearly seven in ten say they feel safe. Older people, women and infrequent users were more likely to report feeling less safe. E-scooter users thought that, for e-scooter use to thrive, there is a need for better infrastructure. Four in five respondents to the trial operator's Summer 2021 Survey regarded infrastructure (quality of roads and having enough cycle lanes) as important for safety. One in four were dissatisfied with the highway infrastructure. This response suggests highway infrastructure is a priority for intervention if usage is to increase.

Observations of interactions. Video-based observations of interactions in Bristol city centre revealed a very high number of near-misses, defined as when an e-scooter or cyclist rode within 1.0 metre of a parked vehicle or when a rider was overtaken by a vehicle leaving a gap of less than 1.5 metres. Observations recorded e-scooters and cyclists, with around 1,000 near-misses per hour of video at eight sites. 95% were with motor vehicles. This number is almost as high as the total number of e-scooters and cyclists passing through the sites and reflects multiple near-misses within the frame of the video. E-scooters are statistically significantly under-represented relative to cycles in near-misses with motor vehicles.

E-scooter riders are less likely than cyclists to have interactions with pedestrians. A similar proportion of e-scooter riders and cyclists ride through red signals and ride on footways. Cyclists were observed wearing helmets at a rate of 57% as compared with e-scooter riders at 9%.

Injury rates. STATS19 data (official road safety data collected by the police) indicates there were 46 casualties for the 43 collisions involving trial e-scooters in 2021. For comparison purposes, the trial e-scooter injury rate in the West of England is 0.530 casualties per 100,000 km ridden and the national urban cycling rate is 0.294 per 100,000 km. These rates suggest that trial e-scooter injuries may be in the order of 1.8 times more prevalent per kilometre ridden than urban cycle injuries in Great Britain. The accuracy of the estimate is questionable because there is known collision and injury under-reporting, and difficulty with estimating distance travelled. This comparison between cycling and e-scooter riding should be used with great caution.

Injured parties and locations of collisions. Exploring the STATS19 data further, a total of 97 casualties occurred in 86 collisions recorded in 2021 involving all types of scooter (trial, illegal and not identifiability either). Nine e-scooter riders suffered serious injury, with the remaining 88 injuries being slight. There were 13 pedestrian casualties, 8 cyclist or cycle pillion casualties, 6 e-scooter pillion casualties and 3 driver casualties.

64% of e-scooter collisions were not at junctions. This compares with the proportion of cycle collisions not at junctions in 2017 to 2019 in Great Britain of 26%. Hence, compared with cycling, there appears to be an over-representation of e-scooter collisions away from junctions. Based on interpretation of collision narrative descriptions, the driver of a vehicle (i.e., a vehicle other than the e-scooter) appears to be at fault in 38 of the recorded collisions while the e-scooter rider was at fault in 42.

Hospital data for the trial area. Hospital data for people injured in e-scooter incidents is available for a four-week period in May and June 2021. Most injuries occurred to the upper and lower limbs and the head and face and are reported to result from falls. Some falls may involve no other vehicle and it is known that most (non-motor) single vehicle collisions are not reported in the Avon and Somerset Police area.

Comparison of data from different sources. As well as the four weeks of hospital data, users self-reported injuries to the trial operator against three levels. Although these levels do not match the STATS19 descriptions, operator Level 2 and 3 injuries approximate to STATS19 slight and serious injury classifications. As such, an approximate estimate of the ratios of injury reporting between the three sources can therefore be made. The ratio of injuries in the STATS 19 to trial operator data therefore is 1:1.8 and in the STATS19 to hospital data is 1:10. This further indicates the difficulty in understanding injury rates due to different reporting methods and underreporting.

Impacts on non-users

Equality. While 67% of respondents to the on-street survey did not feel discriminated against by the deployment of the e-scooter trial, 15% did. Of those that did, disabled people were more likely to feel discriminated against (21%) than non-disabled people (13%). Black, Asian, and minority ethnic respondents and other non-white ethnic groups were also more likely to feel discriminated against (18% and 36%, compared to 11% for white people). The interviews suggested younger people feel more discriminated against because of the requirement to hold a provisional driving licence.

Parking. There were 902 parking locations in Bristol and South Gloucestershire and 117 in Bath. Trial operator data suggests mostly good parking compliance (88%), with 11% categorised as 'not ideal', and 1% as 'illegal' or unclassifiable. An e-scooter parking disposition survey in central Bristol found that 1.3% of e-scooters blocked the pathway used by pedestrians, and 15.8% were located on pedestrian pathways requiring pedestrians to swerve around them. Video observations show that e-scooters may interfere with pathways for walking for extended periods of time.

Responses from nine participants in follow-along surveys of non-users of diverse ages and disability statuses revealed the creation of barriers to access for pedestrians, a sense of risk and a sense of loss of pedestrian space, causing great concern for some.

Implementation and management issues

This section summarises outcomes mainly from interviews with stakeholders.

Parking. Parking location decision-making and management was developed over the course of the trial. Following the trial launch, it quickly became necessary for a process to be developed to define and agree parking locations with the operator, and this needed to be actively responsive. Stakeholders recognise that e-scooter parking needs to move out of the footway into the carriageway for a permanent scheme. This may require traffic regulation orders and physical infrastructure changes. One stakeholder suggested that the operator needs to approach third party land-owners, such as supermarkets, to agree additional parking locations outside the highway boundary.

Stakeholder observations suggest that geofences have not been accurate in defining a parking boundary, with the boundaries varying by up to 20 metres on some occasions. This means parking can spread beyond the parking boundary agreed with the local authority. Stakeholders thought that additional technology is needed to improve geofence accuracy, for example, by using local transponders. In addition, e-scooters could be parked with part of the vehicle outside the (accurate) boundary. These problems could be reduced by having enough parking in the right places and active management of user parking behaviour and its consequences.

Stakeholders recognised the value of geofence flexibility for large public events. This has involved much multi-agency working and brought travel benefits for the public. As a result, one stakeholder noted how e-scooters now form part of the infrastructure of Bristol.

Some stakeholders thought that hire e-scooter parking should be revenue generating for the local authority, in the same way as car parking can be. Penalties for poor parking may also generate revenue, requiring definition in an operator’s contract.

Highway characteristics. The footway, the carriageway and cycle tracks are all part of the highway. Stakeholders thought that cycle tracks are appropriate infrastructure for e-scooter use because e-scooter characteristics are like those of cycles. Surface roughness, potholes, and inadequate reinstatements by utilities enhanced the likelihood of falls from e-scooters.

Digital infrastructure. Digital data is valuable for planning, managing and operating e-scooters, and integration with travel applications such as mobility-as-a-service information systems. Data at a fine level of detail is available, such as knowing the ultimate origin of travellers based on when they open the app to search for an e-scooter. The on-board GPS provides knowledge of route selection. Stakeholders suggested these data could and should be more available to transport authorities.

Licensing and regulation. Stakeholders report that the legislative, regulatory, and licensing frameworks have been generally effective. Most stakeholders agree riders should hold a provisional driving licence, with one advantage noted as being they are subject to the same penalties as drivers, for example for riding under the influence of alcohol. No stakeholders called for private e-scooters to be made legal (though the question was not explicitly asked), with some suggesting their sale should be made illegal.

E-scooter users thought shared e-scooters could make a valuable contribution to cleaner urban mobility but were concerned misuse of e-scooters could lead to their withdrawal. As a result, e-scooter users themselves would welcome better enforcement of illegal practices.

Stakeholders want any further developments in national legislation to avoid creating additional time and cost burdens for highway authorities, for example in relation to traffic regulation orders. One stakeholder noted that the advent and value of geofences now requires focus on the need for law and regulation development linked with the ‘digital highway’. Highway authorities’ duties include managing highway space, and hence they need powers in relation to defining ‘digital spaces’.

Network performance. Based on the video-based interactions of e-scooters, there was no evidence they impacted on flows of motor traffic. This objective evidence is supported by stakeholders who generally had no, or only small, concerns about network performance. Stakeholders suggested e-scooters increased the capacity of the network for moving people because of their efficient size. Stakeholders also noted that e-scooters may enhance individual trip efficiency.

Commercial models. As with the bus industry, there is a dichotomy between profit maximisation and maximisation of social benefit. From a societal point of view, there are equity reasons for ensuring a hire scheme is widely available to all ages and abilities across all socio-demographic geographies. Some stakeholders therefore thought the operator contract should make service scope and coverage explicit, and that service delivery should be monitored.

Stakeholders noted they had contributed considerable time and effort to ensure trial success and that this is a hidden subsidy to the operator. They thought that, as a minimum, transport authorities need to cover their additional costs and that the commercial model should reflect such transactions.

Operations and governance. Stakeholders were satisfied with the overall operations and governance of the trial, while recognising that a lot has developed and been learned. Stakeholders suggested governance could be improved by inter-authority agreements. In addition, a tightly specified contract is required with an operator, possibly with performance incentives and penalties. Both these inter-authority agreements and operator contracts should be sufficiently flexible to allow for the development of technological capability.

Good quality monitoring of data is key and has evolved over the trial. Stakeholders generally thought that monitoring of operational performance could be further enhanced, particularly in relation to parking. One stakeholder suggested a locally based project manager should be required. E-scooter users thought operational matters requiring further attention were parking management, dealing with 'dead zones' where e-scooters cannot be used, and revising rules and messaging implying e-scooters are aimed at a young demographic. Cost competitiveness with bus services was also mentioned as a potential requirement if people are to continue using them.

Communications and education. The trial operator's primary communication method with users was via their mobile application. Stakeholders had conflicting views about whether the messaging had reached saturation, and there was concern about how messaging may be received by users. Some stakeholders see value in expanding the use of in-app messaging to advise of wider highway related matters, with the facility to do this needing to be specified in a contract with an operator.

Complementary applications. Some stakeholders thought that an e-scooter could be a good monitoring device for environmental measurements (e.g. air quality) and the infrastructure (e.g. road condition monitoring). Stakeholders thought that the data analysis would be a significant undertaking requiring a specialist sub-contractor and transport authority funding.

1 INTRODUCTION

1.1 Overview of the report

This report is the Final Report of the evaluation of the e-scooter trial in the West of England Combined Authority area. The trial is taking place within Bristol City, South Gloucestershire and Bath and Northeast Somerset and started in October 2020. The evaluation commenced fifteen months after the start of the trial in January 2022.

A preliminary analysis was produced in a Priorities Report in March 2022, which summarised data available to the evaluation team at that time. A Monitoring and Evaluation Plan (M&E Plan) was finalised in April 2022.

An Interim Report was issued six months into the evaluation period in June 2022 to assist the West of England Combined Authority in making decisions about the future of the e-scooter trial in the West of England area. To that end, a Prior Information Notice[i] was issued on 31st October 2022 regarding the opportunity to tender for the provision of an Integrated Micromobility Service (IMS), which would include e-scooter hire, e-bike hire and e-cargo bike hire.

This Final Report brings together a comprehensive set of results and findings on the impacts and experiences of the trial.

1.2 National e-scooter trials

The 'Future of mobility: Urban strategy' published in 2019[ii] set out the UK Government's approach to seizing the opportunity from new technologies to enhance urban transport. Micromobility vehicles, including e-scooters, were identified as a priority area with the intention to trial their use and examine how to regulate them. On 16th March 2020, the Government announced a call for evidence on the use of e-scooters and the impacts they have on other transport. It also confirmed that trials of new transport innovations, including rental e-scooters, would take place in four Future Transport Zones, one of which was to be in the West of England area.

A few days later, on 23rd March 2020, the Government introduced the first lockdown in response to the Coronavirus (COVID-19) pandemic. Restricted public transport capacity made it urgent to seek safe, convenient, affordable and low emission forms of transport as an alternative to public transport. In July 2020, the Government revised regulations to enable a larger set of rental e-scooter trials to take place than originally envisaged and gave the opportunity for all local areas in England, Scotland and Wales to submit proposals to run one-year trials.

The trials allowed e-scooter operators to provide e-scooters on the street for hire either with or without docking stations. Operators could offer short-term or long-term rentals. Users would be able to use rented e-scooters on roads, cycle lanes and tracks if they had a provisional or full driving licence. The main purpose of the trials was to gather evidence of the impacts of shared e-scooter schemes to inform future policy, legislation and regulation. With deployments in multiple locations,

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[i] See https://www.find-tender.service.gov.uk/Notice/030698-2022
[ii] See https://www.gov.uk/government/publications/future-of-mobility-urban-strategy

it was also an objective to learn how local characteristics affect outcomes, and to learn how to best implement schemes.

The first rental e-scooter scheme was introduced in Santa Monica (California) in 2017 with this rapidly followed by schemes in many other cities across the Americas, Asia, Australia and Europe. A growing body of evidence has emerged from outside the UK on how to deploy such schemes and some of the impacts arising from them. However, with e-scooters being illegal on UK roads until the rental e-scooter trials started, it was important to build the evidence base in the UK context. The West of England trial represented such an opportunity.

A national evaluation of the e-scooter trials was commissioned by the Department for Transport and has explored the operation and impact of the UK Government e-scooter trials, with a subset of trials being selected as case studies for in-depth investigation. The West of England trial is one of the case study areas selected. The DfT appointed Arup and NatCen to carry out the national study.

The West of England evaluation has been designed to complement the national evaluation. The evaluation activities include an analysis of data collected from three sources: the trial operator; other existing datasets; and additional research activities. When combined with results from the national evaluation, the evaluation will permit the West of England Combined Authority to better understand benefits, opportunities, and issues specific to the region. As a result of report timings, this report does not make specific reference to the outcomes of the national evaluation.

1.3 Description of the West of England trial

The rental e-scooter trial in the West of England was launched in October 2020 with an original end date of March 2022 which was later extended until the end of November 2022. The trial has been operated by a single private sector operator, referred to as 'the operator' throughout this report. In July 2022, the Government announced that existing rental e-scooters trials could continue to May 2024. As mentioned above, the West of England Combined Authority took the opportunity in November 2022 to invite tenders from operators, or groups of operators, for a new contract to operate a larger scheme to include the provision of e-bikes and cargo e-bikes.

The trial provides two different rental options: Hop-on Hop-Off (HOHO) and Long-Term Rental (LTR). With the HOHO option, users can pick up a scooter from one of the parking location in the operating area and leave the scooter in another parking location in the operating area. This is the traditional 'sharing' model where e-scooters are available to be used by anyone within the area of operation. There have been two operating areas in the West of England. One covers a combined area within parts of Bristol and South Gloucestershire and the other covers parts of Bath.

There are three different HOHO payment options as listed below, with prices current at December 2022:

- Pay-as-you-go: £0.99 to unlock and £0.16 per minute of use.
- Day pass: £7 for up to nine rides or 200 minutes per day with maximum of 45 minutes per ride.
- Month pass: £50 for unlimited free unlocks, nine rides or 200 minutes per day and maximum of 45 minutes per ride; or £35 pounds for unlimited free unlocks and 300 minutes per month.

LTR refers to a scheme that involves users renting a scooter for their individual use for a longer period of one month or longer. It hence allows use in a similar way to a private e-scooter (which are not currently legal to use on public land). The LTR scheme allows use across the whole West of England Combined Authority area and costs £35 per month at December 2022 prices.

There have also been discounted day and month pass fees available for particular groups as follows:

- A scheme offering a 50% discount for National Health Service, police, fire, military and other public sector workers (100% discount during the lockdown period).
- A scheme offering an 82.5% discount in West of England to low income groups, refugees and asylum seekers, disabled people and older people aged 65 and over.
- A scheme offering a 20% discount to students, apprentices and staff at higher education institutions.

The extent of the trial area at the start of 2022 is shown in Figure 1-1. The combined Bristol and South Gloucestershire operating area started as a central area of $7km^2$ in Bristol before expanding in December 2020 to the north, east and south to an area of $20km^2$. In February 2021 the operating area expanded further to the north into South Gloucestershire to a size of $45km^2$. Further expansion in March 2021 increased the operating area to $102km^2$ and introduced areas to the east. Not shown in Figure 1-1 are later expansions to the north-west (March 2022) and the south (December 2022).

The initial operating area in Bath covered just the central areas of the city with expansions completed in February 2021 and March 2021 to include areas to the south and east of the city. Not shown in Figure 1-1 are later expansions to quadruple the operating area size in June and July 2022 to cover most of the city, with a further expansion to the University of Bath campus at Claverton Down in October 2022.

The LTR service was launched in January 2021 and covers the entire West of England Combined Authority area.

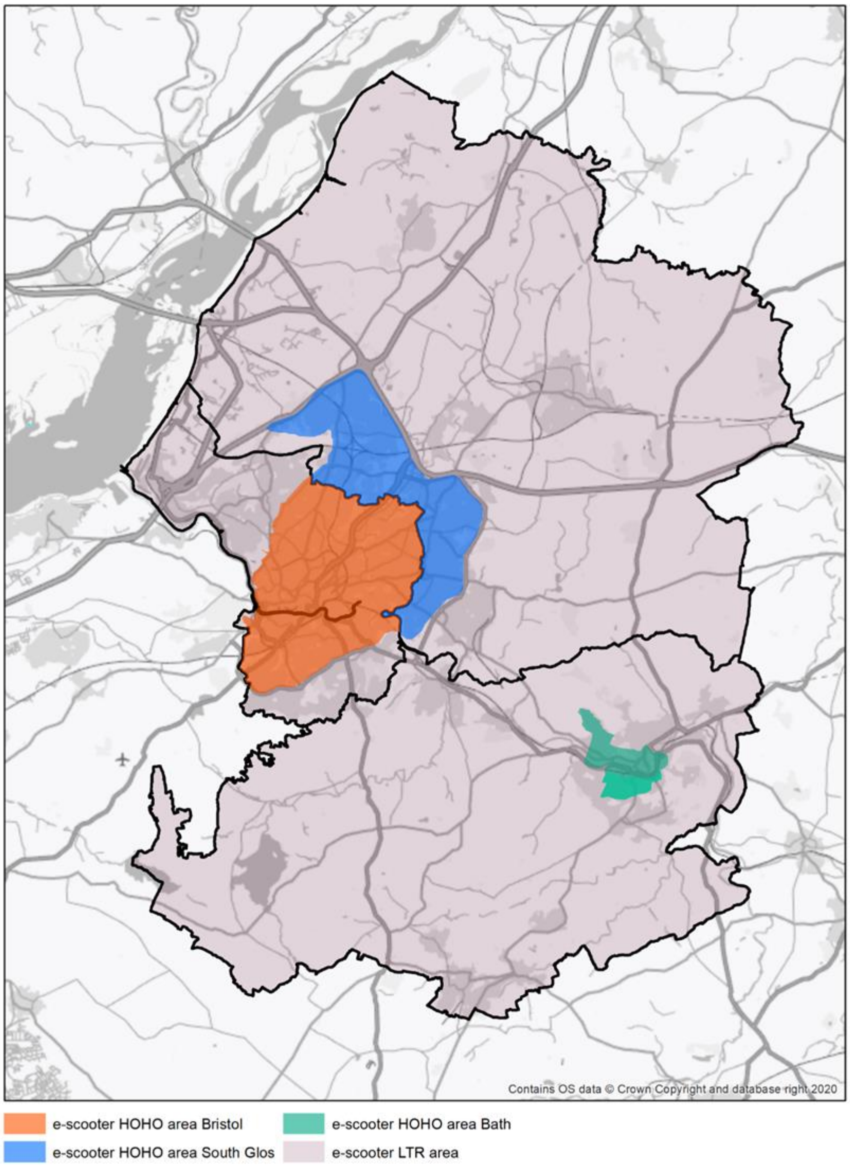


Figure 1-1: West of England e-scooter trial areas

The fleet size in the combined Bristol and South Gloucestershire operating area started with 100 e-scooters in November 2020 and increased to over 3,000 in Summer 2022. In November 2022 the fleet size was 3,105. The fleet size in Bath started at about 50 and increased to over 400 in Summer 2022. In November 2022 the fleet size was 296. The number of LTR users increased over time after the scheme launched in January 2021 to about 400 in October 2021, with a more recent figure being unavailable.

1.4 Evaluation approach

The West of England Combined Authority identified three high-level decisions that needed to be made about the trial and the outputs that need to be produced to support them (see Figure 1-2). The key decisions and outputs needed to be informed through evidence gathered over the course of the trial.

Drawing on a review of the literature, consultations with stakeholders and the decision requirements above, four evaluation main themes and 20 sub-themes were identified. The relationships between the themes and sub-themes, the key decision requirements and the evaluation outputs are shown in Figure 1-2. This figure serves as a logic map for the overall evaluation. An evaluation question was then formulated for each of the 20 sub-themes. The evaluation questions are set out in

Table 1-1. They have been numbered and lettered for convenience of referencing.

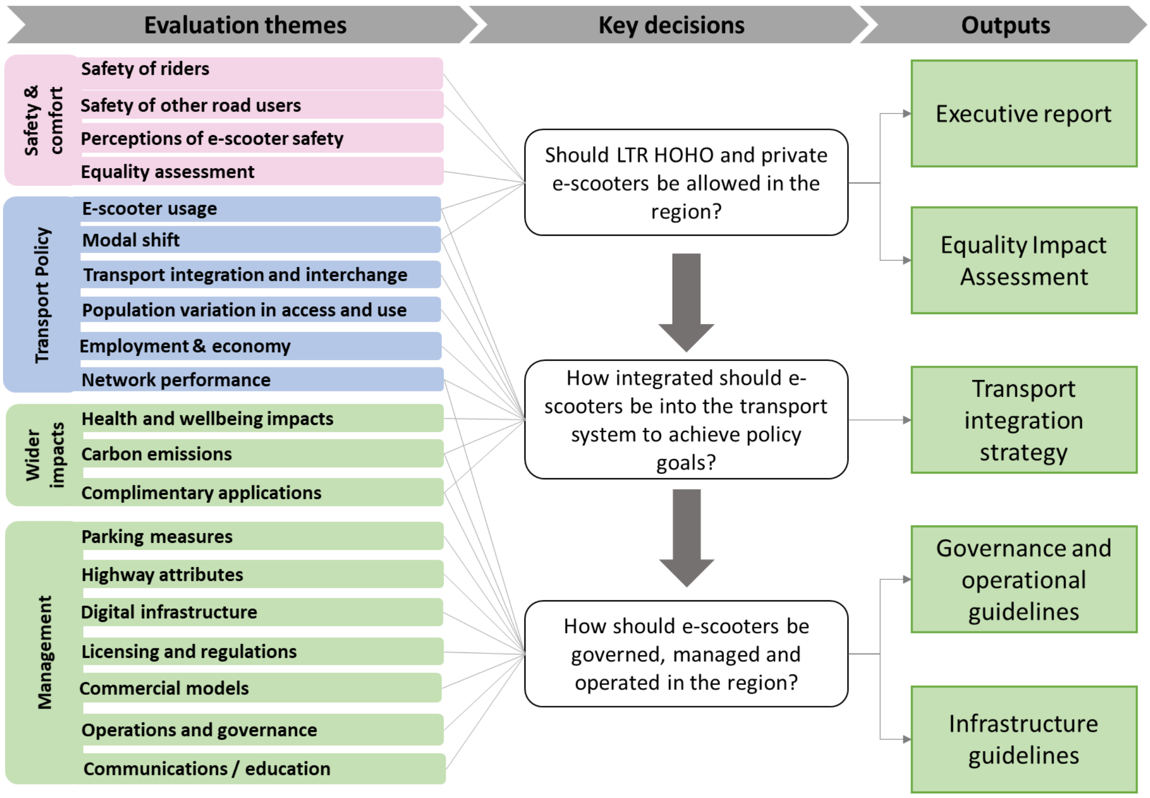


Figure 1-2: Evaluation logic map

Table 1-1: Evaluation questions

Theme	Evaluation question
Safety and comfort	**1a Riders:** How does the safety of riding an e-scooter in the region compare with cycling?
	1b Perceptions: How do perceptions of e-scooter safety vary by gender, age, and ethnicity?
	1c Other road users: How is the safety and comfort of other road users (including pedestrians) impacted by e-scooters?
	1d Equality: To what extent do e-scooters discriminate against the Equality Act 2010 Protected Characteristics?
Transport policy	**2a Usage:** Who, why, when, how and where are e-scooters being used?
	2b Modal shift: Of the e-scooter trips, how many are new? If transferred, from/to which modes?
	2c Transport integration and interchange: How are people using e-scooters to integrate with other forms of transport?
	2d Population variation in access and use: Which groups and areas are restricted in their access to e-scooters?
	2e Employment & economy: How has the trial managed to facilitate transport to jobs and support the wider economy?
	2f Network performance: How have e-scooters impacted the operation of the road network?
Wider impacts	**3a Health impacts:** How does riding an e-scooter contribute to an individual's health and wellbeing?
	3b Carbon: What has been the carbon footprint of the e-scooter trial?
	3c Complementary applications: How has the e-scooter fleet provided data and information for other applications and initiatives? (e.g., air quality monitoring)
Management	**4a Parking:** What different parking measures have worked best (and less well) and why?
	4b Highway: What highway characteristics (e.g., traffic volume, speed, provision of a cycle lane etc.) have affected e-scooter operation and safety?
	4c Digital infrastructure: How well has the e-scooter monitoring systems worked to give us the information we need?
	4d Licensing and regulations: How effective have the legislative, regulatory, and licensing frameworks been?
	4e Commercial models: How commercially sustainable has the trial been for the operator, the West of England Combined Authority, and the Unitary Authorities?
	4f Operations and governance: How has the management, operation and governance contributed to a successful trial?
	4g Communications / education: How effective has engagement been with both e-scooter users and wider stakeholders?

1.5 Structure of the report

The order of procedure of the chapters is as follows. Chapter 2 summarises the data sets and the methodology. Chapter 3 considers safety, and Chapter 4 follows on by describing a study of interactions of e-scooters in the public highway. Chapter 5 and 6 consider e-scooter users' behaviours and perceptions respectively. Chapter 7 discusses pedestrians' experiences of e-scooters. Chapter 8 presents an estimate of the net carbon dioxide equivalent emissions. Chapter 9 presents the analyses relating to parking. Chapter 10 follows on with a presentation of the analysis of stakeholder responses. Chapter 11 then draws the threads of the evaluation together to present responses to each evaluation question, and this is followed by a summarising conclusion in Chapter 12.

2 THE DATA SETS AND METHODOLOGY

The evaluation questions are being addressed using primary and secondary data. Section 2.1 describes the methods used to collect the primary data, and Section 2.2 describes the sources of secondary data.

2.1 Primary data

Six types of primary data were collected and analysed. This section presents the methods of data collection and the key characteristics of the datasets. The six data sets are as follows:

- Observations from video of interactions of e-scooters in the public highway
- Intercept and online surveys of e-scooter users and non-users
- In-depth walk-along interviews with non-users
- In-depth interviews with a selected cohort of users
- Interviews with stakeholders (people from organisations linked with trial delivery)
- Observations of e-scooter parking characteristics (video footage and on-site)

2.1.1 Observations from video of interactions of e-scooters in the public highway

Eight sites were chosen based broadly on the high number of e-scooters using the area around the sites and the potential for interactions (crossing the path) of other road users (drivers, other e-scooter riders, cyclists, and pedestrians). The sites provide an opportunity to consider near-misses, which is where an interaction is very close to being a collision, and the potential impact on flow rates (total throughput of people regardless of mode). The eight sites are as follows:

1. The intersection of Castle Park and Bristol Bridge,
2. Broad Quay also known as The (Tramway) Centre,
3. Prince Street Bridge,
4. The intersection of Queen’s Avenue and Queen’s Road,
5. The intersection of Zetland Road, Gloucester Road, Elton Road and Cheltenham Road,
6. The intersection of North Street and Dean Lane,
7. The intersection of St Michael’s Hill and Upper Maudlin Street, and
8. The entrance to Stokes Croft from the roundabout known as the Bear Pit.

The location of each of the eight sites is illustrated on the map of central Bristol shown in Figure 2-1. The orange circles show the numbered sites. The camera symbol shows sites where, in addition, the video was analysed in relation to e-scooter parking.

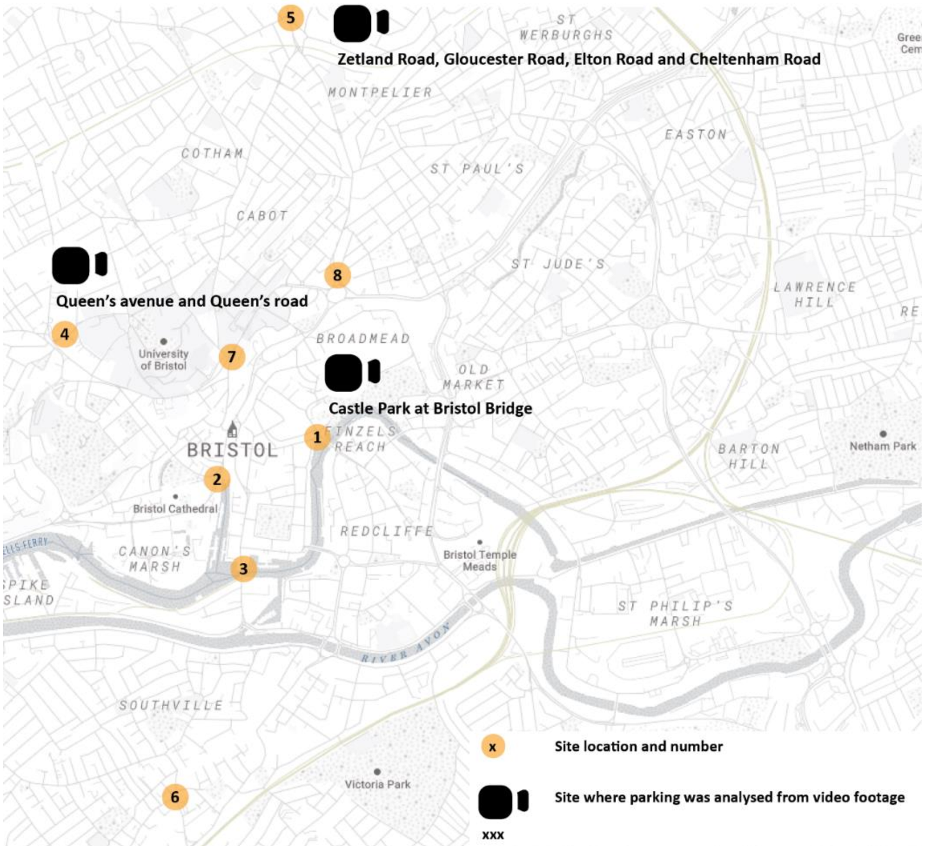


Figure 2-1: Location of video observation sites

Tracsis, a survey sub-contractor, was appointed to carry out the video surveys, and to decode the video footage according to a protocol. The standard outcome from such video footage analysis is the volume of flow of different vehicle types and pedestrians by 15-minute segment. In addition to this, the contractor also extracted occasions when there were near-misses between e-scooters and other modes, and cycles and other modes. A near-miss was defined as when one or other party needed to swerve to avoid a collision, or to slow or stop to avoid a collision. In addition, near-misses were also defined as being when an e-scooter rider or cyclist rode within 1.0 metre of a parked vehicle (Highway Code Rule 213 states 'Cyclists are also advised to ride at least a door's width or 1 metre from parked cars for their own safety'). Near-misses were also defined as being when an e-scooter or a cycle was overtaken by a vehicle leaving a gap of less than 1.5 metres (Highway Code rule 163 states "As a guide ... leave at least 1.5 metres when overtaking cyclists at speeds of up to 30mph, and give them more space when overtaking at higher speeds"). In addition, the number of illegal (e.g., footway riding) or ill-advised (e.g., going through a red signal at a Toucan crossing) actions were also identified.

Finally, further aspects of the near-miss coding related to features of e-scooter riding and included the following: a) whether the e-scooter had a pink stem and was hence a HOHO e-scooter and part of the trial or not (NB LTR trial e-scooters have a black stem but there are very few of them relative to HOHO e-scooters); b) whether the (cycle or e-scooter) rider was wearing a helmet; and c) whether there were two people on the e-scooter.

Video footage was collected for each site from 6am on Thursday 30th June 2022 to midnight on Sunday 3rd July 2022. Manual Classified Counts (MCC), counts of interactions and analysis of those interactions were conducted from 6am to midnight on Friday 1st July 2022 and from 6am to midnight on Saturday 2nd July 2022, which corresponded to the operational hours of the e-scooter trial.

2.1.2 Intercept and online surveys of users and non-users

The purpose of the intercept and online surveys was to gather information not available elsewhere, namely regarding:

- **Pedestrians' experience** – the extent to which people feel safe and comfortable around shared e-scooters, and the aspects that might make them feel unsafe or uncomfortable
- **Users' views, gathering information not available in the trial operator's survey**, such as the reasons for using the shared e-scooters, the destinations reached, the extent to which shared e-scooters allow access to more opportunities, as well as the reasons why users might feel unsafe or not
- **Pedestrians' and users' views regarding discrimination**, examining whether respondents feel discriminated against by the scheme, and if so why, but also if they think others might be discriminated against

Further, the surveys gathered demographic data including disability status, using the Washington Group Short Set questions, which allowed analysis of possible differences between people who have functional difficulties and those who do not.

The intercept surveys were conducted over five days: Tuesday 7th June 2022, Tuesday 14th June 2022, Saturday 18th June 2022, Thursday 30th June 2022, and Saturday 2nd July 2022. The surveys were administered by 18 trained surveyors. Eight surveyors worked simultaneously, with the oversight and support provided on site from a researcher. The locations were chosen to reflect the diversity of users and usages, and included locations at: Broadmead; Filton; University of Bristol; Stokes Croft; and Temple Meads. We concentrated survey resources in areas where we would garner most responses and hence this did not include Bath and outer areas within Bristol and South Gloucestershire.

The first three days covered four locations each. The process was adjusted throughout the data gathering process to increase efficiency and ensure appropriate conditions and breaks for the surveyors. Two long shifts in the morning and the afternoon were adapted to create three shorter shifts targeting busy times of the day. The locations surveyed were also adapted to maximise the response rate with Broadmead replacing Stokes Croft and the final two days being carried out exclusively at Broadmead.

The same questionnaire survey was also distributed on-line, and from now on is referred to as the Experience Survey. The on-line survey was distributed mainly through the Equalities Group established by the West of England Combined Authority to help guide action in relation to the e-scooter trial. The aim was to enhance the representation of disabled people who may have different and more acute experiences of e-scooters.

In total, 643 responses were gathered (589 as on-street intercept surveys and 54 online). Demographic characteristics of the respondents are presented in Table 2-1.

Table 2-1: Demographic characteristics of Experience Survey respondents (intercept and online)

Demography		Uses Voi e-scooters?			
Dimension	Levels	No	Yes	Unknown	Total
Gender	Female	150	81	0	**231**
	Male	174	144	0	**318**
	Agender, non-binary, other definitions	24	11	1	**36**
	Not declared	13	5	40	**58**
Age	18-29	171	163	1	**335**
	30-59	112	66	0	**178**
	60+	68	6	0	**74**
	Not declared	10	6	40	**56**
Ethnicity	BAME	118	69	1	**188**
	Other ethnicity or not declared	39	19	40	**98**
	White	204	153	0	**357**
Disability	Declared having at least some difficulties with one or more of: walking / seeing / hearing / remembering or concentrating	140	53	1	**194**
	No difficulties declared re any of the aspects noted above	221	188	40	**449**
Total		**361**	**241**	**41**	**643**

2.1.3 In-depth walk-along interviews with non-users

The aim of the walk-along interviews was to explore participants' experiences of walking or using a wheelchair or other mobility aid in relation to e-scooters as they were encountered during the walk-along. The walk-along interviews were organised after gathering and analysing the data from the experience survey as a way of further deepening understanding of pedestrians' experiences. The methods are briefly presented below.

Recruitment was undertaken through (a) contacts with Experience Survey respondents who had agreed to be contacted for further research (N=103) and (b) information about the interviews provided via the Equalities Group to their constituent organisations' membership.

Those interested were sent a Participant Information Sheet. To respect possible difficulties people might have walking, the information sheet highlighted that, while the interviews were expected to last 20 to 45 minutes, participants were welcome to stop the interview at any point. After answering any questions about the process, interview time and place were agreed, with the aim that both would be as convenient as possible for the participant.

Eight survey respondents and four people who heard about the survey though the Equalities Group expressed interest in participating. Eight interviews were undertaken in October and November 2022, with one person preferring to submit comments via email. Key demographic indicators of the eight interviewees are as follows (see also Table 7-4, page 142):

- Four were aged 30-59 and four were older than 60
- Three participants identified as female, five as male
- Two participants (both aged 30-59) were non-disabled, while the other six indicated impairments: three participants cannot walk (two use electric wheelchairs and one a manual wheelchair), one participant had a lot of difficulty walking and seeing (uses walking sticks),

one has a lot of difficulty seeing and uses a long cane, and one reported multi-level mechanical disabilities, chronic pain, and fatigue.

One of the eight interviewees chose not to do a walk-along interview but to discuss walking experiences indoors. Both participants who chose not to walk with a researcher had strong individual reasons for doing so: one was partially sighted and described navigating her environment as “terrifying”, the other has acute difficulties with both seeing and balance. These inputs were accepted here, given that the purpose is inclusivity: the researcher aimed to hear people’s experiences, valuing the experiences of those who struggle most and might, for that reason, not be willing to walk for this research.

On the day of the interview, participants were given a brief reminder of the process, asked to sign a consent form, and provided with a £20 shopping voucher as appreciation for their time. Following that, they were invited to guide the researcher along the route of their choosing and to comment on any e-scooter related aspect of interest to them. The researcher primarily listened to participants’ inputs and asked follow-up questions as required. Prompts if required were as follows:

- What are your top of mind thoughts and feelings about e-scooters
- What are the benefits as you see them of e-scooters?
- Who benefits and in what ways do they benefit?
- Are e-scooters problematic? If so, in what ways are they problematic?
- Who may be impacted as a result of these problems?
- Thinking about e-scooters when they are being ridden: what are the issues with them?
- Who is impacted by these issues?
- Thinking about e-scooters when they are parked, what are the issues with them?
- Who is impacted by these issues?

The interviews were audio-recorded and transcribed. Anonymised results were analysed qualitatively using NVivo coding software (version 1.6.1). The coding was based on inductive content analysis, identifying topics from the gathered material in order to build a framework from the inputs (as opposed to verifying pre-existing assumptions). The codes (or topics) were generated by the researcher who interviewed the participants. The first draft of the codes was clustered into groups (e.g., different riding and parking behaviours participants talked about were grouped together). The relationships between the groups were examined, analysing for instance how the aspects related to e-scooter riding and parking related to participants’ walking experiences. The results are presented in Chapter 7.

2.1.4 In-depth interviews of trial e-scooter users

In-depth interviews of trial e-scooter users were conducted in November 2022 to get greater depth of insight than had been possible from the Experience Survey on how e-scooters are being used to supplement and replace other mobility options. They were also aimed at identifying how e-scooters contribute to people accessing destinations and opportunities across the city and people’s health and wellbeing.

There were 55 people who completed the Experience Survey in June-July 2022 who reported having used a trial e-scooter more than once and who said they would be willing to participate in a subsequent interview. After inspecting the characteristics of these 55 people, it was decided to approach all of them to maximise the prospect of recruiting a diversity of interview participants in terms of demographics (gender, age and ethnicity) and e-scooter use (frequency of use, purpose of use, mode substitution). Interviews were completed for 13 out of 15 people who responded positively to the invitation to interview. The interview participants reflected the characteristics of e-scooter users as follows (see also Table 5-13, page 99):

- Eight were aged under 30, four were aged 30-39 and one was aged 40-49
- Three participants identified as female, nine as male and one as non-binary
- Nine participants had no access to a car and four had access to a car.

The interviews were structured into four sections:

- When and why they started using e-scooters in the context of their life situation
- What forms of transport they used to meet travel needs
- How e-scooters have helped them get to destinations/opportunities
- Their planned changes to transport use in future

A life history calendar and transport modes grid were used to assist recording life circumstances and events, and travel behaviour for different travel purposes. The interviews took place on-line by video conference between the 1st and 18th November 2022. Notes were taken of the interviews, and these were supported by transcripts generated by the on-line software. The notes and verbatim quotes from each transcript were written up into individual case summaries.

2.1.5 Stakeholder interviews

A total of 15 stakeholders were interviewed in ten interviews (five interviews were with two people). The stakeholders were drawn from seven organisations as follows: the three unitary authorities (Bristol City Council, South Gloucestershire Council and Bath and North East Somerset Council), the West of England Combined Authority, the emergency services (Avon and Somerset Police and Fire and Rescue), and the trial operator. The interviews took place on-line by video conference between the 11th and 27th October 2022. Notes were taken of the interviews, and these were supported by transcripts generated by the on-line software.

The notes and verbatim quotes from each transcript were written up thematically under the headings of each of the evaluation questions noted above.

2.1.6 Observations of e-scooter parking characteristics (video footage and on-site)

On-street observations of parking quality

The on-street surveys were designed to be an exploratory study of parking issues undertaken by visits to e-scooter parking locations on a pre-defined walking loop (beat). The researcher walked the route several times and noted, for each location:

- The number of e-sooters present;
- The number of e-scooters blocking the footway (i.e., leaving a walking passage of 900 mm or less; the remaining space was measured and recorded). A passageway of 900 mm was chosen because it is the width usually considered necessary for a person with motor impairments using a mobility device such as a walking frame or sticks. This is in a way the

strict minimum, considering that a sight impaired person using a long cane or an assistance dog might need up to 1200 mm.

- The number of e-scooters forcing pedestrians to deviate from their path. This was a qualitative assessment of the type of pedestrian pathway that was impacted by the parking (for instance, access to a pedestrian crossing of the carriageway, or to a building entrance)

The surveys were exploratory because no previous data were available about the ways e-scooters might interfere with pedestrians' desire lines. Thus, the surveys aimed to capture the magnitude of any problem, from which further data collection and analysis could be conducted.

Two routes were explored: the city centre (in the areas of Broadmead and Castle Park), and Stokes Croft. Both routes are illustrated in Figure 2-2.

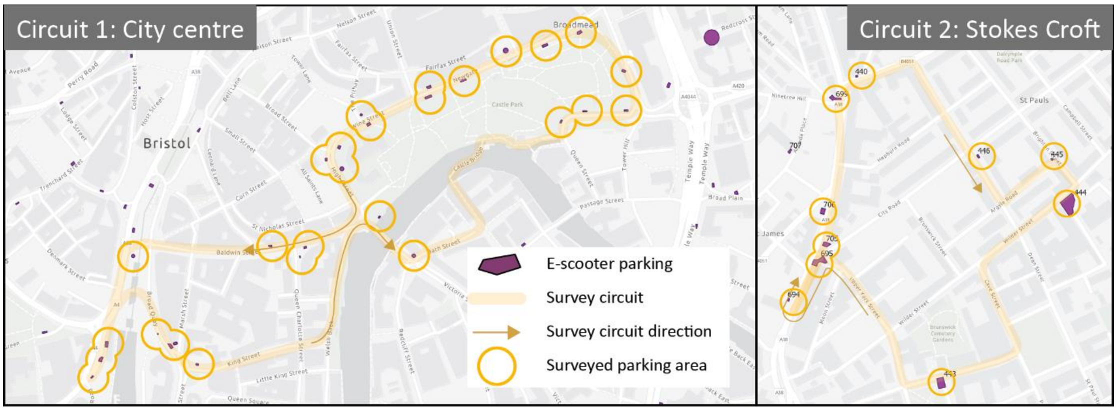


Figure 2-2: Parking spots assessed within the on-street surveys

The on-street parking survey was an exploratory survey and was the initial source of objective data about parking. It was designed partly to replace the absence of disaggregated information available from the trial operator (e.g., photos and locations associated with decisions about the quality of parking made by the operator's agency).

The survey aimed at helping build an initial picture about the interactions between parked e-scooters and walking space. It gathered the following information for each site:

- The number of e-scooters present
- The number of e-scooters blocking the way (i.e., leaving less than 900mm of usable footway width)
- The number of e-scooters forcing people to deviate
- The type of deviation involved (e.g., access to a pedestrian crossing or to a building entrance)
- The parking location, time and date, and a photograph

Manual data gathered by a single surveyor was undertaken, and while distances to the kerb were straightforward to measure, angles of deviation of the walking route could not be measured.

While deviation was the key issue observed, the data can provide only a partial view, and are influenced by the choice of locations, the time of the surveys, and the surveyor's perspective when making the observations. These observations also made sure they recorded multiple barriers, for example, instances where deviation imposed by e-scooters then led to encounters with street furniture or other temporary barriers such as bins or publicity signs.

The surveys took place over three days and 842 e-scooters were recorded. The analysis of the results is presented in Chapter 9 and provided the basis for a more in-depth analysis based on video footage, described below.

Parking data from video footage

The analysis of video footage focused on ways parked e-scooters interfere with walking space, building on the observations gathered in the on-street surveys, described above. Three of the eight video observation sites shown in Figure 2-1 had e-scooter parking spots: Site 1, Castle Park/Bristol Bridge; Site 4, Queen's Avenue/Queen's Road (there were two different parking spots at this location); and Site 5, Gloucester Road/Elton Road. The four parking spots were videoed for continuous periods of between 67 hours (2.8 days) and 98 hours (4.1 days). For each site, the same protocol for extracting data was applied:

- The walkway/footway was defined, using as much as possible existing 'natural' boundaries such as walls, street lighting columns or litter bins;
- Camera footage was viewed, and a spreadsheet was used to record the periods when e-scooters were infringing on the defined walkway/footway (start and end time), and observations about the nature and extent of the infringement)
- Screenshots were saved, covering both:
    - Infringements (e-scooter on the defined walkway/footway)
    - Other behaviours (e.g., passers-by in some way interacting with parked e-scooters)
    - Summary statistics were calculated (e.g., periods of infringement as a proportion of the total period)
- A summary sheet was created, presenting the definition of the walkway and illustrations of situations of infringement observed.

The results are presented in Chapter 9.

2.2 Secondary data

The secondary data used to inform the safety and comfort theme has been drawn from the following sources:

- Data provided by the trial operator on incidents reported by users, and data on distance ridden
- Collisions reported to Avon and Somerset Police, which than are reported in STATS19 to the Department for Transport
- Data from two hospital studies in Bristol that have been undertaken during the trial period

In addition, further background on e-scooter safety has been drawn from the literature, and from the national STATS19 data set for 2021. The principal aims of the quantitative analysis have been to understand as best as possible the numbers of collisions and injuries, their rates per passenger kilometre and the nature and causes of injury collisions.

The **Transport Policy Theme** has drawn secondary data from the following sources:

- Data provided by the trial operator relating to e-scooter rides, and surveys of users undertaken in Summer 2021 and Winter 2022.

The user data has been described in numerous descriptive analyses and cross-tabulations.

The **Wider Impacts Theme** has drawn on the following sources of data:

- Data provided by the trial operator relating to e-scooter rides
- Secondary data from the literature on carbon emissions from vehicles

In addition to the above data, the carbon analysis has drawn information from the literature to assist in providing lifecycle estimates of carbon dioxide equivalent emissions for different vehicle types.

The **Management Theme**, which includes the issue of parking as a major sub-category of interest, has used the following sources of data:

- Data provided by the trial operator relating to e-scooter rides

2.3 Statistical significance testing

Statistical significance tests play an important role when testing a hypothesis from data obtained for a sample drawn from the population. A variety of quantitative data sets have been obtained and analysed in this evaluation and the relevance of significance testing is discussed for three different types of data.

With e-scooter operator system data for users and rides, we had complete data for the population of interest over the trial period up to April 2022. We were therefore able to observe outcomes without any sampling error and statistical significance tests are not relevant. Results can be considered to have a high degree of certainty.

With observations of events occurring over a sample period of time (e.g. video observations for short periods or injury records for a specific time period), it is possible to employ classical statistical tests (for example, a Chi-Square test to examine group differences). Such tests have been carried out and reported for this type of data.

The survey data analysed in this evaluation came from non-probability samples (samples which cannot be considered to be randomly selected participants). Surveys of e-scooter users by the e-scooter trial operator were advertised to all e-scooter users via the e-scooter app and a small proportion of self-selecting users responded to the opportunity. The Experience Survey of e-scooter users and non-users involved approaching people on the street and online with those willing to offer their time participating in the survey. Classical statistical tests are only appropriate for probability samples of randomly selected participants where sampling error and confidence intervals can be estimated. Hence in this report we do not report statistical significance for the results from survey data analysis as there is a high likelihood that we would report results with greater confidence than is warranted. The results from survey data analysis should therefore be treated as indicative and requiring further assessment if more certainty is required.

3 SAFETY

3.1 Introduction

3.1.1 The research questions and the data sources

The Department for Transport (2022) states that safety issues need to be appropriately considered and addressed as part of the e-scooter trials. Data and information available for the assessment of safety is available from three sources: the trial operator, road traffic collision data, and hospital data.

This chapter sets out responses to the following evaluation questions.

- 1a Riders: How does the safety of riding an e-scooter in the region compare with cycling?
- 1c Other road users: How is the safety and comfort of other road users (including pedestrians) impacted by e-scooters? (This question can be partially answered at this stage)
- 4b Highway: What highway characteristics (e.g., traffic volume, speed, provision of a cycle lane etc.) have affected e-scooter operation and safety? (This question can be partially answered at this stage)

There has been a growing research interest in the safety of e-scooters. Hence, this chapter begins with a review of what is known to date from the literature in Section 3.2. Section 3.2 also discusses collision and injury rate calculations for e-scooters and cycles from the literature. This provides context to the results that follow for the West of England area. The trial operator collects data on total distance travelled by e-scooter and logs of incidents and injury reported by users, and this data provides the basis for estimating injury rates as compared with other sources such as the STATS19 official record of collisions. An analysis of trial operator data is presented in Section 3.3.

Collisions and injuries occurring on the public highway are reportable to the police. These data will significantly underestimate the number of collisions and injuries because of under-reporting. This is a known general problem that is particularly pronounced for cycling. However, the STATS19 data provide valuable context on the locations and causes of collisions that is not available in the trial operator data. This analysis is presented in Section 3.4. Section 3.5 addresses the second two evaluation questions above (i.e., impacts on safety of other road users, and patterns in the highway characteristics of collision locations).

A further source of evidence on injuries are results from hospital-based studies and these are compared with the trial operator and STATS19 data in Section 3.5. Figure 3-1 is provided to assist in visualising the different data sets available. It helps make the point that a complete picture of collisions and injuries is not available from a single source of information. It summarises the potential overlaps between the data sets.

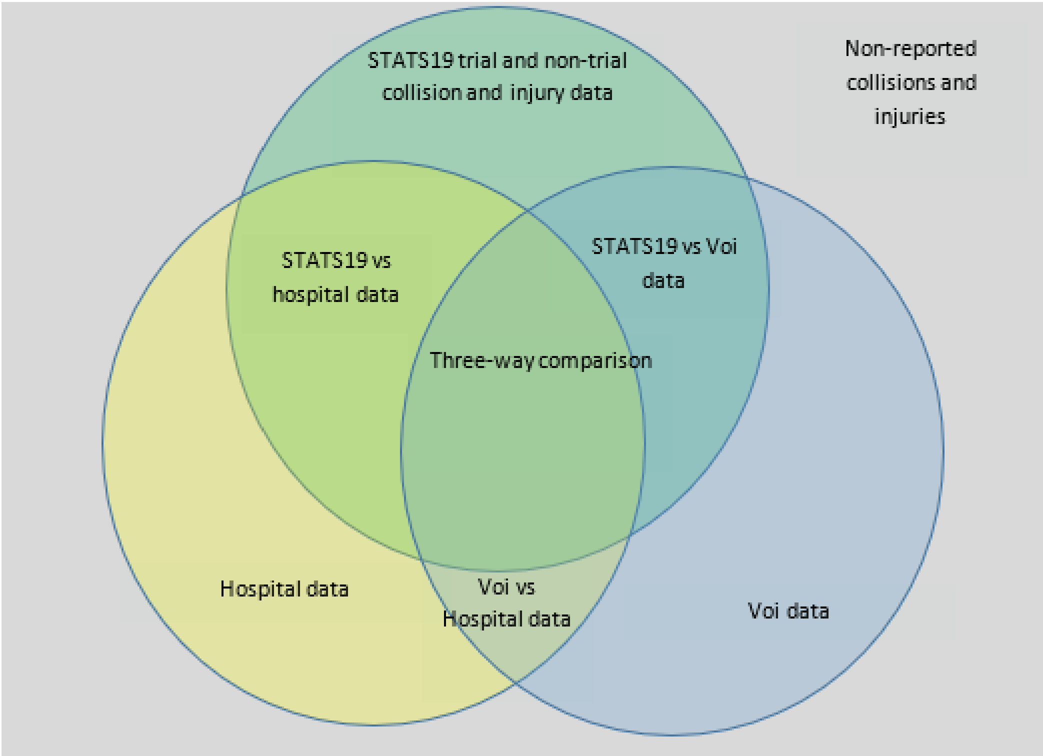


Figure 3-1: Comparison of e-scooter collision and injury data sets

3.1.2 Limitations

Note that there will be collisions and injuries not reported in any data set. Anonymisation of data precludes being able to match individual cases across the different data sets. Comparisons may be made between the data sets, but this needs to be undertaken with caution because the basis of the data will be different for each source. For example, hospital data may not include injuries treated in surgeries, STATS19 data is known to under-report collisions and injuries, especially for single vehicle incidents, and the trial operator data is self-reported.

3.2 Literature on e-scooters and safety

This review considers first the nature of injuries resulting from e-scooter use. Section 3.2.1 deals with hospital-based studies, and Section 3.2.2 considers studies where data is drawn from media reporting. It then considers the nature of infrastructure and interactions with infrastructure in Section 3.2.3. Collision and injury rates are considered in Section 3.2.4, and the final section 3.2.5 reviews current commentary in the literature on policy relating to e-scooter safety and use.

3.2.1 Hospital based studies

E-scooter use has been discussed within the medical profession, specifically in relation to emergency treatment requirements and costs. Several hospital-based studies across the world have been carried out as a consequence. This section summarises understanding to date, with a particular focus on the UK.

Hospital data may be based on emergency department admissions, or records relating to later stages of a patient journey such as radiography records, or orthopaedic records. However, the mechanism of injury is not typically recorded in hospital emergency department data, and in the case of e-scooter collisions an important distinction relates to falls versus collisions with other vehicles or with obstacles. Injury mechanisms from falls from standing e-scooters are likely to be associated with a fall on an outstretched hand (FOOSH), upper and lower limb injuries and head and face injuries (Nellamattathil and Amber, 2020). Proportions of falls and collisions will vary by country and will be based on contributing factors such as intoxication and infrastructure availability and quality for e-scooter use.

Reviews have been undertaken of published, hospital based studies associated with e-scooter collisions (Schneeweiss et al., 2021; Toofany et al., 2021). Toofany et al. (2021) reviewed 28 peer-reviewed sources (25 of which were retrospective studies) and 9 non-peer reviewed sources, such as reports. Of the peer-reviewed studies 13 were in the USA, 3 in New Zealand and 1 each in Singapore, Australia, Denmark, France, Finland, South Korea and Germany. The most commonly injured parts of the body were the upper limbs (one of three most frequently injured regions in 12 studies), head (11 studies) and lower limb (10 studies). For illustrative purposes, Table 3-1 summarises data from a selection of studies reported by Toofany et al., and four papers published afterwards: one from Germany (Kleinertz et al., 2021) and three from the UK (Aurora et al., 2021; Bodansky et al., 2022; Quandil and et al, 2021).

Table 3-1 Summary of main injury type by patient demographic, helmet wearing and intoxication

Reference	Country	Number	Percentage Male	Mean age or range	% wearing helmet	% intoxicated or having taken alcohol	Highest incidence of injury type	Data type
Trivedi, T K et al. (2019)[1]	USA	249	58%	34	4%	5%	Head injury 40%	Emergency Department
Kobayashi et al. (2019)[1]	USA	103	65%	37	2%	48%	Extremity fractures 42%	Emergency Department
Nellamattathil and Amber (2020)[1]	USA	14	76%	-	-	-	Upper extremity fractures 57%	Radiography Registry
Dhillon et al. (2020)[1]	USA	87	71%	35	29%	17%	Brain injury and facial/skull fractures 55%	Trauma Registry
Beck et al. (2020)[1]	New Zealand	54	61%	-	2%	13%	Contusions, sprains, and lacerations, 46%	Emergency Department
Blomberg et al. (2019)[1]	Denmark	112	38%	-	4%	37%	Lacerations 45%	Emergency Department
Kleinetz et al. (2021)	Germany	89	63%	34	0%	28%	Head or face 54%	Emergency Department

Reference	Country	Number	Percentage Male	Mean age or range	% wearing helmet	% intoxicated or having taken alcohol	Highest incidence of injury type	Data type
Aurora et al. (2021)	UK, Bristol	42	79%	26	~20%	~33%	Oral and maxillofacial 43%	Emergency Department
Bodansky et al. (2022)	UK, Liverpool	51	49%	26	-	10%	Upper limb 70%	Orthopaedic registry
Quandil et al. (2021)	UK, Bristol	90	53%	25	7%	28%	Upper limb 51%	Emergency Department

Note 1 referenced in (Toofany et al., 2021)

Typically, more men are injured than women (and typically more men ride than women). The mean age is to the younger end of the age spectrum. Helmet wearing is in the range of 0-29%, with all but two studies suggesting the range is 0-7%, and this is a similar level to self-report studies, e.g., Comer and colleagues (Comer et al., 2020) whose study found 2.5% report that they always wear a helmet.

In addition to the data presented above, other hospital-based studies may focus in more detail on the nature of injuries relating to one particular type of injury; for example oral and maxillofacial injuries (Smit et al., 2021); neurological injuries (Schlaff et al., 2019); craniofacial injuries (Trivedi et al., 2019); and facial trauma (Yarmohammadi et al., 2020).

The range in injury proportions from different studies in the Toofany review (2021) is as follows: Upper limb, 13-70%; Lower limb, 6-58%; Head, 7-65%; and Face, 4-100%.

Injuries to the chest, abdomen and spine were not common. In terms of injury mechanism, Toofany (2021) report single user incidents as the most common injury cause at up to 97%, with collisions with vehicles in the different studies ranging up to 58%.

In the UK, Aurora and colleagues undertook a retrospective study of patients attending the Bristol Royal Infirmary Emergency Department (BRI ED) between October 29th 2020 (the first day of the e-scooter trial) to May 31st 2021 (Aurora et al., 2021). Of the 42 patients identified as having e-scooter related injuries, 87% of injuries were related to falls, with 8% as a result of collision with a car, 2% collision with a pedestrian and 3% collision with an obstacle. It is not clear whether the cause of these falls and collisions was related to rider error, or infrastructure inadequacy, for example, a rough surface, or a combination of both. Just over half of the records did not define whether a helmet was worn, but the paper reports a fifth (i.e. 8) did not wear a helmet and 2 did wear a helmet, and so, based on these numbers the helmet wearing rate may have been around 20%.

Bodansky (2022) undertook a retrospective study of e-scooter riders and cyclists presenting with musculoskeletal injury covering the Liverpool e-scooter trial areas between 6th October 2020 and 5th May 2021 and between 6th March 2020 and 5th October 2020. Using e-scooter trial data and Department for Transport count site data an orthopaedic injury rate of 26.1 injuries per million km on e-scooters, and 24.1 injuries per million km on bicycles were estimated.

Quandil (2021) summarise the results of a prospective observational study undertaken by researchers at Bristol Royal Infirmary, Southmead Hospital and Bristol Children's Hospital in a four-week period in May and June 2021. Note that Aurora et al. (2021) include 14 patients who presented to the BRI ED in May 2021, compared with 90 who presented to the BRI, Southmead and the Children's Hospital Eds combined in the four-week period. E-scooter provenance (trial operator or private) was reported by riders in 81 cases. Most cases involved a trial operator e-scooter (80%, n=65/81) as opposed to a privately-owned e-scooter (20%, n=16/81). The most common injury mechanism was falling from the e-scooter (71%, n=64/90), and this is less than the 87% from falls found by Aurora et al. (2021). 14% (n=13/90) resulted from a collision with another motor vehicle, 2% (n=2/90) with another e-scooter, and 1% (n=1/90) with a cycle.

Flaherty et al. (2022) investigated e-scooter related injury pattern and severity specifically in relation to foot and ankle trauma based on a retrospective case analysis at three London hospitals between 1st January and 31st December 2020. Twenty patients were identified with a total of 27 foot and ankle fractures with nine requiring surgery. Speed was important in relation to the level of injury, with those travelling over 15.5 mph being significantly more likely to require surgery. 85% of injuries involved the foot and/or ankle only.

Alwani et al. (2020) undertook a retrospective review of all orthopaedic paediatric referrals relating to e-scooter use from January 1 to December 31, 2020 at two London hospitals. Ten patients were identified, five required orthopaedic surgery. All patients were male, were not wearing a helmet, and in the age range 13–17 years, and all e-scooters were privately owned. Six sustained lower limb injuries and four upper limb injuries. The authors suggest the findings may inform public policy in relation to child use of e-scooters.

In a short communication, Barker (2022) reported from a four-week period from 11th May 2020 (when Covid-19 lockdown restrictions were eased) that the Oral Maxillofacial Surgery team at King's College Hospital treated four patients aged from 22 to 52 years who sustained various facial injuries from using e-scooters. Three of the patients had consumed alcohol prior to riding an e-scooter and one had been wearing a helmet.

The Parliamentary Advisory Council on Transport Safety (2022) reports an otherwise unpublished study undertaken over four weeks in October and November 2021 of 250 e-scooter use related patients at 20 hospitals. 161 (68%) were resulting from falls from an e-scooter, 33 (14%) hit an object and just under 5% were other road users (pedestrians or cyclists). While not reported, presumably the remaining 13% were in collision with other vehicles. 12 of the hospitals were in areas with an e-scooter trial and in these areas the mean number of patients presenting was higher than in the other areas (19.4 compared with 5.3).

Depending on the health care system in the country in question, not all injuries that need treatment may result in a presentation at hospital. Bekhit and colleagues (2020) report for the Auckland region during the period September 2018 to April 2019 that of the 770 compensation events associated with e-scooters 68.1% were treated in the community by primary care physicians and 31.9% in Auckland hospitals. Of the hospital patients, 19.9% required at least one operation, and 42.7% required specialist follow up care. 26.8% of injuries were thought to be associated with alcohol use (Bekhit et al., 2020).

3.2.2 Injury reporting in the media

The International Transport Forum (ITF) studied media reports of e-scooter deaths between May 2018 to the end of October 2019 and found reports from 10 countries – Australia, Belgium, Canada, France, New Zealand, Singapore, Spain, Sweden, United Kingdom, United States (International Transport Forum (ITF), 2020b). There were 38 deaths in that 18-month period. Two deaths were of pedestrians, and one was of a cyclist. The cause of the death of the remaining 35 e-scooter riders was a collision with motorised vehicles (26) and a tree (1), and otherwise the death was a fall (5) with the remaining 3 being unknown. Hence, in most of the cases (26/38, 68%) the presence of motorised traffic was a factor. The e-scooters in the two pedestrian deaths were not equipped with a speed limiter. As at Spring 2022 the single death in the UK was of a female e-scooter rider on a private e-scooter in collision with a lorry in London in July 2019.

ITF is clear that the issue of motor traffic involvement and absence of e-scooter speed limiting points to the need for both separation created by infrastructure from motor traffic, and regulation. ITF recommends that policy makers should not be distracted from the issue of motorised traffic which creates ‘the main sources of danger in the urban environment’ (International Transport Forum (ITF), 2020b, p.21).

The Parliamentary Advisory Council on Transport Safety (2022) studied media and social media reports of e-scooter incidents in the UK for the year 2021. Internet searches produced 180 records of casualties. 11 deaths were reported, two of which would not be recorded in the official road collision record, STATS19, and therefore must not have taken place on the public highway. Five deaths resulted from falls.

3.2.3 Studies of infrastructure and interactions

Maiti and colleagues (2020) studied pedestrian and e-scooter encounters on two university campuses at the University of Texas in San Antonio to identify potentially unsafe scenarios. The focus was on spatial constraints related to infrastructure, and how these constraints affect the speed and direction of travel of e-scooter rides and pedestrians. They equipped students with smartwatches which recorded encounters with e-scooters using the e-scooter Bluetooth signal strength. They found a positive correlation between the number of encounters and proximity, suggesting a level of crowding in busy locations, and deficiencies in infrastructure which caters for e-scooters as well as other modes.

Cicchino (2021) investigated the most common locations of injuries based on a sample of 105 people who presented at a Washington DC Emergency Department. They found that the most common locations of e-scooter injuries were on footways (58%) and within carriageways (23%). Over a third of the sample were injured on their first ride (Cicchino et al., 2021).

Ma et al. (2021) studied e-scooter riding on the footway and carriageway in Tempe, Arizona. Vibration is more severe than when riding a bicycle and proximity sensors indicated a high frequency of close proximities with objects in the environment. These conditions are conducive to the potential for near-miss events or collisions (Ma et al., 2021).

Currans (2022) evaluated e-scooter use in Salt Lake City at five intersections with and without cycle lanes, and with and without the presence of a tram line (Currans et al., 2022). E-scooter users’ behaviours and the causes of those behaviours were considered. The authors note that it is important to understand the ways travellers move and interact within infrastructure, which may or may not have been designed well for their chosen mode – forbidding footway riding, for example, may not lower the rates of footway riding if the alternative is a lack of protection from motor traffic (Currans et al., 2022). Linked with this finding is the observational study in Berlin by Siebert and colleagues (2021) who report one quarter of observations of shared e-scooter riders using what is termed 'incorrect' infrastructure.

3.2.4 Estimates of collision and injury rates and comparisons with other modes

Preamble

Collision rates are typically expressed in one of three ways: number of collisions per trip, per distance travelled, or per time of exposure. Instead of the number of collisions, the numerator may be the number of deaths, or the number of fatal and serious injuries (FAS) or all injuries. Each of the denominators is acting as a proxy for exposure to risk. No denominator is a perfect proxy for exposure, especially when comparing between modes, although arguably time of exposure is the best measure. If the number of trips is used as the denominator, no account is taken of the higher probability of a collision or injury on a longer journey resulting from longer exposure. If distance is used as the denominator, then differences in journey time between modes lead to different times of exposure for the same trip length.

Typically, collision or injury rates for land-based modes are compared using distance as the denominator, and this is appropriate when the journey times of different modes are similar. The level of risk to travellers on the different types of infrastructure encountered along a journey will be different. A journey undertaken by pedestrians, or cyclists or e-scooter riders, on well-designed infrastructure separated from motor traffic will typically be less risky than where they are mixed with motor traffic. Hence, collision and injury rates by distance are averaging across a range of infrastructure types encountered on journeys. Hence, overall, the variability in collision and injury rates results from variability between traveller types, and variability in the characteristics of the routes used.

The attention being paid to e-scooter safety means that estimates of collision and injury rates are being made. However, distance travelled data is typically unavailable, or available only for a proportion of trip making, for example when the trip is a hire e-scooter. Good quality data on distance travelled is available for hire e-scooter trips, the challenge is therefore in accurately estimating the number of collisions and injuries, which may typically be under-reported either to the police or to the hire operator.

Comparisons are often being made between e-scooter safety and other human scale mobility, such as cycling. It is a requirement to report injury collisions involving injury to the police, and the STATS19 data is a summary of that data. However, it is known that the data set is incomplete because of under-reporting. Jeffrey and colleagues (2009) estimated that, between 1997 and 2005, only 45% of road casualty hospital admissions were recorded in the police data, and cyclist (and motorcyclist) casualties were the most under-reported. Lyons et al. (2008) found, for the period 1996 to 2003, a significantly decreasing trend in police reported serious casualties that was not present in health data sets.

As well as estimates for the number of collisions and injuries being underestimates for comparator modes such as cycling, there is a challenge estimating the number of vehicle miles travelled within a locality. At the national level, National Road Traffic Estimates (NRTE) are based on a sample of manual and automated counts of vehicles on different categories of road, and these counts are then factored by lengths of those types of roads. The relatively low volume of cycle traffic means that there are wide confidence intervals in these estimates (Cope et al., 2007). The National Travel Survey is a rolling survey of households which provide trip diary data for a week, and estimates are produced of average distance travelled per person per annum by mode, average number of trips per person per annum, and average trip length.

So, while rates can form a basis for comparison, there are several challenges to the accuracy of the estimates produced: there is collision and injury under-reporting and difficulty with estimating distance travelled.

International comparisons

ITF (2020b) reports that in higher and middle-income countries, one bicycle rider is killed every 10 million bicycle trips on average, that is 100 deaths per billion rides. This is comparable with e-scooter death rates, as shown in Table 3-2.

Table 3-2 E-scooter death rate per billion ride (Source: ITF, 2020)

Country	Period	Deaths	Trips	Death rate per billion rides	Source
USA	2018	3	38.5 million	78	NACTO (2019)
Lime	To September 2019	9	90 million	100	ITF (2020)
Bird	To August 2019	5	50 million	100	ITF (2020)

ITF also report that they found no study which has compared injury rates of e-scooters and cyclists with the same study protocol, over the same time frame, and in the same area (International Transport Forum (ITF), 2020b). They do summarise sixteen studies using hospital admissions data from a range of cities in eight countries which estimate either e-scooter or cycle injury rates per billion trips, which is summarised as follows:

- From emergency department visits:
  - E-scooter 87,000 to 251,000
  - Bicycle 110,000 to 180,000
- From hospital admissions:
  - E-scooter 29,000 to 62,000
  - Bicycle 1,000 to 10,000

Data from the Auckland region in New Zealand (2020) indicates an e-scooter injury rate of 600,000 per billion trips and a hospital admissions rate of 200,000 per billion trips, considerably higher values than those noted above. These estimates vary by factors of up to 10.

United Kingdom estimates

E-scooters are, currently at least, recorded in the 'other vehicle' category of the STATS19 data, and may be identified as an e-scooter using the associated free text field. E-scooters have the potential, therefore, not to be as accurately identified as other vehicle types. Scooters can include stand on child scooters, and scooters with different propulsion methods including petrol and electricity as well as push scooters. The word scooter is also used for some types of motorcycle and mobility scooters and if this use was clear from the free text field or the description of the collision, re-classification could take place at the validation stage. The Department for Transport has issued guidance so that more than just the word 'scooter' is recorded in the free text field.

The Department for Transport published an e-scooter casualties fact sheet using 2021 data. There were 1,352 collisions involving e-scooters, compared to 460 in 2020, and 1,434 casualties compared to 484 in 2020 (Department for Transport, 2021b). There were 10 people killed in collisions involving e-scooters (all of whom were e-scooter riders) compared to 1 in 2020 (note that e-scooter trials started in September 2020). There were 421 seriously injured and 1,003 slightly injured in 2021, this compares to 129 and 354 respectively in 2020. Note that these casualty estimates are adjusted to correct for the split between serious and slight injury, and this is required because not all police forces are using the more up to date method to assist in accurately categorising injury. 1,102 casualties were e-scooter users, compared to 384 in 2020. 324 collisions included only one e-scooter with no other vehicles involved in the collision (i.e. they were single vehicle collisions), compared to 83 in 2020.

The DfT states that it is not possible to calculate the casualty rates per mile travelled because of the absence of data on distance travelled on e-scooters. This will become available via the National Travel Survey in future years. For comparative purposes, Table 2 in the factsheet compares numbers of casualties in collisions involving e-scooters by police force area with those involving any vehicle. These are then given as a percentage of the Great Britain total. This comparison helps indicate locations where there is over-representation of e-scooter collisions. The Metropolitan police reported over a third (36%) of all casualties involving e-scooters in Great Britain, compared with 21% of all casualties involving any vehicle. The remaining e-scooter casualties were spread across the other 43 police forces, with the second highest percentage of e-scooter casualties being reported in Avon and Somerset at 7% compared with all casualties involving any vehicle being 2%. This indicates that, of all the trial areas, Avon and Somerset Police area has seen the most over-representation of e-scooter collisions, but this is unsurprising given the significant e-scooter use in the area compared with other trial areas.

Commentators frequently wish to compare e-scooter collision and injury with cycle collision and injury. In 2021, 111 pedal cyclists were killed in Great Britain, whilst 4,353 were reported to be seriously injured (adjusted) and 11,994 slightly injured (adjusted). Table 3-3 shows the casualty rate by type of injury for cyclists in the four years 2018 to 2021 taken from the pedal cycle fact sheet for 2021.

Table 3-3: Casualty rates of pedal cycle casualties by severity per billion vehicle miles travelled in Great Britain 2018 to 2021

Year	Killed	Serious injury	Slight injury	All
2018	28	1,256	3,702	5,986
2019	28	1,171	3,455	4,653
2020	27	818	2,230	3,075
2021	26	1,037	2,857	3,920

The severity ratio provides an indication of the level of seriousness of injury from collisions. It is usually estimated as the number of killed and seriously injured as a proportion of all injury levels. This varies from 24.9% in 2019 to 27.1% in 2021. Any comparison between e-scooters and cycling may be more appropriate within urban areas and this is because e-scooters are typically not used to the extent that cycles are used in rural areas. Table 3-4 summarises for 2019 (pre-pandemic) and also 2020 the cycling collision rate in urban and rural areas. The urban cycle collision rate of 3,931 per billion vehicle miles is higher than the rural rate of 1,997 per billion vehicle miles.

Table 3-4: Cycling collision rate urban versus rural for 2019 and 2020

Year	Number, distance travelled, rate	Urban	Rural	Total
2019	Number of collisions	14,263	2,881	17,148
	Distance in billion vehicle miles	2.50519	0.94686	3.45205
	Rate per billion vehicle miles	5,693	3,042	4,967
2020	Number of collisions	13,017	3,432	16,455
	Distance in billion vehicle miles	3.31059	1.7178	5.02839
	Rate per billion vehicle miles	3,931	1,997	3,272

These data are derived from Road Accident Statistics Table 30018 (Department for Transport, 2021a). By far most cycle miles ridden are in urban areas. The collision rate for cyclists is higher in urban areas, a result of greater exposure to motorised traffic in urban areas.

The Royal Society for the Prevention of Accidents (RoSPA) (2022) has used data from e-scooter trial operator Neuron for the period October 2020 to May 2021, which is likely to be, but not reported as being, the data for the trial in Slough. RoSPA states that they have 'calculated rates of harm per unit, i.e., miles travelled, vehicle types, casualty type' and quote an estimate of '0.66 collisions for every million miles travelled on E-scooters'. This rate is compared to the national STATS19 cycle collision rate of 3,272 per billion vehicle miles travelled (or 3.3 per million vehicle miles travelled, a rate apparently five times greater than the e-scooter rate) (The Royal Society for the Prevention of Accidents (RoSPA), 2022). The limitations of this comparison need to be borne in mind, which are as follows: a) it is comparing a small sample with the national data, b) it is comparing self-reported incidents to Neuron with STATS19 reported collision data, and c) it has a different basis of estimating distance.

3.2.5 Policy relating to e-scooters and safety

The ITF examined the safety of cycles, electrically assisted cycles and electrically powered personal mobility devices such as e-scooters, revealing similarities and differences between e-scooters and bicycles in terms of risk (International Transport Forum (ITF), 2020a). The ITF recommends the following:

- Allocate protected space for micromobility and keep pedestrians safe by creating a protected and connected network for micromobility
- To make micromobility safe, focus on motor vehicles, by addressing risky behaviours such as speeding, distracted driving and driving under the influence of alcohol
- Regulate low-speed e-scooters and e-bikes as bicycles and higher-speed micro-vehicles as mopeds
- Collect data on micro-vehicle trips and crashes
- Proactively manage the safety performance of street networks using information collected by sensors and GPS on e-scooters
- Include micromobility in training for road users, especially drivers
- Tackle drunk driving and speeding across all vehicle types
- Eliminate incentives for micromobility riders to speed such as by the minute rental
- Improve micro-vehicle design to enhance stability and grip
- Reduce wider risks associated with shared micromobility operations, for example minimise use of vans for repositioning

The ITF notes that car collisions cause four to seven times more death to street users than vehicle occupants, but that the number of third parties killed in collisions with e-scooters (and bicycles) is no more than 10% (International Transport Forum (ITF), 2020b). They conclude that there is the potential for micromobility to help mitigate the danger of motor vehicle traffic by spurring a mode shift from private cars, taxis and motorcycles (p30).

The Parliamentary Advisory Council on Transport Safety (PACTS) has made recommendations to the Department for Transport concerning e-scooters. They suggest immediate action to address 'dangerous and illegal private e-scooter use' and, despite that, recommend public consultation before a decision on legalisation relating to e-scooter use on the highway, and further research (Winchcomb, 2022). The report provides a detailed list of recommendations in relation to e-scooter vehicle specification. It suggests helmet wearing should be mandatory, and that riding on the footway should be prohibited. In contrast with the International Transport Forum, they have not acknowledged the contributions of appropriate infrastructure within the streetscape to accommodate e-scooters.

3.3 Analysis of the West of England trial operator safety reporting data

Data from the start of the trial on the 29th October 2020 up until 17th April 2022 (a period of just under 18 months) was received from the West of England trial operator and analysed. A total of 1,021 injuries was reported by users. Injuries were mainly minor in nature according to the definitions used, as shown in Table 3-5.

Table 3-5: Number of injuries by severity from the trial operator data

Level	N reports and %	Trial operator definition
1	865 (84.7%)	"Minor injuries like cuts and bruising"
2	153 (15.0%)	"Major injuries which include broken bones, sprains, lacerations, concussions, fractures to the body"
3	3 (0.3%)	"Severe injuries requiring surgery or serious medical treatment."
Total	**1021**	

Trends are now considered over the twelve months of 2021 in the number and distance of rides and number of reported injuries to the trial operator. It is worth being reminded of the levels of lockdown in relation to the Covid-19 pandemic over 2021. The listing below identifies the key dates:

- 4th January 2021 Third national lockdown announced
- 15th February 2021 hotel quarantine introduced
- 8th March 2021 schools reopen in England
- 12th April 2021 non-essential retail and outdoor hospitality re-open
- 17th May 2021 outdoor limit increase to 30 and indoor rule of 6 returns
- 14th June 2021 easing of lockdown due on 21st June 2021 delayed by four weeks to allow for vaccine role out continuation
- 19th July 2021 most remaining restrictions lifted
- 8th December 2021 Plan B Omicron variant measures announced
- 15th December 2021 Covid pass introduced in England

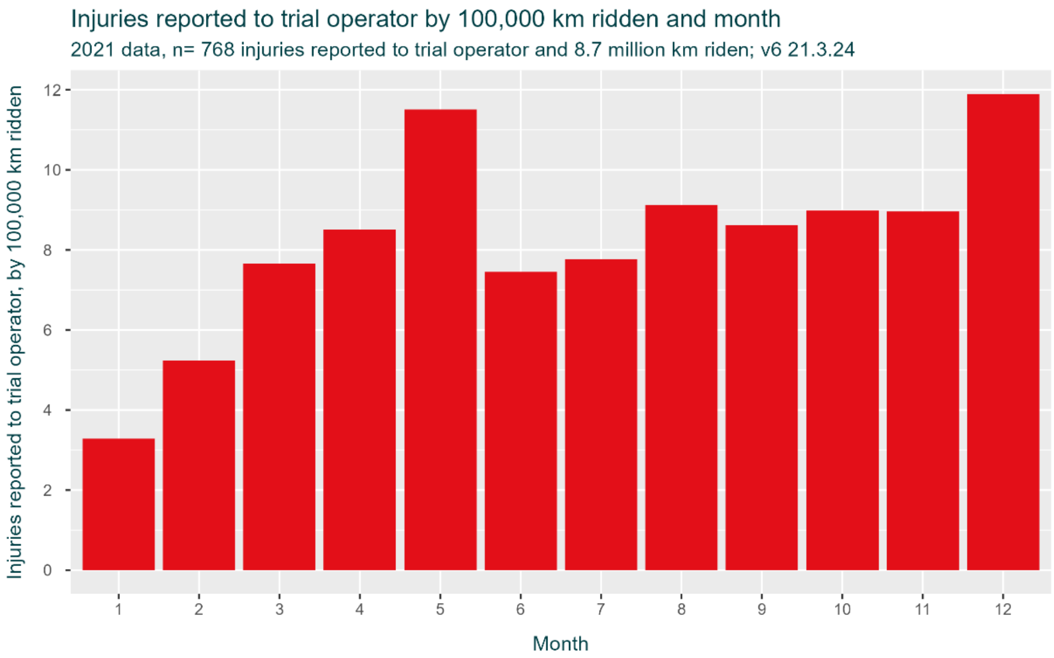
Figure 3-2 shows the distribution of injuries reported, rides, and distances ridden, throughout the year. There was a lower number of rides and distance travelled in the first quarter and this reflects the fact the scheme was still at an early stage of expansion at this point. There is consistent growth in distance ridden and number of trips to a high point in October, with 670,079 miles (1,078 million km) being ridden and 435,401 trips. The number of rides and distance ridden in December returned to levels seen in May to June of 2021.

Figure 3-2: Distances, rides, and injuries, by month

It is noticeable that May and December have higher numbers of injuries than would be expected based on the ride data. For May this could be an artefact of an easing of Covid-19 lockdown restrictions, but the mechanism for this disproportionately high number is not clear. The December effect may be linked with different patterns of behaviour in the holiday period and shorter periods of daylight.

The effects noted in May and December are further revealed in Figure 3-3, which shows the rate of reported injury per 100,000 km. **Based on a total number of injuries of 768 in 2021 and a total distance ridden of 5.39 million miles (8.67 million kms), the injury rate is 8.86 injuries per 100,000 km ridden.** May and December rates are respectively 11.51 and 11.89, while January and February were much lower than the yearly average (3.28 and 5.23 respectively).

It should be noted that the rate includes all injuries, including Level 1 injuries, defined as minor injuries such as cuts and bruises. For purposes of comparison with injury rates that may appear in reportable road traffic collisions, it may be more appropriate to estimate an injury rate based only on Level 2 and Level 3 injuries. **For 2021 the Level 2 and 3 number of injuries was 119, hence giving a rate of 1.37 per 100,000 km.** Figure 3-3 presents by month the rate of injuries by distance ridden and, separately the rate of injuries by number of rides.



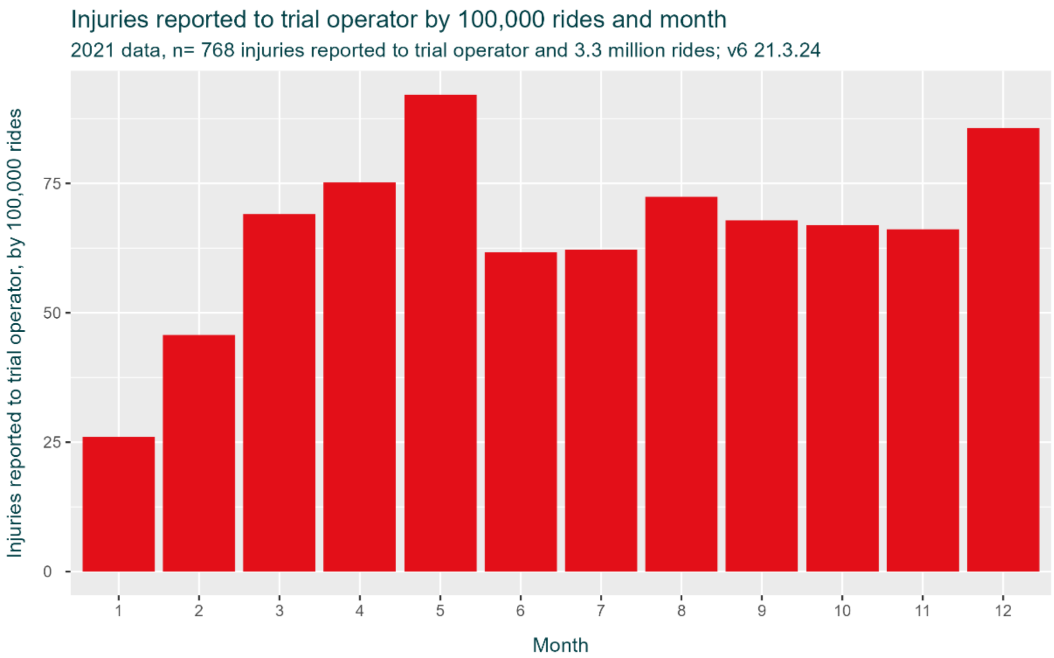


Figure 3-3: Injuries reported to the trial operator by 100,000 km ridden and 100,000 rides, by month

Figure 3-4 shows the rates of injuries by weekday per 100,000 km ridden, and these are consistent but with slight variations throughout the week (non-significant statistically – $\chi 2$ test, $p > 0.05$).

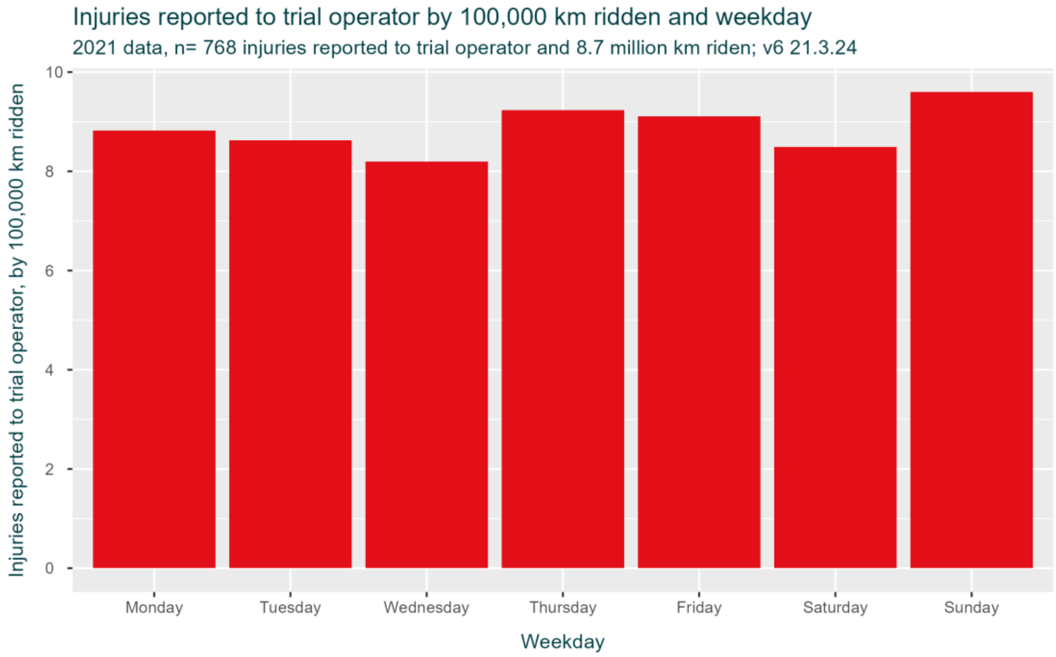


Figure 3-4: Injuries reported to the trial operator by 100,000 km ridden and by weekday

3.4 Analysis of the STATS19 collision records

It is a requirement to report injury collisions involving injury on the public highway to the police, and the STATS19 data is a summary of that data. As well as codes for many types of descriptors, the data includes a narrative summary of each incident. The quality of these narratives is often not sufficiently good that an accurate picture of what occurred can be determined. This is for two reasons. Firstly, a police officer may not have attended the scene and so will be interpreting what involved parties have stated. Secondly, even when a police officer attended the scene, the description they provide can only be constructed from what the officer sees after the event, and what they are told by the involved parties.

Data has been provided to date via Bristol City Council (BCC), South Gloucestershire Council (SGC) and Bath and Northeast Somerset Council (BANES). STATS19 data is provided to the local authorities by the police on a rolling basis throughout the year, and there can be considerable lag between a collision occurring and its appearing in the STAT19 record. This may be as a result, for example, of a complex collision taking time to investigate. After a calendar year end, the local authorities should have validated, by the end of March of the following year, all data for the previous year. On this basis and considering the period October 2020 to December 2020 being the start-up phase of the trial, the focus of the analysis and comparisons will be for the calendar year 2021.

As of 19th May 2022, SGC were awaiting details of eight further collisions they believe have occurred during the year 2021 relating to e-scooters from Avon and Somerset Police. They are also awaiting clarification advice from the DfT on the coding for the speed for one of the collisions (reference number 22201031). SGC also know of three incidents involving e-scooters which are not reportable via STATS19 as a result of their location not being on public highway. Similarly, BCC has noted that it is likely that there will be some e-scooter-related injury collisions in 2021 that have been reported to the police, but which have not found their way to BCC, but that number is unknown. They also note a generic under-reporting issue for single-vehicle collisions involving pedal cycles.

The analysis in this section is based on data from 86 collisions for the year 2021 involving e-scooters which has been provided from STATS19 data by BCC (71 collisions), SGC (12) and BANES (3). The purpose of the analysis of the STATS19 data is to understand patterns in relation to the circumstances and possible causes of collision. It also estimates the injury severity ratio for comparison with cycling. The analysis considers collisions involving both trial and private e-scooters because this provides a wider set of data on which to judge risk to which e-scooter riders are exposed.

On 24th May 2022, Avon and Somerset Police provided from their internal additional collision records a breakdown for these 86 collisions of the types of e-scooters involved. Based on evidence presented to them, 43 of the 86 collisions (50%) were recorded in the police data as trial operator e-scooters, 21 (24%) were privately owned, 19 (22%) were of unknown provenance, and the remaining 3 (3%) were not e-scooters (unpowered, or child scooters). This analysis does not include the possible eight additional collisions as noted by SGC above, and an additional seven STATS19 collision records supplied by BCC on 7th June 2021, and which were not subject to the check by the police on the type of e-scooter.

20 out of 83 collisions (24%) occurred when it was dark, but all occurred in locations that were street lit (information is not available on this for the three collisions in BANES). 70 out of 80 collisions (88%) were in fine weather without high winds. The remaining 10 collisions were in either fog or rain, or what is described as ‘other’ weather. 71 out of 83 collisions were on dry road conditions, with the remaining 12 being on damp conditions. Figure 3-5 shows the number of injuries by time of day for trial operator e-scooters only. While the numbers are low per hour, and therefore subject to random variability, it appears as though the afternoon period has a greater prevalence in aggregate than the morning, and, with an apparent dip in the evening at about 9pm, the number of collisions rises again in the later hours of the evening. Note that it not necessarily the case that the risk rate per kilometre ridden is greater in the afternoon, and the variability in the number per hour will be linked with variability in the number of trips per hour varying across the day.

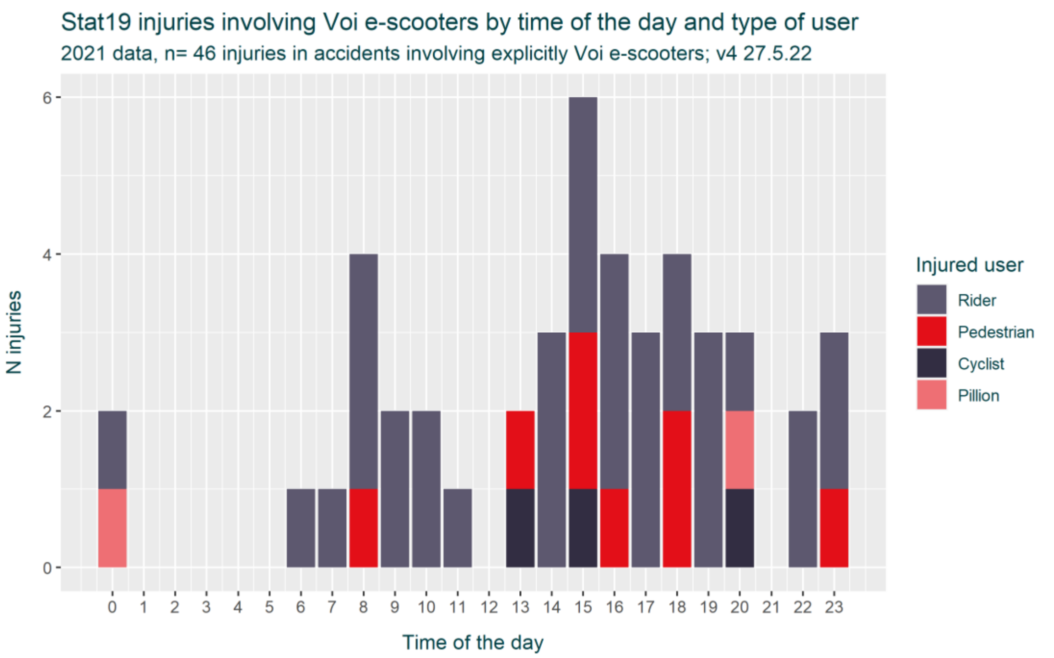


Figure 3-5: Injuries involving trial operator e-scooters reported to police, by time of the day

There was a total of 97 people injured in the 86 collisions. Table 3-6 summarises the number and type of injuries. Nine e-scooter rides suffered serious injury and all remaining 88 injuries were slight. 13 collisions involved pedestrians as the casualty, 8 involved cyclists or a cycle pillion as the casualty, 6 involved injuries to the e-scooter pillion and 3 were drivers.

The severity ratio provides an indication of the level of seriousness of injury from collisions. It is usually estimated as the number of killed and seriously injured as a proportion of all injury levels. The STATS19 data suggests the ratio is 9/97 (9.3%). Using Levels 2 and 3 from the trial operator data and comparing to all three levels of injury suggests a ratio of 156/1021 (15.3%). By comparison, the cycling severity ratio is in the order of 25%. Note that unpublished analysis of cycling data for the years 2017 to 2019 analyses severity ratio by age group (Bastock, 2022). This reveals a severity ratio for those in age bands from 10 to 59 of between 17% to 18.4%, with rates reaching nearly 38% for those aged 90 and over. With most e-scooter riders aged up to 24, the lower rates compared with cycling could be age related.

Table 3-6: Number and types of injury

Injured person	Slight injury	Serious injury	Total
Scooter rider	58	9	67
Scooter pillion	6	-	6
Cyclist	7	-	7
Cycle pillion	1	-	1
Pedestrian	13	-	13
Driver	3	-	3
Total	**88**	**9**	**97**

Of the 73 collisions not involving pedestrians (86 minus 13), four were single vehicle collisions of e-scooters, hence involving either hitting an obstacle, or a fall from the e-scooter. Three involved two other vehicles besides the e-scooter and one involved three other vehicles. The remaining 65 collisions involved one other vehicle.

For the 80 riders for whom an age is given, the average age is 25.6 years. Excluding the 15 aged in the range 11 to 16 gives an average age of 28.2 years. 11 were aged 18 or 19, 29 were in their twenties, 17 were in their 30s, and 8 were in their forties or fifties. Of the 66 with known gender, 23 (35%) are female, hence male injuries are more prevalent by a factor of 1.9. This compares with 2.8 times more e-scooter trips being recorded by men than women and suggests lower risk of collision involvement for women.

Table 3-7 provides location and description of the collisions. It indicates the most likely primary fault that can be imputed from the collision record. Narrative descriptions fall into broadly three groups: descriptions where fault is not discernible, descriptions where fault is probable, but not fully clear, descriptions where fault is fairly or very clear. To best understand the nature of where the possible fault lies, these latter two categories are grouped together, and fault is apportioned based on it being probable and/or clear.

On this basis, the driver of a vehicle (i.e., a vehicle other than the e-scooter) is at fault in 38 of the 83 collisions (excluding the three BANES collisions for which descriptions have not been provided) and the rider (of the e-scooter) in 42. A cyclist was likely at fault in one collision and for two collisions no fault is discernible.

A total of 30 collisions occurred on the carriageway (36%), 11 on the footway (13%), 6 on cycle tracks (7%). Cycle tracks provide the most appropriate infrastructure for e-scooters because their characteristics are most like cycles. The low proportion of collisions on cycle tracks reflect the general absence of cycle tracks in Bristol, South Gloucestershire and Bath.

There were four collisions involving vehicles crossing the footway to reach a drive or an access, and two of these were with the e-scooter in the carriageway, and two with the e-scooter on the footway. There were two collisions at pedestrian crossings.

30 (36%) collisions occurred at junctions, with 17 (57% of junction collisions) at priority junctions, 6 (20%) at roundabouts and 7 (23%) at signal-controlled junctions. Junctions are the usual points of conflict in a network and hence collisions tend to be more prevalent at junctions. Overall, 53 (64%) collisions were not at junctions, and 30 (36%) were at junctions. By comparison, in 2017 to 2019 in Great Britain, the proportion of injury collisions not at junctions for cyclists was 26.2% (Bastock, 2022). There may be some over-representation of collisions away from junctions as compared with cycling.

Table 3-7: Number of collisions by location, type and imputed fault

Location and description	Fault of: Rider	Cyclist	Driver	Unknown	Total
Carriageway	**15**		**13**	**2**	**30**
Parked vehicle door opening			1		1
Pedestrian crossing	1			1	2
Scooter colliding	6			1	7
Scooter crossing	3				3
Scooter overtaking	2				2
Scooter swerving	1		1		2
Vehicle colliding			7		7
Vehicle crossing			1		1
Vehicle overtaking			3		3
Vehicle reversing	1				1
Unknown	1				1
Footway	**10**		**1**		**11**
Scooter colliding	10				10
Vehicle crossing			1		1
Cycle track	**4**	**1**	**1**		**6**
Cycle colliding		1			1
Scooter colliding	3				3
Scooter crossing	1				1
Vehicle turning			1		1
Drive / access scooter on carriageway			**2**		**2**
Vehicle parking			1		1
Vehicle reversing			1		1
Drive / access scooter on footway	**1**		**1**		**2**
Vehicle crossing	1		1		2
Pedestrian crossing	**1**		**1**		**2**
Pedestrian crossing	1				1
Vehicle colliding			1		1
Priority Junction	**5**		**12**		**17**
Scooter crossing	3				3
Scooter turning	1		1		2
Vehicle crossing			6		6
Vehicle overtaking			3		3
Vehicle turning	1		2		3
Roundabout			**6**		**6**
Vehicle colliding			3		3
Vehicle crossing			1		1
Vehicle entering			2		2
Signal controlled junction	**6**		**1**		**7**
Scooter colliding	1		1		2
Scooter failed to stop at red signal	2				2
Scooter overtaking	1				1
Scooter turning	2				2
Total	**42**	**1**	**38**	**2**	**83**

Breath tests were frequently not requested, or the relevant field is blank. From the worded descriptions, it appears as though two e-scooter riders were intoxicated. There is no record of any e-scooter rider having been wearing a helmet, or not.

3.5 Comparisons of collision and injury rates from different data sets

This section describes the estimation of collision and injury rates from the different sources of data (trial operator data, STATS19 data, hospital data, cycling data).

Comparison of trial operator and STATS19 injury rates

The data available from the trial operator is for injuries. There were 768 injuries reported by users to the trial operator, and based on 8.67 million kilometres ridden (from the operator data), this equates to a **trial e-scooter casualty rate of 8.86 per 100,000 km ridden**. **Using only Level 2 and Level 3 injuries of 119 gives a rate of 1.37 per 100,000 km.**

46 casualties are reported in 43 collisions in the STATS19 data which explicitly mention trial e-scooters (and this is exactly half of the 86 e-scooter-related collisions in the STATS19 data). Thirty-three (72%) of the casualties were e-scooter riders. **This suggests a STATS19 reported casualty rate of 0.530 casualties per 100,000 km ridden, or 6% of the 8.86 per 100,000km trial operator rate, or 39% of the 1.37 per 100,000 km trial operator rate**.

The comparison between STATS19 and the operator data is perhaps best undertaken by excluding the Level 1 minor injuries), and hence the 39% proportion is perhaps the most useful comparison to make. Few of the approximately 85% of Level 1 injuries may have required reporting to the police, because they would not have been classified as road traffic collisions and may have resulted from e-scooter mishandling while parking, for example. Similarly, few of them if any would have required hospital treatment.

It is not possible to determine from the trial operator data whether the casualty is the e-scooter rider or not. Also, it is not clear whether trial operator customers were more or less likely to report injuries to themselves, or to third parties.

Comparison with hospital data

Section 3.2.1 summarised the hospital-based studies in Bristol (Aurora et al., 2021; Quandil and et al, 2021). Aurora et al. (2021) report on a retrospective observational study of patients presenting at the Bristol Royal Infirmary between late October 2020 and late May 2021 with e-scooter-related injuries. Quandil et al. (2021) summarise the results of a prospective observational study undertaken by researchers at Bristol Royal Infirmary, Southmead Hospital and Bristol Children's Hospital in May-June 2021.

The two studies were undertaken Independently. The BRI-only sample (Aurora et al., 2021) includes 14 patients who presented to the BRI ED in May 2021, compared with a sample of 90 who presented to the BRI, Southmead, and the Children's Hospital EDs combined in May-June 2021 (Quandil and et al, 2021). It is possible that these 14 individuals recorded in the BRI-only sample also appear within the larger 3-hospital sample. People sustaining serious injuries from e-scooter collisions in Bath are likely to have been brought to one of the Bristol hospitals; hence serious injuries would have appeared in the sample studied by Quandil et al. (2021). However, people presenting at Emergency Departments in Bath with less serious e-scooter-related injuries would not have been captured in the data.

The larger of the two Bristol studies (Quandil et al, 2021) found that 90 people presented to the three Bristol EDs with e-scooter related injuries during the four-week period in May-June 2021. Most injuries (71%) were sustained by people aged 30 or under. Women accounted for 47% of the hospital sample. Almost all patients (95%) had been riding the e-scooter. Two people had been e-scooter passengers and one was a pedestrian.

Based on available evidence, the type of e-scooter (trial or privately owned) was recorded in 81 cases. Most cases involved a trial operator e-scooter (80%, n=65/81) as opposed to a privately owned e-scooter (20%, n=16/81). It is not possible to do a direct comparison because the four weeks of the NHS study straddled May and June, whereas the figures in the trial operator monthly report for June 2021 are by calendar month. Table 3-8 shows the trial operator Level 2 and Level 3 (the more serious injuries, which may have required hospital treatment) for May and June 2021 as compared with the 65 from the Quandil et al. (2021) study.

Table 3-8: Comparison of the number of trial operator reported injuries with hospital data for May and June 2021

	Trial e-scooter related presentations across three Bristol Emergency Departments	**Trial operator injury data (injuries level 2 or 3)**		**STATS19 (all injuries reported are slight)**	
Time period	4 weeks in May-June 2021	May 2021	June 2021	May 2021	June 2021
Level 2 injury **Level 3 injury**		17	7		
Rider or e-scooter pillion				6	1
Cyclist or cycle pillion				2	1
Pedestrian				2	1
Total	65			10	3

There were **65** patients presenting with trial e-scooter related injuries presenting to Bristol emergency departments in a four-week period in May and June 2021. STATS19 records a total of **13** injuries in May and June 2021. There were **24** recorded Level 2 and 3 injuries in the trial operator data (Level 1 is cuts and bruises and may not have needed to be recorded in either STATS19 or needed a hospital visit, and so has been excluded from this total). Dividing the STATS19 and trial operator data by two to equate approximately to a four week period suggests that the ratio of injuries in the STATS 19, trial operator and hospital data are in the proportions 1:1.8 (STATS19 to operator data) and 1:10 (STATS19 to hospital data). It should be noted that trial operator data may not be in line with the STATS19 cases because they might be mutually exclusive (for example some trial operator data not requiring or seeking medical treatment at these specific hospitals).

Comparison with cycle injury rates

The following listing summarises rates from different estimation methodologies for cycle and e-scooter injuries.

- Trial operator e-scooter all injury rate 8.86 per 100,000 km ridden.
- Trial operator e-scooter Level 2 and Level 3 injury rate 1.37 per 100,000 km ridden

- Trial operator e-scooter rate based on STATS19 reported data 0.530 casualties per 100,000 km ridden,
- 2021 STATS19 cycle injury rate of 3,920 per billion miles (Table 3-3) travelled or 0.245 per 100,000km travelled
- Adopting the ratio of trial operator to hospital collisions of 12 to 65 suggests a rate based on hospital data of 1.37 factored up by 65/12, or 7.42 injuries per 100,000km.

To take account of possible under-reporting in the cycle injury data, the most appropriate comparison of rates is arguably the 0.530 rate for trial e-scooters versus 0.245 rate for cycles based on STATS19 data. This would suggest that e-scooters may be riskier than cycling by a factor of 2.2. The cycle injury rate of 0.245 is for all areas, urban and rural. If this is factored by the collisions rate, from Table 3-4, to be an urban injury rate (multiplying by 3931 / 3272), suggests an urban cycle injury rate of 0.294 per 100,000 km, suggesting e-scooters, which have been primarily used only in the urban areas in Bristol, may be riskier by a factor of 1.8. It should be stressed that this is a comparison of e-scooter injury rates in Bristol with the Great Britain urban cycling rate. It was a requirement of the evaluation that such a comparison be made, and it should be used with caution.

However, these comparisons have to be viewed with great caution. To make a valid comparison between e-scooter and cycling collision rates the same protocol needs to be adopted for collecting the data for both the numerator (the number of injuries) and the denominator (the distance ridden). An example of such a protocol would be a joint e-scooter and e-bike hire system operated under similar rules, with accurate distance data collected in the same way for all rides, and injury data collected in the same way. This injury data would at best be collected from three sources: rider self-report, STATS19 data and hospital data.

A comparator to this analysis in Bristol is the retrospective study in Liverpool by Bodansky et al. (2022) who compared e-scooter riders' and cyclists' musculoskeletal injury rate in winter 2020/21. They estimated orthopaedic injury rates of e-scooters and cyclists as, respectively, 26.1 and 24.1 injuries per million kilometres ridden. These data suggest nearly comparable injury rates. While the numerator has been collected based on the same protocol, the denominator for the e-scooter rides was derived from trial data, and the distance cycled was derived from the Department of Transport vehicle count data. This study therefore also suffers from the same issue that it has not been possible for the researchers to derive numerator and denominator for the comparison of the two modes from a single study with a common protocol.

The comparison made for the West of England trial provides an approximate guide only because the comparison is between data from one city region for the e-scooter rate and national data for the cycling rate, and there is a different basis of estimating distance for the two modes.

4 INTERACTIONS OF E-SCOOTERS IN THE PUBLIC HIGHWAY

4.1 Introduction

This chapter presents results of the analysis of interactions of e-scooters with other street users at eight sites across Bristol. It focuses on providing evidence to help answer the following evaluation questions:

> **1a Riders:** How does the safety of riding an e-scooter in the region compare with cycling?
> **1c Other road users:** How is the safety and comfort of other road users impacted by e-scooters?
> **2f Network performance:** How have e-scooters impacted the performance of the road network?
> **4b Highway:** What highway characteristics (e.g., traffic volume, speed, prevision of a cycle lane etc.) have affected e-scooter operation and safety?

Section 4.2 presents results on traffic flows, and Section 4.3 focuses on behaviours related to safety. Section 4.4 reflects on the relationship between the findings and highway infrastructure. Section 4.5 provides a short summary.

4.2 Traffic flow data for each site

Conventionally, highways tend to be described from the perspective of on-carriageway motorised traffic. The focus of attention is switched to the perspective of e-scooter and cycle riders for the purposes of this analysis. As well as using the carriageway, e-scooter riders and cyclists may also cross the carriageway using a Toucan Crossing, which is a signalised crossing where cycle traffic and pedestrians share footway space at either side of the carriageway. It is also a place where e-scooter riders and cyclists can either leave the carriageway or join the carriageway, and so they will be making both straight-across-carriageway movements, and turning movements. Hence, such ‘crossings’ also become ‘crossroad junctions’ for human scale mobility.

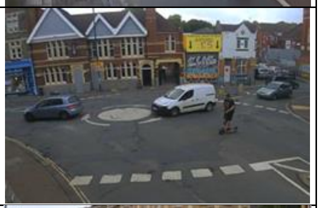
Table 4-1 below provides a description of each site divided into three typologies. These typologies have been determined post-hoc from the flow data and patterns of use, as follows:

Type 1 **Good (separated) cycle infrastructure** and locations with the highest e-scooter flows (3-6%) and cycle flows (3-16%). They are also locations where most of the flow is pedestrians.

Type 2 **Poor cycle infrastructure** with typically lower e-scooter flows (3-4%) and cycle flows (3-8%), but moderately good walking infrastructure. They are also locations with similar flows of pedestrians and motor traffic, and they were also hilly.

Type 3 **On-carriageway cycle provision** with the lowest e-scooter flows (1-2%) and cycle flows (1-4%) flows. They are also locations where most of the flow is motor traffic, and walking is the second most prevalent mode.

Table 4-1: Site descriptions grouped by typology

Typology	Sites	Site Description
T1 Good cycle infrastructure	1	**Castle Park / Bristol Bridge**. Separated two-way cycle and pedestrian signalised crossing, as part of a three-way signalised road junction. 
	2	**Broad Quay**. Toucan crossing (non-separated cycle and pedestrian signalised crossing) across one-way carriageway, linking a two-way cycle track and footways with cycle tracks, footways and an area of shared space (for pedestrians, cyclists and e-scooter riders). 
	3	**Prince Street Bridge.** A one-way carriageway and two-way cycle track and footway. 
T2 Poor cycle infrastructure	4	**Queen's Avenue / Queen's Road**. Priority junction with zebra crossing from one-way carriageway with advisory cycle lanes (i.e., motor vehicles are permitted to enter). 
	5	**Zetland Road / Gloucester Road / Cheltenham Road**. Signalised four-way junction with pedestrian crossing or pedestrian and cycle crossing facilities at each arm, with limited cycle provision (advisory cycle lane or one-way cycle track) on some sections of the carriageway. 
T3 On-carriageway cycle provision	6	**North Street / Dean Lane**. Mini roundabout, with adjacent narrow footways. 
	7	**St Michael's Hill / Upper Maudlin Street**. Signalised junction with pedestrian crossing facilities and advisory cycle lanes. 
	8	**Stokes Croft entry to Bear Pit roundabout**. Signalised Junction with pedestrian crossing facilities and advisory cycle lanes, which is part of a major roundabout. 

Appendix 5 contains sixteen charts showing the proportions of flow at each of the eight sites over the two days of observation. The patterns of use are exemplified in Figure 4-1, Figure 4-2 and Figure 4-3 by three of the sites for Friday 1st July 2022. The 'n' value in the figure title gives the total flow. For this purpose, pedestrians have been included as a 'vehicle' type.

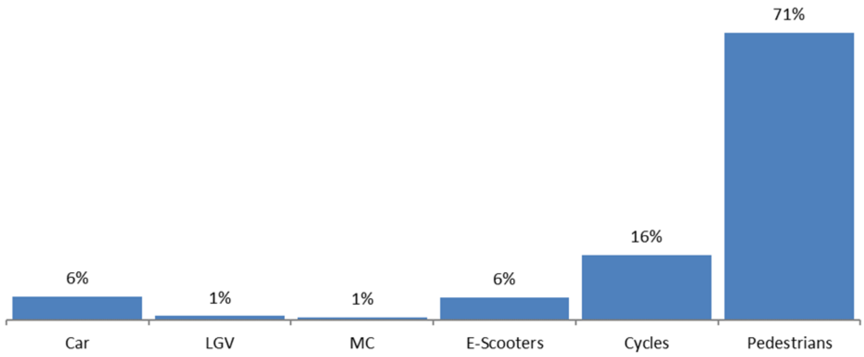


Figure 4-1: Type 1, Site 3, percentage of flow by type, 6am to midnight, Friday 1/7/22 (n=21,912)

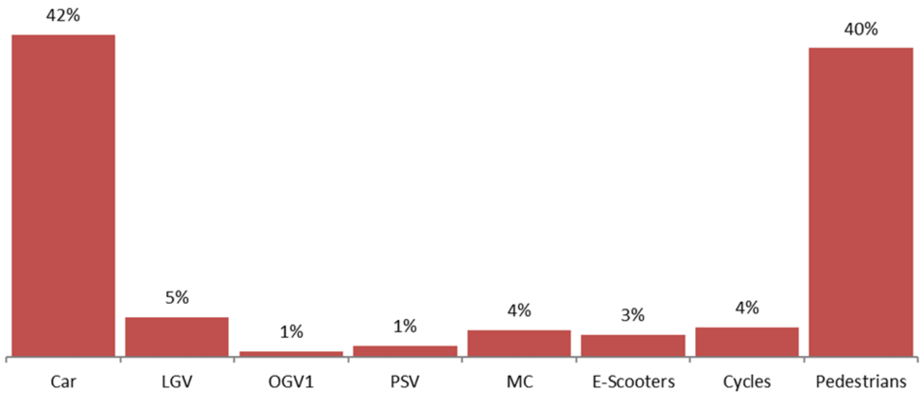


Figure 4-2: Type 2, Site 4, percentage of flow by type, 6am to midnight, Friday 1/7/22 (n=46,590)

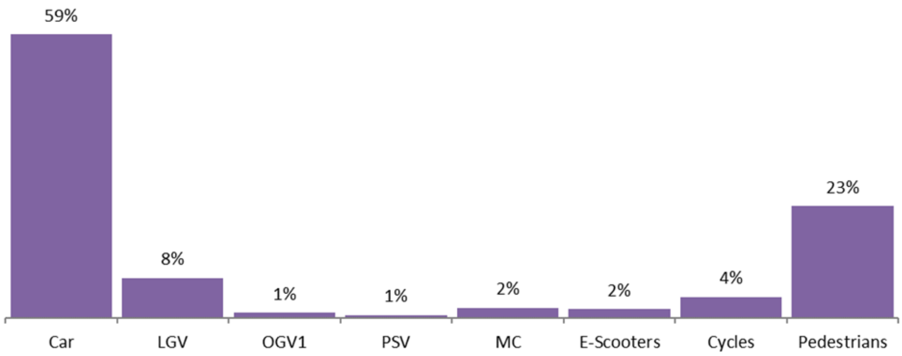


Figure 4-3: Type 3, Site 6, percentage of flow by type, 6am to midnight, Friday 1/7/22 (n=25,793)

Table 4-2 summarises the flow by mode from 6am to midnight for each site for the two days of Friday 1st July 2022 and Saturday 2nd July 2022. Sub-totals are provided for the combined human-scale modes of e-scooter, cycle and walking trips (Sub-total 1) and for all other motorised trips using the carriageway (Sub-total 2). The classification 'Other' includes additional human-scale modes including wheelchairs, skateboards, and mobility scooters. The classification 'Commercial' combines the three categories of goods vehicles (Light Goods Vehicles, LGVs; Other Goods Vehicles Class 1, OGV1; and Other Goods Vehicles Class 2, OGV2). Private motor vehicles (motorcycles and cars) have been combined into one category.

Table 4-2: Flow from 6am to midnight for each site and day by mode

Site	Type	Location	Day	Date	E-scooter	Cycle	Pedestrian	Other	Sub-total 1	Bus	Commercial	Car/MC	Sub-total 2	Total
1	T1	Bristol Bridge	Fri.	01/07/2022	1707	3047	21,822	20	**26596**	460	185	7775	**8420**	35016
			Sat.	02/07/2022	1134	1465	19140	22	**21761**	353	78	8424	**8855**	30616
			Combined		**2841**	**4512**	**40962**	**42**	**48357**	**813**	**263**	**16199**	**17275**	**65632**
2	T1	Centre	Fri.	01/07/2022	2132	3805	29248	65	**35250**	1188	3200	22533	**26921**	62171
			Sat.	02/07/2022	1479	1833	30828	54	**34194**	873	1066	22844	**24783**	58977
			Combined		**3611**	**5638**	**60076**	**119**	**69444**	**2061**	**4266**	**45377**	**51704**	**121148**
3	T1	Prince St Bridge	Fri.	01/07/2022	1213	3507	15542	57	**20319**	0	214	1379	**1593**	21912
			Sat.	02/07/2022	830	1913	18136	49	**20928**	0	79	1263	**1342**	22270
			Combined		**2043**	**5420**	**33678**	**106**	**41247**	**0**	**293**	**2642**	**2935**	**44182**
		T1 totals	**Combined**		**8495**	**15570**	**134716**	**267**	**159048**	**2874**	**4822**	**64218**	**71914**	**230962**
4	T2	Queens Rd	Fri.	01/07/2022	1339	1811	18756	16	**21922**	685	2765	21218	**24668**	**45251**
			Sat.	02/07/2022	1002	925	14823	11	**16761**	521	954	18783	**20258**	**36017**
			Combined		**2341**	**2736**	**33579**	**27**	**38683**	**1206**	**3719**	**40001**	**44926**	**83609**
5	T2	Glos. Rd	Fri.	01/07/2022	1388	2889	11760	25	**16062**	512	2775	18847	**22134**	**38196**
			Sat.	02/07/2022	1111	1452	12439	8	**15010**	330	1106	17063	**18499**	**33509**
			Combined		**2499**	**4341**	**24199**	**33**	**31072**	**842**	**3881**	**35910**	**40633**	**71705**
		T2 totals	**Combined**		**4840**	**7077**	**57778**	**60**	**69755**	**2048**	**7600**	**75911**	**85559**	**155314**
6	T3	North St	Fri.	01/07/2022	456	1112	5951	53	**7572**	154	2424	15643	**18221**	25793
			Sat.	02/07/2022	303	661	5437	18	**6419**	131	984	13800	**14915**	21334
			Combined		**759**	**1773**	**11388**	**71**	**13991**	**285**	**3408**	**29443**	**33136**	**47127**
7	T3	St Michaels Hill	Fri.	01/07/2022	642	767	7999	23	**9431**	127	2693	20743	**23563**	**32994**
			Sat.	02/07/2022	542	434	5060	6	**6042**	92	1140	18512	**19744**	**25786**
			Combined		**1184**	**1201**	**13059**	**29**	**15473**	**219**	**3833**	**39255**	**43307**	**58780**
8	T3	Bear Pit	Fri.	01/07/2022	411	574	10522	19	**11526**	337	2720	19418	**22475**	**34001**
			Sat.	02/07/2022	359	430	11678	14	**12481**	245	1175	18634	**20054**	**32535**
			Combined		**770**	**1004**	**22200**	**33**	**24007**	**582**	**3895**	**38052**	**42529**	**66536**
		T3 totals	**Combined**		**2713**	**3978**	**46647**	**133**	**53471**	**1086**	**11136**	**106750**	**118972**	**172443**
All	T1-3	All eight sites	Fri.	01/07/2022	9288	17512	121600	278	**148678**	3463	16976	127556	**147995**	**296673**
			Sat.	02/07/2022	6760	9113	117541	182	**133596**	2545	6582	119323	**128450**	**262046**
All	T1-3		Sat. as % of Fri.		73%	52%	97%	65%	**90%**	73%	39%	94%	**87%**	**88%**
All	**T1-3**		**Combined**		**16,048**	**26,625**	**239,141**	**460**	**282,274**	**6008**	**23,558**	**246,879**	**276,445**	**558,719**

The proportion of flow that is human-scale, i.e. either e-scooter, cycle, pedestrian or other human-scale mode, is marginally in the majority (50.5%, 282,274/558,719). The proportion of e-scooters out of the total of e-scooters and cycles across the eight sites is 38% (16,048/42,673).

At Bristol Bridge (Site 1), the proportion of human-scale flow is 73.6%. E-scooters account for 4.3% of the flow and cycle 6.9% of the flow, or 11.2% taken together. These proportions may be compared with data from Bristol City Council (BCC).

Following the introduction of a Bus Gate to limit Bristol Bridge to buses, taxis, cycles, and e-scooters, BCC installed Vivacity sensors and monitored the number of people using the bridge. The sensors can detect the different modes using artificial intelligence. Bristol City Council (2022) reported that active travel modes combined together account for 74% of trips per month through the site for the period January 2021 to April 2022. Cycle flow accounted for 9-11% of the flow. Until recently, Vivacity sensors could not identify e-scooters as a separate mode, and so these trips were not identifiable within the cyclist and pedestrian data. This Vivacity data corroborates the observed data as part of this evaluation for Bristol Bridge, and suggests that the 4.3% of e-scooter flow were 'hidden' in the cycle flow data.

4.2.1 Comparison of e-scooter and cycle use

The total volumes for Saturday 2nd July 2022 were compared with the totals for Friday 1st July 2022 to understand differences in travel at the weekend with travel on a weekday. Understandably commercial vehicle trips reduce the most (by 61 percentage points).

Both e-scooter and cycle trips reduce substantially between Friday and Saturday, but, while cycle trips reduce by a half, e-scooter trips only reduce by 25%. This results in the number of e-scooter trips being closer to the number of cycle trips at all sites on a Saturday. Indeed, at two sites (Sites 4 and 7), there was a larger e-scooter flow than cycle flow at the weekend. Both sites 4 and 7 are close to the University of Bristol (UoB). This reduction in cycle, but not e-scooter, use at weekends is corroborated by data collected by the UoB who, like BCC, also deployed Vivacity sensors which can now distinguish between e-scooters and cycles (University of Bristol, 2022). UoB data from Park Row (between Sites 4 and 7) shows that weekend average flows in October 2022 indicate e-scooters flows to be almost the same as cycle flows, and they sometimes peak at a higher flow than cycle flows in the early afternoon.

By contrast foot and private motor vehicle flows remained at a relatively consistent level between Friday and Saturday, with reductions of only 3 and 6 percentage points respectively. The inference that could be drawn is that for private journeys (i.e., trips not in commercial vehicles or buses), cycling is the mode most used for utility trips (i.e. commuting and education), and this is evidenced by the large reduction in cycling flows at the weekend. A similar inference for e-scooter trips being for utility trips may also be made. Indeed, walking trips at the weekend increased slightly at four sites (Sites 2, 3, 5 and 8 which are sites near to shops and leisure attractions), and private motorised vehicle trips increased at two sites (Sites 1 and 2). The inference may be that walking, and driving are important modes for both leisure trips and utility journeys, whereas e-scooters and cycles are relatively more important for the utility role they play.

4.3 Safety of e-scooter riders and other street users

This section provides data to assist in answering evaluation question **1a Riders**: How does the safety of riding an e-scooter in the region compare with cycling? Section 4.3.1 considers helmet wearing, Section 4.3.2 double riding, Section 4.3.3 riding through a red signal aspect, Section 4.3.4 dismounts and injuries, Section 4.3.5 near-misses, and Section 4.3.6 footway riding.

4.3.1 Helmet wearing

An hour of detailed analysis of the video footage was undertaken in relation to helmet wearing at all eight sites, covering the peak hour from 5pm to 6pm on Friday 1 July 2022. The presence or absence of a helmet was noted for all e-scooter riders. It is noted that while helmet wearing while riding an e-scooter (or cycle) is not legally required, the trial operator encourages the use of helmets through their in-app messages. Table 4-3 presents the results.

Table 4-3: Comparing helmet wearing of e-scooter riders and cyclists

Mode	No. of riders	No. wearing helmets	Percentage of riders wearing helmets
Cyclists	1,881	1,066	57%
Trial e-scooter riders	927	85	9%
Other e-scooter riders	25	1	4%
All e-scooter riders	952	86	9%

It can be seen from these observations that most cyclists (57%) wear helmets, and 9% of e-scooter riders wear helmets. From the observations an attempt was made to distinguish between the trial operator 'hop-on-hop-off' (HOHO) e-scooters and other e-scooters from the colour of the stems (HOHO e-scooters have pink handle-bar stems). The number of non-trial e-scooters identified (25) is too low to make a meaningful comparison.

An analysis of every illegal action, and actions that are not advised, was carried out across the eight sites for 6am to midnight on both Friday 1st July and Saturday 2nd July 2022. Illegal and ill-advised actions were defined as when an e-scooter or cycle was observed doing one of the following:

- Footway (pavement) riding
- Using a zebra or other pedestrian crossing
- Double/triple riding (two- or three-up riding)
- Making a banned turn or travelling the wrong way down a one-way street
- Going through a red signal aspect across a stop line on the carriageway, or at a cycle-only crossing which has a white line across the cycle track.
- Going through a red signal at a Toucan or other crossing with cycle facilities which does not have a white line across the cycle part of the crossing.

Note that for the last two bullet points noted above, there is a legal difference between crossing a white line on a red aspect at a signal controlled junction, and crossing a pedestrian crossing on a red standing person red bicycle symbol without a white stop line. The pedestrian or cyclist 'should not' cross when a red signal aspect is illuminated at a crossing (Zebra, Pelican and Puffin Pedestrian Crossings Regulations and General Directions 1997). However, a red aspect on a signal head with a white line conveys a ‘prohibition’ that vehicular traffic shall not proceed beyond the stop line. Many road users are likely to be unaware of this distinction, however.

Table 4-4: Helmet wearing and illegal or ill-advised action

Mode	No. of riders observed making illegal or actions that are not advised	Of which, number wearing helmets	Percentage of riders making illegal actions or actions that are not advised who were wearing helmets
Cyclists	5,867	2,307	39%
Trial e-scooter riders	3,753	136	4%
Other e-scooter riders	277	21	8%
All e-scooter riders	4,030	157	4%

From these results it seems that a lower proportion of riders making illegal and ill-advised actions, potentially endangering themselves and others, are likely to be wearing a helmet than the general population of riders. Again e-scooter riders (whether part of the trial scheme or not) are far less likely to wear a helmet than cyclists.

4.3.2 Double (two-up) riding

Double riding (two people on a single e-scooter) was observed 49 times over two days during the 36 hours of observation across the eight sites, which represents 0.3% of all e-scooter trips through these sites. Three of these were on e-scooters that were not trial operator e-scooters. So far as cycling is concerned, there were no instances of two-up riding, other than on tandems, cycles with a child seat or cargo bikes.

4.3.3 Riding through red signal aspects

At the five sites where there are traffic signals (Sites 1, 2, 5, 7, and 8), riding through a red signal aspect was the most common illegal or ill-advised action. As noted above, going through a red signal and across a solid white stop line on the carriageway, or at a cycle-only crossing, is illegal for both e-scooter riders and cyclists in the same way that it is illegal for motor vehicle drivers and riders. However, going through a red signal at a Toucan (non-separated cycle and pedestrian signalised crossing) is advisory for crossing riders in the same way that it is for pedestrians at pedestrian only signalised crossings. In these situations, the green signal is an ‘invitation to cross’ rather than the red signal being a ‘prohibition’ to crossing. However, when using the carriageway it is illegal for both riders and drivers to go through a red signal and across a solid white stop line at a Toucan crossing.

Table 4-5: Number of riders passing a red signal aspect at the five signal controlled sites

Mode	No. of riders	No. riding through red lights	Percentage of riders passing through red lights
Cyclists	16,696	4,031	24%
Trial operator e-scooter riders		2,549	
Other e-scooter riders		190	
All e-scooter riders	10,905	2,739	25%

The total number of trial e-scooter riders at each site, as distinct from the total number of other e-scooter riders, is not known because the vehicle counts did not differentiate between types of e-scooters. However, the trial operator e-scooters were distinguished from other e-scooters when an illegal action was observed. For the peak hour, when the characteristics of all riders was analysed, 3% of e-scooters were observed to be non-trial operator e-scooters (n=25).

The results suggests that a similar proportion of e-scooter riders and cyclists ride through red signals. There will be various reasons for this, including self-protection on the one hand (wanting to move away from congested and potentially risky situations at a stop line when the next green aspect shows), and on the other hand risk taking (linked with not wanting to be unnecessarily delayed as a result of signal control only being necessary as a result of the volume of motor vehicle traffic). Differences between sites in the number of illegal red signal crossings may indicate specific infrastructure issues of concern to riders, or conversely which more easily allow riders to break the law, and this is dealt with below when addressing the question of how highway attributes have affected e-scooter operation and safety.

4.3.4 Dismounts and injuries

In 36 hours of observations across the eight sites, e-scooter riders were observed to be forced to dismount nine times following an interaction with another vehicle. This appeared to result in injury to three riders. Cyclists were observed to dismount five times at three sites, resulting in one injury.

Eight of the dismounts that involved e-scooters were interactions with other e-scooters and include two of the three injuries. The other dismount was an interaction with a cyclist, and this also resulted in injuries to both parties. Seven of the nine e-scooter rider dismounts were on separated cycle infrastructure and only two (an interaction between two e-scooters) were on the carriageway.

The interactions that resulted in five cyclists dismounting were more varied, with one occurring with a pedestrian, one with an e-scooter rider, one with another cyclist and one with a car driver. The one injury to a cyclist was a collision with an e-scooter. The interaction with a car took place on the carriageway while all the other interactions occurred on separated cycle infrastructure.

It should be noted that most cycle infrastructure in Bristol was constructed before Local Transport Note 1/20 was issued, which is the current design guidance for cycle infrastructure. The fact that the majority of e-scooter (7/9) and cyclist (4/5) dismounts occurred on separated cycle infrastructure suggests that there is scope to improve the cycle infrastructure in Bristol. This issue was discussed by stakeholders and their comments are presented in Chapter 10.

4.3.5 Near-misses

A near-miss is defined as being when an e-scooter rider or cyclist is at risk of being imminently in a collision. This could be caused for three reasons: a) passing within a door’s width (1.0m) of a parked vehicle (putting themselves at risk of being hit if a door is opened, sometimes referred to as ‘dooring’); b) occasions when a driver of a motor vehicle close passes a rider within 1.5m of an e-scooter or cycle; and c) paths otherwise crossing with another street user. The trigger for identifying that paths would otherwise have crossed is the consequent action of the e-scooter rider, cyclist or other street user, which was either swerving to avoid, or slowing or stopping to avoid, a collision.

Fault for passing too close to a parked vehicle usually rests solely with the e-scooter rider or cyclist, but sometimes they are directed towards being too close to parked vehicles by the infrastructure. Site 5 has a peak time bus and cycle lane which is used for parking and loading in the off-peak period. At off-peak times it leaves what looks like a mandatory cycle lane between the parked cars and the carriageway, and this may encourage riders to ride within a door's width of parked vehicles. More generally, mandatory cycle lanes (with solid white lines) and advisory cycle lanes (with broken white lines) can enhance the risk of 'dooring' when they are adjacent to parked vehicles and the distance from a parked vehicle to the white line does not account for the usual width of the cycle lane, plus an additional metre for an open door.

The fault for a driver passing within 1.5 metres of an e-scooter rider or cyclists is with the driver of the passing vehicle. Drivers who commit this offence can receive six fixed penalty points and a £100 fine. Some police forces offer drivers road-side educational input on safe overtaking but repeat offenders can expect to be prosecuted for driving without due care and attention, as can anyone deemed to have driven dangerously close to a rider.

The fault, if there is fault, when paths would otherwise cross may be with either party. However, riding with excess speed for the circumstances would tend to favour fault being placed on the faster street user. Also, if one of the street users is making an illegal, or ill-advised action, such as crossing on a red standing person aspect at a signal-controlled crossing, or riding through a red signal aspect across a white stop line, or otherwise riding in an area that is not for riding, would provide a clearer indication that the person undertaking that action was at fault.

During the 36 hours of observations across the eight sites there were 39,369 occasions when near-misses involving e-scooter riders or cyclists were observed. Remarkably, this number of occasions is almost as many as the total number (42,673) of e-scooters and cyclists that passed through the sites, and this results from many riders having multiple interactions with other street users. Table 4-6 summarises the number of near-misses experienced by e-scooter and cycle riders with each street user type.

Table 4-6: The number of near-misses experienced by e-scooter and cycle riders

	Near miss with…							
	Motor vehicles		**Pedestrians**		**E-scooters**	**Cycles**		**Total**
Mode	**No.**	**%**	**No.**	**%**	**No.**	**No.**	**%**	**No.**
E-scooter	13,225	35%	112	32%	402	570	43%	14,309
Cycle	24,080	65%	234	68%	Note 1	746	57%	25,060
Total	37,305	100%	346	100%	402	1,316	100%	39,369

Note1: 'E-scooter with cycle' near misses (570) are the same as 'cycle with e-scooter' near misses and are entered only once.

The proportion of e-scooters out of the total of e-scooters and cycles across the eight sites is 38% (16,048/42,673, see Table 4-2 for the totals). The proportion of e-scooter riders out of the total of e-scooter riders and cyclists in near-misses with motor vehicles is slightly lower than this proportion 35% (13,225/37,305), and the proportion of near-misses with pedestrians is lower again (32%). This difference between e-scooter and cycle near-misses with motor vehicles is statistically significant at the 5% level based on what would have been expected according to the flows ($\chi^2(1) = 73.8$), the difference is not significant at the 5% level for pedestrians ($\chi^2(1) = 3.82$, but note that the rather arbitrary 5% significance boundary that is taken for such considerations is 3.84). This evidence suggests that e-scooter riders are significantly less likely to have near-misses with motor-vehicles than cyclists, and possibly this lower pattern of near-misses is repeated with pedestrians.

Table 4-7 groups the near-misses by type as follows: (a) evading, (b) passing within a door's width (1.0m) of a parked motor vehicle, and (c) close passed within 1.5m by a driver.

Table 4-7: Number of near-misses classified by type

Type of near-miss	User taking the evading action	Motor vehicles	Pedestrians	E-scooters	Cycles	Total
Evading action	E-scooter rider	9,642	112	402	263	10,419
	Cyclist	17,415	232	307	746	18,700
	Pedestrian			0	2	2
	Motor vehicle driver			965	1,846	2,811
Total evading actions		27,057	344	1,674	2,857	**31,932**
Passing within 1.0m of parked vehicle	E-scooter rider	1,494				1,494
	Cyclist	2,863				2,863
Total at risk of 'dooring'		4,357				**4,357**
Close passed within 1.5m	E-scooter rider	1,124				1,124
	Cyclist	1,956				1,956
Total closed passed		3,080				**3,080**
Total near miss interactions		34,494	344	1,674	2,857	**39,369**

The majority of near-misses are evading actions (81%, 31,932/39,369). Of the remaining near-misses 11% (n=4,357) were occasions when riders passed within a door's width of a parked vehicle, and 8% (n=3,080) were occasions when riders were closed passed by motor vehicles.

The difference in the proportion of near-misses of e-scooters relative to cycles that involved evading action (9,642/27,057, 36%) is significantly different than would be expected based on flow at the 5% level ($\chi^2(1) = 44.7$). The proportion of e-scooter riders that evaded pedestrians is 33% (112/344) and this is not statistically significantly different from what would be expected based on relative flows.

Considering now the locus of attention of the driver of a vehicle, the proportion of motor vehicle drivers that took evading action for e-scooter riders relative to cycles is 34% (965/2,811). This is a statistically significantly lower proportion than would be expected based on flow ($\chi^2(1) = 12.7$).

The proportion of e-scooters passing too close to parked cars or being close passed by drivers is 34% (1,494/4,357) and 36% (1,124/3,080) respectively. Statistically significantly fewer e-scooter riders ride close to parked cars than cyclists ($\chi^2(1) = 20.3$), but there is not a statistically significant difference in the close passing by drivers of e-scooters or cycles. It is remarkable that there were a total of 4,357 instances of passing too close to a parked vehicle, and 3,080 close passes in 36 hours of observations. That equates to 1.4 close passes a minute. It should be noted that if a rider close passed a row of parked cars this would be counted as multiple near-misses.

The number of evading actions involving only e-scooters and cycles was far lower (n=1,316 + 402, see Table 4-6) than the number of near-misses with motor vehicles (n=37,305), and the number involving pedestrians was lower still (n=346). As described in Section 4.3.4 there were a total of 14 dismount incidents observed. Surprisingly, given the high number of near-misses, only one such dismount involved an interaction with a motorised vehicle, one was with a pedestrian and the other twelve involved only e-scooter rider and cyclists.

83% (32,820/39,369) of near-misses involving e-scooters or cycles took place during carriageway riding with general traffic, while the others occurred on cycle tracks, shared space, and footways.

4.3.6 Footway riding

This section provides data to assist in answering the evaluation question **1c Other road users**: How is the safety and comfort of other road users impacted by e-scooters?

Pavement riding is something that concerns pedestrians, particularly those that are visually impaired, hard of hearing, or older. Table 4-8 shows the number of riders observed riding on the footway during the 36 hours of video at the eight sites.

Table 4-8: The number of riders observed on the footway

Mode	No. of riders	No. riding on the footway	Percentage of riders riding on the footway
Cyclists	26,625	1,315	5%
Trial operator riders		869	
Other e-scooter riders		73	
All e-scooter riders	16,048	944	6%

The total number of trial operator riders as distinguished from the total number of other e-scooter riders at each site is not known and so these figures have been omitted. The data suggests that a slightly higher proportion of e-scooters than cycles are ridden illegally on the footway.

4.4 Highway infrastructure

This section provides data to assist in answering the following two evaluation questions:

4b Highway: What highway characteristics (e.g., traffic volume, speed, prevision of a cycle lane etc.) have affected e-scooter operation and safety?

2f Network performance: How have e-scooters impacted the performance of the road network?

Section 4.4.1 considers the case study of the signal-controlled junction at Bristol Bridge / Castle Park which provides separated infrastructure as a means of crossing the junction. Section 4.4.2 considers poor or missing infrastructure and Section 4.4.3 considers the issues connected with the performance of the network.

4.4.1 Separated cycle infrastructure

The junction at Bristol Bridge / High Street / Baldwin Street (Site 1) is three-armed and signal controlled for motor traffic. So far as cycle and e-scooter traffic is concerned, it is four-armed, with the cycleway north through Castle Park being the fourth arm. Cycle traffic is provided with a two-way cycle track on the east side of Baldwin Street. Hence the north-south movement across the High Street / Bristol Bridge is an important movement.

The layout of the junction and turning movements are shown in Figure 4-4. The figures in blue are counts from 6pm to midnight on Friday 1st July 2022, and the figures in red are from 6pm to midnight for Saturday 2nd July 2022. The four counts shown are the left turn out of Castle Park, right turn into Castle Park, left turn into Baldwin Street cycleway and right turn out of Baldwin Street cycle track. These flows demonstrate that the junction is important not only for north south movements of cycles and e-scooters, but also for turning movements onto and off Bristol Bridge, both north and south.

Figure 4-4: Bristol Bridge (site 1) e-scooter and cycle turning movements 1st and 2nd July 2022

The staging, phasing and timings of the traffic signal control junction are configured with general traffic on the carriageway in mind. In fact, the junction does not cater for all four turning movements noted in Figure 4-4. The right-turn out of Baldwin Street and the left turn out of Castle Park conflict with the pedestrian crossing phase across Bristol Bridge. The green signal aspects facing Bristol Bridge have an ahead green arrow and a left turn green arrow, and these arrows are an indication that traffic should proceed only in the direction of the arrows (i.e., no right turn from Bristol Bridge into Castle Park). So far as the left turn is concerned, the green arrow indicates a movement into Baldwin Street, and not the Baldwin Street cycle track.

It is perhaps unsurprising therefore that riders may cross the junction against a red signal aspect because they may deem this less risky than making turns against, for example, pedestrian flows. This is in fact demonstrated by the evidence. Table 4-9 shows the number of e-scooter rides and cyclists proceeding through red signal aspects.

Table 4-9: Number of e-scooter riders and cyclists passing red signal at Bristol Bridge

Turning movement	No. of e-scooters	%	No. of cyclists	%	Total
Right turn into castle Park (C-B)	94	16%	162	20%	256
Left turn out of Castle Park (B-C)	73	12%	189	23%	262
Left turn into Baldwin Street (C-D)	191	32%	241	29%	432
Right turn from Baldwin Street (D-C)	234	40%	234	28%	416
Total	**592**		**826**		**1,366**

The table provides data just for these movements. Overall, 49% of all e-scooter riders (n=1,394) and 54% of cyclists (n=2,417) passed through red signals at this junction over the two days of observation. While there may be some level of justification for riders making the turns in and out of Castle Park, and in and out of Baldwin Street, there is little justification for turning on a red aspect for an e-scooter rider and cyclist approaching the junction from the High Street (Arm A). 204 riders (11 of which were on e-scooters) passed a red aspect going straight on to Bristol Bridge from the High Street, and 242 (135 on e-scooters) passed a red aspect going straight on from Bristol Bridge to the High Street.

The most common movements through red aspects at this junction are the straight on movements between Baldwin Street and Castle Park. 895 riders (219 of which were on e-scooters) proceeding towards Baldwin Street went through red aspects over two days, and in the reverse direction to Castle Park the number is 727 (187 on e-scooters).

As noted above, this north-south crossing of the junction between Baldwin Street and Castle Park signalised crossing is a separated cycle-only crossing. However, while there is a solid white line painted on the exit from Castle Park, there is no such white line exiting from the Baldwin Street cycleway. As the offence is crossing the white line on a red signal aspect, riders are prohibited from exiting Castle Park on a red signal. However, strictly speaking, it is only the case that they 'should' not do so when exiting the Baldwin Street cycleway. An additional risk to riders and pedestrians is that there is no pedestrian signal head provided for pedestrians on the footway crossing the cycle track out of Castle Park (Arm B), and so crossing pedestrians are unaware that they will be crossing in conflict with riders when a green signal aspect is provided for riders travelling between Castle Park and the Baldwin Street cycle track.

The ambiguities in the design of this signal control junction, which is heavily used by cycle and e-scooter traffic, is perhaps bound to lead to inconsistencies in the manner of its use by riders. Crossing a white line on a red signal aspect is illegal, but the reasons for such action may be linked with junction design as with behaviour.

The Bristol Bridge junction was the only one of the eight sites that included a cycle-only cycle crossing, and the rates of passing through red signals was twice as high as the next worst site for passing a red signal (Site 8, the Bear Pit Roundabout). Additionally, the other sites with signal control were all toucan crossings, and at these sites riders that went through a red signal were strictly not acting illegally, but choosing not to follow advice and cross when the green invitation to cross signal was shown.

It can be concluded that separated cycle infrastructure attracts e-scooter riders (as well as cyclists), but when that infrastructure has issues with its layout design and signal staging and phasing, such as those described above, it will negatively affect rider behaviour and hence junction operation and safety. Such designs cause e-scooter riders and cyclists to need to take their own decisions on how to behave when undertaking movements that the designer has not formally accounted for.

4.4.2 Poor and missing cycle infrastructure

The prevalence of e-scooter footway riding varied greatly across the sites from 2% of all riders (n=77) at Site 2 to 11% (n=248) at Site 4 and 18% (n=218) at Site 7. Table 4-10 shows the level of e-scooter and cycle riding on the footway across the eight sites.

Table 4-10: Number of e-scooter riders and cyclists riding on the footway by site

				Cycles on footway		E-scooters on footway		
Site	**Type**	**Location**	**Date**	**No.**	**% of all cyclists**	**No.**	**% of all riders**	**Comments**
1	T1	Bristol Bridge	01-02/07/2022	125	3%	99	3%	
2	T1	Centre	01-02/07/2022	166	3%	77	2%	
3*	T1	Prince St Bridge	01-02/07/2022	n/a		n/a		Although the design of Prince St. Bridge suggests that there is a footway and a kerb separated cycle track, signage indicates that the footway is 'shared space' and so there are no footways.
4	T2	Queens Rd	01-02/07/2022	225	8%	248	11%	Very wide footways.
5	T2	Glos. Rd	01-02/07/2022	189	4%	150	6%	Reasonably wide footways in places and some ambiguity due to lack of signage where 'shared space' ends.
6	T3	North St	01-02/07/2022	47	3%	20	3%	Narrow footways with a lot of clutter.
7	T3	St Michaels Hill	01-02/07/2022	168	14%	218	18%	
8*	T3	Bear Pit	01-02/07/2022	n/a		n/a		What looks like footway adjacent to the observed junction at the Bear Pit roundabout is designated as 'shared space' and so there are no footways.

**Note: no figures have been included for Sites 3 or 8 as what looks like footway at these locations has signage indicating that it is 'shared use' and so available for e-sooter riding and cycling.*

The sites with the lowest rates of footway riding were categorised as T1, characterised by good (separated) cycle infrastructure. By contrast the sites with the highest rates of footway riding were categorised as T2 and T3, characterised by poor cycle infrastructure or on-carriageway cycle provision. Other factors should be noted that either encourage or deter footway riding, such as footway width. Narrow footways deter footway riding even in areas with large motor traffic flows, whereas wide footways can encourage footway riding. There is an incentive for an e-scooter rider to leave such hostile carriageways to seek sanctuary on the more benign footway. However, such footway riding is illegal and may affect the safety and comfort of pedestrians.

4.4.3 Performance of the road network

This section provides commentary from the interactions data on evaluation Question **2f Network performance:** How have e-scooters impacted the performance of the road network?

During two days of observations there were no situations when the presence of e-scooter riders on the carriageway was seen to be impacting on the flow of general traffic. The same is true for the presence of cyclists on the carriageway. There were rare occasions at some sites when the presence of either an e-scooter rider or a cyclist on the carriageway momentarily slowed down the general traffic. On these occasions, a motor vehicle that may have been slowed was quickly able to catch up with the general flow of traffic, but was then impeded by the volume of general traffic and not the presence of e-scooters or cyclists on the carriageway.

From the observations across the eight sites, it can be concluded that there was no evidence that the use of e-scooters at those sites had any significant impact on junction or network performance that either slowed traffic flows or created increased queue lengths at junctions. The suggestion from the observations was that the quality of the traffic flows would be the same at each of the sites with or without e-scooters. Very similar inferences were made for the impact of cycle journeys through these sites. Increasing the proportion of small agile vehicles, such as e-scooters, within traffic flow may enhance the quality of the flow, certainly increase the throughput of people, and likely reduce queue lengths.

4.5 Summary

For the sites surveyed the proportion of flow that is either e-scooter, cycle, pedestrian or other human scale transportation observed in the videos at the eight sites is marginally in the majority (50.5%). The proportion of e-scooters out of the total of e-scooters and cycles across the eight sites is 38%.

Cyclists were observed wearing helmets at a rate of 57% as compared with e-scooter riders at 9%. Double (two-up) riding was observed 49 times, representing 0.3% of e-scooters in the observations. The percentage of rides at signal-controlled locations that passed a red signal aspect was 25% for e-scooter riders and 24% for cyclists.

There were 39,369 near-misses observed. The majority of near-misses are evading actions (81%, 31,932/39,369). Of the remaining near-misses, 11% (n=4,357) were occasions when riders passed within a door’s width of a parked vehicle, and 8% (n=3,080) were occasions when riders were close passed by motor vehicles. Compared with cyclists based on relative flow, e-scooters are statistically significantly under-represented in near-misses with motor vehicles ($\chi^2(1) = 73.8$). In the case of near-misses with pedestrians, while the proportion is again lower for e-scooters compared with cycles than may be expected, the difference is not statistically significant. E-scooters also undertake significantly fewer evading actions than cyclists ($\chi^2(1) = 44.7$). Drivers were observed taking statistically significantly fewer evading actions for e-scooters than for cyclists ($\chi^2(1) = 12.7$).

The high number of carriageway near-misses (37,305 near-misses with motor vehicles) will likely deter many riders from wanting to ride in the carriageway, and this may help explain the relatively high level of footway riding of 5% for cyclists and 6% for e-scooters. A recent review of cycling behaviour in 17 countries across 6 continents (Goel et al., 2022) suggests that street environments become more inclusive when cycle mode share reaches 7%. This proportion may only typically be reached with good levels of separated infrastructure for cycle traffic. 14 dismount incidents and three injuries were observed, and 11 of these occurred on separated infrastructure. A reason for this is likely to be linked with infrastructure not designed to current design standards.

There are comparable proportions of cycle and e-scooter riders who cycle on the footway. It should be noted that it can be ambiguous at some of the videoed sites (and other locations in Bristol) as to whether part of, or all, the footway is given over to a shared or segregated cycle facility. The greatest ambiguity is where such facilities are provided by signs because it can be unclear where such a facility ends. This ambiguity can therefore result in a genuine lack of clarity to riders. At other locations, for example the North Street / Dean Street mini-roundabout, where the footways are very narrow and there is no cycle provision, little footway riding takes place not because on-carriageway riding feels safe or comfortable, but because it is very difficult to ride on the footway.

5 E-SCOOTER USERS' TRAVEL BEHAVIOURS

5.1 Introduction

This chapter presents results on the contribution that e-scooter use is making to travel behaviour in the West of England trial areas. It mainly focuses on the following evaluation questions:

2a Usage: Who, why, when, how and where are e-scooters being used?
2b Modal shift: Of the e-scooter trips, how many are new? If transferred, from/to which modes?
2c Transport integration and interchange: How are people using e-scooters to integrate with other forms of transport?
2d Population variation in access and use: Which groups and areas are restricted in their access to e-scooters?

The chapter starts with a brief summary of literature on the topics covered in this chapter before presenting results from analysis of the following datasets:

- **Ride data** supplied by the trial operator. This covers all recorded rides of Hop-on Hop-Off e-scooters from the start of the trial on 28th October 2020 to 27th April 2022.
- **User responses to Summer Survey and Winter Survey** undertaken by the trial operator in July 2021 and February-March 2022. The surveys approached those people that had used an e-scooter in last three months (assumed to include both Hop-on Hop-Off and Long-term Rental users)
- **User responses to End-of-Ride Survey** which sampled e-scooter users between 3rd March 2021 and 7th April 2022 (assumed to include both Hop-on Hop-Off and Long-term Rental users)
- **User and non-user responses to Experience Survey** conducted by UWE between June and August 2022 and achieving a total of 643 responses
- **In-depth interviews** with 13 e-scooter users conducted by UWE in November 2022

Section 5.3 presents results on overall level of use followed by section 5.4 with results on user characteristics. Section 5.5 focuses on trip patterns with section 5.6 considering trip distances and speeds and section 5.7 considering trip purpose. Section 5.8 provides results on modal shift and section 5.9 on modal integration. Section 5.10 reports in-depth findings from user interviews on how shared e-scooter use has influenced travel routines.

5.2 Literature on e-scooter users, trip patterns and modal shift

5.2.1 User characteristics

A consistent picture emerges from the literature that shared e-scooter users are younger than the general population and disproportionally male (Bozzi and Aguilera, 2021; Wang et al., 2022).

Taking a typical example, a large user survey in Portland in 2018 found that 85% of resident users were aged 20-49 while only 50% of the city's population is in that age range (Currans et al., 2018). 62% of resident users were men while 38% were women. The proportions of male users reported in other locations is at least as high as that in Portland with, for example, 66% reported across three French cities (Paris, Lyon, and Marseille) (Wang et al., 2022). The French data also showed that 50% of resident users were under 35 years of age.

The Portland survey found users were more likely than the general population to have a higher education qualification but less likely to be white and be earning a high income. The Portland survey also included responses from visitors to the city and these comprised 24% of survey responses. The visitor demographic profile was similar to that of residents. The percentage of visitors was higher in the French survey at 42%.

5.2.2 Trip patterns

An average journey length of 1.8km has been reported for e-scooter rides in European cities (Bozzi and Aguilera, 2021) with 50% of rides having a duration of under 15 minutes reported in France. It has been suggested that e-scooters fill a gap in serving trips that are too short for public transport or taxis but too long for walking (Button et al., 2020).

Examination of temporal profiles has shown e-scooter usage is characterised by a long afternoon plateau and greater use at weekends than weekdays (Bozzi and Aguilera, 2021). Comparisons with shared bikes show e-scooters are used less for commuting and have more concentrated use around major trip attractors, including public transport interchanges (Bozzi and Aguilera, 2021).

A clear picture is not evident from the literature on the most popular trip purposes for e-scooter use with some studies reporting greater use for work and education purposes and others for recreational activities and tourism (Bozzi and Aguilera, 2021).

5.2.3 Modal shift

Wang and colleagues (2022) reported results on mode substitution associated with shared e-scooter schemes. The majority of evidence they found was from schemes in the USA. Table 5-1 has been compiled to present the results for a subset of studies from different parts of the world.

Table 5-1: Reported modes replaced by the use of shared e-scooters

City	Survey timing	n	Car	Motor-bike	Taxi / ride-hail	Bicycle	On foot	Bus	Train	Other	Would not have made the journey	Source
New Zealand (multiple cities)	Feb–- March 2019	380	14%	0%	9%	4%	52%	5%	0%	4%	11%	Calculated using data from Curl and Fitt (2020)
Paris	May – June 2019	459	4%	N/A	6%	7%	35%	37%		6%	6%	Christoforou et al. (2021)
Oslo	Nov–- Dec 2019	549	3%	N/A	5%	6%	60%	23%		N/A	2%	Fearnley et al. (2020)
Thessalon-iki	July–- Oct 2019	271	13%		3%	7%	44%	33%		N/A	N/A	Nikiforiadis et al. (2021)
Portland	Sept – Oct 2019	1,534	17%	N/A	23%	7%	37%	10%		1%	4%	City of Portland Bureau of Transportation (PBOT) (2019)

Wang et al. (2022) noted “walking as the most common travel mode substituted, ranging between 30 and 60% of trips” and that most studies showed less than 10% substitution from bicycle. Public transport substitution is higher in European cities than in North American and Australasian cities and car and taxi substitution is lower.

There is limited evidence in the literature on the extent to which shared e-scooters are used in combination with other motorised modes of transport such as public transport. A study in three French cities found 44% of users used the e-scooter for a one-way trip with return trips more likely to be made by public transport (57%) and walking (37%) (6-t, 2019). A study in San Francisco found nearly 30% of e-scooter trips were associated with induced new public transport trips where e-scooters had been used as a first/last-mile connection.

More detailed data is required on how the use of shared e-scooters fits into people’s travel routines and how they would manage their travel in the absence of shared e-scooters.

5.2.4 E-scooter perceptions

Standardised questions do not exist on e-scooter perceptions for users and non-users and hence generalised findings are not available. What is apparent from a variety of different studies is that there are very different perceptions between users and non-users. A Norwegian study has reported that most e-scooter users in Oslo feel safe in traffic, but one in four pedestrians and cyclists feel unsafe when interacting with e-scooters (Hegna Berge, 2019).

5.3 Overall level of use

The trial operator's latest monthly reports (February 2023) provide an indication of overall usage since the start of the trial and current usage levels. From the start of the trial up to the end of February 2023, the operator has registered 8,650,692 rides in Bristol (21,857,716 km, 345,450 unique users) and 429,017 rides in Bath (829,263 km, 57,437 unique users).

In the month of February 2023, the operator registered 371,916 rides in Bristol (942,522 km, 58,435 unique users) and 19,552 rides in Bath (37,263 km, 5,325 unique users). Hence at this time, 96% of rides and 92% of users were recorded in Bristol. The fleet size of e-scooters was 3,070 in Bristol and 363 in Bath. The results that follow sometimes report combined data for Bristol and Bath and sometimes focus on Bristol given the greater scale of e-scooter use in Bristol. The analyses below are based on trial operator's ride data collected between 28 October 2020 and 27 April 2022, as well as surveys.

5.4 User characteristics

5.4.1 Demographic characteristics

The ride data allows the assessment of usage patterns by age and gender. Table 5-2 provides a breakdown of the number of rides and users by age group and gender in Bristol and Bath.

Table 5-2: Rides and users by age group, gender and frequency (source: trial operator's ride data)

Grouping categories		N rides					N users					N rides per user		
		HOHO* Bristol	HOHO* Bath	LTR*	Total	% LTR	HOHO Bristol	HOHO Bath	LTR	Total	% LTR	HOHO Bristol	HOHO Bath	LTR
Age range	18-24	2,128,835	113,019	80,615	2,322,469	3%	110,090	20,116	827	131,033	1%	19	6	97
	25-34	1,500,616	56,182	91,613	1,648,411	6%	85,583	11,060	709	96,643	1%	18	5	129
	35-44	417,172	20,497	31,457	469,126	7%	27,116	3,363	271	30,479	1%	15	6	116
	45-54	168,623	12,477	11,121	192,221	6%	12,642	2,040	102	14,682	1%	13	6	109
	55-64	45,645	4,202	3,514	53,361	7%	4,586	675	35	5,261	1%	10	6	100
	65+	6,763	216	44	7,023	1%	607	92	5	699	1%	11	2	[NA, only 5 users]
Gender	[NA]	623,183	29,131	34,159	686,473	5%	38,530	5,550	270	44,080	1%	16	5	127
	F	971,151	47,168	40,555	1,058,874	4%	70,280	11,980	451	82,260	1%	14	4	90
	M	2,673,320	130,294	143,650	2,947,264	5%	131,525	19,801	1,228	151,326	1%	20	7	117
N rides per month	<1	315,440	44,446	200	360,086	0%	141,311	24,720	121	166,031	0%	2	2	2
	[1-3[	396,175	35,519	707	432,401	0%	46,797	6,356	173	53,153	0%	8	6	4
	[3-5[	279,295	18,959	1,161	299,415	0%	14,395	1,748	137	16,143	1%	19	11	8
	[5-10[	525,408	27,671	3,550	556,629	1%	14,856	1,661	217	16,517	1%	35	17	16
	[10-30[	1,123,300	41,473	25,371	1,190,144	2%	14,469	1,660	473	16,129	3%	78	25	54
	[30-50[	537,984	16,779	25,439	580,202	4%	3,753	474	220	4,227	5%	143	35	116
	>50	1,090,052	21,746	161,936	1,273,734	13%	4,623	706	608	5,329	11%	236	31	266
Total		**4,267,654**	**206,593**	**218,364**	**4,692,611**	**5%**	**240,624**	**37,346**	**1,949**	**279,919**	**1%**	**18**	**6**	**112**

* HOHO: Hop-on-hop-off; LTR: Long-term rental; data from 2020-10-28 to 2022-04-27

Table 5-2 shows there were 2.8 times more rides by men than women across the trial area in total and 1.8 times more men registered as users than women. 2011 Census data showed there were 2.4 times more men who cycled to work than women in the Bristol local authority area[iii], hence the gender difference in e-scooter use is similar to that with cycling.

Table 5-2 also indicates that users were younger than the general population. Most individual users were under 35 (81% across the trial area). The youngest age segment (18-24) represented 47% of registered users across the trial area and 49% of registered rides. In the Bristol trial area, 50% of HOHO rides were made by 18-24 year olds. In contrast, those aged 16-24 made up 16% of the total population in the Bristol local authority area in 2020[iv]. 2011 Census data showed that cycle to work rates in Bristol are highest in the 25-44 age range[v], suggesting that shared e-scooters have attracted use among 18-24 year olds not seen with other forms of transport.

The number of rides undertaken on Long-Term Rental (LTR) e-scooters was 5% of the total rides in the trial area even though LTR users only made up 1% of total users. LTR use was relatively lower amongst 18-24 year olds than other age groups.

About 60% of registered e-scooter users (166,031) made less than 1 ride per month with 15% (42,202) making five or more rides per month. This highlights that a minority of registered e-scooter users were frequent users but this still represents a substantial number of people. LTR users made a much larger number of rides (112 on average) than HOHO users in Bristol (18 on average) and Bath (6 on average).

Not shown in Table 5-2, most rides have been paid for on a pay-as-you-go basis (56%). Daily and monthly passes represented respectively 18% and 26% of the rides. Rides made with passes were more common in Bristol compared to Bath, which is consistent with the higher individual ride frequency in Bristol.

[iii] Source: https://www.bristol.gov.uk/files/documents/1861-2011-census-topic-report-who-cycles-to-work-v2/file
[iv] Figures for 2020; source: https://www.bristol.gov.uk/statistics-census-information/the-population-of-bristol
[v] Source: https://www.bristol.gov.uk/files/documents/1861-2011-census-topic-report-who-cycles-to-work-v2/file

Figure 5-1 below presents the distribution of rides in the Bristol trial area by age-gender groups and shows decreasing use with age and the male majority in usage across all age groups.

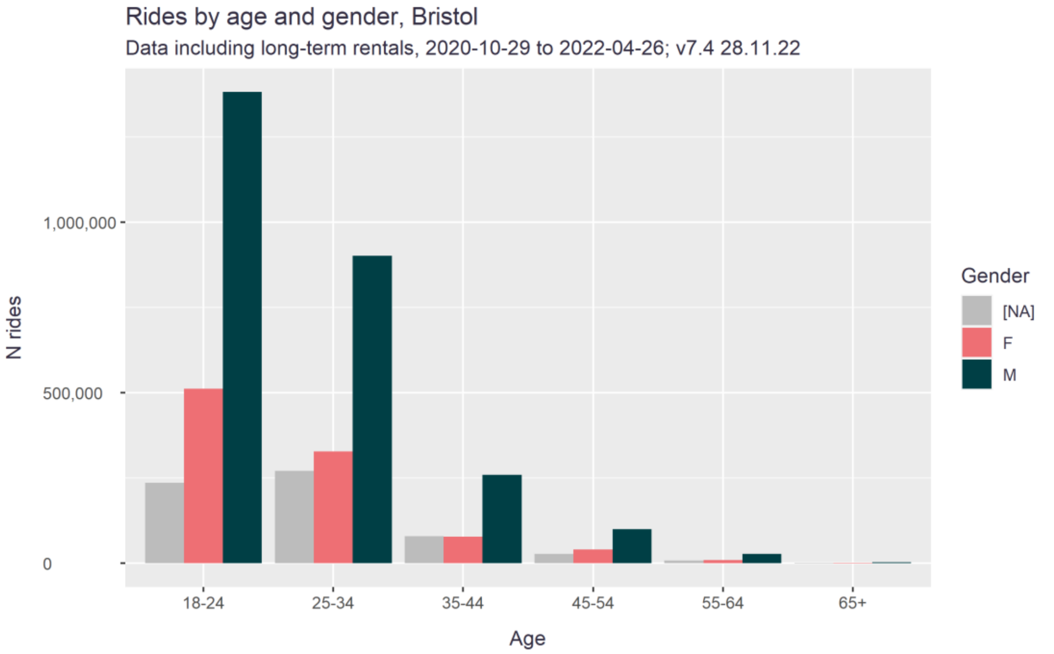


Figure 5-1: Rides by age-gender groups in Bristol

The trial operator's 2021 Summer Survey and 2022 Winter Survey provide an alternative source of data on age and gender of e-scooter users. It should be noted that compared with the profile of users based on rides, both the Summer and Winter Survey responses from Bristol and Bath under-represent young people and frequent users (see data in Table 5-3). The gender representation is on the other hand similar between the Summer Survey and the rides, but men are over-represented in the Winter Survey.

Table 5-3: Comparison of demographic characteristics of the trial operator's surveys and ride data

	Summer survey		Winter survey		Rides		User accounts	
	N	%	N	%	N	%	N	%
People aged <35	1,884	69%	597	57%	3,970,880	85%	228,385	86%
Males	1,755	64%	742	71%	2,947,264	63%	152,554	57%
Riding at least weekly	1,090	40%	502	48%	3,600,709	77%	43,720	16%
Sample size	**2,724**		**1,036**		**4,692,611**		**266,968**	

The demographics of both surveys were also checked against work status and ethnicity for Bristol[vi]:

- **The proportion of people in formal employment was comparable between both surveys and Bristol's statistics.** In the summer and winter survey, respectively:
    - **76% and 74% of respondents were in formal employment** (similar to Bristol's 2021 statistics of 78% (NOMIS, no date))
    - 11% and 13% were students/interns
    - 8% and 7% were homemakers or self-employed
    - Only a small minority (under 5% in both surveys) was not working
- **In both surveys, there is a slight under-representation of those of non-white ethnicity.**
    - 87% and 88% identified as White, in the summer and winter surveys
    - 13% and 12% identified as non-white, slightly less than the 16% noted in Bristol's 2020 population report (Bristol City Council, 2020), based on data from the 2011 census.

[vi] The comparison is made with Bristol as the majority of survey respondents reported using e-scooters in the Bristol trial area.

5.4.2 Frequency of use across demographics

Frequency of e-scooter use, as self-reported in the trial operator's surveys, is presented below against age group (Figure 5-2), gender (Figure 5-3), work status (Figure 5-4) and ethnicity (Figure 5-5). This highlights higher frequency of use among young adults, males, students, and those of non-white ethnicity.

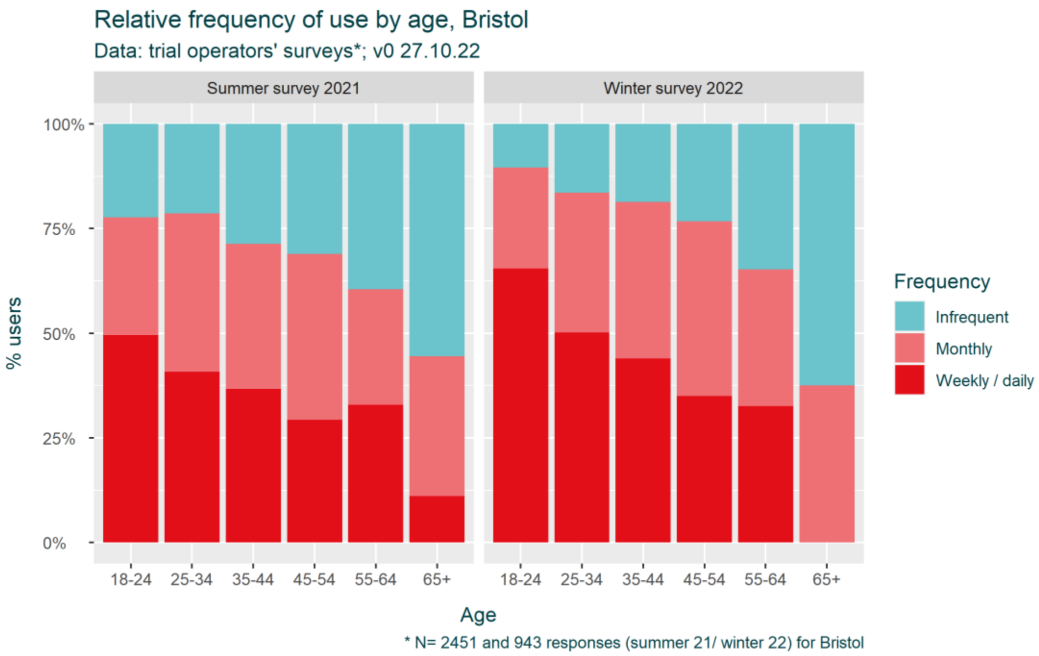


Figure 5-2: Frequency of e-scooter use by age group

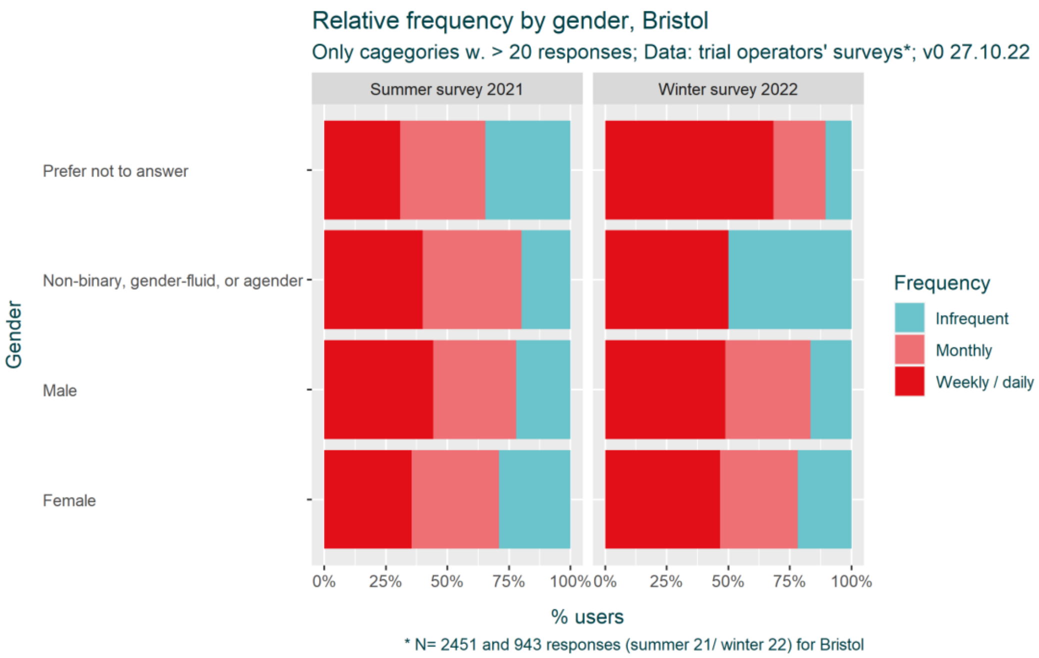


Figure 5-3: Frequency of e-scooter use by gender

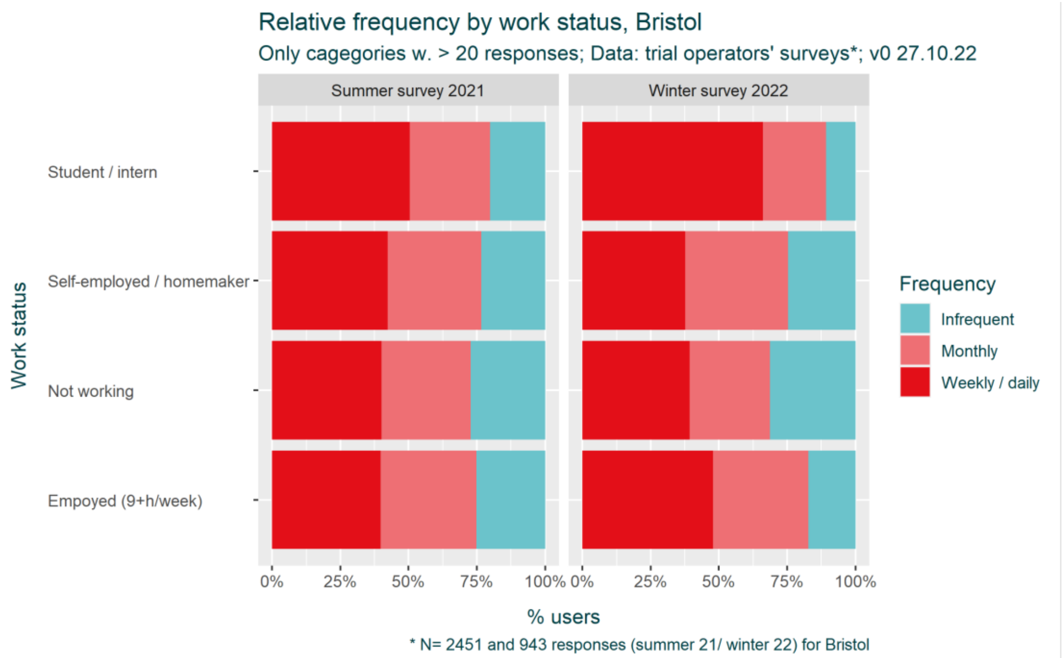


Figure 5-4: Frequency of e-scooter use by work status

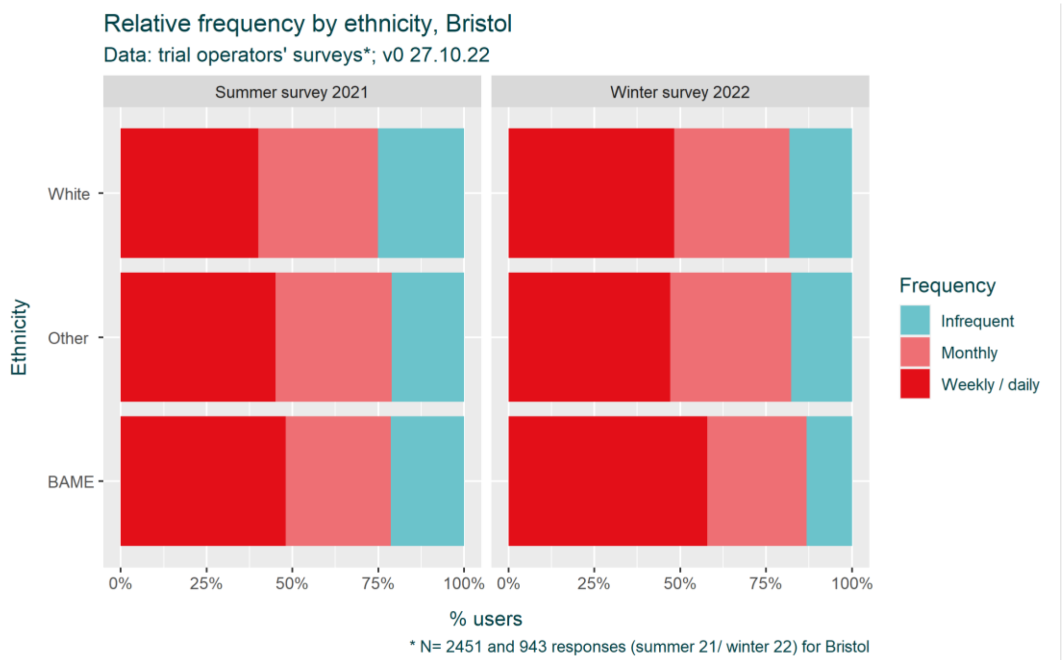


Figure 5-5: Frequency of e-scooter use by ethnicity

5.4.3 Number of rides per month per user

The number of rides per month per user, derived from the ride data, differed between Bath and Bristol (see Figure 5-6 below). In Bath, the average number of rides by user per month peaked in November 2020 (first full month of implementation), with around 8 rides per user, and then decreased, plateauing between 3 and 5 rides per user per month. In Bristol, the usage per month has been increasing in an almost linear fashion, from 2.5 rides per user per month in November 2020 rising to almost 15 in March 2022. These contrasting patterns of use suggest different roles being played by e-scooters in the two cities. It would appear that users in Bath are more occasional users, with the higher use at the start being due to the novelty effect. In Bristol, the high average number of rides per use per month suggests greater use for everyday travel, and a progressive integration of e-scooter use into daily travel amongst those that use them.

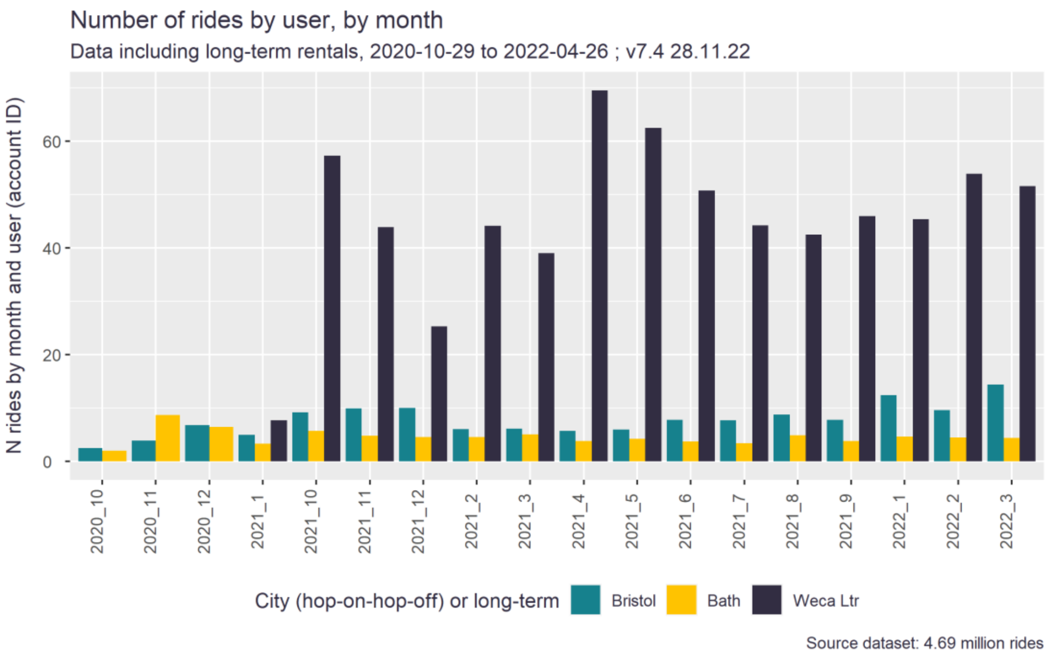


Figure 5-6: Number of rides per month per user

5.5 Trip patterns

5.5.1 Parking zones distribution in Bristol

Before looking at the spatial distribution of e-scooter trips, the potential to use e-scooters is considered by examining the distribution of e-scooter parking zones across Bristol (at the start of 2022). Figure 5-7 shows there is an uneven distribution of parking zones across the city with greater concentrations in the centre of the city and a corridor connecting the centre to the northern suburbs of Bristol. There are outer suburbs to the north-west of the city and south of the city with little or no provision. Table 5-4 shows how parking zone density per MSOA area varies with Index of Multiple of Deprivation (IMD) decile. There is no clear pattern with the highest density in the second decile (second most deprived ten per cent of MSOAs across England).

While e-scooter provision is not clearly linked to IMD, it is clear that suburban and peripheral areas of Bristol are relatively less well served, particularly in the north-west and south. Some of the most deprived areas of the city (Lawrence Weston and Hartcliffe) were not covered by the trial area at the start of 2022. These areas have historically suffered from limited transport options and have been perceived as cut off from the city. In March 2022 the operating zone was extended to the outer north-western suburbs of the city and in December 2022 it was extended to the outer southern suburbs of the city. The expansion of the operating zone over time (jointly decided by the trial operator with local authorities and the West of England Combined Authority) has led to a more equitable distribution of e-scooter parking zones across the city.

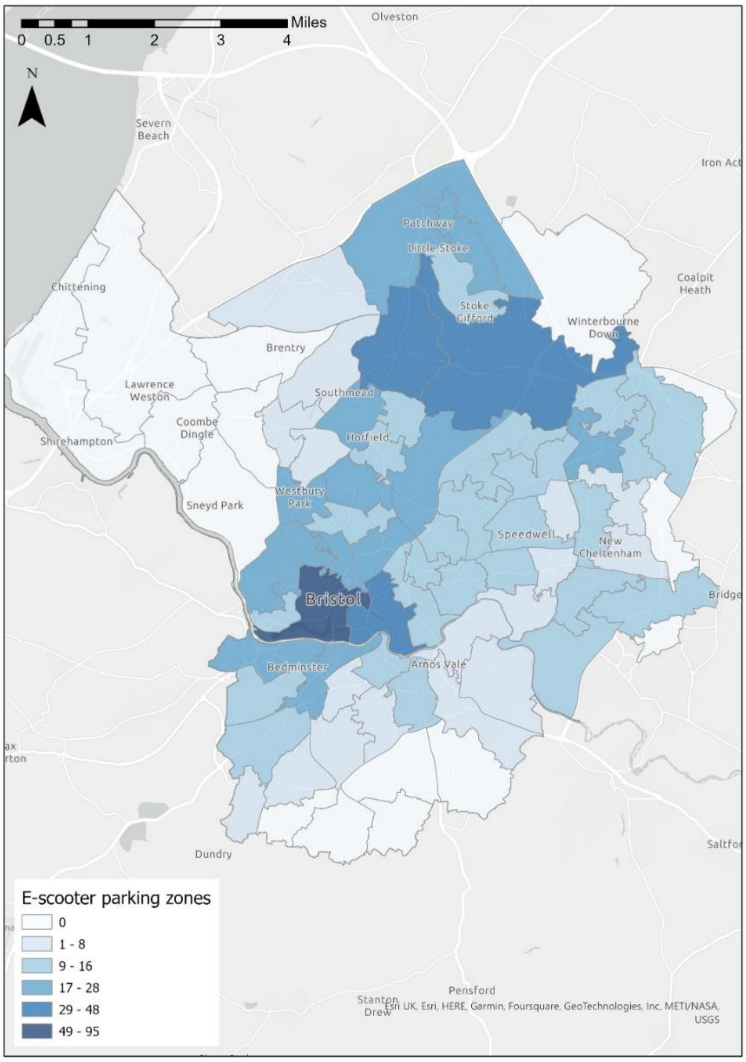


Figure 5-7: Distribution of parking zones across Bristol

Table 5-4: Parking zone density and deprivation (Index of Multiple Deprivation 2019; a lower value of the index corresponds to higher deprivation)

IMD 19* decile	N MSOA zones**	N e-scooter parking zones per km2
1	6	8.4
2	7	14.3
3	7	9.0
4	6	8.3
5	8	10.8
6	7	8.7
7	4	6.8
8	5	9.0
9	6	10.3
10	5	6.6
Overall	**61**	**9.5**

* Index of Multiple Deprivation 2019 - www.ons.gov.uk

** Middle Layer Super Output Areas - www.ons.gov.uk

5.5.2 Spatial distribution of trips

The ride data provides the coordinates of trip starts and ends. A spatial analysis has been undertaken for the months of March and April 2022. There were just under 700,000 rides in this period, and these months have been selected to reflect the scheme operating in its maturity and in periods after the Covid-19 lockdowns that continued to occur during 2021.

Figure 5-8 shows the mapping of the trip start locations from the hours starting 7am, 10am, 1pm, 4pm, 7pm and 10pm[vii].

The data show an interesting development in the pattern of the start location of trips as the day progresses. The area from which the rides originate tends to shrink towards the core urban centres: thus, the proportion of trips originating from the suburbs decreases, and almost disappears in the afternoon/evening. The location of the end of the rides (not shown) follows the inverse pattern with an increasing number of trips ending in peripheral areas. This situation can be explained by the presence throughout the day of short distance, centre-centre rides, and longer distance rides that tend to be periphery-to-centre in the morning and centre-to-periphery in the afternoon and evening. Note that the level of use is different in the different periods, and the scale bars to the right-hand side indicate that the red coloured areas have four times more e-scooter journey starts in the red shaded areas (2,000 trip starts) in the final two hours (starting 4pm and starting 7pm) as compared with the first hour from 7am where the red shading indicates a level of 500 trip starts.

[vii] Note that the colour scale is adjusted for each represented hour, with blue tones for the minimum and red tones for the maximum of that hour – this helps to show the granularity of the spatial distribution for each hour. A single scale would have made the distribution almost invisible for those hours having lower absolute usage rates. The comparison between the times of the day is presented in the next point.

Figure 5-8: Mapping of trip starts

For Bristol, ride patterns were also examined across age groups. This further analysis showed younger users (aged 18-24 years) predominantly start rides in the vicinity of the central urban attractors, especially Broadmead, the University of Bristol area, Temple Meads, the Arches area and Cotham Hill. While the central urban area remains important for all age groups, older users' trips start less exclusively in the centre with a larger proportion starting in more residential areas.

5.5.3 Temporal variation in trips

Variation of trip making is presented by month of year, day of week and hour of day. Figure 5-9 shows the profile of use from October 2020 to November 2022 which encompasses the initial period of user take up at the start of the trial and the growing use of the scheme over the duration of the trial.

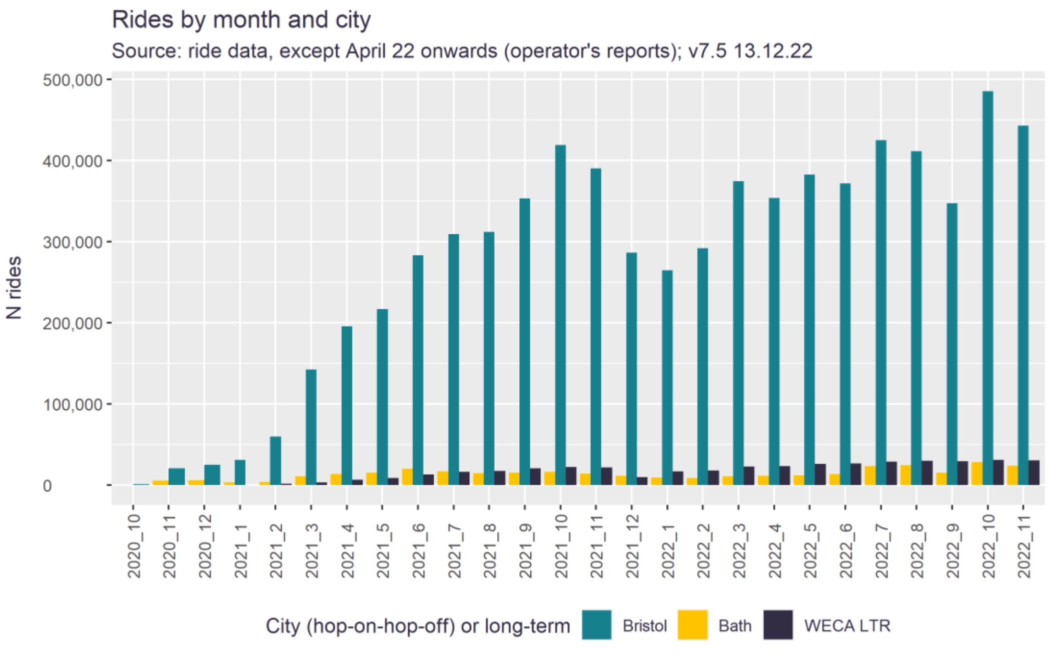


Figure 5-9: Rides by month and city

The number of rides per month increased rapidly in Bristol, especially in Spring and early Summer 2021. There was little change in the number of rides from June to August 2021 but another increase in September and October 2021. Rides then declined to a low point in January 2022. The number of rides in March 2022 at a little under 400,000 is considerably greater than the nearly 150,000 in March 2021 with the increase in March 2022 coinciding with the expansion of the operating zone to north-west Bristol. The Winter reduction in the number of rides reflects seasonality in use, the pattern of which would need to be confirmed by a longer time series. Such a seasonality would be akin to the seasonality of cycle traffic flows. A maximum monthly total of rides in Bristol was recorded in October 2022.

For Bristol, the proportion of rides undertaken by different age groups is relatively consistent across the months, as shown in Figure 5-10. The youngest age group (18-24) always represents the highest share of the rides. This share fluctuated throughout the trial with the lowest proportion being in the range of 45-50% of rides in July-August 2021, December 2021, January 2022 and April 2022. The lowest values correspond to Summer and Winter holiday periods and are driven in part by fewer students being in the city (34% of 18-24-year-olds are students). The highest proportions of young riders ranged between 55% and 58% of rides in November 2020 and February-March 2021. The proportions of rides by young riders in November 2021 and February-March 2022 were slightly lower at 51-52%.

The periods with the highest representation of the 25-34 age group (December-January, July-August) correspond to the periods of lowest representation of 18–24-year-olds. This could be due to there being a higher proportion of professionals in the 25-34 group, an age group also able to take holidays outside of the peak holiday times (for students and people with school-age children).

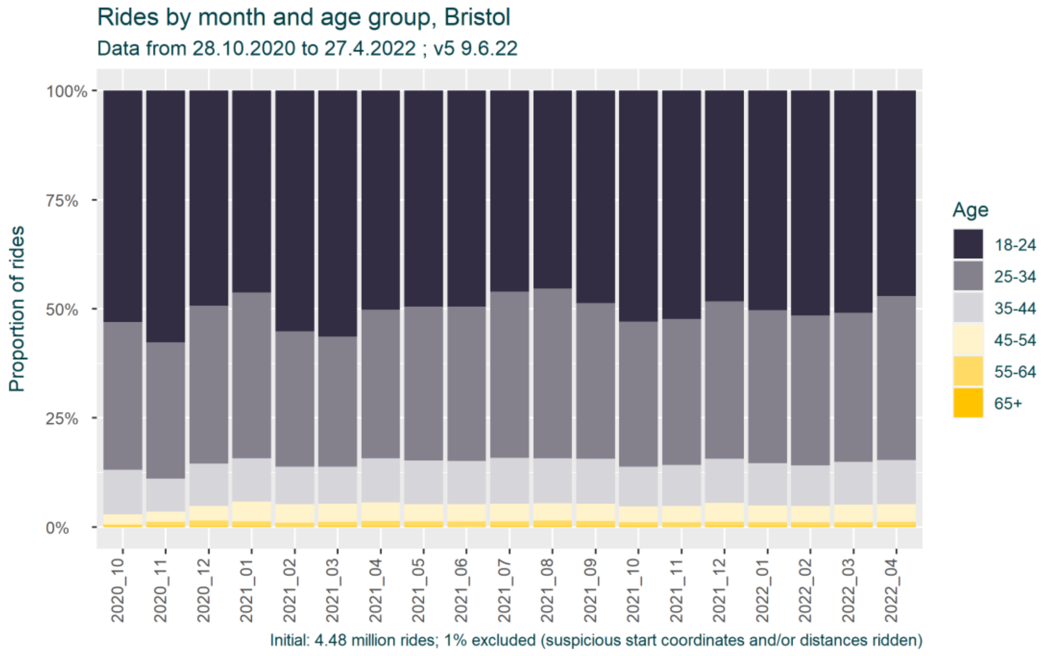


Figure 5-10: Rides by month and age group for Bristol

E-scooter use has varied across days of the week, as shown in Figure 5-11. Fridays and Saturdays have had the highest levels of use. In Bristol, the two days together comprise a third of all rides. Use has been lowest on Sundays (30% lower than on Fridays and Saturdays) and Mondays (26% lower).

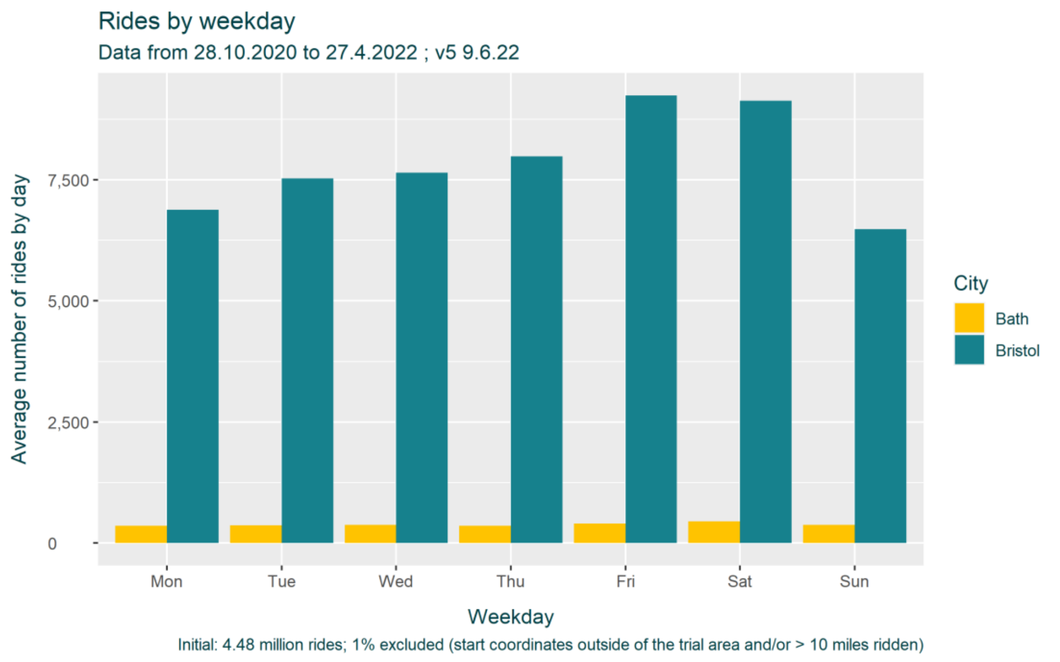


Figure 5-11: Rides across weekdays: Rides across weekdays

As can be seen from the plots in Figure 5-12, usage has varied within the day. Weekdays have had a noticeable morning and afternoon peak. The afternoon peak has been more intense with 28% of all rides occurring between 4pm and 7pm, as compared with 14% between 7am and 10 am. The highest hourly uses were recorded between Tuesday and Friday at 5-6 pm (750 to 900 rides per hour on average). Saturdays and Sundays display a single peak period, with hourly rides ranging between 440 and 780.

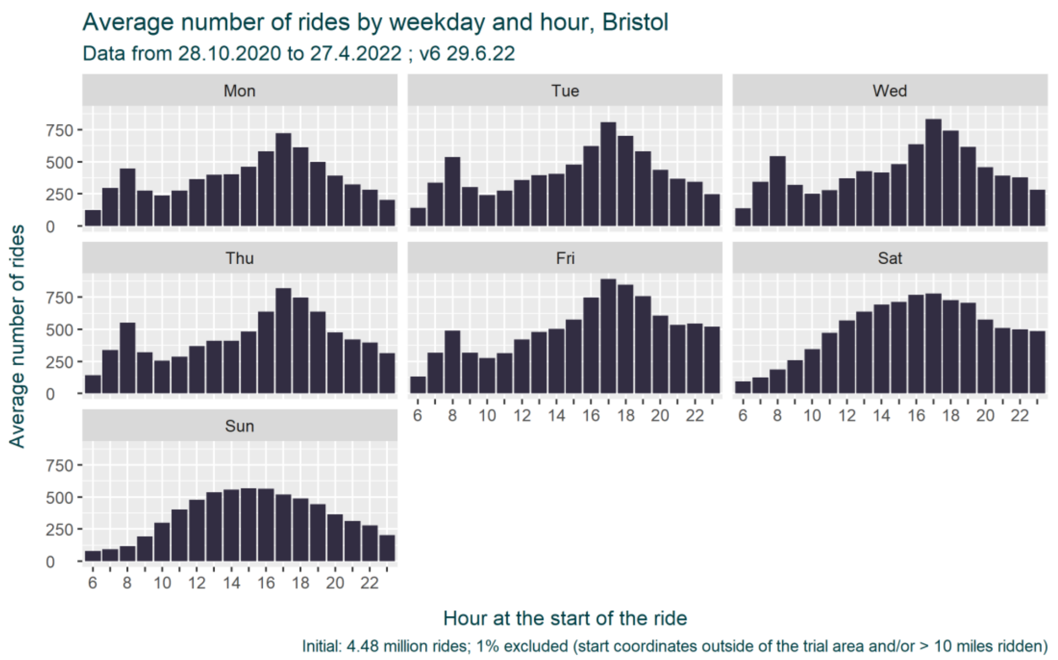


Figure 5-12: Rides by hour and weekday for Bristol Trip purposes

5.6 Trip distances and speeds

Table 5-5 shows that 91.8% of total distance travelled on rental e-scooters (11.039 million kilometres) up to 27th April 2022 has been by HOHO users in Bristol with 3.6% by HOHO users on Bath (0.427 million kms) and 4.6% by LTR users (0.555 million kms).

Average trip distances ridden in Bristol were longer than those ridden in Bath. For the HOHO scheme in Bristol, the median ride distance was 2.1 km and for the HOHO scheme in Bath it was 1.7 km. Three-quarters of trips were less than 3.3 km in Bristol and three-quarters of trips were less than 2.5 km in Bath. The difference in length is likely to be a result of the larger geographical size and wider geographical coverage of e-scooter parking spots in the Bristol trial area. For LTR rides, the median ride distance was 1.7 km and three-quarters of trips were less than 3.5 km.

Table 5-5: Trip distances by age, gender, frequency, and type of usage

Grouping categories		Distance, Q25 [m]			Distance, median [m]			Distance, Q75 [m]			Distances, total [km]		
		HOHO Bristol	HOHO Bath	LTR	HOHO Bristol	HOHO Bath	LTR	HOHO Bristol	HOHO Bath	LTR	HOHO Bristol	HOHO Bath	LTR
Age range	18-24	1,261	1,093	656	2,026	1,669	1,714	3,209	2,544	3,359	5,334,589	240,393	199,697
	25-34	1,394	1,043	627	2,218	1,588	1,760	3,385	2,401	3,646	3,948,538	110,377	242,831
	35-44	1,412	1,041	513	2,327	1,670	1,632	3,589	2,639	3,207	1,154,340	41,913	74,045
	45-54	1,382	1,092	677	2,289	1,685	1,898	3,571	2,554	3,927	462,436	25,497	30,349
	55-64	1,370	1,012	730	2,257	1,552	1,712	3,427	2,375	3,636	122,072	8,293	8,361
	65+	1,252	1,019	[NA, only 5 users]	9	1,252	[NA, only 5 users]	3,219	3,222	[NA, only 5 users]	17,278	542	[NA, only 5 users]
Gender	[NA]	1,317	1,062	695	2,112	1,640	1,710	3,275	2,456	3,380	1,581,655	58,356	82,807
	F	1,301	1,076	605	2,079	1,709	1,551	3,223	2,725	2,975	2,434,508	102,341	88,144
	M	1,336	1,069	627	2,161	1,626	1,795	3,385	2,440	3,707	7,023,090	266,318	384,413
N rides per month	<1	1,251	1,093	0	2,118	1,878	157	3,440	3,253	1,621	841,770	111,028	214
	[1-3[	1,307	1,093	8	2,134	1,687	683	3,398	2,667	2,132	1,047,113	78,583	1,242
	[3-5[	1,309	1,074	50	2,090	1,599	1,152	3,247	2,380	3,105	711,632	37,731	2,478
	[5-10[	1,309	1,029	189	2,080	1,514	1,303	3,211	2,198	2,871	1,321,042	50,960	8,006
	[10-30[	1,318	1,035	507	2,085	1,564	1,649	3,210	2,255	3,345	2,810,787	75,975	63,753
	[30-50[	1,335	1,160	686	2,131	1,712	1,786	3,310	2,425	3,539	1,378,455	31,993	65,345
	>50	1,371	1,095	657	2,238	1,615	1,742	3,509	2,379	3,522	2,928,453	40,745	414,327
Total		**1,325**	**1,069**	**630**	**2,134**	**1,645**	**1,725**	**3,331**	**2,510**	**3,493**	**11,039,253**	**427,015**	**555,364**

* HOHO: Hop-on-hop-off; LTR: Long-term rental; data from 2020-10-28 to 2022-04-27

Table 5-6 presents statistics for Bristol on distance travelled by age, frequency of e-scooter use, e-scooter ride plan and gender. There are minor variations in trip distances by age group and frequency of use with median values in a range between 2.0 and 2.3 km. Longer distances by middle-aged users may reflect a tendency to live further from the city centre. Distances travelled with a day pass tend to be longer than those on other ride plans (median of 2.8 km as compared with 2.3 km for monthly passes and 1.9 km for pay-as-you-go). Additional graphs showing ride distance distributions are included in Appendix 1: Additional graphs showing ride distance distributions.

Table 5-6: Trip distance statistics for Bristol by age group, frequency of use, ride plan, and gender

		Bristol - ride distances [km] by age, frequency, ride plan				
		25% quantile	median	75% quantile	Distance between 75% quantile and 25% quantile	Standard deviation
Age groups	18-24	1.26	2.03	3.21	1.95	1.81
	25-34	1.39	2.22	3.38	1.99	1.77
	35-44	1.41	2.33	3.59	2.17	1.89
	45-54	1.38	2.29	3.57	2.19	1.90
	55-64	1.37	2.26	3.42	2.05	1.85
	65+	1.25	2.06	3.22	1.97	1.96
Frequency (rides / month)	<1	1.27	2.09	3.34	2.07	1.92
	[1-3[	1.31	2.14	3.37	2.06	1.90
	[3-5[	1.31	2.10	3.28	1.97	1.80
	[5-10[	1.31	2.08	3.22	1.91	1.74
	[10-30[	1.33	2.09	3.22	1.90	1.71
	[30-50[	1.35	2.15	3.32	1.98	1.75
	>50	1.37	2.24	3.52	2.15	1.85
Plan	Day pass	1.62	2.81	4.43	2.81	2.22
	Month pass	1.37	2.29	3.63	2.26	1.89
	Pay-as-you-go	1.25	1.93	2.88	1.63	1.51
Gender	[NA]	1.32	2.11	3.27	1.96	1.75
	F	1.30	2.08	3.22	1.92	1.75
	M	1.34	2.16	3.38	2.05	1.84
Bristol, overall		**1.32**	**2.13**	**3.33**	**2.00**	**1.81**

Journey speeds can be calculated for rides based on the total distance covered and the time between the pick-up and drop-off of the e-scooter. This accounts not only for periods the e-scooter is in motion but also stops along the way. This measurement is referred to as the ‘ride speed’.

Across the dataset, the median ride speed was 13.1 km/h with 50% of rides having ride speeds between 9.8 and 15.5 km/h. Ride speeds were higher and more consistent early in the morning with a median of 15.7 km/h for rides between 6.00 and 7.00 and an interquartile range of 4.0 km/h. Ride speeds decreased to a median of around 13 km/h from 11.00 onwards and an interquartile range of around 6 km/h. The distribution of speeds throughout the day is presented in Figure 5-13 below.

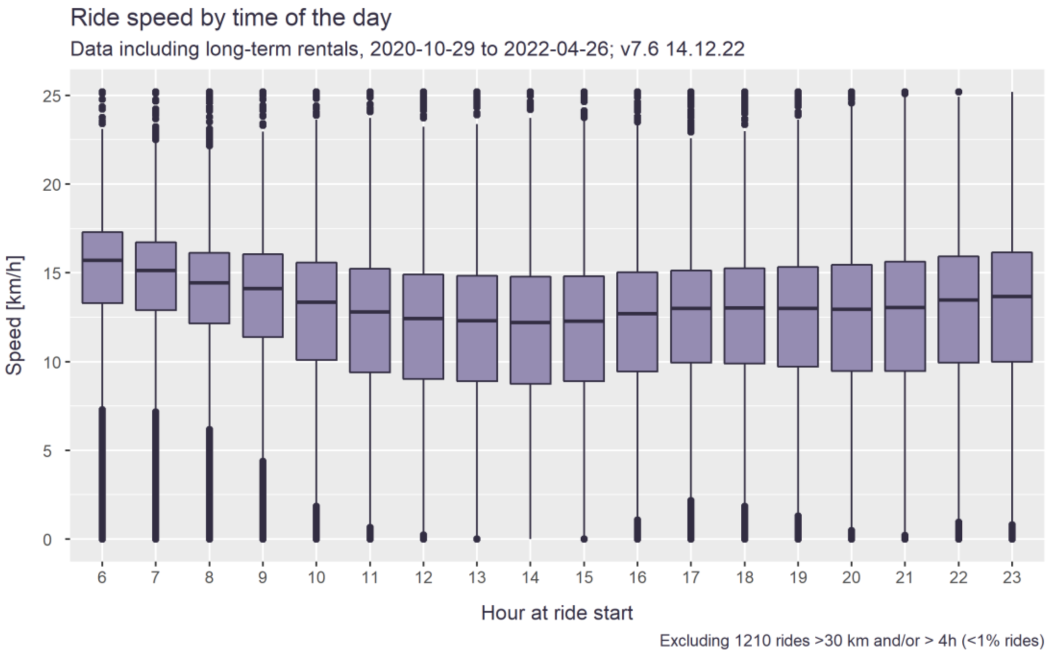


Figure 5-13: Ride speed by time of the day; source: trial operator's ride data

Ride speeds were relatively constant for trips longer than 1km, with medians varying between 13.1 and 13.9 km/h. Trips below 500m are comparatively slower, with a median speed of 4.9 km/h which can partly be explained by the comparatively higher influence of the time taken to pick up and drop off the e-scooter. The distribution is shown in Figure 5-14 below.

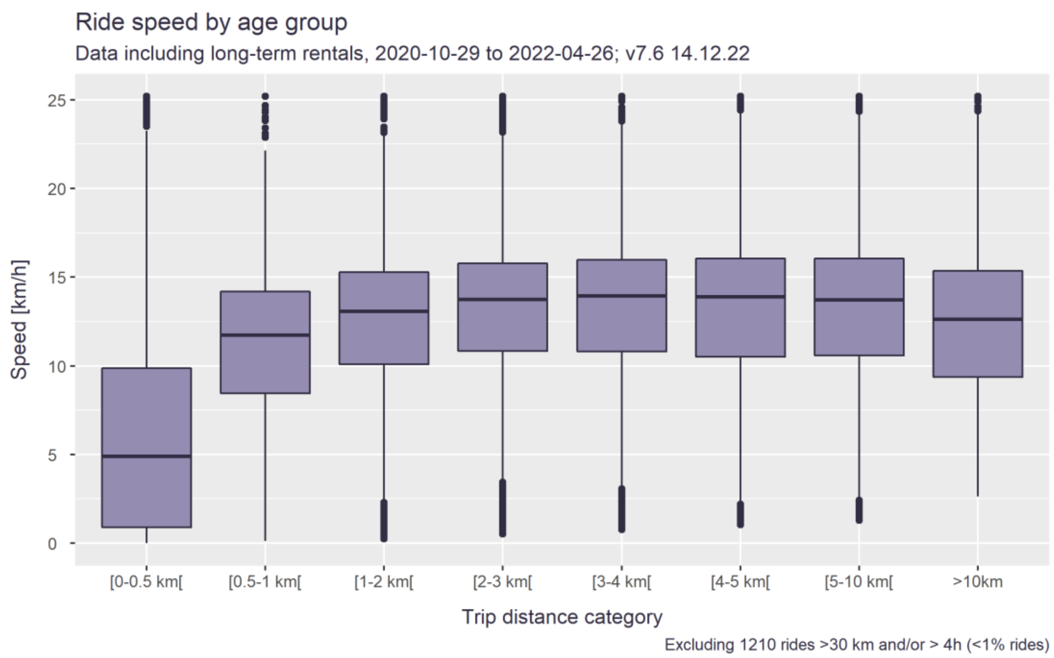


Figure 5-14: Travel speeds by trip distance; source: trial operator's ride data

Ride speeds were relatively constant across age groups, with median values between 13.0 and 13.3 km/h for the age groups 18-24, 25-34, 35-44 and 45-54. Median values for ride speeds were slightly lower for people aged 55 and over (12.3 km/h). The speeds across age groups are shown in Figure 5-15.

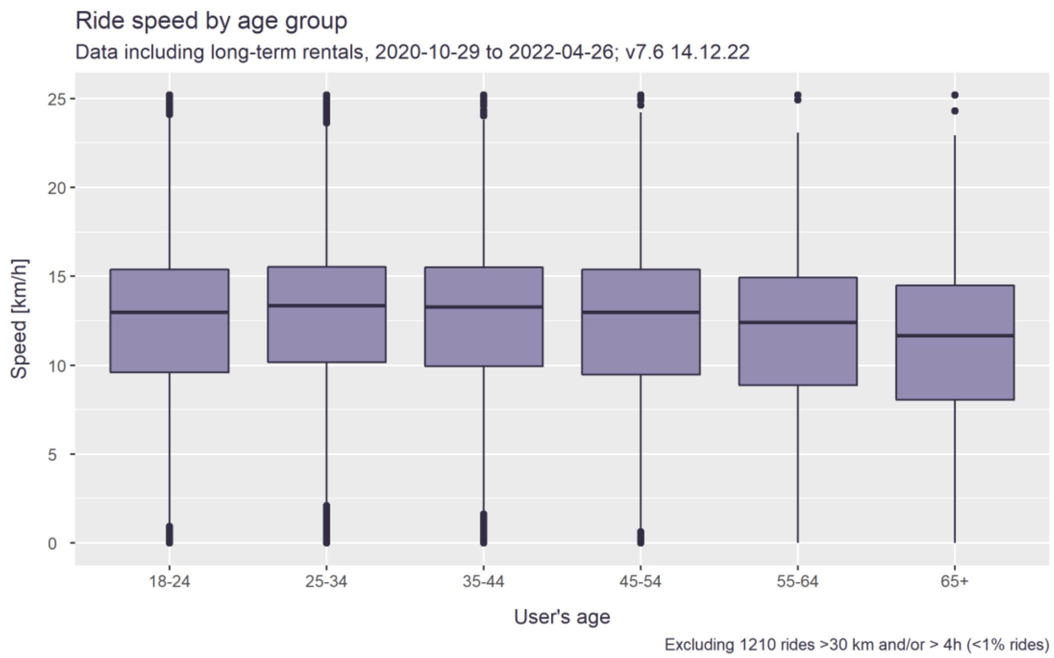


Figure 5-15: Travel speeds by age group; source: trial operator's ride data

It is difficult to compare journey speeds for e-scooter rides with those that would have been experienced by other transport modes as equivalent data was not available for other modes. Flower (2022) reported indicative urban speeds for different transport modes in the UK based on a wide range of sources. A typical journey speed of 19 km/h was identified for urban car and bus travel with specific data for car travel in Bristol in 2017 suggesting an inner city last mile speed of 13 km/h and speed within a 5 miles radius of the centre of Bristol of 19 km/h. This suggests that e-scooter journey times are likely to be quicker than bus journey times in inner city areas, once bus stopping time and walking and waiting times are taken into account. Flower notes a typical walking speed is 5 km/hour and cycling speed is 24 km/hour. Hence e-scooters journeys are likely to be considerably quicker than walking but of a similar speed to cycling. In section 6.1 it is shown that the most frequently stated reason for using rental e-scooters is that they are 'quick'.

5.7 Trip purpose

Information about trip purpose was collected in the trial operator's Winter Survey (but not the preceding Summer Survey). The trip purposes recorded in the Winter Survey are presented in Table 5-7 below, overall and by age group. The high proportion of work-related trips (36%) demonstrates that the rental e-scooters are directly supporting economic activity, while the use of e-scooters for running errands (e.g. shopping) and visiting gym/sports venues (combined total of 19%) shows they are indirectly supporting businesses in the area. Trips for social engagements and leisure (combined total of 39%) might also support businesses. The purpose of travel does not vary very much by age group, except that younger users use the e-scooters more for education purposes and older users for leisure.

Table 5-7: Trip purpose for the last ride; source: trial operator's 2022 winter survey

		Proportions of rides - total and by age group					
Trip purpose (last ride)	**Total**	**Total**	**18-24**	**25-34**	**35-44**	**45-54**	**55+**
Work	368	36%	30%	37%	42%	42%	23%
Social engagements	278	27%	24%	27%	27%	33%	29%
Running errands, eg shopping	149	15%	12%	17%	15%	11%	21%
Leisure - riding for fun!	117	12%	13%	9%	8%	14%	27%
Education	52	5%	16%	3%	0%	0%	0%
Gym / sports club	42	4%	5%	6%	3%	0%	0%
Medical / health appointment	10	1%	0%	0%	4%	0%	0%
Total	**1016**	**100%**	**100%**	**99%**	**99%**	**100%**	**100%**

In the Experience Surveys, participants were asked about the destinations they travelled to by rental e-scooters and were able to select all the destinations that applied. The results were grouped so to examine the proportion of users:

- Accessing only work- or education-related destinations
- Accessing only destinations not related to work or education
- Accessing both work- or education-related destinations and other destinations

The results are presented in Table 5-8 below and show e-scooters were widely used for getting to work/education destinations with 20% of users using e-scooters for work/education destinations only and 42% for both work/education and other destinations.

Table 5-8: Types of destinations usually reached, by age group; source: experience surveys

Types of destinations	Total N	Total %	Age: 18-29 N	Age: 18-29 %	Age: 30-59 N	Age: 30-59 %	Age: 60+ N	Age: 60+ %	Age: NA N	Age: NA %
Only related to work and/ or education	49	20%	31	19%	15	23%	2	NA, low absolute values	1	NA, low absolute values
Only other than work or education	91	38%	68	42%	21	32%	1		1	
Both work/education and other destinations	101	42%	64	39%	30	45%	3		4	
	241	100%	163	100%	66	100%	6		6	

5.8 Modal shift

As a precursor to examining modal shift, e-scooter users' access to a car and/or a bicycle was examined based on data from the trial operator's Winter Survey (where a question had been included on car and bicycle access). Overall, 37% of survey respondents said they did not have access to a car they could use whenever they wanted and the figure was 36% for access to a bicycle. Both access to a bicycle and to a car varied with age as shown in Table 5-9. 66% of e-scooter users aged 18-24 did not have access to a car, a figure that drops to 9% for those aged 55 and over. Surprisingly, 59% of the youngest group (18-24) did not have access to a bicycle while the figure was 17% for those aged 55 and over. The proportion of users having access to both a bicycle and a car varied strongly across age groups, from a minority (19%) amongst the 18-24 to a majority (77%) amongst users aged 55 and over. The full results are in Table 5-9 below.

Table 5-9: Access to a bicycle and/or a car, by age group; source: trial operator's winter survey 2022

Access to bicycle and/or car	Age group: 18-24 N	18-24 %	25-34 N	25-34 %	35-44 N	35-44 %	45-54 N	45-54 %	55+ N	55+ %
Neither bicycle nor car	101	44%	79	22%	27	12%	9	6%	2	3%
Car, not bicycle	35	15%	61	17%	29	12%	22	15%	9	14%
Bicycle, not car	51	22%	70	19%	28	12%	10	7%	4	6%
Bicycle and car	44	19%	155	42%	149	64%	101	71%	49	77%
Total	**231**	**100%**	**365**	**100%**	**233**	**100%**	**142**	**99%**	**64**	**100%**
No bicycle	**136**	**59%**	**140**	**38%**	**56**	**24%**	**31**	**22%**	**11**	**17%**
No car	**152**	**66%**	**149**	**41%**	**55**	**24%**	**19**	**13%**	**6**	**9%**

A relationship between access to a car and/or a bicycle and frequency of use of e-scooters was also noted: the proportion of users not having access to either alternative is highest amongst frequent users (weekly/daily users; 32%) and lowest amongst infrequent users (less than monthly; 8%). On the other hand, while the majority (66%) of infrequent users had access to both a car and a bicycle, this is only the case for 35% of the frequent users. The full results are presented in Table 5-10 below.

Table 5-10: Access to a bicycle and/or a car, by frequency of use; source: trial operator's winter survey 2022

Access to bicycle and/or car	Frequency of use: Infrequent N	Infrequent %	Monthly N	Monthly %	Weekly / daily N	Weekly / daily %
Neither bicycle nor car	16	8%	44	13%	158	32%
Car, not bicycle	35	18%	53	15%	67	13%
Bicycle, not car	21	11%	43	13%	98	20%
Bicycle and car	121	63%	202	59%	175	35%
Total	**193**	**100%**	**342**	**100%**	**498**	**100%**
No bicycle	**51**	**26%**	**97**	**28%**	**225**	**45%**
No car	**37**	**19%**	**87**	**25%**	**256**	**51%**

The trial operator's Summer and Winter Surveys asked two questions about mode substitution, as follows:

> *Think of your last e-scooter ride, which main mode of transport would you have taken if not an e-scooter?*
> *What mode of transport would you use if the current e-scooter trial ended?*

The analysis that follows focuses on the first question as the second question is more hypothetical and its relevance less clear.

An alternative source of data for mode substitution is the trial operator's End-of-Ride Survey. This survey is presented to individuals when they end their rides and typically consists of a very short set of questions delivered through a Google Form. Unlike the biannual survey, the sampling strategy for targeting the End-of-Ride Survey to users is not currently known. Details of the sampling strategy have been requested from the trial operator. The End-of-Ride Survey asks respondents about their most recent trial operator location (either Bristol or Bath) and they are asked:

> *Think back to your last [trial operator] ride, which mode of transport would you have taken if not an e-scooter?*

In total, 6,053 responses from the End-of-Ride Survey covering the period from 3rd March 2021 to 7th April 2022 are analysed for this report.

Table 5-11 shows results from the Summer and Winter Surveys and End-of-Ride Survey to the question about what mode the respondent would have taken if not an e-scooter. In both Bristol and Bath, the percentage of walking trips replaced was higher in the End-of-Ride Survey than in the Summer Survey. Without having additional information about who has been targeted with the End-of-Ride Survey and who completed them, the reasons for any differences remain unclear.

Table 5-11: Alternative mode of travel if e-scooter had not been used; data: trial operator's Summer Survey, Winter Survey and End-of-Ride survey

	Bristol			Bath	
	Summer survey 2021 (n = 2,451)	Winter survey 2022 (n = 943)	End of ride survey (n = 5,314)	Summer survey 2021 (n= 283)	End of ride survey (n = 739)
Bike	12%	15%	7%	5%	4%
Bus	15%	19%	11%	12%	11%
Car	24%	17%	20%	21%	20%
Taxi or ride-hail	13%	10%	15%	8%	9%
Walking	31%	35%	41%	45%	50%
Other (active)	0%	2%	0%	0%	1%
Other (non-active)	1%		1%	3%	0%
Multiple options	NA (participants had to choose one mode)	NA (as in summer survey)	0%	NA (participants had to choose one mode)	0%
I would not have made this journey	3%	1%	5%	5%	4%

Note: Results from the Winter Survey are not presented for Bath due to the relatively small sample (96 responses); values might not add up to 100% due to rounding.

From the Summer Survey, 43% of Bristol respondents would have used active modes as an alternative to an e-scooter (31% walking, 12% bike), values similar to those from the Winter Survey (51% active modes: 35% walking, 15% bike). The majority of Bristol respondents would have chosen either an active mode or public transport (59% and 70%, in the Summer and Winter surveys). A minority indicated that the e-scooter trip replaced a car or taxi trip (37% in the Summer Survey, 27% in the Winter Survey).

It is important to consider here the fact that the survey had an under-representation of young e-scooter users. The analysis by age group showed younger people being less likely to report they would have used a car instead, but more likely to have walked or used public transport, as shown in Figure 5-16. Hence 31% or 32% substitution of walking trips (summer/winter survey) may represent an underestimate, and this is supported by the End-of-Ride Survey figure being 41%. The 24% or 15% substitution of car trips may be an overestimate for similar reasons.

Mode substitution figures for Bath suggest a higher percentage of walking trips are replaced (45% from Summer Survey and 50% from End-of-Ride Survey) with a lower percentage of car trips replaced (21% from Summer Survey and 20% from End-of-Ride Survey).

It is notable that only a small percentage of respondents (1-5% across different datasets) said they would not have made the trip if an e-scooter had not been used which indicates that e-scooters are generating only a small amount of additional travel.

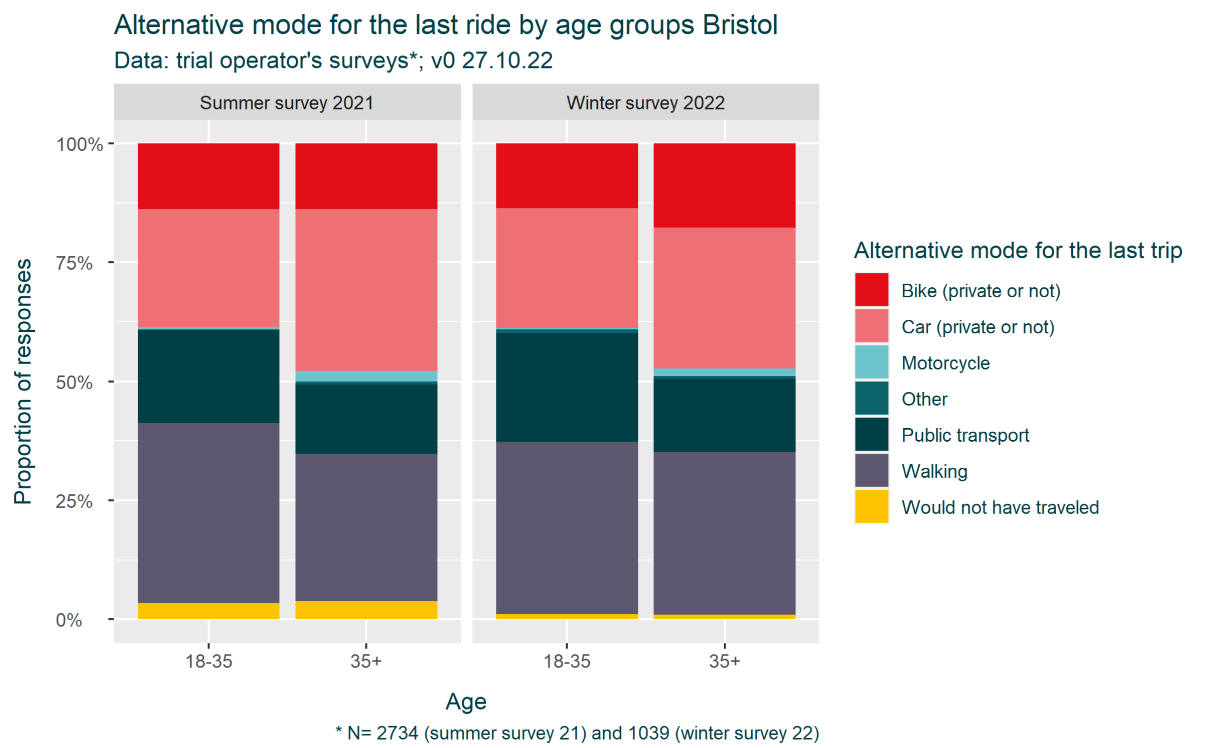


Figure 5-16: Alternative mode of travel if e-scooter had not been used by age group from the trial operator's Summer Survey and Winter Survey

Table 5-12 shows that car and taxi substitution is slightly lower for more frequent users (using e-scooters weekly or more) and public transport substitution is higher for more frequent users. This points to the Summer Survey average mode substitution figures over-estimating car and taxi substitution and under-estimating bus substitution.

Table 5-12: Alternative mode of travel if e-scooter had not been used by frequency of use; source: trial operator's Summer Survey and Winter Survey

	Overall		By frequency of usage					
			Infrequent users (less than monthly)		Monthly		Weekly or daily	
Probable alternative mode for the last ride	**S21***	**W22***	**S21***	**W22***	**S21***	**W22***	**S21***	**W22***
Bike (private or shared)	295	144	58	22	110	48	127	74
Car (private, shared, hailed)	591	254	126	51	224	96	240	107
Motorcycle	23	8	4	2	6	4	12	2
Other	7	6	1	0	2	2	4	4
Public transport	383	186	54	21	130	55	199	110
Walking	762	333	224	68	238	104	299	160
Would not have traveled	76	10	34	3	22	4	20	3
Total	**2,137**	**941**	**501**	**167**	**732**	**313**	**901**	**460**
% car	**28%**	**27%**	**25%**	**31%**	**31%**	**31%**	**27%**	**23%**
% public transport	**18%**	**20%**	**11%**	**13%**	**18%**	**18%**	**22%**	**24%**
% walking or cycling	**49%**	**51%**	**56%**	**54%**	**48%**	**49%**	**47%**	**51%**

* S21: Summer Survey 2021; W22: Winter Survey 2022

Those with usual access to a car were more likely to say that their last journey would have been taken with a private car (24%, vs 4% for those without usual car access). The mentions of taxi or ride hailing were similar, albeit slightly higher for those with usual access to a car (11% vs 8%). The proportions of alternative modes noted are illustrated in Figure 5-17 below.

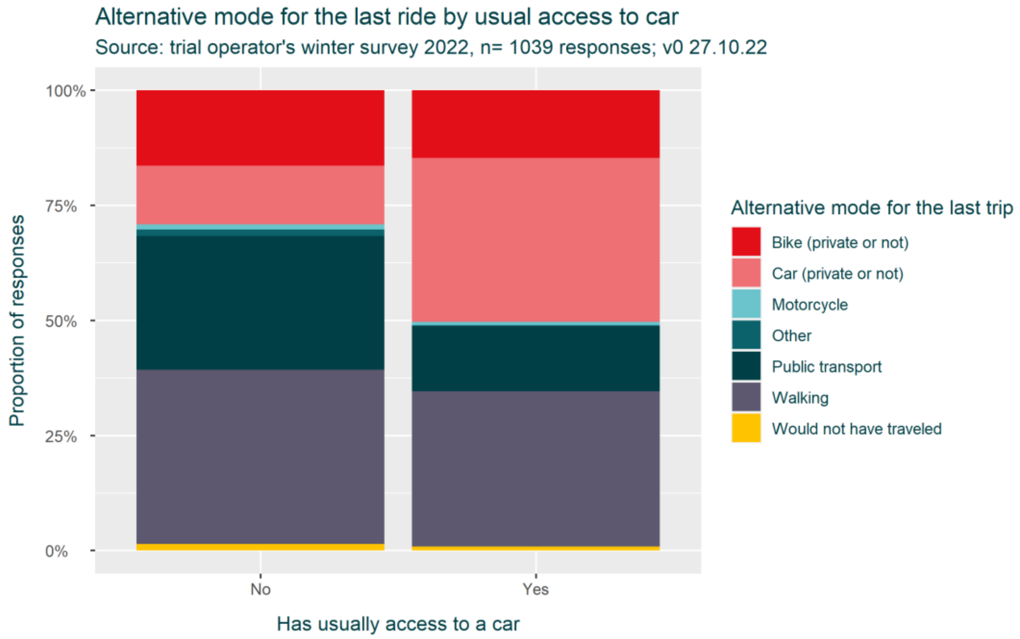


Figure 5-17: Alternative mode for the last ride for those with and without usual access to a car; source: trial operator's Winter Survey

One advantage of the End-of-Ride Survey is that data are collected continuously, so seasonal patterns and overall trends in mode substitution can be observed. Figure 5-18 shows how mode substitution varied between March 2021 and February 2022[viii] when combining data from Bristol and Bath. This suggests that compared to the first few months of the survey, the proportion of e-scooter trips replacing walking trips decreased and the proportion of e-scooter trips replacing taxi trips increased. There is also an indication that car substitution has decreased slightly since the early period of the trial and bus substitution has increased slightly, although it would be useful to obtain more current data for 2022.

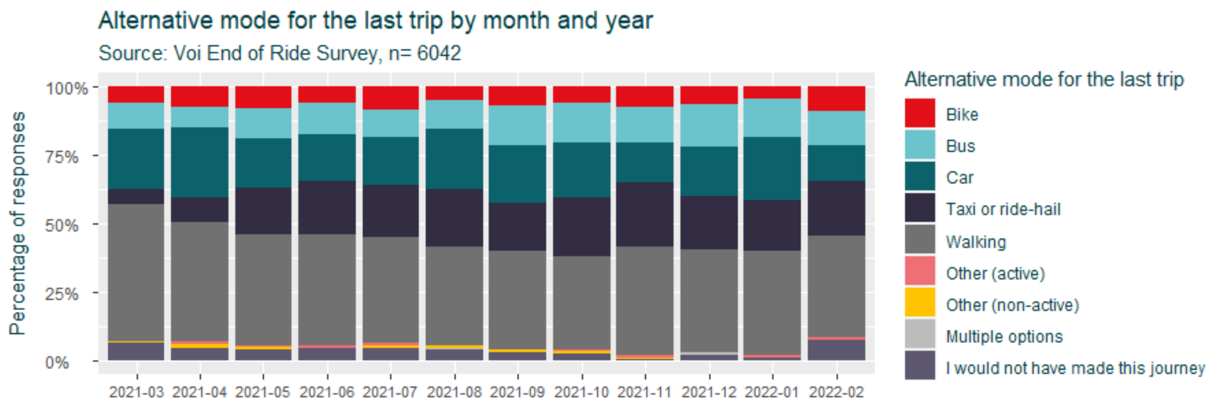


Figure 5-18: Alternative mode of travel if e-scooter had not been used by month and year from End-of-Ride Survey

In the Experience Survey, participants were asked to indicate their most likely alternative mode for their last e-scooter ride. An overview of the results is presented in Figure 5-19 below. Walking was mentioned by the majority of users aged 18-29 and 30-59 (53% in both groups) and 17% of users aged 60 and over. Public transport was another key alternative mode, mentioned by 58% of users aged 18-29, 41% users aged 30-59, and 50% of those aged 60 and over. The substitution of car trips showed a pattern different to that of public transport, with a higher rate for users aged 30-59 (21%) and lower for the younger and older group (respectively 16% and 17% respondents aged 18-29 and 60+ mentioned the car, either as driver or passenger).

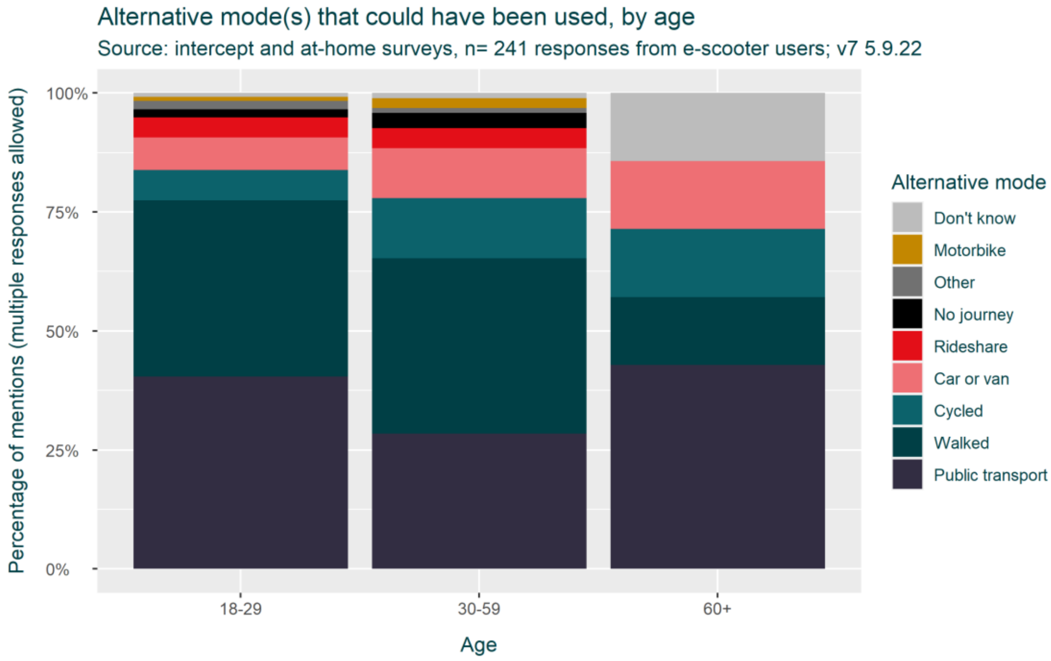


Figure 5-19: Most likely alternative mode for the last ride (multiple responses permitted); source: Experience Survey

5.9 Modal integration

From 7th May 2021, two additional questions were added to the End-of-Ride Survey. Firstly, users were asked:

> *Think back to your last [trial operator] ride, did you combine the e-scooter with another mode of transport?*

If they answered "yes", then they were asked which other mode they combined with the e-scooter.

Overall, 30% of the 3,618 respondents to this question stated that they had combined the use of an e-scooter with another mode. This is somewhat misleading, however, as 51% of the people who stated that they also used another mode stated that walking was the other mode. Given that most respondents are likely to use the HOHO e-scooters as opposed to LTR e-scooters[ix], then it would be expected that they would need to walk to some extent to hire a vehicle.

[ix] The available data shows that 1% of users have a long-term rental contract and make 5% of the rides.

People who selected that they combined walking with e-scooter use were excluded from the following results to focus on the use of other transport modes. After making this adjustment, 22% of respondents in Bath reported combining the use of an e-scooter with another mode, compared to just 13% in Bristol. People who would otherwise have walked to their destination had the lowest levels of combined modes. This is likely to be because these are relatively short trips. Only 12% of trips which respondents would not have made if an e-scooter was not available were made in combination with another mode.

The results on the modes which are typically combined with e-scooter use are also interesting and raise some questions about the validity of the question asked. After removing respondents who stated that they combined e-scooter use with walking, the mode which the largest percentage of people reported combining with an e-scooter was a car (39%). This is somewhat surprising as people generally have more choice in where they can park their car in relation to their destination compared with where the nearest bus stop might be, for example.

The next two highest modes are bus (23%) and train (20%). In terms of car travel, it is possible that people are using e-scooters in a manner similar to Park-and-Ride in order to access cheaper parking spaces or to avoid very congested city centre traffic during peak periods. Alternatively, it is possible that people did not fully understand the question, as half of the people who stated that they used an e-scooter in combination with a car also stated that their alternative mode would have been a car. This might mean that they would have driven to a different/closer location, or it could be that they were reporting that they sometimes use an e-scooter and sometimes drive.

The question of mode complementarity was also asked in the Experience Survey. E-scooter users responding to the Experience Survey were asked what mode(s) they used to get to the start of their last ride and to travel between the e-scooter parking and their destination. Walking constituted 75% of all the mentions and was noted by 82% of respondents as a mode used at the start and/or the end of the ride. The predominance of walking was relatively constant across age groups (noted respectively by 85%, 79%, and 83% respondents aged 18-29, 30-59, and 60+), as well as for respondents having functional impairments compared to those not reporting any (respectively 77% and 84% mentioned walking). Public transport was the second mode indicated, with this time some differences across age groups (13% users aged 18-29 vs 17% older users) and impairments (25% users with functional impairments vs 11% without). Combining the e-scooter with cars was marginal (5% respondents noted it), however differences were observed between age groups (3% 18-29 vs 7% users aged 30 and over) and impairments (7% users with functional impairments vs 3% users not reporting any).

The users not identifying as female or male were a group displaying distinct patterns of integration: they mentioned walking less than those identifying as male or female (50% mentioned it compared to 81% females and 86% males), but noted the use of a car at the start and/or the end of a ride more often (13%, vs respectively 2% females and 5% males).

In the trial operator's Winter Survey, participants were asked if they had combined e-scooter with public transport (*Think of your last e-scooter ride, did you also combine this with public transport as part of your journey?*). A minority of 16% answered positively. This proportion was similar across age groups. A slight variation was noted when comparing the proportions of users having combined trips with public transport across alternative mode considered for the last ride: 23% of those who would have taken the public transport instead of riding an e-scooter combined their ride with public transport, as compared to 13% of those who would have walked and 15% of users who would have used a car.

5.10 Impacts on travel routines

5.10.1 Interview participants

Interviews of rental e-scooter users were conducted in November 2022 to get greater depth of insight than had been possible from the different surveys on how e-scooters are being used to supplement and replace other mobility options. They were also aimed at identifying how e-scooters contribute to people accessing destinations and opportunities across the city and people's health and wellbeing (this is reported in the next chapter).

Table 5-13 lists the interview participants and their characteristics (participant names are pseudonyms). The interview participants reflect the characteristics of e-scooter users reported in section 5.4 with a high proportion of young adults (8 out 13 under the age of 30), more males than females and limited access to a car (9 out of 13 with no access to a car).

Of the 13 interviewees, 5 said they used a shared e-scooter more than once per week ('frequent users'), 5 more than once per month but not more than once per week ('occasional users') and 3 monthly or less ('infrequent users').

Table 5-13: Interview participants

Participant	Age	Gender	Ethnicity	Occup-ation	Personal transport	Freq-uency	Mode replaced	Purpose
Toby	18-20	Male	White	Student	None	4	W	W/PB/L
Michael	18-20	Male	Arab	Student	None	3	N	W
Sienna	21-24	Female	White	Full-time employed	None	5	B	W/PB/L
Lily	21-24	Female	White	Full-time employed	None	1	B	L
Gabriel	21-24	Male	Arab	Student	None	2	B/T	W/L
Tyler	21-24	Male	White	Full-time employed	Cycle	5	B	W/PB/L
Alex	21-24	Non-binary	White	Student	Cycle	1	B	L
Henry	25-29	Male	White	Full-time employed	None	3	B	PB/L

Ruby	30-39	Female	White	Self-employed	Car	1	W	L
Seb	30-39	Male	Mixed	Self-employed	Cycle	3	B/C/W/CP	W/PB/L
Max	30-39	Male	White	Full-time employed	Car & cycle	4	W	W/PB/L
Dylan	30-39	Male	White	Full-time employed	Car & cycle	4	C	W/L
Samuel	40-49	Male	White	Full-time employed	Car & cycle	3	W	W/L

Key:
Frequency (of shared e-scooter use): 1 = monthly or less, 2 = a few times per month, 3 = weekly, 4 = several times per week, 5 = every day or almost every day
Mode replaced (for last e-scooter trip): B = bus, C = cycle, W = walk, CD = car driver, CP = car passenger, T = taxi, N = not made journey
Purpose (of travel using shared e-scooter): W = work or education, PB = personal business, L = leisure

5.10.2 Impact of shared e-scooter use on travel routines

The interviews explored how rental e-scooter use altered the mix of transport modes that were used for travel in the Bristol area. E-scooter journeys were used for short to medium length journeys in Bristol, typically focused on the central area of the city, which would not otherwise have been made by car. E-scooter use had a major impact on the walking, cycling and bus use for some participants, while for others it played a more modest role as a complementary option along with continued use of other modes.

First looking at interviewees where e-scooter use had a major impact, three university students reported that their use of shared e-scooters had reduced the amount they walked and used buses. Even if destinations were near to where they live, the e-scooters might be used in certain circumstances (see CASE SUMMARY: GABRIEL).

CASE SUMMARY: GABRIEL – STUDENT E-SCOOTER USER

Gabriel is an international student studying in Bristol. He first used an e-scooter in July 2021 for an urgent appointment when he couldn't rely on buses.

> *"So I used to live in Filton where the buses are not totally reliable and I had an urgent meeting to attend to. It was close by, but then at the same time I couldn't get there by the bus cause it's always not on time, so I decided to use the scooter. Get there very, very brief trip but it was nice, knowing that I can get to close places quicker than having to get the bus."*

Gabriel doesn't have a car or bike and was relying on walking and buses for his travel needs. Using an e-scooter has replaced travel by those methods of transport for various travel purposes such as getting to university, food shopping, social activities and getting to a temporary job. It depends on circumstances whether he will use an e-scooter such as time pressure and weather.

> *"I live close to uni, but I do still use it sometimes to get to uni. Sometimes when I'm late to lecture or when the weather is not helpful to walk when it's raining."*

The e-scooter helps him get to his temporary job in a different part of Bristol which he wouldn't have been able to do otherwise.

> *"First of all right it helped me get to work. That on its own is a huge thing. Otherwise I wouldn't be able to."*

Gabriel has increased use of e-scooters and has got a month pass recently. This is encouraging him to travel longer distances in the city.

> *"I'm starting to get monthly passes. And it makes it quite easier to use them to be honest, not having to wait to, you know, process the payment and everything. It makes me wanna use them more frequently, like every day or so, it's for simpler trips as well. Even like further trips to maybe Cribbs or Cabot, some trips like that."*

E-scooters were particularly helpful for getting to temporary jobs.

> *"I'd walk to work and then, you know, cause I'd start work at one or two in the afternoon and then when I'd finished at 10 or 11 at night, I then use the [operator's e-scooter] to get back because I was, you know, it's uphill and I've already been on my feet for 10 hours on a shift."* (Toby, M, 18-20)

Alex, a university student, had cycled for journeys in Bristol, as well as walking and occasional bus use, but Alex started using e-scooters in preference to cycling due to it being less tiring.

> *“The main advantage I'd say for me personally is that I'm not tired when I get to my destination ‘cause I'm just standing still pushing the button, it's quite nice. If I'm cycling, I usually cycle quite quickly and thus you know I get exhausted on my way there, especially if I'm going up hill somewhere. So back from university, I'll get home absolutely knackered.”* (Alex, A, 21-24)

As well as students, there were examples of working young adults for whom e-scooters had made a big difference to their daily travel.

Tyler (M, 21-24) had almost entirely replaced other modes for local travel within Bristol, going from walking, cycling and bus use to mainly using e-scooters (see CASE SUMMARY: TYLER). He said he might have considered getting a car if there were no e-scooters in Bristol.

CASE STUDY: TYLER – E-SCOOTER CONVERT

Tyler first used an e-scooter in August 2021 to get to and from work and avoid getting as tired as when cycling.

> *"Well, I was always a keen sort of cycler and I used to cycle to and from work, but because I had like split shifts, it meant that if I cycled home, I've been kind of knackered so I was sort of expending all my energy on my break to get home. Whereas if I got a [an operator's e-scooter], it was like a really comfortable means of getting home pretty quickly and efficiently."*

He has gone on to use them more generally and has moved from pay-as-you-go to getting a monthly pass.

> *"Initially as a means to get to work. But then following that just sort of really, I really enjoy riding them. So just ride them all the time to get from A to B."*

He is aware that his e-scooter use means he is walking and using buses less.

> *"Yeah, I use them almost every day. I use them probably more than I need to - to be honest. Like there's times where I'm nipping to the shop or, you know, popping round someone's house or something and I could walk, but I think they are fun."*

> *"I used to get the bus quite a lot as well, just not as much a fan of getting the bus. I'd rather get some fresh air and I think I found it during rush hour especially. It's actually quicker to get [an operator's e-scooter] because the bus is stuck in traffic all the time anyway."*

Tyler's e-scooter use has continued after moving from a suburb of Bristol to live close to the city centre and nearer his workplace there.

> *"I do live within walking distance from my job. And sometimes I enjoy having a walk in the morning, but sometimes, you know, I take longer to get ready and then having [an operator's e-scooter] means it shortens the journey and gives me a bit more flexibility in that respect."*

Tyler said he might have considered getting a car if there were no e-scooters in Bristol.

> *"I think if they hadn't been a thing in Bristol, I might have considered getting a car. But at the moment I see no reason to, 'cause most of the journeys I do are pretty short. And if it's not [scooter]-able, I yeah, I probably get a train."*

Tyler believes the shared e-scooters are beneficial to the city.

> *"So I do understand what some people's gripes with them are and, but I think it would be a loss for the city. I think they're quite a forward thinking means of transport and I think we should be doing anything we can to get cars off*

the road, particularly 'cause Bristol's air is not of the best quality. I think it would be a shame."

He would however not be so keen on acquiring his own e-scooter.

> *"I think probably not, because the thing I like about them is the fact that you can just take them one way and then either decide to ride it back or you know walk back or get another means of transport. Rather than have to worry about it and lock it up. And I think if I was gonna invest a chunk of money in an electric vehicle I would probably get a hybrid bike."*

Sienna (F, 21-24) replaced walking and bus use when using e-scooters and this saved her time and stress and opened up opportunities to visit more places in the city (see CASE SUMMARY: SIENNA). Aware that she was spending a lot on e-scooters, she has since got a bicycle, and uses e-scooters less but they still have a role in certain situations when she does not want to have the bicycle with her when going out.

CASE SUMMARY: SIENNA – ECONOMISING E-SCOOTER USER

Sienna started using e-scooters in Bristol in May 2022 when she realised they would be quicker than using the bus for getting to work from a suburb of Bristol to the city centre.

> *"Because it was just super convenient, I was taking the bus to work or walking, but then when I was running late, I realised I could use the [operator's e-scooter] to get there faster and then it just became a habit of using it almost every day to travel to work because it was just faster and a bit more reliable than the bus."*

For Sienna e-scooters have been particularly helpful in getting her to the railway station for long distance travel visiting family and are a much faster and more reliable option than buses or local trains.

> *"My family lives in London, so I travel back to London a lot, probably, say maybe two to three times a month... I take the train from Bristol Temple Meads and to get from my house to Temple Meads there's no direct bus... So it was quite out of my way to get there, but when I started taking the scooter it's like a 7 minute scooter from my house to the station so it just allowed me to get there very quickly. If I'm running late for my train, I don't need to worry about that I'm gonna be late. Whereas if I'm running late and I missed the bus, then I'm most definitely gonna miss my train."*

She used them every day she went to work for a few months but has cut back to use the bus and walk recently to save money. She has also acquired a bicycle.

> *"So I was using them every day and then I think I realised that it was actually quite costly. So I tried to go back to taking the bus because it was a bit cheaper to take the bus to work and then walk home, but if I was in a pinch I would definitely take the e-scooter. They are very reliable, so if I ever needed to go out, not just to work, but to get somewhere and the bus wasn't coming on time or something like that. I would always get the e-scooter, but yeah, I realised that it was quite high cost. So that's when I got a bike and I started cycling. Just because it was much, much cheaper to cycle than to [use an operator's e-scooter] ."*

The e-scooters, however, are still useful even now Sienna has started cycling.

> *"Even now that I'm cycling, I still use the scooter if I'm going to meet up with friends who don't cycle. I'll use the scooter to get there and then once I've met up with my friends, we then go to the next point by other means like by bus or by Uber because they don't cycle. So it would be weird if I brought my bike and I'm cycling and they're walking."*

Regarding the possibility of shared e-scooters no longer being available, Sienna would be concerned about not having a fall-back option.

> *"Like people who drive, they can be like, oh, I'm just gonna drive there. If there's no other way to get there, but I don't have that that to fall back on like I have the scooter to fall back on. So if there was no scooters, I don't know, I think I'd have to get more serious about cycling everywhere, or just have to take the bus again. But just thinking about taking the bus, I don't know, I'm so used to travelling alone."*

There were other interviewees for whom e-scooter use is more selective and it has become an additional option in their menu of transport modes.

Max (M, 30-39) is a regular cyclist for whom e-scooters sometimes replace cycling and also replace walking. They have also reduced his occasional use of buses and taxis. He was confident in using them having tried them elsewhere before they arrived in Bristol. They enhance his set of options and could be even more attractive if routes/areas of operation are expanded and prices kept competitive against buses.

> *"Yeah, it was just convenience, really. It was just needing to get from A to B in a sort of faster fashion. I'm a cyclist normally, but it was a like, you know, on a day when I didn't have my bike with me or if I was just trying to go get a haircut or, you know, something across town it was just a very easy, convenient way to do that, really."* (Max, M, 30-39)

Seb (M, 30-39) does not drive and before using e-scooters he cycled, walked, took local trains and buses and was a car passenger (see CASE STUDY: SEB). He now rarely uses the bus, and often uses an e-scooter instead of cycling for work, shopping and leisure.

CASE SUMMARY: SEB – E-SCOOTER BECOMING MORE CENTRAL TO DAILY TRAVEL

Seb first used an e-scooter in December 2020 and initially he used an e-scooter as a leisure activity, often with friends. In the last six months Seb has been buying a month pass and using e-scooters 'as a form of transport'. Seb's life has experienced a lot of change in his life since December 2020 with a house move, birth of first child and changing employment situation. His partner drives but he has not learnt yet. He has been using shared e-scooters through this period.

> *"When they first arrived I was using them kind of just more here and there. I was just getting a daily pass and using it every now and again. And I was probably using it more as like a leisure activity, just like going out with friends and we, you know, scoot around for quite a long time on the day pass and then more recently in probably the last six months I've had a monthly pass. I've used that monthly pass more as a form of transport."*

Seb will use e-scooters when it offers advantages over other options.

> *"Sometimes I'm going into situations where I don't want to arrive very sweaty. You know I'm cycling somewhere. I might be arriving quite kind of like sweaty and hot, whereas on an e-scooter you can sort of arrive a bit more…calm and well presented and not sweaty, if that makes sense."*

E-scooters have encouraged him to explore the city.

> *"I've lived in Bristol for a really long time and it did make me kind of just start exploring the city again in a way that I hadn't done for quite a long time. Just because it was a new form of transport and it was kind of like it kind of invites… you to sort of like drift around a bit more as opposed to just being like, I'm going from one destination to another."*

Seb has benefited from discounted monthly pass for lower earners and he said his future use will depend on how competitive the cost of using e-scooters is compared to buses.

> *"I do think it's a bit expensive, like I think £5 for a daily pass. I think what I'm trying to say is I think you want the price to compete with like the cost of a bus. So if you're getting like a four pound day rider on a bus. I think you want the kind of e-scooter to kind of compete with that price wise. If it was up to me, I probably would make it a bit cheaper so that it was more accessible."*

For Dylan (M, 30-39) e-scooters are useful for certain journeys that are not so convenient by his main modes of cycling and driving. This particularly involves trips to the city centre and around the central area of the city.

CASE SUMMARY: DYLAN – E-SCOOTER ADDS TO THE MIX

Dylan first tried an e-scooter in early 2022 to join family members enjoying leisure time in the city centre.

> *"My wife was taking a walk around the harbourside and I thought I'd catch up with them with her and my sister-in-law. After finishing work early, just thought I'd jump on and there's no other mode of transport really other than walking and walking would take too long? So yeah, just thought it was a great idea. Great time to jump on it."*

Dylan lives in an outer suburb of Bristol and has access to a car and bicycle. He uses both of these for getting to work and the car for shopping and leisure. He tends to use an e-scooter for getting into the city centre for social activities and will use a taxi to get home.

> *"So the area that I found it very useful is going for some drinks or a meal into town. Because you are just unencumbered, you don't have a bike if I was to use that. It's cheaper than a taxi and you don't have a car, so you can choose to get a scooter into town and a taxi home and that's where a scooter would pop in. Much more social."*

He also uses e-scooters for short journeys within the centre of Bristol such as going to get a haircut. When he gets a day pass he tries to make the most of it.

> *"It's difficult because it has replaced walking in that respect. So I'm working in Temple Quay, the barbers is on Broad Street. So it's only a 15 minute walk at most and that's a slow walk. There's some times I've hopped on a scooter if I've got a day pass…. so sometimes I've popped on it to grab something from say a bakery or go and get my haircut."*

Dylan will probably use e-scooters less in future as he has invested in an electric cargo bike.

> *"It's probably decreased because I've recently invested in a new bike which is sort of an e-bike cargo bike sort of thing. So it's a really positive change because one, we can't drive our car into the centre of Bristol anymore well from the Clean Air Zone charge. And so I'm able to travel with my daughter. She's 2 and a half on the bike and get pretty much a full 4 weeks worth of shopping in the basket on the front."*

Samuel (M, 40-49) reported using e-scooters selectively as an alternative to walking, buses and taxis for his travel to and from city centre, particularly when returning home from the centre as it is up a hill. He has an e-bike but does not use this because of concerns whether he can leave the e-bike securely parked. With a shared e-scooter there is no such issue.

There were interviewees where e-scooter use made a significant difference to their personal mobility for a period (in particular when they were originally surveyed) but this has not been sustained.

Lily (F, 21-24) used e-scooters for a few months near the end of her university days but has since got a job outside Bristol and bought a car which she is now using for most of her travel needs. When she used an e-scooter, it had complemented use of other transport modes, particularly walking, taxis and the bus.

Coming out of the pandemic, Henry (M, 25-29) used an e-scooter instead of the bus to visit friends when nervous about using buses. At the time of the interview he was starting to use e-scooters less as their cost had risen and was now greater than using buses.

> *"I previously pre-pandemic would always get the bus and then I think there was a kind of window where things were kind of easing up but I was still slightly trepidatious about getting on the bus. So I gave the scooter a go having probably discussed it with a friend. And so I signed up for the app and then tried it out, and it was for me. It was actually immediately like amazing because I don't drive, so I'd gotten used to like walking quite far."* (Henry, M, 25-29)

Ruby (F, 30-39) can drive but does not often do so within the city. She has been using e-scooters as an alternative to walking for longer journeys in the city. Her use of e-scooters has dropped off in recent months with roads becoming busier.

> *"Probably the two reasons that I'd use it would be slightly further walks… you know that kind of when it's starting to get to about an hour walk, it might not be the entire way, might be kind of half-way we'll pick up a scooter… I have also used it a couple of times… I'm self-employed and I'm going to deliver a workshop or something and I don't wanna get there all kind of out of breath and hot and whatever it might be, I'll jump on a scooter instead."* (Ruby, F, 30-39)

5.10.3 Summary

The interviews showed how e-scooters are being incorporated into daily travel routines. Of the people interviewed e-scooters are replacing walking, cycling and bus and taxi use. Some mention was made of e-scooters encouraging people to get out when they might not have done otherwise but this seemed to apply only to a minority of e-scooter use (see next chapter for interview findings on the impact of e-scooters on accessibility, health and wellbeing).

The replacement of bus use was more commonly mentioned than other modes and was particularly notable for students and younger adults who disliked the long journey times and unreliability of buses. There were some interviewees who reported they had mainly got around by bicycle in the past but preferred e-scooters over cycling to avoid getting tired, sweaty and wet and to avoid leaving bicycles in unsecure locations.

While for some interviewees, it is clear that the e-scooter has become the first mode of choice for travel within Bristol, for others it is an option that is selectively chosen for particular situations. Interviewees could be considered to lie on a spectrum where, at one end, e-scooters are fully replacing other modes to, at the other end, e-scooters only occasionally being used. In other words, rental e-scooters have been added to people's menu of options with the relative amount they are used varying from person to person.

The interviews also revealed changes over time in e-scooter use. There were some interviewees who had been curious to try the e-scooters soon after they were introduced with others taking longer to give them a go. It was evident that e-scooters were used in a distinctive way by some interviewees during the 'lockdown phases' of the pandemic and in the 'opening up' period after that. Using e-scooters as an activity in its own right with family and friends, or to visit parts of the city further distant than possible on foot, were mentioned by some interviewees.

The interviews were able to explore how use had settled down in the year since opening up after the pandemic. Some interviewees were no longer actively using e-scooters and did not seem to have become very confident in using them on roads in the city. Some were cutting back their use due to them becoming more costly and less competitive against the bus and due to a wish to be more physically active and cycle. On the other hand, just as some e-scooter users had been decreasing their use since they had taken part in the Experience Survey in June-July 2022, there will be others who have started using the rental e-scooters since then and would not have been in the frame for being interviewed.

5.11 Summary

The shared e-scooter trial has registered 8,650,692 rides in Bristol by 345,450 unique users and 429,017 rides in Bath by 57,437 unique users from the start of the trial in October 2020 to the end of February 2023. The number of rides per day and per user has been steadily increasing in Bristol during the trial, but this is not the case for Bath where usage peaked in the first months before dropping and remaining broadly constant until rising again after expansion of the operating area in June 2022.

The number of rides undertaken on LTR e-scooters is 5% of the total rides in the trial area. About 15% of registered e-scooter users are frequent users who use the e-scooters at least once per week but this still represents a substantial number of people (42,200 people in April 2022). Most rides have been paid for on a pay-as-you-go basis (56%). Daily and monthly passes represented respectively 18% and 26% of the rides. Rides made with passes are more common in Bristol compared to Bath, which is consistent with the higher frequency of use of e-scooters by individual users in Bristol.

Consistent with what has been found elsewhere, rental e-scooter users in the West of England are much younger than the general population and males are over-represented. Users under 35 represent 81% of those signed up to use the system. Those aged 18-24 represent 47% of registered users across the trial areas and 49% of registered rides. There are on the other hand 1.8 times more men than women signed up to use the system (gender is undeclared for 16% of subscribers) and 2.8

times more rides have been made by men than women (noting that gender is undeclared for 15% of rides).

The trial operator's 2021 Summer Survey and 2022 Winter Survey give some insights regarding work status and ethnicity of e-scooter users. The surveys suggest three-quarters of users are in formal employment with students representing just over one in ten responses. It should be noted that the surveys had an under-representation of young people. It is therefore likely that the proportion of students using e-scooters is higher than identified from the survey. Regarding ethnicity, 87% of respondents were of white ethnicity which is slightly higher than their representation in Bristol's population (84% at time of 2011 census).

E-scooter provision is not clearly linked to deprivation but is more related to centrality with greater concentrations of parking zones in the centre of the city and a corridor connecting the centre to the northern suburbs of Bristol. Suburban and peripheral areas were relatively less well served up to the start of 2022, particularly in the north-west and south of the city and these include some of the most deprived areas of the city.

Average trip distances ridden in Bristol were longer than those ridden in Bath. The median trip distance was 2.1 km in Bristol and 1.7 km in Bath. Three-quarters of trips were less than 3.3 km in Bristol and three-quarters of trips were less than 2.5 km in Bath. In Bristol, the e-scooters are used for trips within dense urban areas throughout the day with an addition of movements towards the centre in the morning and exiting the centre in the afternoon/evening.

The high proportion of work-related trips (36%) demonstrates that the rental e-scooters are directly supporting economic activity, while the use of e-scooters for running errands (e.g. shopping) and visiting gym/sports venues (combined total of 19%) shows they are indirectly supporting businesses in the area. Trips for social engagements and leisure (combined total of 39%) might also support businesses.

According to the trial operator's survey of e-scooter users, more than half have access to a car (63%) and to a bicycle (64%), but this varies strongly with age with only 34% of 18-24 year olds reporting access to a car and 41% access to a bicycle. Frequent riders had much lower availability of each of these forms of personal mobility. This highlights that rental e-scooters are tending to serve young adults without access to personal transport options.

Available data (from the trial operator's 2021 Summer Survey and Winter Survey 2022) suggests that the modes replaced by an e-scooter in Bristol in descending order are: walking (31%/35%); car (24%/17%); bus (15%/19%); taxi and ride-hail (13%/10%); bicycle (12%/15%). Only a small minority of trips (3%/1%) would not have been made if an e-scooter was not available. The ranking is similar for Bath but with higher replacement for walking. Mode substitution figures from cities in other countries indicate a lower substitution of car trips and higher substitution of public transport trips.

It is important to note that the surveys had an under-representation of young e-scooter users and younger people are less likely to have used a car instead of an e-scooter. It is also important to note that car and taxi substitution are slightly lower for more frequent users (using e-scooters weekly or more) and public transport substitution is higher for more frequent users. This points to the survey mode substitution figures overestimating car and taxi substitution and underestimating bus substitution.

It is challenging to identify the extent to which e-scooters are combined with other motorised modes when making journeys. The data available suggests that this lies between 10% and 20% of trips using e-scooters.

In-depth interviews of 13 e-scooter users, selected to be typical of e-scooter users in general, showed how e-scooters are being incorporated into daily travel routines. Based on these interviews, e-scooters are replacing walking, cycling and bus and taxi use. The replacement of bus use was more commonly mentioned than other modes and was particularly notable for students and younger adults who disliked the long journey times and unreliability of buses. There were some interviewees who reported they had mainly got around by bicycle in the past but preferred e-scooters over cycling to avoid getting tired, sweaty and wet and to avoid leaving bicycles in unsecure locations. While for some interviewees it is clear that the e-scooter has become the first mode of choice for travel within Bristol, for others it is an option that is selectively chosen for particular situations. Rental e-scooters have been added to people’s menu of options with the relative amount they are used varying from person to person.

The interviews also revealed how individual e-scooter use has changed over time. There were some interviewees who had been curious to try the e-scooters soon after they were introduced with others taking longer to give them a go. Some interviewees were no longer actively using e-scooters and did not seem to have become very confident in using them on roads in the city. Some were cutting back their use due to them becoming more costly and less competitive against the bus and due to a wish to be more physically active and cycle.

6 E-SCOOTER USERS' PERCEPTIONS AND VIEWS

This chapter presents results on users' subjective perceptions of shared e-scooters and their views on how they contribute overall to their travel and lives. It focuses on the following evaluation questions:

1b Perceptions: How do perceptions of e-scooter safety vary by gender, age, and ethnicity?
2a Usage: Who, why, when, how, and where are e-scooters being used?
2e Employment & economy: How has the trial managed to facilitate transport to jobs and support the wider economy?
3a Health impacts: How does riding an e-scooter contribute to an individual's health and wellbeing?

The chapter presents results from analysis of the following datasets:

- **User responses to Summer Survey and Winter Survey** undertaken by the trial operator in July 2021 and February-March 2022. The surveys approached those people that had used an e-scooter in last three months (assumed to include both HOHO and LTR users)
- **User and non-user responses to Experience Survey** conducted by UWE between June and August 2022 and achieving a total of 643 responses
- **In-depth interviews** with 13 e-scooter users conducted by UWE in November 2022

Section 6.1 presents results on the reasons given by users for using rental e-scooters and section 6.2 looks at perceptions of the e-scooter system considering safety and other aspects. Section 6.3 considers how e-scooters are contributing to people's access to opportunities and section 6.4 to health and well-being. Finally, section 6.5 reports in-depth findings on what a small sample of e-scooter users say about how shared e-scooter use has benefited their travel and lives.

6.1 Reasons for using rental e-scooters

Results on the travel purpose for individual e-scooter trips were reported in section 5.7 but this section presents results on the reasons that people gave for choosing to use rental e-scooters. This was asked of e-scooter user participants of the Experience Survey. The reasons noted mainly relate to speed, convenience, cost, and flexibility, often compared to other modes of transport (some participants noted for instance the inadequacy of public transport services). The reasons noted are represented in Figure 6-1 below.

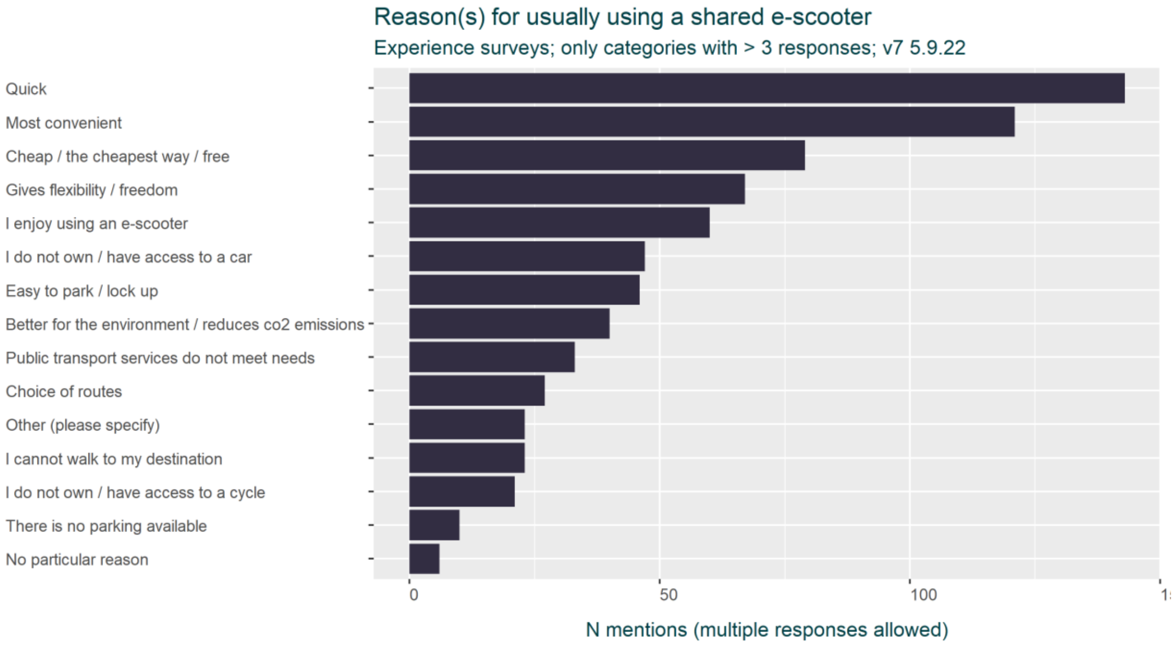


Figure 6-1: Reasons for using rental e-scooters; data from Experience Survey

Two key types of reasons were examined across the demographic groups:

- **Generalised convenience**, encompassing the mentions of e-scooters being fast, convenient, and/or offering flexibility/freedom (44% of all the mentions)
- **Limited choice**, encompassing mentions of poor public transport service, inability to walk to destination, and/or not having a car or a bicycle (18% of all the mentions)

Both types of reasons were cited at similar rates across ages, gender, and disability, with one exception: women and people not associating with a binary notion of gender more frequently noted having a limited choice (21% women, 28% for those not associating with a binary notion of gender, vs 16% for men).

Another source of data is the trial operator's winter survey, which included the question:

Why do you like [the trial operator]? (Select up to five answers)

The categories available were:

- Affordable mode of transport
- Company that cares about safety
- Enjoyable mode of transport
- Makes it easier and more accessible to move around in my town/ city
- Reliable mode of transport
- Sustainable mode of transport
- Other reason
- I don't know
- None of the above

The main cited reasons related to convenience ("easier travel"), the idea of e-scooters as an enjoyable mode of travel, sustainability and affordability and reliability. The frequencies of mentions are represented in Figure 6-2 below.

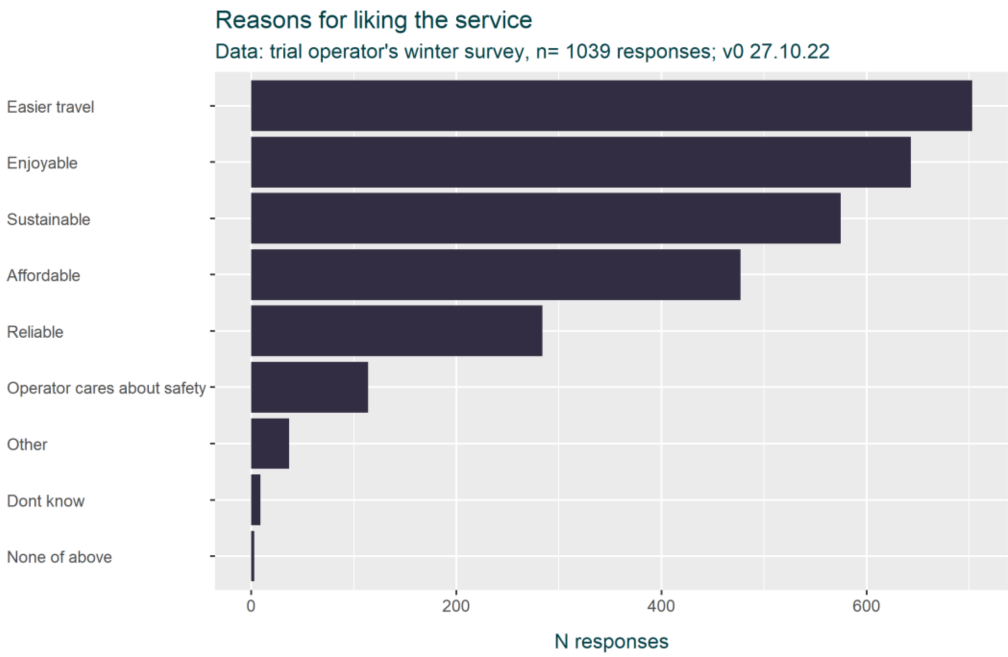


Figure 6-2: Reasons for liking the service; source: trial operator's Winter Survey

The responses were similar across age groups, as illustrated in Figure 6-3 below.

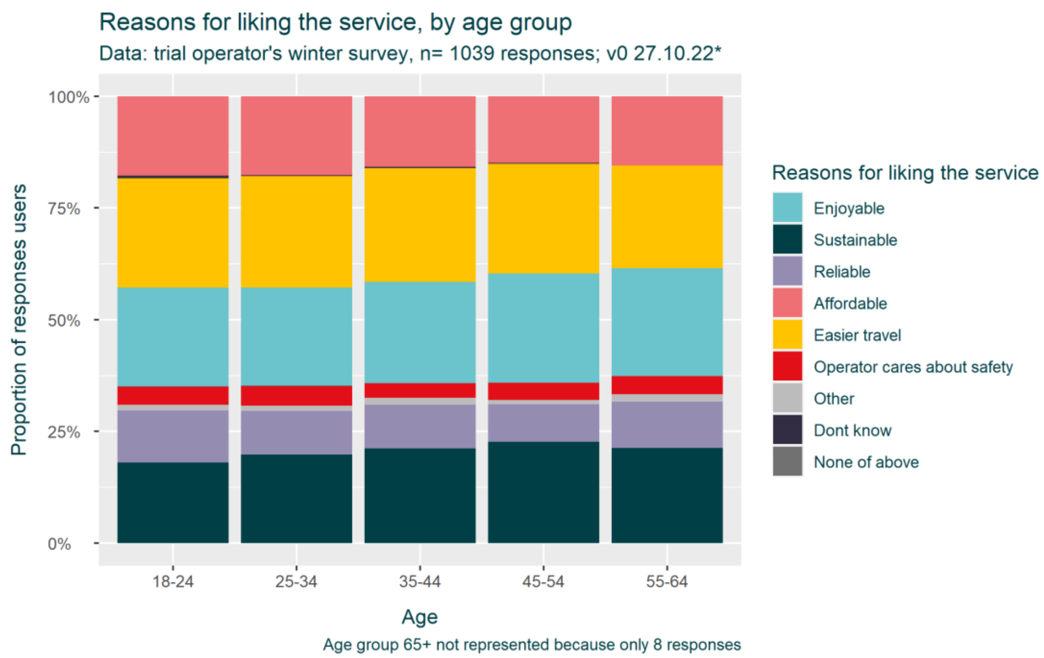


Figure 6-3: Reasons for liking the service, by age group; source: trial operator's Winter Survey

6.2 E-scooter perceptions

Users' perceptions of different aspect of the e-scooter system have been analysed based on the trial operator's Summer and Winter Surveys, as well as the Experience Survey.

6.2.1 Importance and satisfaction of different aspects of e-scooter trial

The Summer and Winter Surveys asked users about the importance to them and their satisfaction of seven different aspects of the e-scooter trial. The questions asked were:

> *How important are these factors for your safety while riding an e-scooter?*
> *How do you rate these factors in your city?*

The seven aspects were:

> *Quality of the e-scooter*
> *Having a helmet to hand*
> *Having enough cycling lanes*
> *Quality of roads*
> *Being visible at night*
> *Visibility to other road users*
> *Clear traffic rules*

The availability of information on both importance and satisfaction allows for an analysis of what has been termed disgruntlement (Stradling et al., 2007). Disgruntlement applies to aspects that users consider important and for which they are dissatisfied – these aspects should be considered priorities for intervention.

Bristol and Bath present similar results, regarding the relative importance of different features. For instance, being visible to others is rated important by respectively 81% and 82% participants, while the quality of e-scooters is important to respectively 79% and 80%. Slight differences are noted for the availability of bike lanes (68% for Bristol, 63% for Bath) or the availability of a helmet (32% and 27%). This is possibly related to the infrastructure, traffic and usage: in Bristol, trips are longer which might lead to users feeling greater need for safe infrastructure and equipment.

Summer and Winter survey responses were compared, for Bristol, regarding the relative importance of different features (Figure 6-4 below). The proportions of respondents rating different elements as important were similar, albeit slightly higher for the Winter survey. This could be explained by both riding conditions, (higher likelihoods of wet days and darkness in winter) but possibly also higher proportions of utilitarian rides, in winter. This last element could not be tested, given that the trip purpose was asked only within the Winter Survey. In the following paragraphs, both surveys are considered together.

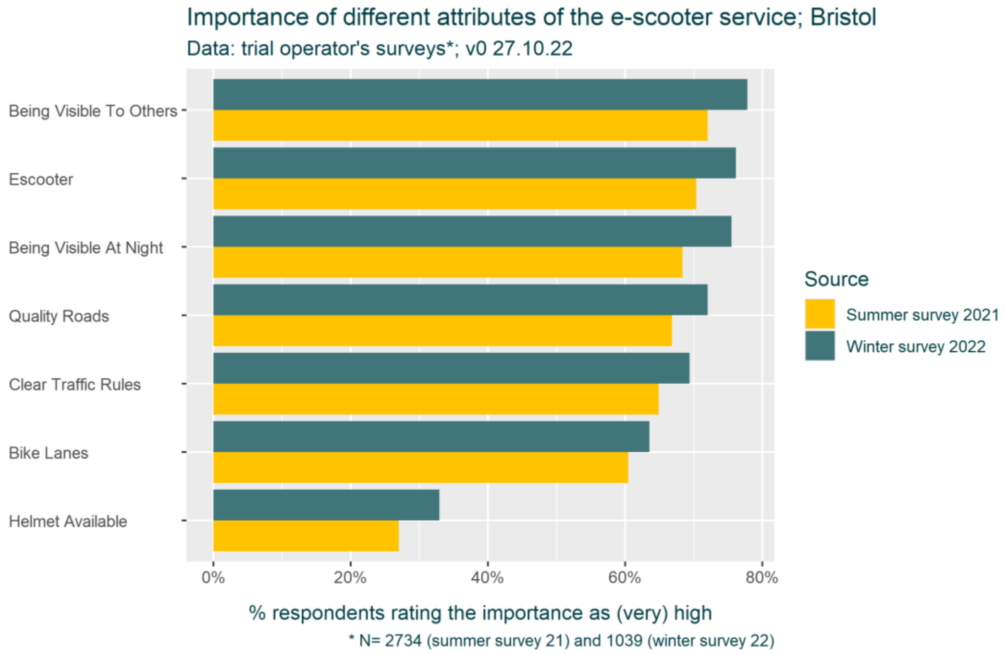


Figure 6-4: Importance of different features by survey; source: trial operator's Summer Survey and Winter Survey

Figure 6-5 presents the levels of importance of different topics. Most respondents regard all the investigated aspects as being important or very important, except for helmet availability.

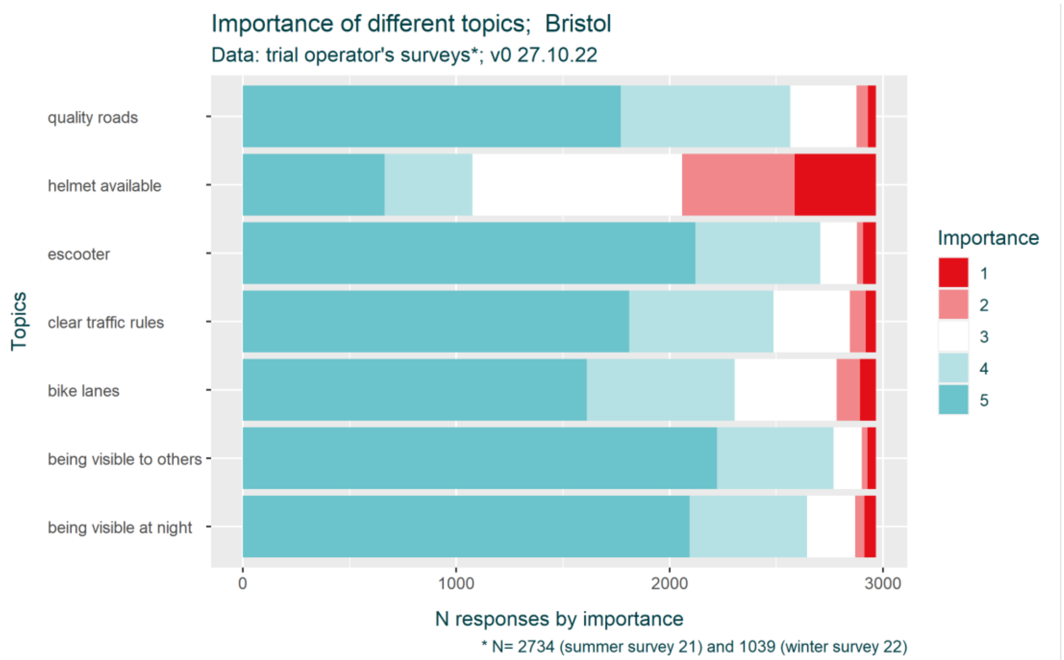


Figure 6-5: Importance of seven different topics in Bristol; source: trial operator's Summer Survey and Winter Survey

Figure 6-6 shows the levels of satisfaction with the investigated aspects. There is a high level of satisfaction with the e-scooter as a vehicle, being visible to others, and being visible at night. The availability of a helmet was seen as generally not being satisfactory, despite its lack of importance. The next two highest levels of dissatisfaction are with the quality of the roads and the sufficiency of cycle lanes.

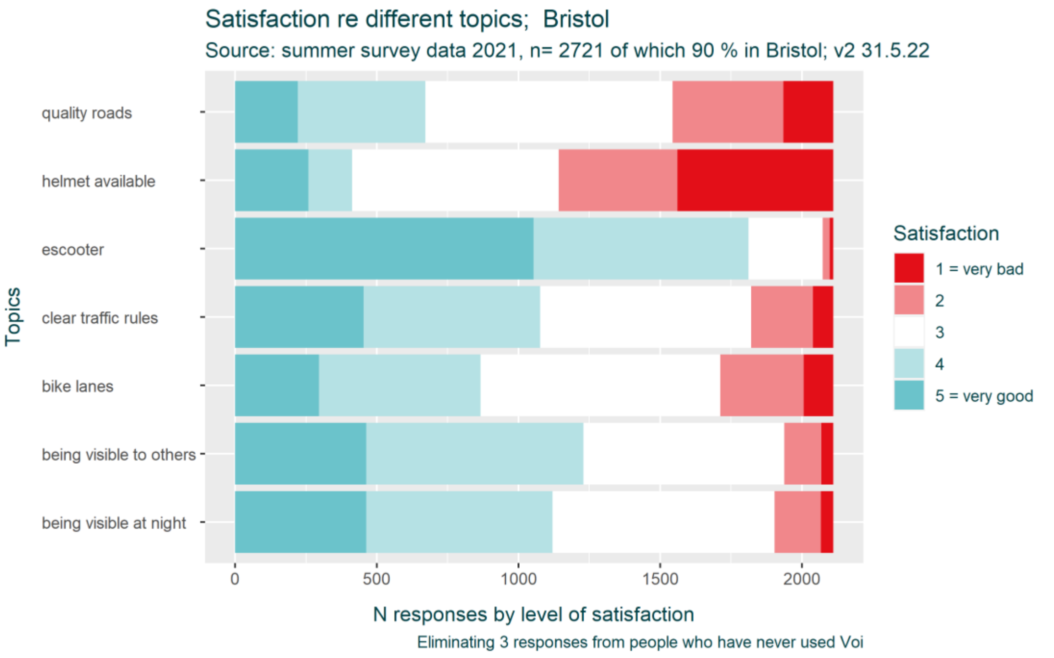


Figure 6-6: Satisfaction with seven different topics in Bristol; source: trial operator's Summer Survey and Winter Survey

6.2.2 Key aspects from the perspective of disgruntlement

Considering together the issues of importance and satisfaction allows for an identification of those topics that are both important and not satisfactory (i.e., the notion of disgruntlement). In this case, users are mainly disgruntled about:

- The infrastructure (quality of the roads and availability of cycle lanes)
- The availability of helmets

These two topics have a different pattern of disgruntlement, however. The quality of infrastructure is important to most users (amongst Bristolian respondents, respectively 76% and 68% rate the quality of roads as important and the availability of cycle lanes as important), and a non-negligible proportion is dissatisfied (17% in relation to there being enough cycle lanes and 13% in relation to quality of roads). On the other hand, the availability of helmets is important for only 32% of users but is deemed not satisfactory by 39%.

It is important to recognise that, even though only about one-fifth of Summer/Winter Survey respondents are dissatisfied with cycle lanes and one-quarter with quality of roads, this represents the views of relatively frequent users (most survey respondents reported using a shared e-scooter at least once per month) and there may be greater dissatisfaction among those who are infrequent users (tried using an e-scooter but have not continued to use them) and these aspects may be discouraging non-users from trying them.

6.2.3 Perceived safety by socio-demographics

The Summer and Winter Surveys asked users to what extent they agreed with the statement ‘I feel safe riding a [trial operator] scooter’, on a seven-point scale. Users felt safe overall, and this was comparable between the two surveys: amongst the valid answers, respectively 10% and 11% were negative (levels 1-3), and 69% and 66% positive (levels 5-7). Results were also similar when comparing Bristol and Bath, with respectively 12% and 11% negative opinions, and 68% and 67% positive ones.

In the paragraphs below, data from both surveys and both cities are further examined by age, gender, and ethnicity.

Figure 6-7 below presents responses on feelings of safety by age band. It is interesting to note a pattern of decreasing levels of perceived safety across the age groups: the youngest cohort (aged 18-24) felt the safest (73% felt safe, 11% unsafe). At the other end of the spectrum, 57% of the older participants (55 and over) felt safe, and 19% unsafe (only 13 responses were recorded amongst those aged 65 and over). The full breakdown of the levels of agreement is presented in Appendix 2: Additional tables of results from Summer Survey.

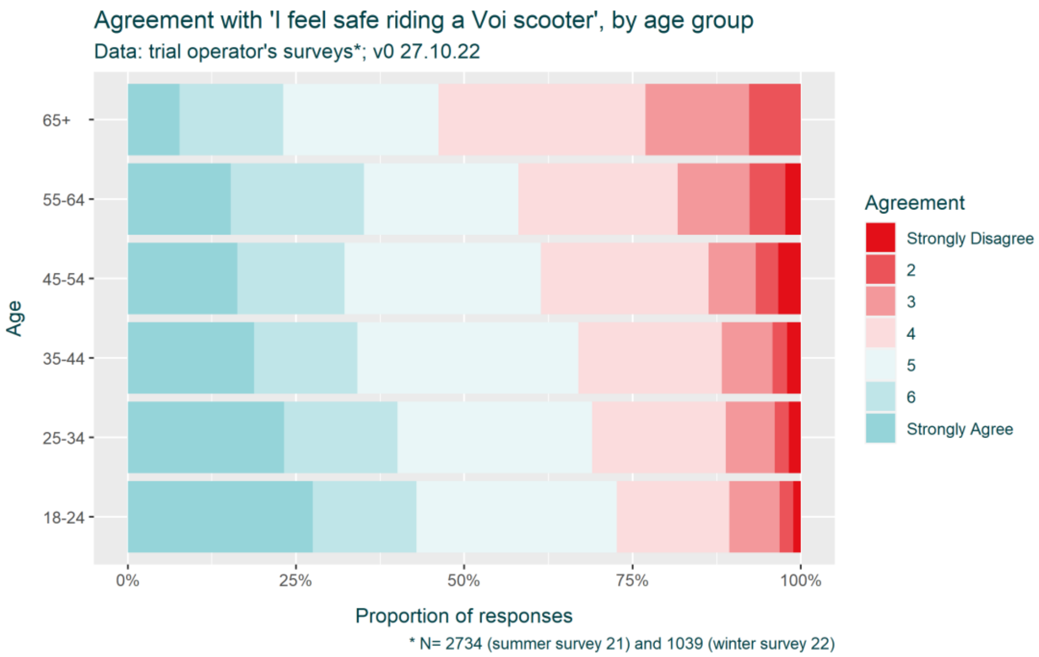


Figure 6-7: Levels of perceived safety by age; source: trial operator’s Summer Survey and Winter Survey

Perceived safety by gender is presented in Figure 6-8 below. Male users had slightly better perceptions of safety than females (71% felt safe, compared to 63%, while respectively 10% and 15% felt unsafe). Those respondents who did not want to indicate their gender (N=48) also expressed low levels of perceived safety (22% felt unsafe, 54% felt safe).

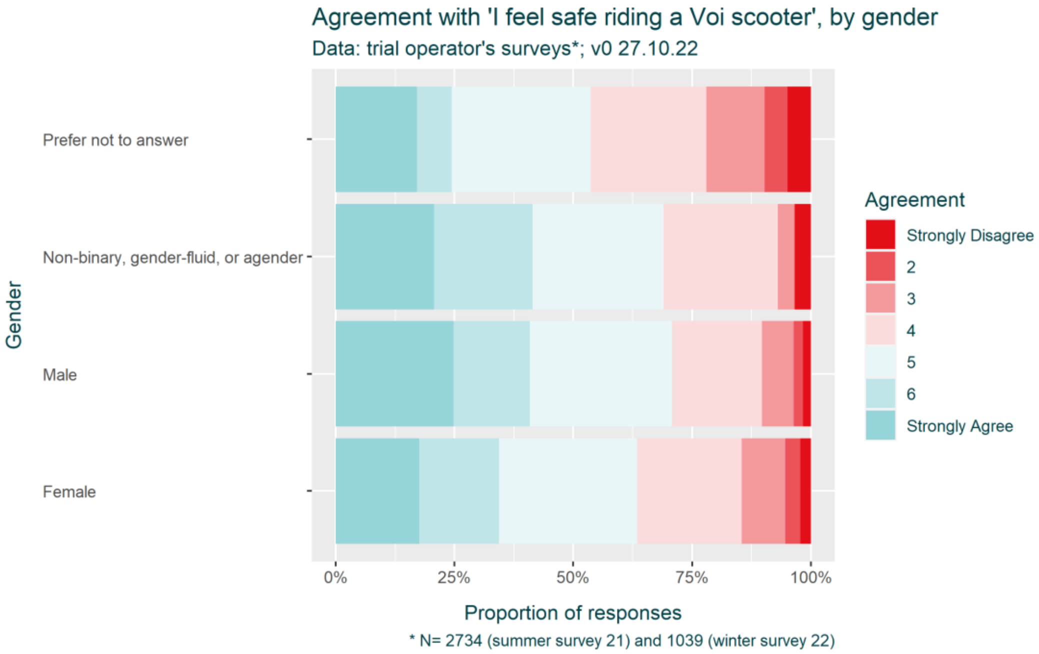


Figure 6-8: Levels of perceived safety by gender; source: trial operator's Summer Survey and Winter Survey

Perceived safety by ethnic group is presented in Figure 6-9 below. Results were similar when comparing white and BAME respondents: 11% of both groups disagreed feeling safe riding trial operator e-scooters and respectively 69% and 67% agreed. Within those people not self-identifying with any of the 14 suggested ethnic groups ("other", N=119), 20% disagreed while 58% agreed.

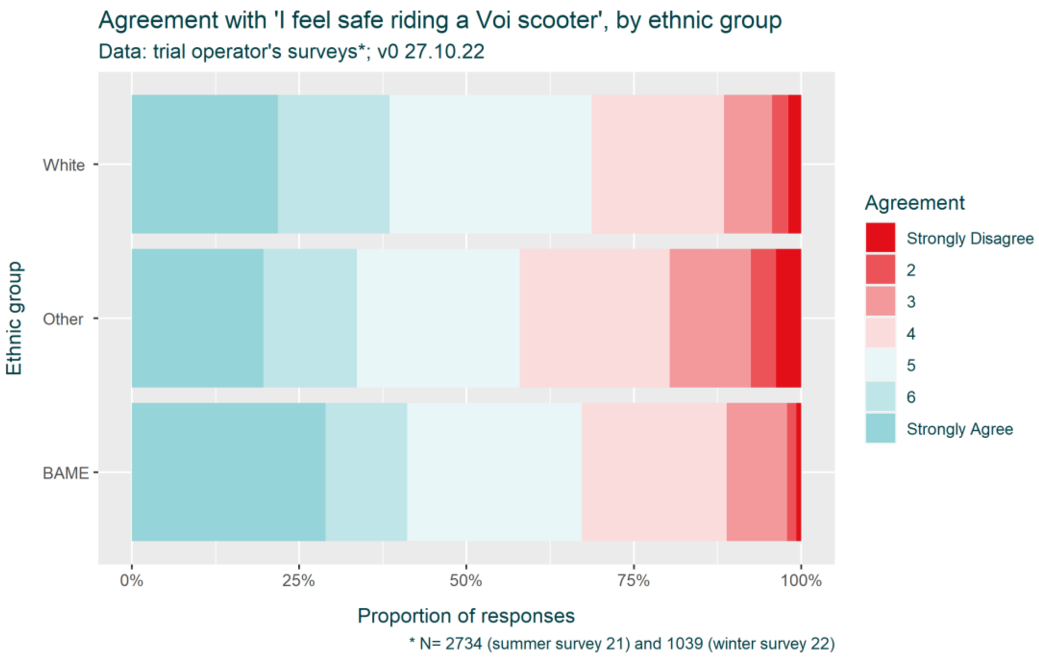


Figure 6-9: Levels of perceived safety by ethnic group; source: trial operator's Summer Survey and Winter Survey

Perceived safety by frequency of use is presented in Figure 6-10 below. Perceived safety was lowest for infrequent users (using the service less than monthly): 18% felt unsafe, compared to 9% for those using the service daily or weekly. Respectively 61% and 74% felt safe.

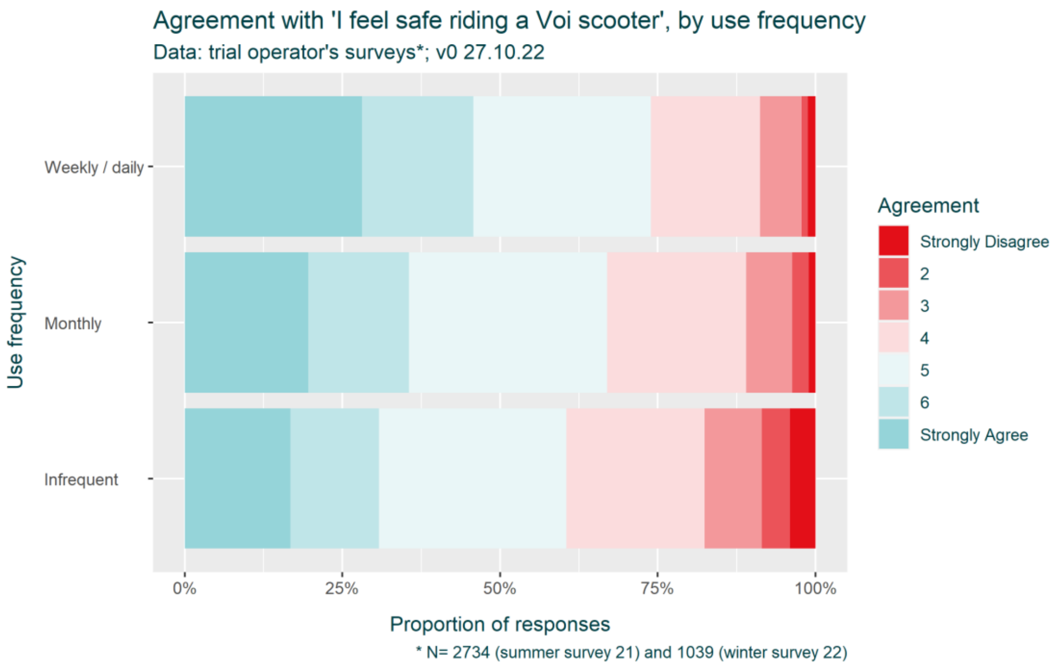


Figure 6-10: Levels of perceived safety by frequency of use; source: trial operator's Summer Survey and Winter Survey

6.2.4 Perceived ease of accessing e-scooters

The ease of accessing e-scooters was examined through the Experience Survey. Amongst the 235 users who answered the question, the majority (205, 87%) agreed or strongly agreed with the statement that e-scooters are easy to access. Differences exist across age and disability (but not gender).

- Younger users (aged 18-29) find access easier than older users do
- Non-disabled find it easier to access e-scooters than disabled users.

The full results, including the levels of agreement across demographics, are presented in Table 6-1 below.

Table 6-1: Perceived ease of accessing e-scooters; source: Experience Survey

Demography		Agreement					
Dimension	Levels	High	Low	Other	Total	% high	% low
Age	18-29	147	6	9	162	91%	4%
	30-59	52	6	5	63	83%	10%
	60+	4	1	1	6	67%	17%
Disability	Non-disabled	169	6	10	185	91%	3%
	Disabled (see definition)	36	9	5	50	72%	18%
Ethnicity	White	137	8	6	151	91%	5%
	BAME	60	3	5	68	88%	4%
	Other ethnicity or not declared	8	4	4	16	50%	25%
Gender	Male	129	5	8	142	91%	4%
	Female	71	5	4	80	89%	6%

6.3 Access to destinations

In the Summer and Winter Surveys, respondents were asked if the trial operator e-scooters had enabled them to access destinations that would have been difficult to reach otherwise[x]. This question gives a sense of the role that e-scooters are playing in widening access to destinations and opportunities. Both surveys were comparable in terms of percentage of respondents who thought that the trial enabled access to new opportunities (37% in the Summer Survey, 40% in the Winter Survey, 38% overall).

A greater proportion of survey respondents who indicated that they do not have access to a car responded positively that e-scooters enable easier access to destinations (54%) than survey respondents with access to a car (32%). The proportions did not differ between those with and without access to a bicycle.

For Bristol respondents, 39% answered that e-scooters enabled travel to new destinations, a higher proportion than in Bath (31%). The next paragraphs consider both surveys together and focus on Bristol.

In Bristol, the perception of being able to access new destinations is highest in the 18-24 age group (53%) and decreases with age with the lowest value for 55–64-year-olds (22%), as presented in Figure 6-11 below. One possible explanation is that older people tend to have a greater availability of personal transport options.

[x] Question: Has riding [the trial operator's e-scooter] allowed you to travel to places that previously you didn't, because, for example the journey was too long or expensive?

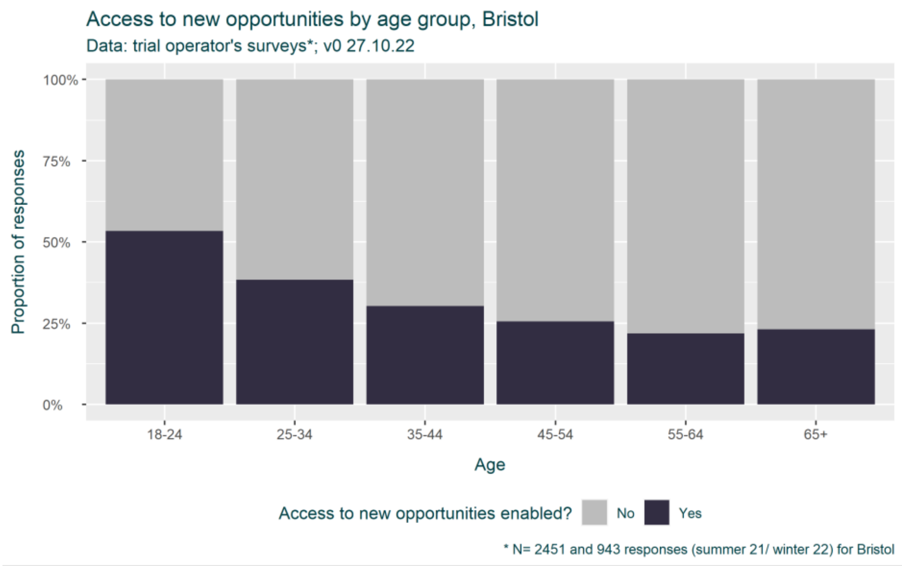


Figure 6-11: E-scooters contribution to accessing new destinations by age group for Bristol; source: trial operator's Summer Survey and Winter Survey

Figure 6-12 shows that people using e-scooters more often were more likely to consider that they enabled able to access new destinations: 48% of weekly or daily users agreed, compared to 35% of those using e-scooters monthly and 27% for respondents using the service less than monthly. Numerical values are presented in Table 6-2 below. A table with all the figures is provided in Appendix 2: Additional tables of results from Summer Survey.

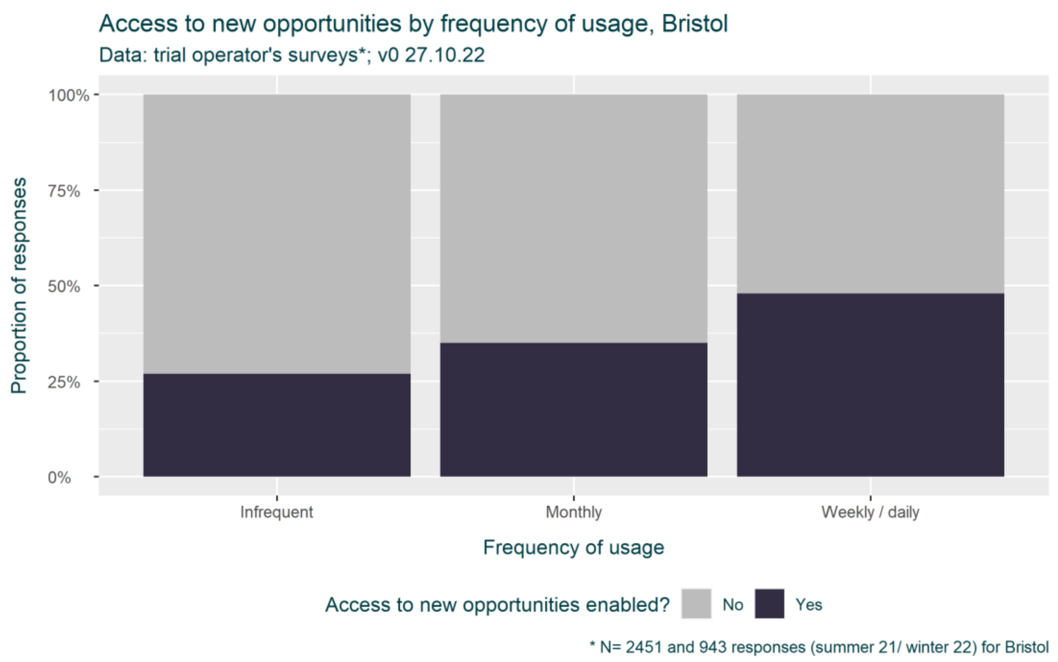


Figure 6-12: E-scooters contribution to accessing new destinations by frequency of use for Bristol; source: trial operator's Summer Survey and Winter Survey

Table 6-2: Has the trial enabled access to new opportunities? Responses by city, age group, and frequency of usage; source: trial operator's Summer Survey and Winter Survey

	Both surveys		Both surveys, Bristol only								
	By city		**By age group**						**By frequency of usage**		
	Bath	**Bristol**	**18-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65+**	**Infrequent**	**Monthly**	**Weekly / daily**
No	229	1,821	356	723	410	236	86	10	499	669	650
Yes	104	1,145	408	451	178	81	24	3	184	361	600
Total	**333**	**2,966**	**764**	**1,174**	**588**	**317**	**110**	**13**	**683**	**1,030**	**1,250**
% yes	31%	39%	53%	38%	30%	26%	22%	23%	27%	35%	48%

In the Experience Survey, e-scooter users were asked:

> *Has riding a [trial] e-scooter allowed you to travel to places that previously you didn't, because, for example the journey was too long or expensive?*

40% answered positively (96 out of 241 users who answered the question). This ratio was similar across age groups, gender and ethnicity. Users were further asked:

> *Has renting an e-scooter made it easier for you to access any of the following things?*

The options included education; employment; essential shopping (e.g. food, medicine); exercise; leisure activities (e.g. seeing friends); medical services; other errands (e.g. banking); support services (e.g. social care or mental health); or none of the destinations listed. The participants could also indicate a non-listed destination (open field).

Three-quarters of the users (181) thought that the e-scooters has made it easier to access at least one type of destination. Those who indicated destinations easier to reach noted on average 1.9 destinations. Employment and leisure were most frequently noted, as illustrated in Figure 6-13 below.

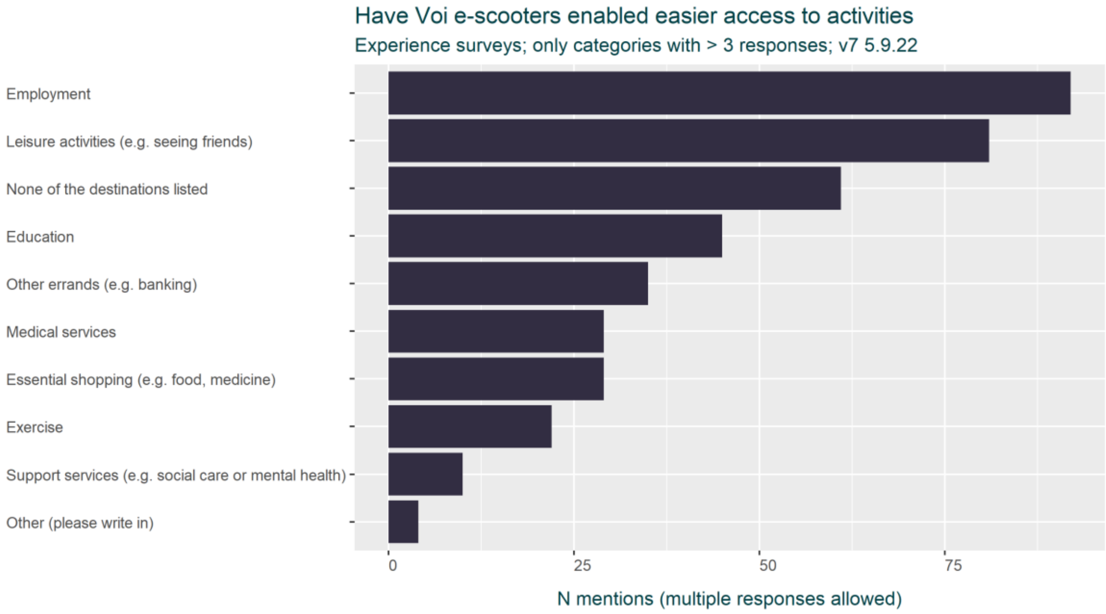


Figure 6-13: Destinations e-scooters made easier to access; source: Experience Survey

The frequencies of mentions of different types of destinations were overall similar across ages and genders, with exceptions discussed below. Interesting differences were however noted between disabled and non-disabled e-scooter users:

- Disabled users were more likely to answer that e-scooters made it easier to access destinations (85% noted at least one type of destination was easier to access compared to 62% for non-disabled users).
- Disabled users were more likely to find access to medical services, exercise, and support services easier, thanks to the e-scooters. For each category, the proportion of disabled users noting easier access is at least two times higher than that of non-disabled users.

Numerical values are presented in Table 6-3 below.

Table 6-3: Destinations easier to access as proportion of users who noted them and proportion of mentions, by user group

Proportions of users who mentioned easier access to given destinations	Gender			Age			Disability	
	Female	Male	Agender, non-binary, other or NA	18-29	30-59	60+	Disabled (see definition)	Non-disabled
Employment	33%	42%	25%	39%	41%	proportions not calculated, only 6 users	43%	37%
Leisure activities (e.g. seeing friends)	32%	35%	25%	36%	33%		30%	35%
None of the destinations listed	27%	25%	19%	25%	29%		15%	28%
Education	16%	22%	6%	23%	6%		19%	19%
Other errands (e.g. banking)	14%	13%	31%	16%	12%		19%	13%
Essential shopping (e.g. food, medicine)	11%	12%	19%	15%	6%		13%	12%
Medical services	10%	13%	13%	13%	12%		21%	10%
Exercise	7%	10%	6%	10%	6%		15%	7%
Support services (e.g. social care or mental health)	5%	3%	13%	4%	5%		9%	3%
Other	2%	1%	0%	1%	2%		2%	2%
Total (>100% because several answers possible)	158%	177%	156%	182%	152%		187%	164%

Proportions of mentions (Display rounded to the percent for each type of destination; rounded values may not add up to 100%)	Gender			Age			Disability	
	Female	Male	Agender, non-binary, other or NA	18-29	30-59	60+	Disabled (see definition)	Non-disabled
Employment	21%	24%	16%	22%	27%	proportions not calculated, only 6 users	23%	22%
Leisure activities (e.g. seeing friends)	20%	20%	16%	20%	22%		16%	21%
None of the destinations listed	17%	14%	12%	14%	19%		8%	17%
Education	10%	12%	4%	13%	4%		10%	11%
Other errands (e.g. banking)	9%	7%	20%	9%	8%		10%	8%
Essential shopping (e.g. food, medicine)	7%	7%	12%	8%	4%		7%	7%
Medical services	6%	7%	8%	7%	8%		11%	6%
Exercise	5%	6%	4%	6%	4%		8%	5%
Support services (e.g. social care or mental health)	3%	2%	8%	2%	3%		5%	2%
Other	2%	1%	0%	1%	1%		1%	1%
Total	100%	100%	100%	100%	100%		100%	100%

6.4 Contribution to health and well-being

Respondents to the Experience Survey who used the shared e-scooters were asked whether and how e-scooters contribute to their health and well-being:

> *To what extent do you agree with the statement "[Trial] e-scooters contribute to my health"?*
>
> *To what extent do you agree with the statement "[Trial] e-scooters contribute to my well-being"?*
>
> *Can you tell us why you think [trial] e-scooters contribute to your well-being?*

While 23% of respondents thought that e-scooters contributed to health, a higher proportion (45%) considered that they contribute to well-being. It is unclear if respondents to the survey interpreted health as physical health only or mental health as well, but the difference in these responses suggests many respondents interpreted the first question as focusing on physical health. The differences in proportions were similar across ages, gender, and disability, with two exceptions:

- Disabled users were more likely to think that the shared e-scooters contribute to their health (33% vs 20%).
- Women agreed less to the statement that e-scooters contribute to their well-being (39% vs 49% for men)

The results are presented in Table 6-4 below.

Table 6-4: E-scooter contribution to health and well-being; source: Experience Survey

	Demography		Agreement				
	Dimension	Levels	High (H)	Low (L)	Other	Total	% H
R11 'Voi e-scooters contribute to my health'	Age	18-29	36	72	43	151	24%
		30-59	12	33	17	62	19%
		60+	1	4	0	5	20%
	Disability	Non-disabled	35	89	48	172	20%
		Disabled (see definition)	16	21	12	49	33%
	Ethnicity	White	35	71	37	143	24%
		BAME	13	31	19	63	21%
		Other ethn. / NA	3	8	4	15	20%
	Gender	Male	33	69	32	134	25%
		Female	18	32	25	75	24%
R12 'Voi e-scooters contribute to my well-being'	Age	18-29	70	42	43	155	45%
		30-59	29	16	19	64	45%
		60+	2	3	0	5	40%
	Disability	Non-disabled	79	45	51	175	45%
		Disabled (see definition)	23	16	12	51	45%
	Ethnicity	White	66	35	47	148	45%
		BAME	29	20	15	64	45%
		Other ethn. / NA	7	6	1	14	50%
	Gender	Male	67	35	34	136	49%
		Female	31	22	26	79	39%

The reasons why e-scooters might contribute to well-being were further examined and are presented in Figure 6-14 and Table 6-5 below. Fun, ability to reach destinations, and the pleasure of being outside appear as key factors. However, some differences can be noted across gender and age:

- Men are most likely to think that riding is fun and to note fresh air/ being outside as a contributor to well-being.
- Older users (30 and over) are more likely to see riding as fun – 33%, as compared to 22% for the 18-29.

Further investigation is needed to confirm if there are differences in enjoyment of e-scooter riding between demographic groups and to understand the reasons for this.

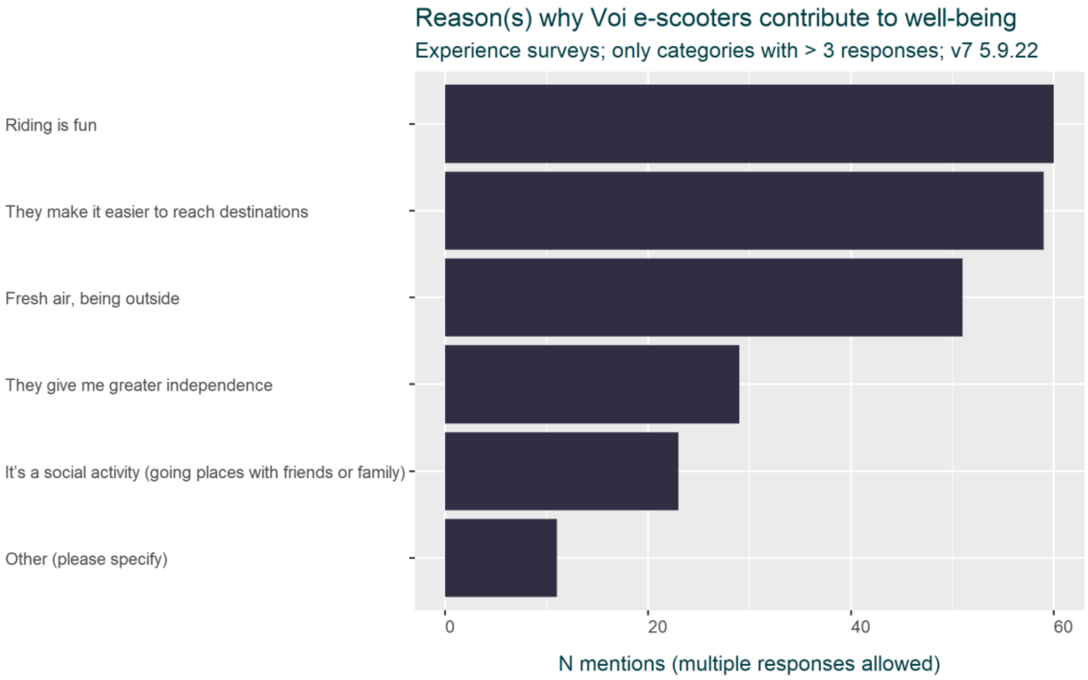


Figure 6-14: Reasons why e-scooters contribute to well-being; source: Experience Survey

Table 6-5: Reasons why e-scooters contribute to well-being and proportions of e-scooter users from each demographic group mentioning them; source: Experience Survey

Percentage of participants noting different reasons why e-scooters contribute to well-being	Gender			Age			Disability	
	Female	Male	Agender, non-binary, other definitions, NA	18-29	30-59	60+	Disabled (see definition)	Non-disabled
Riding is fun	21%	29%	6%	22%	33%	Percentages not calculated, only 6 participants	23%	26%
Easier access to destinations	25%	26%	13%	25%	26%		25%	24%
Fresh air, being outside	16%	25%	13%	20%	26%		23%	21%
Greater independence	10%	15%	0%	12%	14%		15%	11%
A social activity	10%	10%	6%	8%	15%		13%	9%
Other	5%	5%	0%	5%	5%		6%	4%
Don't know	0%	0%	0%	0%	0%		0%	0%

6.5 Benefits of shared e-scooter use to opportunity and well-being

As well as exploring the contribution of shared e-scooters to travel routines (reported in section 5.10), the in-depth interviews of e-scooter users explored how the trial had benefitted their lives and contributed to accessing opportunities and broader well-being. It also asked interviewees what improvements could be made to the way the rental e-scooter scheme operates.

6.5.1 Advantages over other modes

Interviewees were asked to explain the advantages of e-scooters over other transport modes that they had used previously to get to the same destinations. The advantages mentioned are consistent with the reasons reported for using and liking e-scooters in section 6.1. They were often identified to be faster than walking and faster and more reliable than taking the bus. Being outside and exposed to fresh air was cited by some interviewees, as well as them being a fun form of transport. Quicker and more certain journey times led to more time availability to do other things like spend time with family.

Compared with cycling they were said to be less tiring and afforded greater flexibility (with onwards travel not being restricted to cycling).

> "*And also I think sort of well-being benefits like I think it's a really enjoyable form of transport. Like I used to ride a scooter when I was younger and I like skateboarding and stuff, so I quite like being like out in the fresh air and, yeah, it's the same sort of enjoyability you get from cycling, but it's not as tiring. You don't end up sweating when you get somewhere."* (Tyler, M, 21-24)

Using an e-scooter at night enabled female users to feel safer than walking or using a bus or taxi. A number of interviewees have enjoyed demonstrating the e-scooters to visitors and using them together. Interviewees mentioned enjoying travelling together with partners and friends on e-scooters and being able to do more things together. There were cases when partners would not use e-scooters and therefore this was not possible.

6.5.2 Widening horizons

It has been seen in section 6.3 that about four in ten e-scooter users say that e-scooters have enabled travel to places not previously possible. This was elaborated in the interviews where a number of interviewees highlighted that e-scooters facilitated them exploring the city and discovering new places. Seb (M, 30-39) said that it encouraged him to explore the city ("drift around a bit more as opposed to just being like, I'm going from one destination to another"). This gave more diversity in opportunities such as places to shop or eat. Tyler (M, 21-24) noted that with e-scooters he has been able to do his grocery shopping further afield where prices are lower while managing to get heavy shopping back with the e-scooter.

For some interviewees the rental e-scooters made it easier to visit family and friends in other parts of the city and they would not have done this otherwise. This was particularly beneficial during and immediately after the pandemic. The e-scooters had helped students to take on temporary jobs which wouldn't have been possible otherwise (Gabriel, M, 21-24) and they made journeys less tiring.

6.5.3 Health and well-being

It was recognised that using an e-scooter is less exercise than cycling but some interviewees said they already got sufficient exercise.

It was stated by a number of interviewees that e-scooters made a difference in whether they went out (not just for leisure but also for education, work or personal business reasons).

> *"Yeah, I think daily well-being, it gives me a chance to get out and get some fresh air, and if there's some errands I need to run, which I probably wouldn't because of what could be tiring or something, it can sometimes be the difference between getting outside and going doing something."* (Tyler, M, 21-24)

More broadly, e-scooters gave reassurance that it would be possible to get around the city with changing circumstances (new workplace) without needing to get a car.

"…my work at the moment had sort of debating whether to change the location of our offices, you know. But you know, as long as it's sort of in the city, it doesn't really make much of a difference because there's so many [operator's e-scooter] spots." (Tyler, M, 21-24)

6.5.4 Future role of e-scooters

A few interviewees remarked that they felt rental e-scooters made a valuable contribution to cleaner urban mobility. While they were considered to be an important future part of urban mobility, there was concern that misuse was not being tackled in the West of England and this was compromising the future of the scheme. One interviewee said they were in a dilemma whether to call out dangerous behaviour which was not being tackled by any authority.

A better infrastructure for e-scooters and other micromobility transport was identified by some interviewees as urgent if e-scooters are to thrive. A downside of using e-scooters often mentioned was the difficulty of finding a parking spot which could extend the journey time and cost. Also no-ride zones where e-scooters cannot be used had disappointed interviewees with these sometimes being the most attractive routes (i.e. green, off-road cycle paths). Some of the rules and messaging imply that e-scooters are aimed at students and young people and not the rest of the population and this risked alienating potential and current older users.

A number of interviewees noted that the cost of using e-scooters needs to be competitive with the bus if they are to continue using them and that recent price increases were threatening that. Discounts to students, those looking for work and low income workers had been pivotal for some interviewees using e-scooters. One interviewee said if he stopped getting the discount he might consider buying his own e-scooter.

There were mixed opinions on buying a personal e-scooter (if legalised) with some interviewees stating that the freedom of not having to worry about looking after their own vehicle is a key attraction of using them, while others were keen to have their own e-scooter. A preference to have an e-bike over an e-scooter was mentioned by some who wanted a form of transport suitable for longer distances.

6.6 Summary

When asked for reasons why they choose to use shared e-scooters, respondents to the Experience Survey referred to relative advantages over other modes (speed, convenience, cost and flexibility) (44% of mentions) with limited choice representing 18% of mentions (poor public transport service, inability to walk to destination, not having a car or bicycle). Similarly, in response to why they liked the service, the main cited reasons related to convenience ("easier travel"), the idea of e-scooters as an enjoyable mode of travel, sustainability and affordability and reliability.

From the trial operator's Summer Survey and Winter Survey, infrastructure (quality of roads, having enough cycle lanes) is regarded as important by most users (about four in five) with a significant minority dissatisfied with it (about one in four). This suggests it is a priority for intervention if usage is to increase. Safer infrastructure could also attract people who are not confident to use e-scooters currently. Perceived safety of riding is relatively high among users but there are differences between demographic groups with older people, women and infrequent users feeling less safe using e-scooters.

Access to e-scooters is overall perceived as easy (87% of responses), with some differences across ages and disabilities: younger users (aged 18-29) find access easier than older users, and non-disabled find it easier to access e-scooters than disabled users.

Four in ten Bristol respondents (39%) and 31% of Bath respondents to the trial operator's surveys said that e-scooters enabled travel to places not previously possible. In Bristol, this figure is highest in the 18-24 age group (53%) and decreases with age. This provides an indication that e–scooters are widening the travel horizons of younger users and enabling them to access new opportunities.

From the Experience Survey, 40% of users indicated that rental e-scooters allowed them to access opportunities that would otherwise be difficult to get to. This ratio was similar across gender, age groups, and disability. Three quarters of respondents thought that e-scooters have made it easier to access at least one type of destination. Education and leisure were most frequently noted. While 23% of survey respondents thought that e-scooters contributed to health, a higher proportion (45%) considered that they contribute to well-being. Enhanced wellbeing was attributed to the 'fun' factor of riding e-scooters, the increased ease of reaching destinations and the pleasure of being outside.

Interviews explored in greater depth how the trial had benefitted e-scooter users accessing opportunities and their broader well-being. A number of interviewees highlighted that e-scooters facilitated them exploring the city and discovering new places. For some interviewees the e-scooters made it easier to visit family and friends in other parts of the city and students noted e-scooters helped them take on temporary jobs which wouldn't have been possible otherwise. It was recognised that using an e-scooter is less exercise than walking and cycling, but some interviewees said that e-scooters encouraged them to go out when they might not have otherwise (not just for leisure but also for education, work or personal business reasons).

Regarding the future role of e-scooters, interviewees felt shared e-scooters could make a valuable contribution to cleaner urban mobility but were concerned misuse of the scheme could lead to it being withdrawn. A better infrastructure for e-scooters and other micromobility transport was identified as urgent if e-scooters are to thrive. Operational matters requiring attention were the management of parking, the existence of no-ride zones where e-scooters cannot be used, and rules and messaging implying e-scooters are aimed at a young demographic. A number of interviewees noted that the cost of using e-scooters needs to be competitive with the bus if they are to continue using them and that recent price increases were threatening that. There were mixed opinions on buying a personal e-scooter (if legalised) with some interviewees stating that the freedom of not having to worry about looking after their own vehicle is a key attraction of using them, while others were keen to have their own e-scooter.

7 PEDESTRIANS' EXPERIENCES OF E-SCOOTERS

This chapter presents results from surveys of pedestrians' experiences of e-scooters. Data gathering and analyses were staged as follows: first, surveys relating to people's experiences were undertaken as on-street intercept surveys or on-line; second, walk-along interviews were conducted and analysed to provide in-depth understanding of topics identified in the experience surveys. First, section 7.1 examines disability as an important overarching dimension, given the understanding that disability is not inherent to the person but rather related to the interaction between a person and their environment (which might not allow them to function at their full potential). From this perspective, the section frames the ways in which a shared e-scooter scheme can influence the extent to which environments support people in their everyday lives or not. Further, Section 7.2 describes the experience surveys, and Section 7.3 describes the walk-along interviews.

7.1 Disabled street users

The ways in which the e-scooter scheme is operated, particularly regarding parking, are important in relation to disabled people in particular. On this basis it is important to frame the issues appropriately. This section provides a basis for that framing.

The United Kingdom Equality Act (2010) definition states that a person has a disability if they have a physical or mental impairment, and the impairment has a substantial and long-term adverse effect on their ability to perform normal day-to-day activities.

Disability is a 'situation, caused by social conditions, which requires for its elimination' (Union of the Physically Impaired Against Segregation & The Disability Alliance, 1976). Hence, disability is about the disabling nature of the environment and not an inherent characteristic of the person. This understanding is at the core of the Social Model of Disability (Oliver, 2009, 2013).

Impairments relate to a diminishment or loss of function or ability relative to motor or sensory skills, cognition, or broader mental health. Impairments are considered as a factor that can be associated to the risk of being disabled by socially constructed barriers.

Language is important because it can hide the everyday marginalisation of disabled people. Disability scholars recommend using language that refers to disablement – 'something that is experienced when people encounter restrictions due to disabling social barriers (and/or bodily impairment)' (Ross, 2013) rather than to the characteristics of a person (Ross, 2013; Titchkosky, 2007). People-first language (e.g., 'person with disabilities') is seen as problematic as it suggests that some people 'just happen to' have 'abnormal limitations', as opposed to understanding disability as a complex social and political phenomenon (Titchkosky, 2011). The terminology 'disabled person' (or people) is recommended by disability scholars and advocates (Titchkosky, 2007; Collier, 2012; Jernigan, 2009; Vaughan, 2009).

Approximately 19% of males and 23% of females in the UK population have an impairment (Department for Work & Pensions, 2015; Papworth Trust, 2018), with a sixth of those having had the impairment from birth (Regan and Stanley, 2003). Hence, the prevalence increases with age. 42% of disabled people report mobility impairment (Department for Work & Pensions, 2015), most of which is relatively invisible.

Transport is the largest concern for disabled people in their local area, with footway and road maintenance, access issues, and frequency of public transport being the biggest issues (Office for Disability Issues, 2011). Disabled people, while travelling a third less often than non-disabled people, use buses, taxis and minicabs more often.

Categories of theory relating to disability studies include the medical model, the social constructionist approach which underpins the social model of disability and most disability studies, and finally critical disability studies development of the social model of disability.

In the medical model, disability is defined in terms of the impairment in bodily, sensory, or mental capacity, which is measured against an idealised human norm. The focus of the medical model is then to 'fix' the individual so that their body (or capacity) resembles the norm as closely as possible – often with disregard to the impact on their actual functioning (Sparkes et al., 2017). In contrast, the social model of disability emerged in a different way than the medical model of disability. Here, disability scholars and activists highlighted that it was not the body or capacity of the disabled person which prevented them from functioning but, rather, systematic infrastructural and cultural barriers that exclude them. Thus, it is society that needs to change, not disabled people.

However, the social model of disability (Oliver, 2013) has been challenged by critical disability scholars for its lack of attention to the embodied aspects of disability experience and identity. In focusing solely on external barriers, the social model ignores embodied aspects of disability experience and identity and, in doing so, defers all interpretation of bodily experiences to medical (rather than experiential) perspectives. Secondly, the social model also neglects intersectional identities such as age, sexuality, gender, and 'race'. In this way, critical disability scholars demand that attention is focussed on the embodiment (the impairment), the experiential (the disabling environment) and the intersectional (relating to other relevant factors) barriers.

In relation to the provision of public service, such as travel, and in this specific context, e-scooter use and parking, the Social Model of Disability is the most appropriate framing to adopt. This needs to be tempered by detailed understanding of the requirements of different types of impairment, and the ways they may intersect with other factors such as age. A lack of space for movement on the footway also has implications for parents or carers with pushchairs, especially double-width pushchairs. The ways they are disabled by the environment have parallels with the way disabled people are also disabled.

So far as e-scooter parking is concerned, inappropriate parking can create navigation and obstruction issues. This is manifest, for example, where inadequate width remains for wheelchair users and they are forced to enter the carriageway (and without the benefit of dropped kerbs). Adding to the complications is the juxtaposition of such parking on the footway with other street furniture which may otherwise block the footway or force people to swerve, and which is particularly complicated for blind people to negotiate (Bozovic et al., 2021). At least with e-scooters, there are locations which are designated for parking; however, the issue is then with parking outside of these areas or parked inappropriately within these areas.

Approximately 140,000 people in the UK use a white cane (Guide Dogs for the Blind Association, 2006), which may be a 'symbol cane' (as an indication to others), a 'guide cane' (held across the body to afford protection from obstacles) or a 'long cane', which is swept from side to side to identify way-finding landmarks, the space available, the surface type and obstacles. As well as tactile clues from the cane and feet, other clues are used including auditory clues (traffic, sound shadows from, e.g., bus shelters, controlled crossings, sounds from frontage buildings, e.g., shop music, and REACT talking signs developed by the Royal National Institute for the Blind (2009); visual clues (contrasts, yellow and white lines, colours, the skyline) and olfactory clues (e.g., a bakery).

There are approximately 5,000 guide dog partnerships in the UK and the guide dog is trained to walk in a straight line, while avoiding obstacles. They are taught to stop at kerbs, find doors and frequently visited locations, but the responsibility for route finding rests with the person and this requires clues for navigation. A long cane user will follow either the inner shoreline (building line) or the outer shoreline (kerb line) using others clues as appropriate. A guide dog partnership would usually be more remote from either of these shorelines.

Parkin and Smithies (2012) noted how discrete features, such as gaps in the frontage to a road and countable objects such as street lighting columns, and linear features, including serendipitously located features not specifically designed for navigation purposes, are essential requirements for blind and visually impaired people. Successful introduction of the additional presence of e-scooter parking within a footway could therefore be achieved if it adds value somehow for those people who are navigating with a visual impairment. This therefore suggests some sort of physical presence of a permanent feature, such as a boundary around e-scooter. These could become wayfinding points within the footway for visually impaired people.

7.2 Experience survey perceptions of safety, comfort, and discrimination

All experience survey participants, regardless of whether or not they use, or have used, shared e-scooters, were asked to what extent they agreed with the following statements:

I feel safe around people riding [trial] e-scooters
I feel comfortable walking around people riding [trial] e-scooters
I feel comfortable walking around parked e-scooters
I feel discriminated against by the deployment of [trial] e-scooters
I feel that the deployment of [trial] e-scooters might discriminate against others

In each case, the options were: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. Follow-up questions were asked of those who declared that they did not feel safe or comfortable, or that they felt that the scheme discriminates against them or other people. These follow-up questions were designed to better understand the reasons for feelings of lack of safety, comfort or discrimination.

7.2.1 Pedestrians' safety and comfort around e-scooters

Figure 7-1 shows the proportions of people who agreed or strongly agreed, or disagreed or strongly disagreed, about feelings of safety around ridden e-scooters, and comfort around ridden and parked e-scooters. Most respondents feel safe (56%) and comfortable (58%) around riders, while almost a third respondents feel unsafe (30%) or uncomfortable (28%). A larger majority (73%) felt comfortable around parked e-scooters, while 13% did not. This suggests that pedestrians' feelings regarding safety and comfort are relatively divided, with only a (significant) minority of approaching a third feeling unsafe and uncomfortable around moving e-scooters, and a lower one in eight feeling uncomfortable around parked e-scooters.

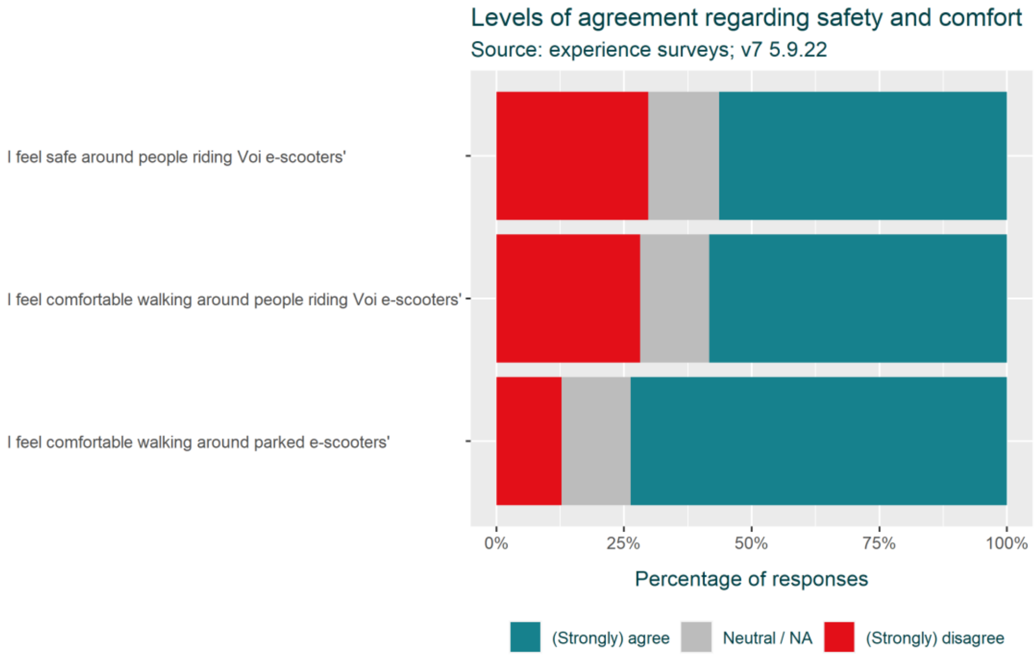


Figure 7-1: Feelings of safety and comfort around ridden and parked e-scooters

Table 7-1 shows responses to feelings of safety around ridden e-scooters, and comfort around ridden and parked e-scooters split down by classifications of age, disability, ethnicity and gender. High is equivalent to strong agreement or agreement, low indicates disagreement or strong disagreement. The classification 'other' includes neutral, don't know and did not respond.

Table 7-1:Pedestrians' perceptions of safety and comfort around e-scooters by demography

	Demography		Agreement				
	Dimension	Levels	High	Low	Other	Total	% high
X1 'I feel safe around people riding Voi e-scooters'	Age	18-29	220	65	48	333	66%
		30-59	88	65	25	178	49%
		60+	20	45	9	74	27%
	Disability	Non-disabled	245	114	48	407	60%
		Disabled (see definition)	90	67	37	194	46%
	Ethnicity	White	185	123	48	356	52%
		BAME	116	45	27	188	62%
		Other ethn. or NA	34	13	10	57	60%
	Gender	Male	203	79	36	318	64%
		Female	116	79	35	230	50%
X2 'I feel comfortable walking around people riding Voi e-scooters'	Age	18-29	101	22	28	151	67%
		30-59	64	28	11	103	62%
		60+	9	34	2	45	20%
	Disability	Non-disabled	128	45	29	202	63%
		Disabled (see definition)	49	42	14	105	47%
	Ethnicity	White	112	65	21	198	57%
		BAME	54	14	15	83	65%
		Other ethn. or NA	11	8	7	26	42%
	Gender	Male	109	39	19	167	65%
		Female	58	39	15	112	52%
X3 'I feel comfortable walking around parked e-scooters'	Age	18-29	119	12	18	149	80%
		30-59	73	9	18	100	73%
		60+	22	17	6	45	49%
	Disability	Non-disabled	161	13	24	198	81%
		Disabled (see definition)	58	27	18	103	56%
	Ethnicity	White	149	24	20	193	77%
		BAME	58	10	16	84	69%
		Other ethn. or NA	12	6	6	24	50%
	Gender	Male	127	18	17	162	78%
		Female	83	13	15	111	75%

The following differences between demographic groups are apparent:

- Age:
    - Younger respondents aged 18-29 feel safer around people riding than those aged 30-59 and those aged 60+. 66% report feeling safe, versus 49% for the 30-59 age group and 27% for those aged 60 and older. It is however worth noting that even in the 18-29 age group, 19% reported not feeling safe.
    - Younger respondents aged 18-29 feel more comfortable walking around people riding or around parked e-scooters than those aged 60+. While 80% young people feel comfortable around parked e-scooters, this is the case for 49% those aged 60 and older
- Disability: compared with non-disabled participants, disabled people are:
    - Less likely to feel safe around people riding (46% vs 60%)
    - Less likely to feel comfortable walking near people who ride (47% vs 63%)
    - Less likely to feel comfortable walking around parked e-scooters (56% vs 81%)
- Gender: compared with men, women are:
    - Less likely to feel safe around people riding (50% vs 64%)
    - Less likely to feel comfortable walking near people who ride (52% vs 65%)

The reasons for not feeling safe mainly relate to interactions between e-scooters and pedestrians, with the respondents noting that the influencing factors on such unsafe feelings are both riders' behaviours (people who ride too fast / too close to them / recklessly–- words used by several respondents) and infrastructure (narrow footways but also the nature of road infrastructure more generally). This use of the footway can create unwanted interactions, which can be exacerbated by the narrowness of footways. A series of quotes from people feeling unsafe is provided below, to illustrate these points.

> *I have observed too many [e-scooter] users swerving between the road and pavement to avoid red lights, joining pedestrians as they cross the road and cutting them / us up (F, 60+, non-disabled)*

> *As I am blind, E-scooters terrify me as they have no noise and most people who seem to ride them have no care for other pedestrians. (F, 30-59, disabled)*

> *Some don't appear to be aware of other pavement users, or pedestrians crossing roads or zebra crossings or traffic lights (F, 60+, disabled)*

> *Abusing pedestrian crossings and roads. Also the attitude of many in that they assume that the pedestrian will have to get out of their way even if they are inconsiderate. Obviously this only applies to some. (F, 60+, non-disabled)*

Participants were asked about their perceptions about the safety and comfort of being around e-scooters regardless of whether or not they were e-scooters users. Differences in the levels of agreement about perceptions of safety and comfort were revealed between users and non-users belonging to same age groups, disability statuses, and gender groups. Overall, users felt safer and more comfortable around both ridden and parked e-scooters than non-users. In relation to feeling safe around people who ride:

- Amongst participants aged 30 and over, 67% of users felt safe, compared with 36% of non-users
- Amongst non-disabled participants, 79% of users felt safe, compared with 49% of non-users
- Amongst females: 67% users felt safe, compared with 45% of non-users
- Amongst males: 83% users of users felt safe, compared with 53% of non-users

Full results are reported in Appendix 3: Additional insights from the intercept and at-home surveys.

7.2.2 Perceptions of discrimination

As a reminder, respondents were asked to what extent they agreed to the following statements:

> *I feel discriminated against by the deployment of {trial operator] e-scooters*
> *I feel that the deployment of [trial operator] e-scooters might discriminate against others*

Figure 7-2 shows the proportions of respondents who agree or disagree with these statements. Most (67%) respondents did not feel that the scheme discriminated against them, while 15% did feel discriminated against, with the remainder being neutral. However, the respondents were more likely to think that the scheme might discriminate against *others* (27% agreed or strongly agreed to that statement).

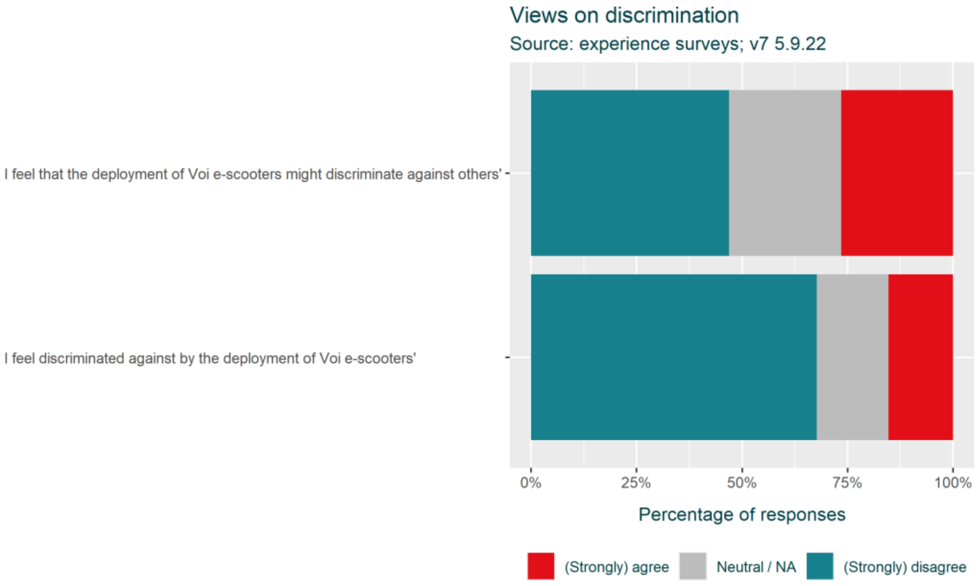


Figure 7-2: Pedestrians' feelings about discrimination of e-scooters against themselves and others

Differences in feelings of discrimination were evident between age groups and disability statuses. The results are presented in Table 7-2.

Table 7-2: Discrimination by demographic group and e-scooter usage

Demography		Users				Non-users				Chi2p
Dimension	Levels	Agree	Disagree	N total	% agree	Agree	Disagree	N total	% agree	<0.05
Age	18-29	4	105	125	3%	33	138	207	16%	**
	30+	9	42	57	16%	43	105	190	23%	ns
Disability	Disabled (see definition)	7	30	40	18%	32	73	150	21%	ns
	Non-disabled	7	118	145	5%	46	178	259	18%	**
Gender	Female	4	46	58	7%	35	108	169	21%	**
	Male	7	93	114	6%	35	129	202	17%	**
	Agender / other / NA	3	9	13	23%	8	14	38	21%	ns

It is worth noting that:

- Younger respondents (18-29) were less likely to feel discriminated against by the trial (11% versus 16% for the 30-59 group and 33% for those aged 60+)
- Younger respondents (18-29) were also less likely to think that the deployment might discriminate against others (20% versus 31% for the 30-59 and 45% for those aged 60+)
- Disabled people were more likely to feel discriminated against than non-disabled people (21% versus 13%)
- Disabled people were also more likely to feel that the deployment discriminates against others (31% vs 25%)
- Those associating with being BAME or other non-white ethic groups were also more likely to feel discriminated against by the trial (18% of BAME respondents and 36% of those of other ethnicities, compared to 11% for white people)

Amongst younger and non-disabled respondents, e-scooter non-users feel more discriminated against by the trial than users. Those who felt discriminated against were asked why this was the case. Responses related to the perspectives of both pedestrians and e-scooter users, as shown in Figure 7-3.

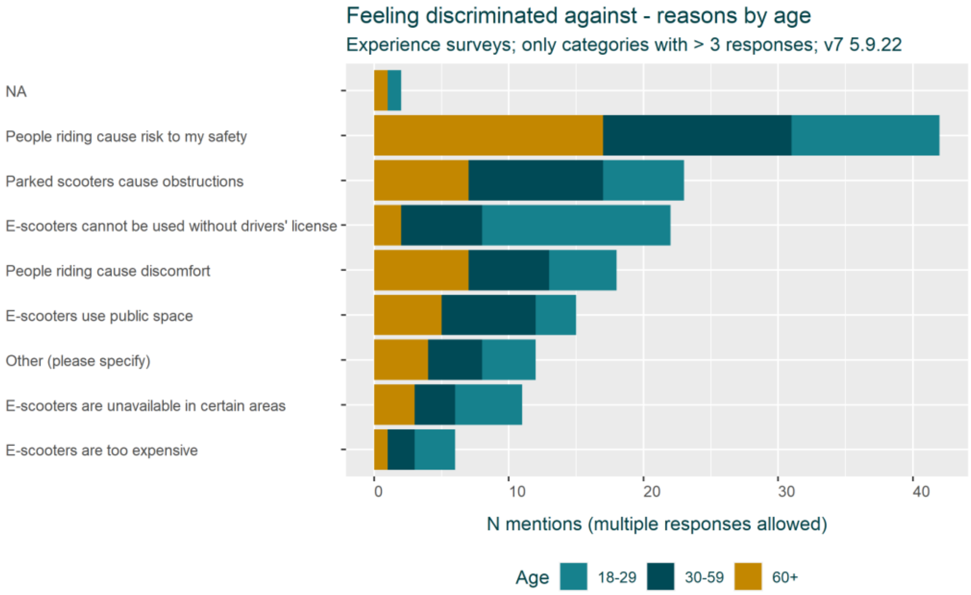


Figure 7-3: Reasons for feeling discriminated against, by age group

Most responses (103 out of 156, 66%) relate to the pedestrian perspective, including for instance that e-scooters cause risk to safety, discomfort, or obstructions. These pedestrian related perspectives were noted at similar rates across genders (64% to 68% of mentions for males and females), but some differences are apparent as follows:

- Older respondents were more likely to mention pedestrian-related concerns: three quarters (74%) of the reasons invoked by those older than 30 related to the pedestrian environment, compared to 49% for those aged 18-29.
- Disabled respondents were more likely to mention pedestrian-related concerns: 73% of the mentions, compared to 60% for those having no difficulty walking/ seeing/ hearing/ remembering or concentrating)

It is also noticeable that younger people feel discriminated against because e-scooter use needs the rider to hold a provisional driving licence (which is a requirement mandated by the Department for Transport for all the e-scooter trials).

The 160 respondents who felt that the e-scooters might discriminate against others were also asked to specify who was being discriminated against, and why. The results are presented in Table 7-3.

Table 7-3: Discrimination against others by demographic group and e-scooter usage

Demography		Users				Non-users				Chi2p
Dimension	Levels	Agree	Disagree	N total	% agree	Agree	Disagree	N total	% agree	<0.05
Age	18-29	20	73	125	16%	45	99	207	22%	**
	30+	18	29	58	31%	71	71	193	37%	ns
Disability	Disabled (see definition)	12	18	40	30%	48	57	153	31%	ns
	Non-disabled	28	85	146	19%	72	119	258	28%	**
Gender	Female	12	28	58	21%	45	79	171	26%	**
	Male	22	71	115	19%	63	83	203	31%	**
	Agender / other / NA	6	4	13	46%	12	14	37	32%	ns

Disabled people and older people were the most often cited (respectively, 66% and 53%). Other groups mentioned included children and young people (36%), people on low income (13%), and pregnant women (11%). Discrimination against disabled people and older people were noted at similar rates by participants of different age groups and gender, and hence there was overall agreement amongst the respondents on this point. As noted previously, higher numbers of non-users compared with users thought that that the scheme discriminated against others.

The main reason why respondents were reporting that 'other people' might be discriminated against was safety (78 responses, noted by 49% of the participants who felt others were discriminated against), as shown in Figure 7-4.

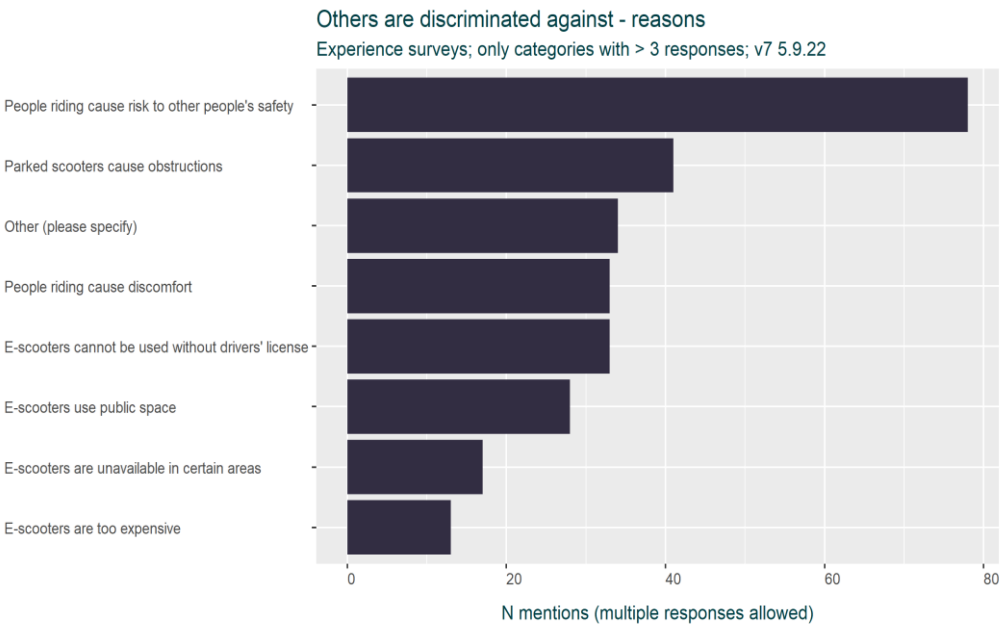


Figure 7-4: Reasons why others might be discriminated against by the deployment of shared e-scooters

Similarly, as for perceptions about discrimination against the respondent personally, the reasons for discrimination to others was spoken of mainly from the perspective of the pedestrian. Issues raised were footway obstruction (26%), discomfort caused to pedestrians (21%), or the use of public space (18%). Discrimination relating to other people who are users was also noted by respondents including the need to have a drivers' licence (21%), the unavailability of e-scooters in certain areas (11%, and parking locations were agreed with the transport authorities as further discussed in the stakeholder chapter), or the cost of usage (8%). Fifteen of the thirty-three 'other' mentions relate to disabled people and/or people unable to use e-scooters (sometimes the notion of disabled people and people unable to use e-scooters were conflated by respondents).

Some respondents raised issues experienced by disabled people and noted a lack of prior consultation and involvement:

> *The plan to introduce E scooters was brought forward with no involvement from visually impaired people. It was decided that the scooters could be parked on pavements before we were consulted about this. My main issue is that they are vehicles to be ridden on the public highway and should not have designated parking spaces for them on the pavement. Their introduction has caused an avoidable obstruction on pavements for visually impaired people which could*

have been completely avoided with prior consultation. F, 70-79, with some difficulty hearing and remembering/concentrating

7.3 The walk-along interviews

The walk-along interviews explored in-depth the walking experiences of non-users. Information about the participants is presented in Table 7-4.

Table 7-4: Walk-along interviews participants (pseudonyms used)

Pseudonym	Gender	Age group	Reported difficulties walking / seeing / hearing / remembering or concentrating	Mobility device used	Notes
Sam	Male	30-59	Cannot walk	Electric wheelchair	
Jesse	Male	30-59	Cannot walk	Manual wheelchair	
Alasdair	Male	60+	A lot of difficulty walking and seeing	Walking sticks	Sit-down interview
Jay	Male	60+	Cannot walk	Electric wheelchair	
Alex	Male	30-59	[None]	[None]	
Attila	Male	60+	Some difficulty walking	[None]	
Fran	Female	60+	Multi-level mechanical disabilities, chronic pain and fatigue	[None]	
Nicole	Female	30-59	[None]	[None]	
Anna	Female	60+	A lot of difficulty seeing	Long cane	Contributions via email

Five participants chose to walk in central Bristol, one in Cotham, and one in Kingswood. The indicative areas covered by the walk-along interviews are presented in Figure 7-5.

Figure 7-5: Indicative areas of the walk-along interviews

The comments made by participants has been structured into five themes. These are summarised below, together with the section numbers that deal with them as follows:

- **Issues relating to e-scooters** – further grouped into comments about riding and parking (Section 7.2.1)

- **Influence of issues on the pedestrian experience** –perceptions of the impacts on themselves and others (Section 7.2.1)
- **Factors contributing to the issues** – participants' ideas about why the issues may be happening (Section 7.2.2)
- **General thoughts** –views on e-scooter s as an addition to the transport mix, their broader roles or benefits, but also the fact they might aggravate pre-existing issues such as poor usability of footways by mobility device users (Section 7.2.3)
- **Ethics of public space use and user behaviour** – ideas relating to private company's responsibilities (Section 7.2.4)

The key ideas relating to each theme from the walk-along interviews, and their relationships are presented in Figure 7-6.

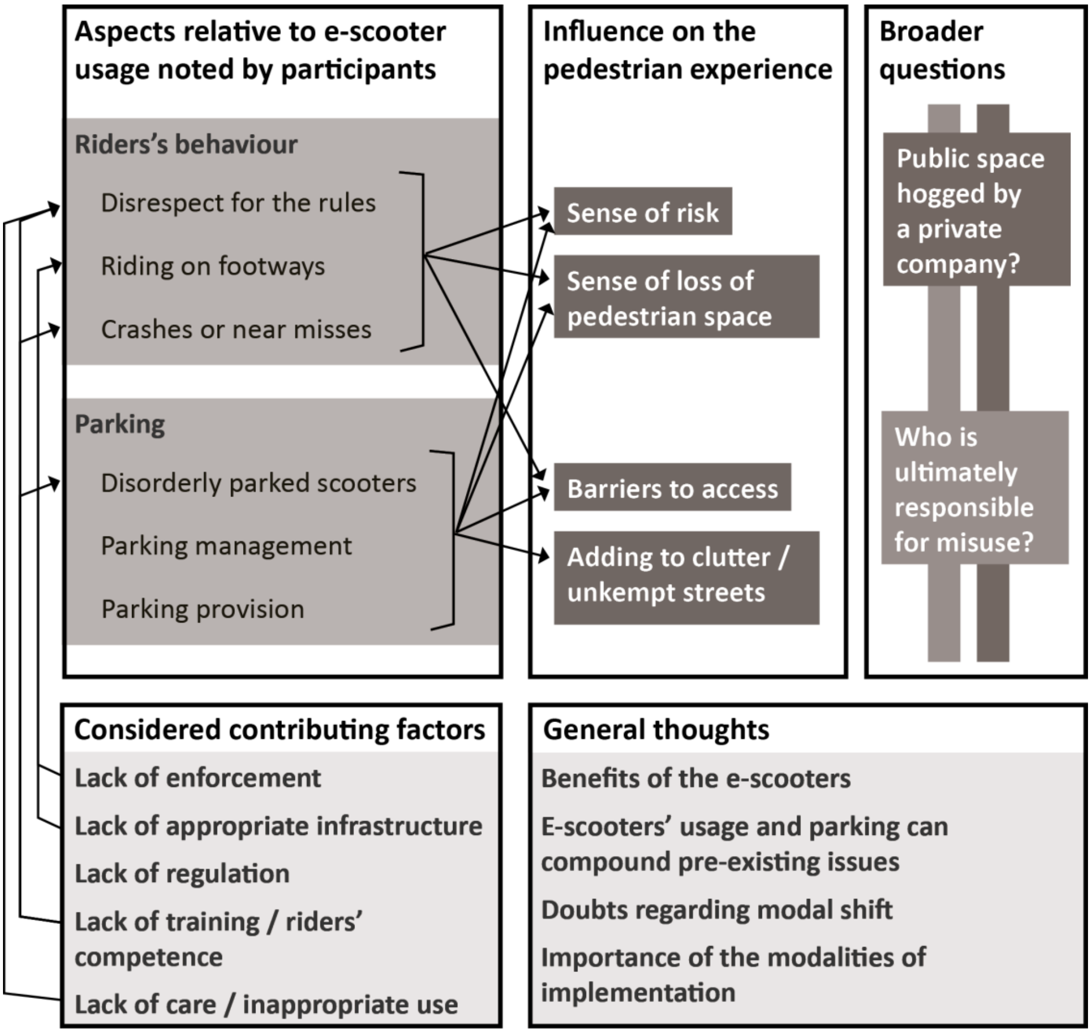


Figure 7-6: Key ideas from the walk-along interviews

7.3.1 Issues relating to e-scooters and influences on pedestrian experience

Participants were welcome to mention anything that might be important to them, without being guided by a question (e.g., why do you feel unsafe?). However, the riding and parking behaviours noted by the participants were in line with those recorded in closed-ended experience survey, the results of which have been described in the previous section. The issues noted include, for instance, disrespect for rules (noted by all participants, stressing particularly the fact that users ride on footways), and disorderly parking. The responses therefore provide a broader view than the experience surveys of ways in which e-scooters interact with the walking experience. Figure 7-7 provides an overview of the aspects relating to e-scooter usage noted by the participants and the impacts on pedestrian experience.

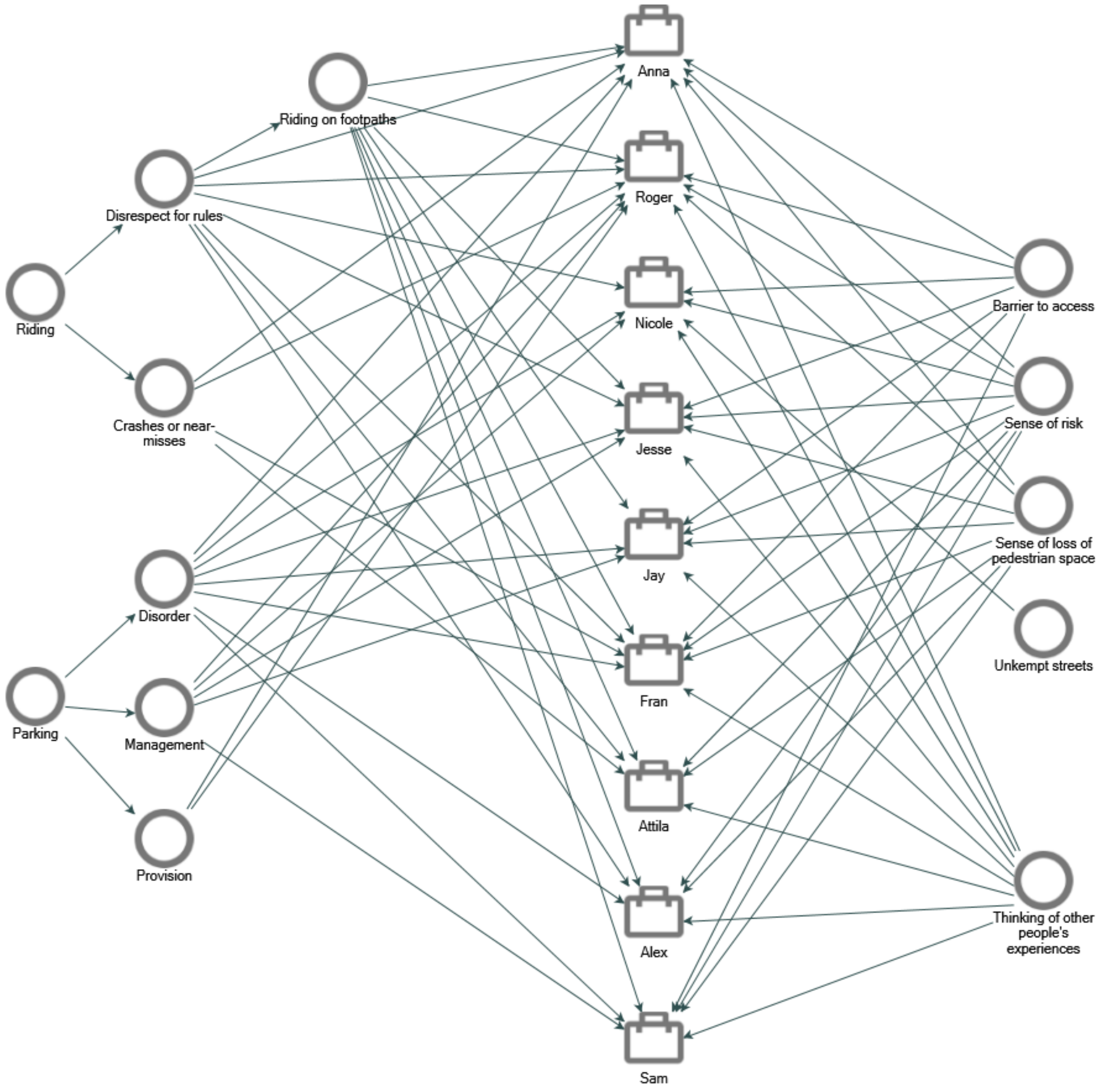


Figure 7-7: Issues noted (left) and impacts on the pedestrian experience (right)

Three topics were commonly discussed by the participants: barriers to access, a sense of risk, and a sense of loss of pedestrian space. These are further described below. Nicole also noted a fourth aspect: e-scooters contributing to streets looking unkempt or disorderly.

1. **Barriers to access**, i.e., e-scooters making it difficult or impossible to reach destinations on foot or when using a mobility device. Most of the barriers referred to what may be termed 'micro' effects, i.e., e-scooters blocking a certain section of a footway. Often respondents were thinking of the needs of others rather than themselves, or they were remembering having witnessed other people struggle, as exemplified by the quote below.

I noticed because he was on two sticks […] walking down Blackboy Hill and he actually had to turn sideways to walk down the public footpath. And I've seen *often people having to walk into the road in order to get along, in other words putting themselves at severe risk. – Alasdair, having difficulties walking and seeing*

One respondent talked about broader barriers to access, as he avoids visiting Broadmead altogether during the Christmas Market because the chalets reduce available space, which creates a certain stress around possible encounters with e-scooter riders. In relation to e-scooters he said the following.

Well, I can't get by them. I have to divert. I can't always get off the pavement to go into the road. That's another big problem because not all the pavements are accessible. So, if you needed to get off in a hurry, you could get off but you could end up being thrown out of your chair. And also another thing is you see elderly people might see the husband pushing his wife in an ordinary wheelchair. Again they're the sort of people who do suffer. – Jay, electric wheelchair user

2. Sense of risk is an issue related to fear of encounters with e-scooter riders or the result of having witnessed or experienced crashes or near-misses. These are exemplified by the following two quotes (and note that trial e-scooters are speed limited but some illegal scooters may be faster).

I have seen several times, because I live near Temple Meads, e-scooters zipping across the zebra crossing the way the pedestrians would walk over it, when they're not meant to, through red lights, both against the pedestrians […]. I've actually seen four elderly pedestrians had to jump out the way and […] three [e-scooters] racing each other. – Fran, multi-level mechanical disabilities, chronic pain and fatigue

So, e-scooters make going out and about to accomplish ordinary tasks like shopping have made the world of mine, and other disabled residents, a frightening place. – Anna, partially sighted

I have been knocked in my back by a woman using such a scooter because she could not steer it. – Anna, partially sighted

Alasdair's account (below) evokes some level of violence on the footway but also some helplessness with the question raised as to what to do when hit by a rider who then continued their ride. Note that Alasdair refers to the absence of registration numbers on e-scooters in a general sense. Trial e-scooters have registration numbers, but it is not clear in this specific case whether the e-scooter rider was a trial e-scooter rider or an illegal e-scooter rider.

I've been hit by an e-scooter [walking on the footway]; I was hit in the side by the handlebar of an e-scooter and … I've had to get out of the way a couple of other occasions as well. […] I was walking down the street and an e-scooter was coming towards me near the very edge of the pavement and the handlebar caught me on my side. I turned round and yelled, and he just carried on. […]

Based on a follow up question about whether the respondent report the incident, he said the following.

No. I didn't report it. I mean, the point is, there is no registration number on an e-scooter and if there were I couldn't see it anyway. […] I didn't know who the person was. There were no witnesses. It was quite late. It was in the dark. I think, to be honest, if I'd fallen over the person would have stopped and probably come back but the fact that I was still standing up, you know, he probably felt it was not important and carried on. But, anyway, that's an aside. But there are people far more vulnerable than me that could have got hit by a scooter and damaged and that's serious. – Alasdair, having difficulties walking and seeing

For Anna and Alasdair, both partially sighted, parked e-scooters also constitute potential threats. Alasdair knows that he would not see a parked e-scooter outside of his narrow cone of vision and fears the encounter, and a probable fall, given that his balance is poor. Anna, on the other hand, says that the e-scooters have made negotiating her neighbourhood terrifying.

Negotiating my neighbourhood, as described, is terrifying because too often these scooters are just thrown on the ground. – Anna, partially sighted [who also noted having been knocked over by a rider – see above]

3. Sense of loss of pedestrian space refers to instances where e-scooter riders are on footways, which otherwise would be a safer space. This was exemplified by a number of respondents, as shown in the three quotes below about locus of attention, being forced to move out of the way and relative speed of the e-scooter and a pedestrian.

Well especially at pedestrian crossings, because you're concentrating on the pedestrian light, you're not always aware of an e-scooter coming towards you [on the footway] or overtaking you because you only get a limited amount of time to cross the road. You're more focussed on actually doing that [crossing the road]. […] I would say it's dangerous, but it's also stressful […]. You've just got to keep your eyes open and keep your wits about you.

[…] … they have the Christmas market all the way along here so of course, all the space is then taken up with these chalets and the problem is, you know, everybody is sort of squeezed into a smaller space. – Jay, electric wheelchair user

I've seen mothers with pushchairs had to really move over to let the e-scooter get by. This, unfortunately, personally I feel that the misuse far outweighs the correct usage. – Fran, multi-level mechanical disabilities, chronic pain and fatigue

I've had a few times where people have slowed down for me but because they've got more momentum on them, more often they keep their momentum and just carry through […]. I'm generally the one who stops first and gives them space. And that's just an ilk to my old psychology in my head that I accept and I live with, part of my peace making. – Sam, electric wheelchair user

For Alasdair, the issue of loss of space raised the broader question of the right of use of footways.

If [the trial operator] uses it [the footpath], it is purely under licence to Bristol City Council by way of the West of England Combined Authority. But that piece of *footpath belongs to me and my fellow taxpayers […]. Everything that you and I paid for in order to make that footpath more useful and more helpful for those business has been annexed by those businesses, and [the trial operator] is doing the same. Now, we might feel reasonably happy with that because they might be doing something we consider to be good for the city, and that's where I started off, but there's a point at which it does not become good for the city and that's where we need to be sure about. – Alasdair*

It is interesting to note how frequently participant spoke of other people's experiences. Participants typically thought about disabled people or parents with prams.

So, as a citizen and somebody that's actually been involved in the governance of this city, I feel very strongly about it. I'm an alderman now and this is my city. I feel very concerned for anything that goes on in my city which could cause problems for people's safety and their wellbeing. […] the fact is there are people with buggies, there are people with wheelchairs, there are people with children's buggies as well and they all have a problem negotiating streets that are called 'public footpaths' – that's what they are, they are pedestrian areas which the council has chosen to let other people take over. – Alasdair

And also, another thing is, you know, you see elderly people, you know, might see the husband pushing his wife in an ordinary wheelchair. Again, you know, they're the sort of people who do suffer, you know. – Jay, electric wheelchair user

I wouldn't say every day but every second day at least I see something which is frightening. Not for myself […] but for example elderly people it can be kind of threatening I would say. – Attila, having some difficulties walking

7.3.2 Factors contributing to the issues

Spontaneously, participants often reported ideas about factors that might contribute to the problems of riding and parking that they had observed. Figure 7-8 provides an overview of the contributing factors noted by different participants. Four topics were commonly perceived as lacking, as follows:

1. appropriate infrastructure for riding, which encourages riders onto the footways
2. regulation
3. enforcement
4. riders' training or ability

Some participants also thought there was a certain carelessness of riders, and two noted an issue of e-scooter design, namely: that the vehicles are virtually silent.

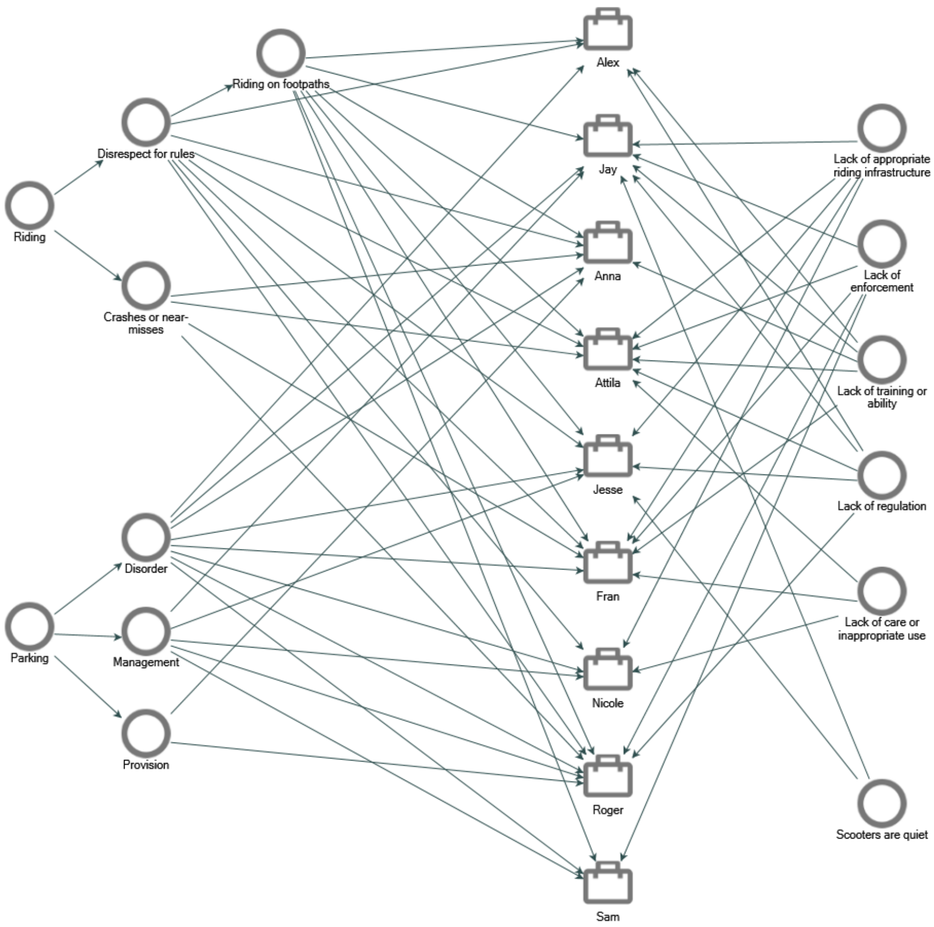


Figure 7-8: Issues noted (left) and suggested contributing factors (right)

1 Lack of appropriate infrastructure for riding – five of the participants had a certain understanding of riders using footways, given the issues they note regarding cycle tracks. They thought more space should be made for e-scooters and cycles.

> *Yes, so that they're not interfering with pedestrians and then you […] I mean, it must be quite daunting for the e-scooterers coming down a main road with lots of buses and that because you're standing, in clothes, on a scooter. […] That's why the infrastructure should be set up that they have their own designated routes. – Jesse, manual wheelchair user*

> *And for Bristol to be considered as a cycling city, in the UK, just makes me laugh. There are a few cycle paths, but in the grand scheme of things, to get from A to B... [...] I will leave around 7.30 in the morning, to avoid the madness, but it's a lot more risky. – Nicole, non-disabled*

A respondent thought the use of footways we related to threat level.

> *Maybe because for them it's less threat because with cars the cars are tall and those people who are walking on the pavement are not a threat. They are a threat for those. It's the very same thing. – Attila, having some difficulties walking*

2 Lack of regulation. Participants spoke about rules relative to poor riding or parking, which were often related to questions of enforcement, and with financial sanctions mentioned as a possible remedy (even though they already exist). It should be noted that several participants spoke of the need to regulate parking. One participant, Jesse, noted that "there's no designated parking area", clearly not being aware that the parking is in fact defined by (invisible) geofencing. In their experience, e-scooters were often scattered and left in a disorderly manner.

> *I think would be very beneficial is the authority should be thinking about like instead of people leaving the e-scooters around, like they do, that there should be various e-scooter points so that they could – like you have with the bicycles. People can – they can lock their bicycles away on bike racks but there's nothing for e-scooters. – Jay, electric wheelchair user*
>
> *Now, the last thing I want to talk about is […] regulations or enforcement. If someone misbehaves on a scooter while they're driving, I guess there's nothing unless it was reported to the police or to [the trial operator] and the person could be identified, there's nothing that can be done about it. But if people park badly, if people do not return the machines in the right way, I understand there are penalties for them. […]*
>
> *So, if someone transgresses, and we've all seen it, we've seen scooters left all over the place, I would like to be assured that [the trial operator], when they've come up with a scooter that's been left badly, in some cases literally on its side across the footpath and they're quite heavy to pick up, I want to be assured that [the trial operator] is able to track that back to the renter and penalise that renter and enforce. – Alasdair, difficulties seeing and walking*

3 Lack of enforcement was noted by five participants in relation to rider behaviour and parking, as illustrated by the quotes below.

> *But what I don't understand is why people who do this [park badly] cannot be sanctioned, in other words cannot be, for example, banned from using a scooter for a month. I mean, the software must allow that […]. So, if someone transgresses, …. I would like to be assured that [the trial operator] […] is able to track that back to the renter and penalise that renter and enforce. – Alasdair, difficulties seeing and walking*
>
> *The police don't do anything, … I don't wholly blame the police, they've got a lot of work, they're very understaffed … have a lot of major crimes and … have to prioritise. – Fran, multi-level mechanical disabilities, chronic pain and fatigue*

4 Lack of riders' training or ability is related to participants' doubts about riders' knowledge of the Highway Code, and worries regarding use of relatively powerful vehicles by people who are possibly not fully in control. Some participants also noted having seen riders who they thought looked too young to have a driving licence (who may have been illegal e-scooter riders).

Let's take that as an example. If you've never used an electric wheelchair or an electric scooter around the area, somebody from shop mobility would show you how to do […]. But you don't have any of that [training] with e-scooters. – Jay, electric wheelchair user

There is a kind of logic that says if you've got your driving licence, you're okay to drive […] but there are plenty of times I've seen people swerving all over the place and I think they haven't been trained. – Alex, non-disabled

I am practically sure that the two young girls [I saw] are of the age of maximum fourteen hadn't got a driving licence. – Attila, having some difficulties walking

I have been knocked in my back by a woman using such a scooter because she could not steer it. – Anna, partially sighted

They have to have a provisional driver's licence. […] All you need to do is apply for a provisional driving licence, get it and then you've got this e-scooter. – Fran, multi-level mechanical disabilities, chronic pain and fatigue

7.3.3 General thoughts

Some of the participants noted positive qualities of a shared e-scooter service, such as providing a sustainable, convenient, and relatively cheap mode of transport. The benefits noted also included two participants' views that e-scooters might broaden the available destinations for people with some impairments:

I said to [my partner] 'they'd be really handy for me if I was in the centre because I can get the bus into the centre because I can walk a little bit, if I wanted to go to a museum or up to the downs or something. The downs is rubbish for access. […] so I was thinking 'oh, I could take an e-scooter and have a tour of Bristol' for as long as I can stand, but [it doesn't work] because I don't actually have a smart phone. – Jesse, manual wheelchair user

I think also if you have impaired mobility but could walk a little bit, i.e., you didn't need a wheelchair, then I could see that maybe an e-scooter would be good because you could then go further, it would broaden your horizons and you would feel more satisfied with life and your mental health would be better from not being so stuck in that position of not being able to go very far. – Fran, multi-level mechanical disabilities, chronic pain and fatigue

Fran also made the interesting point of e-scooters possibly allowing women to travel in a safer way, by night:

Admittedly, late at night, sadly women have to be more careful, I don't agree that that's right, I'm just saying it's a fact this happens, that for those sort of people it would be good if they could hire e-scooters to get home from the nightclub or the pub, because then they're not walking on the street and so, potentially, that *would help their safety at night. – Fran, multi-level mechanical disabilities, chronic pain and fatigue*

However, five of the participants also expressed ideas around e-scooter usage compounding existing issues such as narrow footways. For instance, Sam's first comment was:

> *My complaints are more about the built environment infrastructure, like the pavements and the cars parked on the pavements but that's a separate research project or is it? – Sam, electric wheelchair user*

This comment provides a backdrop for the observations of e-scooter riders using footways, which may be already narrow and/or obstructed, a point made, for instance, by Alasdair.

> *What's now happening and this is nothing to do with e-scooters but I'll say it anyway, many premises have now been given permission to put tables and chairs outside their premises. That takes away a lot of the public footpath. Then there are things like A-boards, you know, the advertising boards? There are street signs. There's litter bins. There's commercial, sometimes domestic, waste bins and bags. […] And I've seen often people having to walk into the road in order to get along, in other words putting themselves at severe risk. And that is not just because of e-scooters, but e-scooters are compounding this problem, and that's something that e-scooters must respect because they're the last in the line. All these other things had already happened before e-scooters came along so they could see what the situation was before they actually had to add their devices to the problem. – Alasdair, having difficulties seeing and walking*

Further, four of the participants questioned the narrative that the e-scooters were necessarily a substitute for driving.

> *I think the argument has been to get more people out of cars, but I cannot see too many people using an e-scooter for a journey that they would use for the distance of a car but I could well be wrong. But my feeling is that e-scooters are used more for the journeys people might take on a bike. But again, I mean, I would really like to hope that more people would, instead of using a car to go down to their local shop, hop on an e-scooter to do the same job. But I just feel that that's a questionable as to how much that would be done. – Sam, electric wheelchair user*

> *E scooters are not crucial to city transport, their advent has not lessened cars on these roads, and many drivers, including `bus drivers, complain about e scooter users taking up the bus lanes. – Anna, partially sighted*

> *From the environmental point of view, yes, it's better than driving a vehicle, but it's known that it has actually reduced the walking, people being active, which is a serious no no. The idea for health, for better health, for longevity and a comfortable longevity, is to increase physical activity generally. – Fran, multi-level mechanical disabilities, chronic pain and fatigue*

7.3.4 Ethics of public space use and behaviour

Two broader questions were raised by two participants: the question of public space taken up by a private company, and the question of who has the ultimate responsibility over riders' misbehaviours. Both questions relate to ethics over the use of public space and the public's ability to exercise their right to use public space. They are illustrated by the quotes below.

> *[The Council has] given licence to a private organisation like [the trial operator] to actually take up another massive, massive piece of that public domain. [But] there are people that need to use it and it's absolutely fundamental to getting around. Remember that Bristol has styled itself as a walking city and if we're making it more difficult for people to walk, it's actually blowing a hole in its own policy. […] However positively we feel about this, we are not in the business of saying, 'Here's our city. Use it any way you want to make money.' That is not acceptable. There has to be regulation and the regulation has to suit the city and its citizens, not [the trial operator]. – Alasdair, having difficulties walking and seeing.*
>
> It is not necessarily possible to know who has toppled an e-scooter if it was not the user.
>
> *Okay, in that case the only person that's liable is [the trial operator]. You see, I know this as an ex-councillor, if one of the utility companies digs a hole in the road and finishes it unevenly and someone trips over, Bristol City Council can deal with them. If someone leaves a bin or a damages a road sign, Bristol City Council will deal with them. I want to know that Bristol City Council or somebody else, even if it's the Archbishop, can somehow have an overview of [the trial operator].*

7.3.5 Summary of the findings from the walk-along interviews

The responses from nine walk-along participants of diverse ages and disability statuses showed both shared views and very different experiences. The issues created for pedestrians are barriers to access, a sense of risk and a sense of loss of pedestrian space. These issues are created partly because of a lack of the following: infrastructure for riding e-scooters, regulation and enforcement, rider ability. Shared views related mostly to their observations about riders using footways, with the overall sense that rules preventing footway riding were being disrespected and that parking is disorderly.

The participants also showed much empathy and understanding for other citizens, and a deep consideration of the difficulties in travelling that others might have. They recognised that the scheme could have very different impacts on different people's everyday lives. While some non-disabled participants were indifferent to e-scooters except when they saw situations they thought might be difficult for other people. One respondent reported that e-scooters make their world a '*frightening*' place. Another respondent reported avoiding certain areas and this raised ethical questions for many participants in relation to the use of public space and accountability of private company operation in the public realm.

8 CARBON EMISSIONS

8.1 Introduction

This chapter presents the findings on the net impacts of e-scooter operations on carbon dioxide emissions resulting from travellers switching mode to e-scooter. The chapter therefore sets out to answer evaluation question **3b Carbon**: What has been the carbon footprint of the e-scooter trial?

The analysis is based on the approach of considering the modes that e-scooter users would have used had they not travelled using the e-scooter and estimating the carbon dioxide emissions both for the e-scooter ride, and, where applicable, for the other mode that would have been taken.

Forms of powered travel involve three types of emissions: a) operational carbon emissions from fuel used, b) the carbon emissions from fuel (or energy) supply, and c) the embodied carbon in the vehicle based on a lifecycle assessment of the vehicle. For most transport planning applications, only the operational carbon emissions are estimated (for example, Transport Appraisal Guidance Data Handbook Table 3.3 provides data on kilogrammes of carbon dioxide equivalent emissions per litre of fuel, and Tables 1.3.8 and 1.3.9 which provide formulae for estimating vehicle fuel consumption per kilometre travelled for the vehicle fleet). This is an appropriate methodology for estimating marginal changes to the network, such as discrete sections of new road or cycleway, where these may result in some mode switching, and a net change only in direct emissions but no anticipated changes in, for example car ownership.

A question arises, then, as to whether an e-scooter scheme needs to be assessed based on direct emissions only, or as a wholly new system with potentially significant impacts on not only mode switching, but, for example, car ownership changes. On the one hand, arguably an e-scooter system is typically of the same scale as some other transport infrastructure interventions and hence, from an appraisal point of view, might be to consider in relation to direct emissions only. On the other hand, it is known that, relative to other vehicles, the lifecycle of an e-scooter has been, to date at least, short. This means that the embodied carbon in the e-scooter as a vehicle is a significant proportion of the lifecycle emissions. This suggests that an assessment dealing only with direct emissions may not account for all that ought to be accounted for in relation to e-scooter emissions.

Overall, it is probably appropriate, therefore, to estimate both direct and lifecycle carbon emissions of e-scooter use.

Section 8.2 describes the methodology, and within that section references to the relevant literature are made. Section 8.3 notes the limitations of the methodology. Section 8.4 presents the estimated impact on carbon emissions of the e-scooter trial. Section 8.5 provides a short summary.

8.2 Methodology

This section describes the methodology adopted for estimating the carbon dioxide emissions. Firstly, the approach taken by the trial operator in estimating carbon dioxide emissions is described and comment on that method is provided. Following that is a description of the methodology adopted in this evaluation.

The trial operator uses a methodology developed by Dr Manos Chaniotakis, Lecturer in Transport Modelling and Machine Learning at University College London's MaaSLab. The method is limited to estimating the net change resulting from mode switching from both bus and car to e-scooter. The formula is shown below.

$$CO_2 = ESkm.DF_{car}(Car_{carbon} - ES_{carbon}) + ES_{km}.DF_{bus}(Bus_{carbon} - ES_{carbon})$$

CO_2 = carbon dioxide emissions saved
$ESkm$ = E-scooter distance travelled, kilometres
DF_{car} =Diversion factor to e-scooter from car, proportion
DF_{bus} =Diversion factor to e-scooter from bus, proportion
Car_{carbon} = Car carbon dioxide emissions factor, gCO_2eq/km
ES_{carbon} = E-scooter carbon emissions factor, $gCO_2eq/person/km$
Bus_{carbon} = Bus carbon emissions factor, gCO_2eq/km

It should be noted that this method is limited to estimating change resulting from mode switching from car and bus. No net effects are estimated for switching from, for example, walking or cycling, to e-scooter use, or for new e-scooter journeys that were not made before.

The e-scooter carbon dioxide factor used was 35 $gCO_2eq/person/km$. This was estimated by EY (2020) using a lifecycle assessment process. Most of the emissions relate to the production of the e-scooters, with transport contributing 4.6g, re-distribution of e-scooters in use, 1.1g and repairs 5.5 $gCO_2eq/person/km$. The assessment conducted by EY was based on the trial operator operation in Paris. While much French electricity is produced using nuclear power plants, and hence this will have lower carbon emissions per kilowatt than, for example, UK electricity, only a very small proportion of the emissions per kilometre from e-scooters are linked with electricity in use.

The estimates of carbon emissions factors relating to e-scooters varies greatly. Ishaq et al. (2022) conducted a life cycle assessment of personally owned e-scooters in Turin, Italy and estimated that they generate 21 $gCO_2eq/person/km$.

A lifecycle assessment of e-scooters based on a shared e-scooter scheme in Brussels made a baseline estimate of 131$gCO_2eq/person/km$ (Moreau et al., 2020). This was based on a relatively short lifespan of 7.5 months. It should be noted that the lifespan of Version 3 of the trial operator's e-scooter is 24 months. Hence, it is reasonable to assume that the estimate of Moreau et al., based on a 2.5-year lifespan, is more applicable to the West of England scheme. For that scenario they estimated that the e-scooters would generate 51 $gCO_2eq/person/km$. They also acknowledge that this emission rate may be reduced further by improving the sustainability of e-scooter distribution in use and charging.

A study conducted in North Carolina State University is also referred to in the EY (2020) report on the trial operator's emissions. That study was undertaken by Hollingsworth et al. (2019), producing an initial life cycle assessment estimate of 202g CO_2-equivalent per passenger-mile, which equates to 126g CO_2-equivalent per passenger-kilometre. They also present scenarios which include measures which could reduce emissions at different stages of the life cycle. One of the scenarios relates to a two-year lifespan for e-scooters. Under this assumption, the average life cycle emissions reduced to 88g CO_2-equivalent per passenger-kilometre (141g CO_2-equivalent per passenger-mile) (Hollingsworth et al., 2019).

Figure 8-1 shows the timing of different developments of the trial operator's operation in Paris in relation to the vehicle emissions. These values show a considerable reduction as time has progressed in carbon dioxide emissions, and the dimensions of these reductions are linked with e-scooter utilisation, e-scooter vehicle characteristics, and e-scooter operations management.

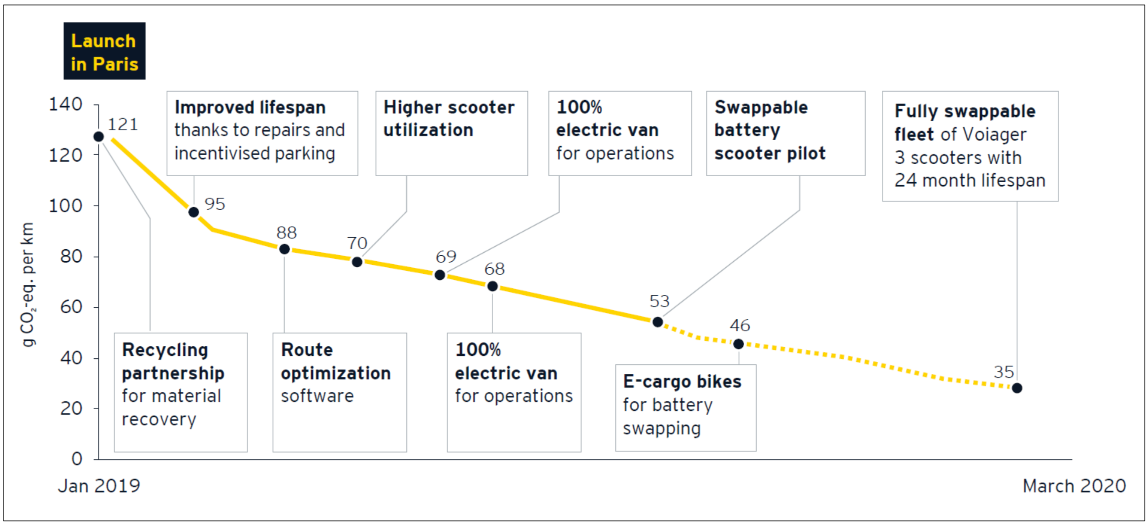


Figure 8-1: Average life cycle emissions for the trial operator's e-scooter scheme in Paris over time (EY, 2020, p.23)

Gebhardt et al. (2022) estimated carbon emissions reductions from switching from car to e-scooter in Germany. They estimated a reduction of 5.8 Kt of CO_2eq per day for the 13% of trips that are suitable, and which represents 2% of car kilometres. They note how dependent the estimates are on e-scooter lifecycle and the type of car replaced, with the possibility of increases in emissions for replacement of battery electric cars in some conditions (NB emissions from other vehicles are discussed more fully below). They estimated a total carbon emissions of 590 kg CO_2eq over a two-year life of the e-scooter. A very small proportion of the carbon emissions are from electricity in use with most emissions being from vehicle production (approximately 60%), and a further 12% from battery production. A further large proportion comes from servicing and maintenance. They estimated a daily e-scooter distance 10.2km for their context, and hence estimated emissions of 79 gCO_2eq per passenger kilometre. It seems reasonable to adopt this most current estimate of 590 kg CO_2eq over a two-year life of the e-scooter, and use values for the daily distance ridden on an e-scooter to estimate carbon emissions from the trial.

With an average daily distance travelled of 12.4km in Bristol, and assuming the lifetime carbon emissions for the e-scooter of 590 kg CO_2eq, the per kilometre ridden value of carbon emissions for the trial would be 65.2 gCO_2eq per passenger kilometre. The average daily distance travelled in Bath is 6.3km and this would suggest lifetime carbon emissions of 130.4 gCO_2eq per passenger kilometre. It is assumed that there is, however, some mixing of the fleet between Bristol and Bath and so the value of 65.2 has been adopted because the Bristol part of the trial is by far the larger part of the trial. Note that a value of 35 gCO_2eq/pkm was adopted in the Interim Report estimates. It should be noted that the trial operator has stated to the evaluation team that they offset their estimate of lifecycle carbon emissions from the trial. The direct emissions from Figure 7 of Gebhardt et al. (2022) for Germany are about 10 gCO_2eq/pkm.

In summary, the range of values from the literature indicates values for lifecycle emissions of 21-88 grams of carbon dioxide equivalent per passenger kilometre. The trajectory for carbon emissions of e-scooters may be in a downward direction. For the purposes of this estimate of trial carbon emissions change, a central case value is assumed to be 65.2 gCO_2eq per passenger kilometre. A value of 35 gCO_2eq per passenger kilometre will be adopted as a sensitivity test, and a value of 10 gCO_2eq per passenger kilometre will be adopted for direct emissions estimates only.

Attention is now given to the methodology adopted for the estimation of the net carbon dioxide emissions from the West of England trial. The method is similar to that adopted by the trial operator to date, excepting that it includes all modes from which e-scooter users may have diverted. The equation driving the methodology is straightforward, and estimates net carbon emissions changes from other modes by age group. Data is available from surveys for mode switching by age and from the trial operator for median distance of the e-scooter ride by age. The following equation defines the estimate for net change in carbon emissions by mode and age group:

$$CO_{2.ma} = DF_{ma}(ES_a.CER_m - ES_a.CER_{es})$$

$CO_{2.ma}$ = carbon dioxide emissions saved for diversion from mode m for age group a
ES_a = median e-scooter distance travelled, kilometres for age group a
DF_{ma} =Diversion factor to E-scooter from mode m for age group a
CER_m = emissions rate per kilometre, gCO_2eq/km, for mode m
CER_{es} = E-scooter carbon emissions rate, $gCO_2eq/person/km$, for the e-scooter

The overall estimate of the net change is then made by aggregating across age groups and modes. There will be variability in distance travelled by trip purpose and based on mode from which the trip has been diverted. This is discussed in the next section.

Diversion factor information is available both from the trial operator's Summer 2021 and Winter 2022 Survey the End-of-Ride Survey, and the on-street survey conducted as part of this evaluation in Summer 2022. The sampling basis for the end-of-ride data is unknown and so these data have not been used in carbon estimation. There is evident variability in the estimates of diversion from these survey sources and hence each survey is used to produce an estimate to understand the range of possible estimate of net carbon emissions change. In addition to options concerning which mode would previously have been used, it was possible to state that the e-scooter journey was a journey that would not otherwise have been made.

8.3 Estimated impact on carbon emissions

8.3.1 Modes for inclusion

The Department for Business Energy and Industrial Strategy (BEIS) data tables for use by companies to report their carbon emissions provide carbon dioxide equivalent emissions for business travel by different modes. 2022 estimates were published on 20th September 2022. These data are more recent data than that used by the trial operator for its estimates, which were based on the BEIS 2019 data. The BEIS emissions factors are based on direct emissions rather than a life cycle assessment (and for example show zero emissions for electric cars). BEIS defines three scopes as follows for company reporting:

- Scope 1 (direct emissions) emissions are those from activities owned or controlled by the organisation. Examples include emissions from combustion in owned or controlled vehicles.
- Scope 2 (energy indirect) emissions are those released into the atmosphere that are associated with the organisations consumption of purchased electricity, heat, steam and cooling.
- Scope 3 (other indirect) emissions are a consequence of the organisations actions that occur at sources not owned or under the control of the organisation, and which are not Scope 2 emissions. An example is business travel in an employee's car.

The values for Scope 1 (company owned vehicles are the same where they overlap with Scope 3 emissions (for employee-owned vehicles). The estimate of the net carbon impact using BEIS figures for switching from different modes to an e-scooter would therefore be, based on the fact these are direct emissions, an underestimate.

Brand et al. (2021, p.SI-7) provide lifecycle estimates for modes in London as part of a European project, and these are the estimates that have been used in this analysis for car, motorcycle, taxi, and cycle, but not bus or train. Each mode is discussed in turn. The values used are summarised in Table 8-1.

Brand et al. (2021) give the following values for car, van and motorcycle: Operational 165.6 gCO_2/pkm (standard deviation, S.D., 46.7); Fuel supply 30.4 gCO_2/pkm (S.D. 6.8); Vehicle supply 12.9 gCO_2/pkm (S.D. 1.9). This gives a mean total of 208.9 gCO_2/pkm. The BEIS estimates, however, are given for car and motorcycle separately, even though they are not lifecycle estimates. The factor given by BEIS for the average **car** for business travel is 170.824 gCO_2/pkm. The vehicle mix, in terms of vehicle size, type and fuel type, will vary across cities in Great Britain and it will change over time, and the detail provided by BEIS gives some idea of the quite large potential variability by type of car.

The factor given by BEIS for the average motorcycle for business travel is 113.55 gCO_2/pkm. The factor given by BEIS for the travel by taxi for business travel is 148.76 gCO_2/pkm for a regular taxi and 204.17 gCO_2/pkm for a black cab. By adopting the higher lifecycle value of Brand et al. (2021), the comparison with e-scooter lifecycle emissions is preserved. In sum, for lifecycle analysis the car figure of 208.9 gCO_2/pkm has been used for car, van, motorcycle and taxi. For the direct emissions estimate, the individual values have been used.

Brand et al. (2021, p.SI-7) give the following lifecycle estimate for public transport in London: Operational 52.0 gCO_2/pkm (S.D. 0.3); Fuel supply 43.5 gCO_2/pkm (S.D. 0.6); Vehicle supply 3.6 gCO_2/pkm (S.D. 0.0). This gives a total lifecycle cost for car of 99.1 gCO_2/pkm. This is for a train and bus and for the share of those two modes observed in London and the relatively high London load factors. It is therefore not feasible to estimate lifecycle emissions for bus or train for lifecycle analysis.

The direct emissions factors have been used as proxies for the lifecycle emissions for buses and trains. This is on the basis that the embodied carbon in the vehicle will be a lower proportion of the carbon emissions resulting from the relatively long life of rail vehicles and buses, and the fact they carry relatively more passengers. The factor given by BEIS in 2022 for travel by local buses outside London for business travel is 107.78 gCO_2eq/pkm. The factor for London is given as 79.36 gCO_2eq/pkm. This difference is likely to primarily be because of higher passenger load factors in London. It is appropriate to try both values in the analysis to determine a range.

Also, to be taken into consideration is the relatively large proportion of the Bristol bus fleet that is fuelled by biogas, and so the values for Bristol could therefore be lower than these estimates. Additional information about the bus fleet in Bristol would need to be obtained to confidently amend this figure. (Note that the previous estimate used by the trial operator for buses was from BEIS for 2019 and was 119.74, which was for gCO_2/pkm (i.e. it was not a carbon dioxide equivalent value because it did not take account of methane and nitrous oxide). The estimate given by BEIS in 2019 was actually 120.76 gCO_2eq/pkm).

The factor given by BEIS for the national rail travel is 35.49 gCO_2/pkm. This is not a lifecycle estimate, but the only one available. There is little switching from train to e-scooter and so the effect of this value on the estimates is limited.

Cycle and cycle share have been combined for this analysis and the proportion of trips that would have been made by cycle share is very low. There was an e-bike hire scheme operating in Bristol in the spring and summer of 2022. Brand et al. (2021) also give a figure of 0.236 gCO_2eq/pkm for energy supply for e-bike use. As e-bike use is relatively low in Bristol, although growing, this additional emissions factor has not been considered.

The additional carbon dioxide emissions resulting from walking rather than resting have not been considered. The effect of this is to slightly exaggerate additional e-scooter carbon emissions.

The responses given as 'other' mode is a small group in the survey data collected and the types of modes used vary in terms of carbon emissions. Accounting for these trips will have negligible impact overall, and hence the alternative mode has been assumed to have zero carbon emissions. The effect of this is to slightly exaggerate additional e-scooter carbon emissions.

We assumed that any new trips would have a negative carbon emissions effect. This is assuming there is no difference in carbon dioxide emissions for the activity that would have been undertaken had the trip not been made compared with the carbon dioxide emissions of the activity at the destination end of the trip. The effect of this may be to slightly exaggerate additional e-scooter carbon emissions.

Table 8-1: Carbon emission factors based on mode replaced (gCO_2/pkm)

Mode replaced	Direct (BEIS, 2022)	Lifecycle emissions factor (Brand et al. 2021)		
		Mean	Lower bound	Upper bound
Car, van and motorcycle	170.82	208.9	100.3	317.5
Motorcycle	113.55	208.9	100.3	317.5
Taxi regular	148.76			
Taxi Black cab	204.17			
Bus	107.78			
London bus	79.36			
Train	41.0			
Cycle and cycle share	-	5.336	5.328	5.344

8.3.2 Estimation of net carbon dioxide impacts

Table 8-2 presents estimates for the net change in the tonnes of carbon for the scheme for both Bristol and Bath using data on previous mode used from the Summer 2021 and the Winter 2022 surveys conducted by the trial operator, and an estimate for Bristol using the Summer 2022 surveys undertaken on-street as part of the evaluation. The mode shares from these sources provide a range of possible proportions drawn from previous modes and hence will give a range to the estimates for carbon saved.

The mode shares vary by age group, and the estimates are made based on the breakdown of mode share to age groups, with mean distances estimated from the trial operator's data for each of the age groups. The estimates of carbon savings are for the number of rides undertaken between 28th October 2020 and 27th April 2022 as follows: Bristol, 4.15 million rides; Bath, 206,000 rides.

The table shows estimate for carbon dioxide equivalent emissions saved for two scenarios as follows: a) lifecycle assessment (but using direct emissions for bus and train) and e-scooter emissions of 65.2 gCO_2eq per passenger kilometre; b) direct emissions and 10 gCO_2eq per passenger kilometre.

Table 8-2: Change in tonnes of carbon dioxide equivalent saved

Emissions type	Bristol Summer 2022	Bristol Summer 2021	Bristol Winter 2022	Bath Summer 2021	Bath Winter 2022
Lifecycle (mean)	6.1	237.8	117.1	4.9	7.4
Lifecycle (lower bound)	-115.4	-100.3	-132.6	-9.2	-8.9
Lifecycle (upper bound)	127.7	575.9	366.8	18.9	23.6
Direct emissions	435.6	575.9	490.0	23.1	24.4

Note: Bristol carbon emissions change based on 4.15 million rides and Bath carbon emissions change based on 206,000 rides.

There are several significant points to note, as follows.

- The replaced modes that are influencing the majority of the either net reduction or net increase in carbon emissions are walk, car, taxi and bus. There is a lot of variation between the surveys in the declared replaced mode which causes significant differences in the estimates for net carbon reduction.
- The replaced mode proportion of walk for Bristol varies between 31% and 39%, whereas for Bath it is higher at between 42% and 47%.
- The replaced mode proportion of car, car share or motorcycle (taken together) varies between 9.3% and 25.1% in Bristol and 20% to 22% in Bath.
- The replaced mode proportion of taxi varies between 4% and 13% in Bristol and 8% to 10% in Bath
- The replaced mode proportion of bus in Bristol varies between 15% and 38% in Bristol and 13% and 15% in Bath.
- Because of the variation in figures for replaced modes, there is a wide range in estimated carbon changes.
- While the estimates vary quite considerably, they all indicate carbon emissions saving, but of different scales for different scenarios.
- The estimates for the mean values of the lifecycle estimates from 6 to 238 tonnes net saving in Bristol for 4.15 million rides, from 5 to 7 tonnes saving in Bath for 206,000 (which, if straight factored to the rides level in Bristol would be 97 to 150 tonnes net saving).

- These savings in carbon emissions are lower than those in the Interim Report estimates because of better current information, and the use of 65.2 rather than 35 gCO2eq/pkm.
- The 95% confidence intervals for the upper and lower bounds of the estimates are very wide and the lower bound estimates indicate that there would be a net negative impact on carbon emissions.
- The estimates just using direct emissions show a larger saving than using the lifecycle estimates.

8.4 Methodological limitations

There are several issues relating to the assumptions and data used for estimating carbon dioxide emissions. These are summarised as follows:

- The diversion factors from other modes to e-scooter used in the trial operator's estimation represent the spread across the trial operator's users and so it implicitly assumes that the diversion proportions are the same for e-scooter trips. The frequency with which an individual makes e-scooter trips may be correlated with the type of mode which the trip replaces (or vice versa). For example, it may be that an e-scooter trip frequently replaces walking trips for an individual who uses the system regularly, however, for another user, less frequent e-scooter trip making may be used as a car replacement. It is not possible to resolve this issue with the data available because it is not possible to link the survey or end-of-ride diversion factors to user trip frequency.
- There may be differences in trip length for e-scooter trips that have substituted different modes. For example, e-scooter trips replacing walking trips are likely to be shorter than e-scooter trips replacing car use. It is not possible to resolve this issue with the data available for the same reason as above: we are not able to adjust the diversion factors by previous alternative mode.
- Linked with the above the De Bortoli and Christoforou (2020) found in Paris that trip distance reduced on average by 38.5% when trips were switched from previous modes to e-scooters, that is to say, people were changing destinations as well as modes. This adjustment has not been applied to our estimates because there is no data to support such an assumption. If an adjustment along these lines were made, it would increase the carbon saving.
- These estimates are for Hop-on and Hop-off rides. Long-term rental rides comprise 5% of the distance travelled of hop-on hop-off rides. Estimates of carbon savings for long-term rental rides have not been made.
- Absence of good data on trip chaining means that substitution of longer car trips by for example an e-scooter trip plus a train journey have not been possible to estimate. However, the number of these is uncertain, and there will be a greater degree of uncertainty and more variability in possible options that people might make for different longer distance journeys which would reduce the confidence in assessing such effects.

8.5 Summary

The estimation of net carbon dioxide emissions changes of mode switching to e-scooters, using lifecycle estimates per passenger kilometres for different modes, indicates that there are emissions savings. The estimates have wide variability and this is based on significant variability in estimates of replaced mode available from different surveys. The level of the savings is driven significantly by the proportion of walk trips as compared with motorised trips that divert to e-scooter use. The estimates have adopted an e-scooter lifecycle carbon emissions factor of 65.2 gCO_2eq per passenger kilometre (and this is a higher value than adopted in the Interim Report of 35 gCO_2eq per passenger kilometre). The estimates of net saving for the year 2021 range from 6 to 238 tonnes net saving in Bristol for 4.15 million rides, and from 5 to 7 tonnes saving in Bath for 206,000 rides. As previously noted, the trial operator has stated to the evaluation team that they are offsetting carbon emissions from the trial, and this includes vehicle lifecycle emissions.

9 PARKING

9.1 Introduction

The analysis presented in this chapter is based on both the trial operator's data, which includes data on parking locations, patterns of parking across time and parking compliance, and primary data, which is based on observations of parked e-scooters from both street observation and measurement and from video footage. This chapter sets out part of the response to the following evaluation question: 4a 'What different parking measures have worked best (and less well) and why?'

Parking measures may be divided into two broad classes: supply and management. As with most cycle parking, e-scooter parking is being provided by highway authorities on footways and pedestrian areas, rather than within carriageways. This takes away space from pedestrian movement. Consequently, there may be disadvantages for pedestrians if designated parking space within the footways is inconveniently defined in terms of its location or extent. Unlike the physical nature of cycle racks, e-scooter parking is typically defined by geofencing, and rides are not able to park outside the geofenced area without sanction from the trial operator. In some locations in South Gloucestershire, white paint to de-mark an e-scooter cycle location has been added to the footway. Note that the responsibility for managing day-to-day compliance with the parking rules rests with the trial operator, and not with the highway authority.

Section 9.2 summarises the background to parking management. Section 9.3 and 9.4 deal with parking supply and parking compliance. Section 9.5 provides a summary.

9.2 Background to e-scooter parking management

While the issue of riding on a footway is an important one to understand, so also is parking on the footway or other pedestrian areas. This is because inappropriate parking can cause issues for other street users (as demonstrated in chapter 7). On the footway, these would typically be pedestrians, and within that classification disabled people are an important grouping of people to consider. This section firstly describes issues in relation to disability. It then considers the literature in relation to e-scooter parking. Finally, it summarises the trial operator's parking management methodologies.

9.2.1 The literature

Footways, especially in central urban areas, or shopping streets, are often challenging environments for pedestrians, and the challenges result from many sources. Firstly, there is the intrinsic nature of conflicting movements of pedestrians, who may be walking at quite different paces, or crossing footways to access shops or other property fronting the street. Secondly, there is the fixed nature of much street furniture serving other purposes, but which is located within the pedestrian space, such as street lighting columns, sign-posts, cabinets for utilities, and streets trees. Thirdly, there are, sometimes sanctioned and sometimes not, other temporary obstructions such as advertising A-boards, and goods for sale or tables and chairs belonging to shops and cafes. Finally, there may be street furniture, such as benches and litter bins, provided specifically for pedestrians. It is important therefore that, if wheeled vehicle parking is to be located within the footway, careful thought is given to its location, size, ease of access for cycle and e-scooter users, and issues relating to potential to further disrupt pedestrian utility.

Several evaluation studies have been undertaken of pilots of e-scooter use in the United States of America and Canada in 2019 and 2020, but little in Europe. The evaluation has produced insights in relation to pavement parking. It should be noted that some of the evaluations applied to free-floating models, where e-scooters can be parked anywhere, as opposed to in designated bays which is in place in the West of England.

In Santa Monica (City of Santa Monica, 2019), the city authority actively educated the public to raise awareness about the e-scooter pilot and its rules. 85% of riders and 90% of the public reported a general awareness of the pilot's basic parking and riding rules. It was one of the first US cities to enforce geofencing and digital policy tools to remedy parking, safety, and oversaturation problems. The most common problems with the parking of the e-scooter were that it was not parked upright (17%) or did not provide sufficient clearance for other street users (25%).

In Denver (2019) surveys of parking were undertaken to ascertain whether e-scooters were parked in designated places. 78% of e-scooters observed were parked properly, 18% of e-scooters were parked too close to the kerbline, and this is noted as an issue in relation to access to bus stops. The suggestion is that this may have been because of a lack of footway width. 4% were blocking access. In response to an on-line survey, 92% of e-scooter riders reported that they knew where to park an e-scooter properly.

In San Francisco, riders are required to lock the e-scooter to an item of street furniture at the end of their ride using an onboard lock. This is reported to addresses major issues with sidewalk clearance and pedestrian safety (San Francisco Municipal Transportation Agency (SFMTA), 2019).

In Portland, Oregon (City of Portland Bureau of Transportation (PBOT), 2019), improper e-scooter parking was a major concern of the public during an initial pilot. Consequently, the Portland Bureau of Transportation required e-scooter operators to provide relevant local laws within their apps. They also created a legal mechanism to warn and fine operators and users for improperly parked e-scooters. They also required operators to respond quickly to public complaints about improperly parked e-scooters, and finally to instal e-scooter parking 'corrals' across the city.

Calgary authority installed e-scooter parking zones that will not 'block or inhibit' footway users (City of Calgary, 2020). Riders are also allowed to park in the 'furniture zone' of the footway, which is that part of the footway in line with cycle racks, trees, or litter bins. (It should be noted that the update of Manual for Streets will include the concept of furniture zones within its guidance when published probably in 2023.)

Chicago e-scooter riders in the second, 2020, pilot were required to lock e-scooters to a fixed object (e.g., a cycle rack, or street sign pole) at the end of their trip (City of Chicago, 2021). This was purposely to reduce clutter and obstruction of the footway. An observational survey of the second pilot found that 97.3% of e-scooters were locked and parked correctly. Complaints from the public were reduced from 0.72 per 1000 e-scooters per day (2019) to 0.16 complaints (2020). In a survey of non-users, 44% of those reporting disabilities thought that the locking requirement was helpful. However, 50% of non-rider survey respondents with disabilities said that e-scooters parked on sidewalks were 'often' a danger or inconvenience and 66% that e-scooters parked on sidewalks made it more difficult to access a bus stop or train station.

In a multi-city review, Gössling (2020) found that random parking of e-scooters was a major discussion point in cities and recommended designated parking zones for e-scooters. Scaling availability of e-scooters to demand would also reduce to the minimum the space required for parking. He also reports discussion on the issue of whether parking violations should apply to operators or users. In the former case, this would require a body funded to police such violations external to the operator, while in the latter case, the cost is born by the operator.

In summary, the main issues are fallen e-scooters and insufficient clearances left for other street users. The tools used to manage parking supply are geo-fencing, designating specific locations, installing physical corrals for e-scooter parking, and requiring that an e-scooter is locked to an item of street furniture. Where they exist, parts of the footway designated as (street) furniture zones may allow e-scooter parking. A final method of managing parking demand is to manage e-scooter supply to more closely match the demand for e-scooter use. In relation to enhancing compliance, methods include requiring the trial provide to provide relevant local laws within their apps and developing a legal mechanism to warn and fine operators.

9.2.2 The trial operator's management methodologies

The following list on the [trial operator's website](#) (consulted on 14th December 2022) indicates the behaviours the trial operator expects of its customers when parking:

- ***Keep it neat***. *Place your scooter parallel and close to a wall, in a scooter rack, or within a designated parking zone. When in doubt, a good tip is to park your scooter next to obstacles that already exist.*
- ***Don't block the pavemen****t. Always leave at least two metres free and be sure not to obstruct the path of pedestrians. Poorly parked vehicles are accidents waiting to happen.*
- ***Keep access points fre****e. It's the same for any vehicle. We need to make sure not to block the entry or exit to garages, bus stops, stores, underground stations, etc.*
- ***Don't block traffi****c. Ask yourself if your parking choice will work for everyone else. Don't park in the way of other vehicles and keep roads, bicycle lanes and pedestrian crossings free.*
- ***Use the kickstand***. *Ensure that the scooter remains standing upright by using the kickstand. A fallen scooter can be a real hazard to the visually impaired and to those with limited mobility.*
- ***Learn the zones in the app***. *The in-app parking zones vary between cities. Study the zones before taking a ride and plan your parking accordingly*.

To encourage riders to park properly, the trial operator introduced end-of-ride photos within their app in February 2021, which requires users to take a picture of their parked e-scooter. The photos are reviewed by the trial operator's user support team and an infringement is classified as either 'illegal' or 'imperfect'. Illegal parking is when an e-scooter has been parked in such a way that it blocks the footway or other area where it should not be parked. A fine is issued on the second occasion this happens. In its 2021 Safety Report (Voi, 2021), the trial operator suggests that most riders who have been fined have only been fined once. Imperfect parking is when an e-scooter has been parked in an appropriate place, but its positioning could have been better. In such cases, the trial operator emails the rider to explain how they could improve their parking. The following section describes the disposition of parking supply.

9.3 Parking supply

Parking supply is defined by the areas in which parking is permitted. This is achieved principally by geofencing which defines the size of the area of parking using boundary coordinates of the location. Incentivised Parking Zones are marked on the in-app map in green and within these areas riders will be given a credit to use on their next ride. These are not used in the West of England Combined Authority trial. Mandatory Parking Zones spots show the geofenced area in blue on the in-app map. In some locations the parking zones may also be marked with white paint on the footway or be equipped with racks into which the e-scooter may be docked, this latter shown in the right hand image of Figure 9-1.

An e-scooter is approximately 1.1 metres long and the handlebars are 0.660 metres wide, and so has a footprint of 0.726 square metres. The left-hand image in Figure 9-1 shows two e-scooters parked neatly and close together. They take up an area of 1.3 square metres, or 0.65 square metres each. E-scooters parked next to each other but not overlapping may result in a rate of approximately 1.4 e-scooters per square metre. With neatly parked e-scooters, this rate may increase to 1.5 e-scooters per square metre. Untidy parking would result in fewer e-scooters per square metre than 1.4.

Figure 9-1: A pair of e-scooters and e-scooters in an e-scooter rack

Data provided by the trial operator indicates 902 parking zones in Bristol and 117 in Bath as shown in Figure 9-2 and Figure 9-3. In Bristol, the offer is mainly composed of the following:

- A high density of parking zones in the city centre (Broadmead, Old Market, Temple Meads, Stokes Croft;
- Several zones at main hubs including, for example, the University of Bristol, Cotham Hill, Downend, Lawrence Hill, Patchway, Bradley Stoke
- Zones along main routes, for example, Cheltenham Road / Gloucester Road, Whiteladies Road, Concorde Way, Fishponds Road, Church Road; Southmead Road; and
- Isolated locations, mostly at peripheral locations, and these constitute a small proportion of the total supply.

Within the overall boundary of the trial, there are areas into which e-scooters are not allowed to travel, or park. These include parks and green spaces, other public open spaces such as crematoria, and parts of other sites with public access, such as Southmead Hospital campus.

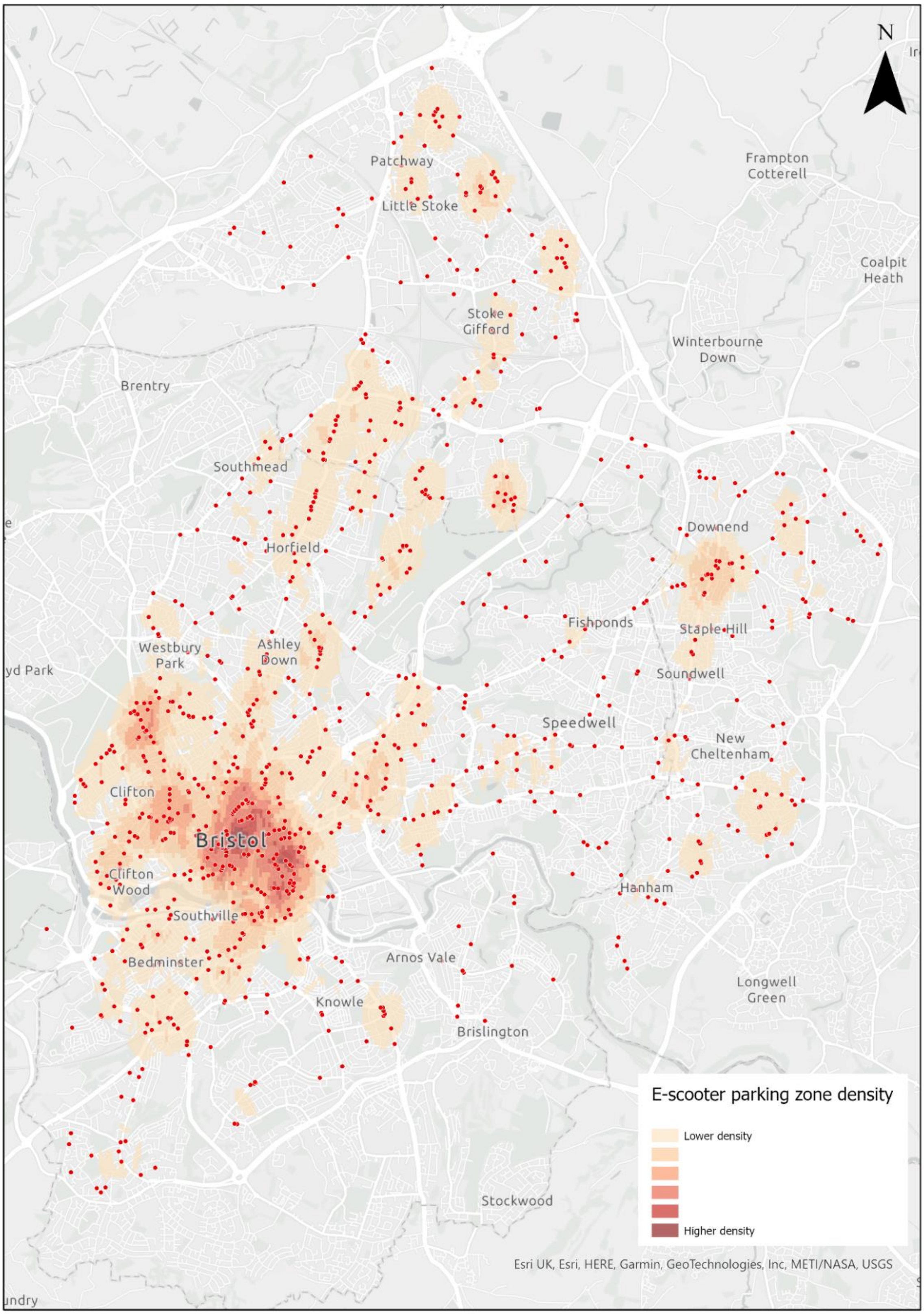


Figure 9-2: Parking locations and density, Bristol (source: trial operator, January 2022)

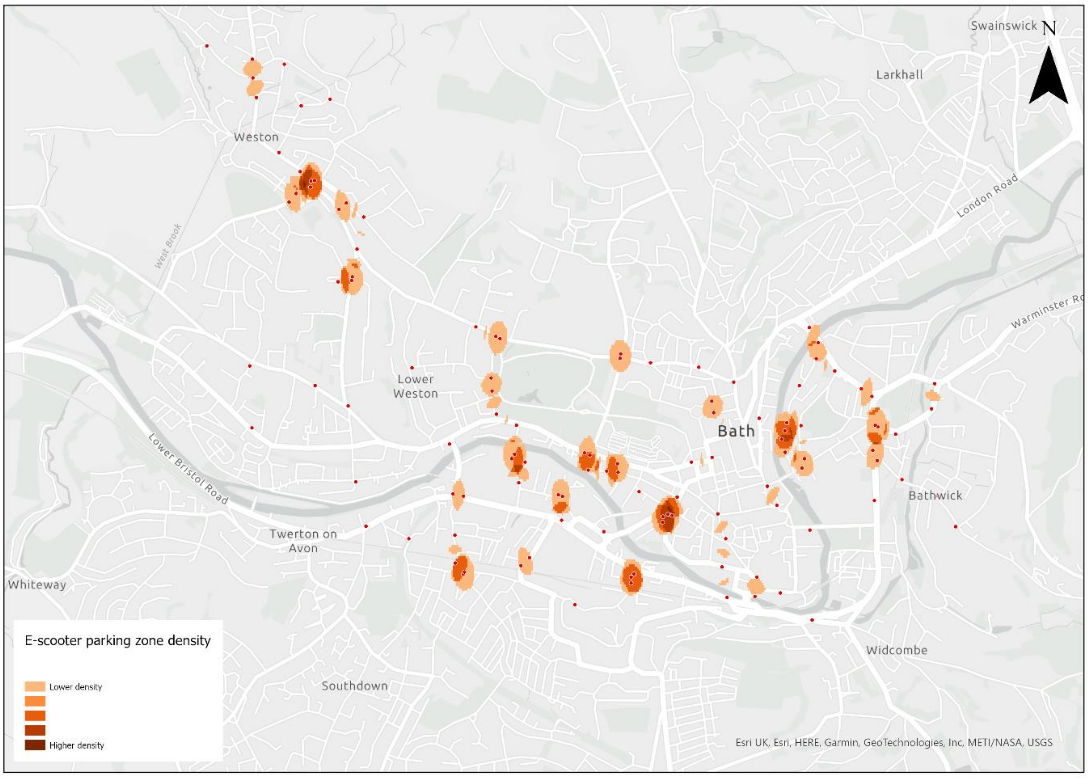


Figure 9-3: Parking locations and density, Bath (source: trial operator, January 2022)

The sizes of the designated parking areas vary significantly as shown in Figure 9-4 and Figure 9-6 for Bristol and Bath respectively. In Bristol, the median size is 23.3 square metres, with 25% of the locations being smaller than 12.4 square metres, and the largest 25% of locations being larger than 57.1 square metres. The number of e-scooters in the median size of 23.3 square metres is therefore in the order of 33 to 35 e-scooters, but quite possibly less than that with untidy parking.

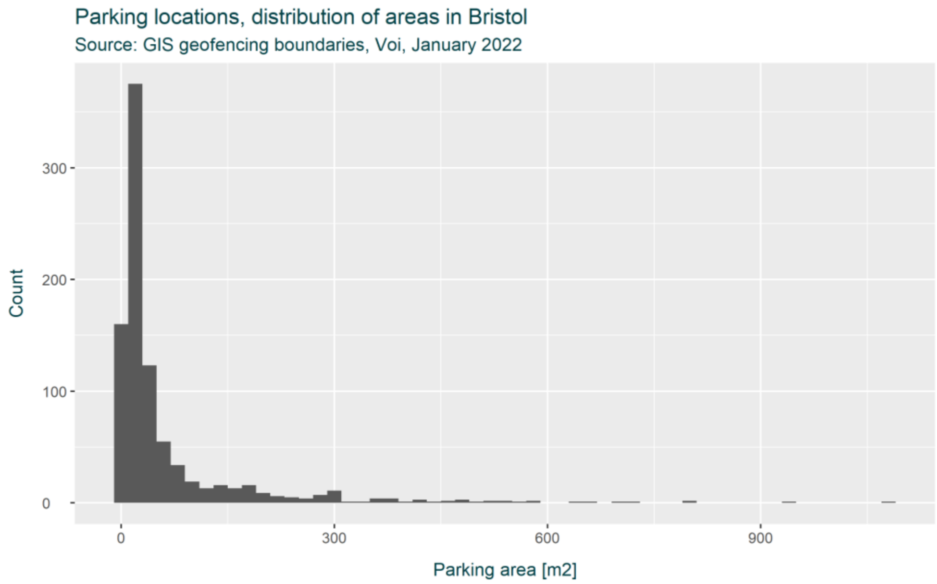


Figure 9-4: Parking areas size distribution in Bristol

On the high end of the spectrum, 15 of Bristol's zones have areas above 500m^2. All but one are located in the North Fringe (see Figure 9-5 below), and are defined as circles, as opposed to polygons as seen in the rest of the city.

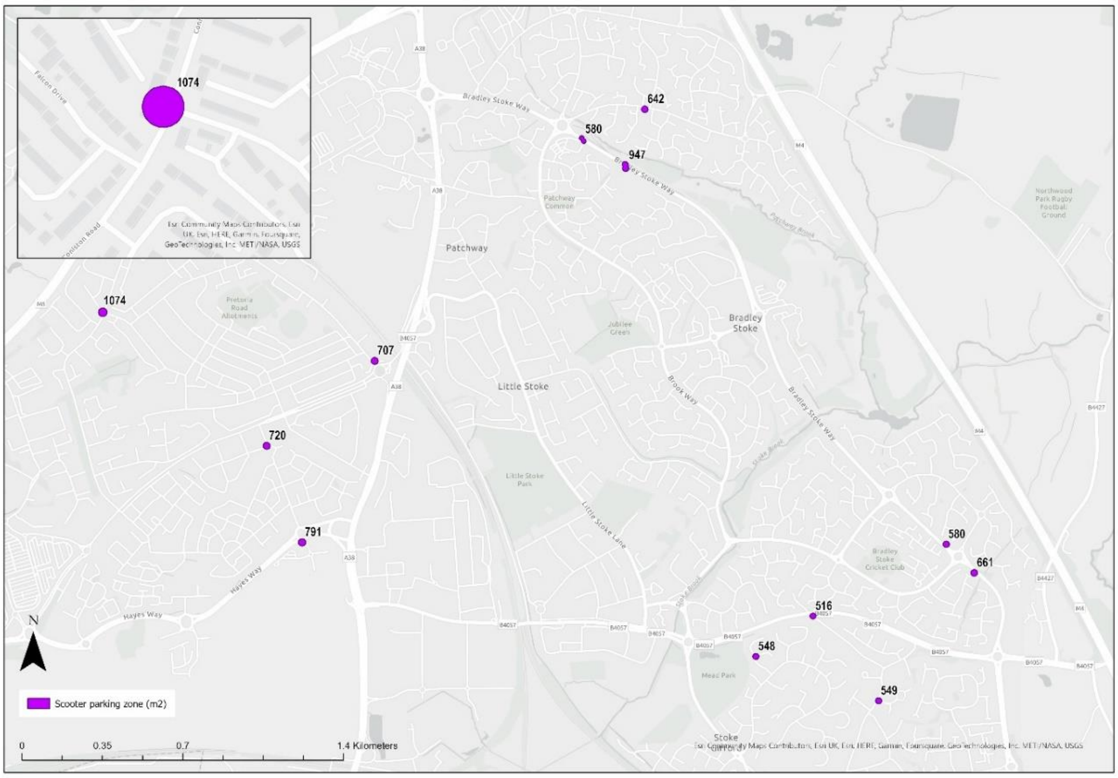


Figure 9-5: Location of the parking areas above 500 m²

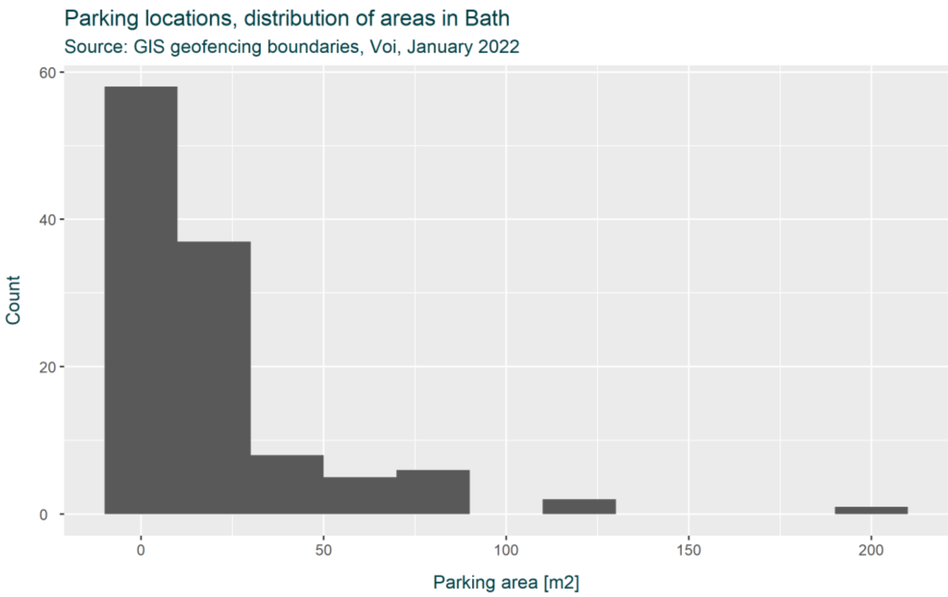


Figure 9-6: Parking areas size distribution in Bath

9.4 Parking compliance

Parking compliance was examined in three ways. First, the trial operator's summary reports relative to parking decisions were assessed, and this includes a discussion of the methodology used and its limitations. Second, on-street surveys were undertaken as part of the evaluation, with visits to selected locations where the number and disposition of the e-scooters present was noted. Thirdly, an analysis was undertaken focusing on the layout of the parked e-scooters in relationship to the footways for four sites for which there was video observations available from the interactions video footage (see Chapter 4). The data were collected from fixed overhead cameras at the following sites: Site 1 Castle Park / Bristol Bridge; 4 (two camera positions) Queen's Avenue / Queen's Road; and Site 5 Zetland Road / Gloucester Road / Cheltenham Road. These four sites indicate the range of parking behaviours across the range of users parking at these sites. They may not exemplify the full range of problems and issues that could occur at e-scooter parking sites. The results from the three analyses approaches are presented below.

9.4.1 Operator's data

A sample of so-called 'Parking Assistant' summary reports has been received, and the total number of fines and strikes during the trial. The data fields are as follows: city; decision on parking quality (i.e., 'illegal parking', 'not ideal parking', 'good parking', 'bad photo'), week of the year, and number of decisions by type. A 'bad photo' means that the quality of the parking cannot be determined.

The 'Parking Assistant' data is manually coded by an agency working for the trial operator, but we do not have the handbook provided to staff to undertake the coding. There are few decision options the person checking the quality of the parking can make, and the main differentiation of interest is likely to be between 'good parking', 'not ideal parking' and 'illegal parking'. The decision considers how the e-scooter is parked within a given bay, without considering the geometry or placement of the bay itself, which has been already agreed between the trial operator and the local authority.

Further understanding of the processes would be revealed by the handbook. However, it is understood that users can ring up when they are having trouble parking, and the assistant will allow a 'manual ride end', which may not then be within the boundary of a parking location. It is not clear whether a photograph is taken in this instance. Such 'manual ride ends' could account for the relatively higher proportion of inappropriate parking that is generally observable on the street. Additional data that would be required to validate this supposition of widely scattered parking being linked with manual ride ends would require further data to be supplied by the trial operator.

It should be noted that, after an e-scooter has been parked, it may then be moved by another person, perhaps often a member of the public. An e-scooter may also be knocked, perhaps resulting in it falling over, sometime after it has been parked, and e-scooters will be more vulnerable to this if they are parked on a slope.

The quality of fines and strikes data will vary over the trial period and this is because of the migration from one system to another during the currency of the trial. The subsequent system allows additional information to be captured in a more systematic way. Ambassadors were people supported by the trial operator to help enforce good behaviour amongst e-scooter riders. Ambassadors could request a strike for a rider for poor parking. The number of ambassador-related strikes will be determined in part by the number of ambassadors operating in an area on that day. However, no data on ambassador related-strikes has been made available to the evaluation team.

The assessment of the quality of the park relies in large part on the judgment of people assessing the photographs. Both 'good' and 'not ideal' parking require the e-scooter not to be 'obstructing anything' and allow for the passage of a wheelchair and pushchair. Thus, it is the Parking Assistant who is deciding whether the remaining space for pedestrians is sufficient. This is a challenging task because it implies that they have to visualise the width of a wheelchair or a pushchair and consider the remaining width available relative to other possible obstructions (for instance, the presence of an uneven surface which could constrain the available width usable by a wheelchair or push-chair, or someone with limited mobility). It should also be noted that footways usually allow pedestrians to walk side-by-side and to cross paths with other pedestrians. The assessment of what is good or acceptable parking does not consider the fact that e-scooters might narrow the path in a way that makes the more usual free movement constrained or even impossible. Also, a visually impaired person, whether accompanied, using a white cane or a dog, will require greater widths than a non-visually impaired person. A 'good parking' decision requires an accompanying dimension of tidiness to be expressed, as follows:

> 'The scooter is neatly parked in a painted parking spot for scooters or in a rack'. Even if the position within a parking spot or rack may be determined objectively, 'neatly' is more qualitative in nature.
>
> 'The scooter is standing orderly next to other [trial operator] scooters (the scooter in question is neatly standing next to other scooters, facing the same direction)'. As noted above, 'orderly' and 'neatly' are subjective.

In some instances, compliance cannot be judged because of a 'bad photo' having been submitted.

Parking compliance data are available from 27th December 2021 to 4th April 2022. The parking decisions taken by week (smallest time disaggregation) are presented in Figure 9-7. Overall, 88% of all submitted photos were classified as 'good parking', with a minority classified as 'not ideal parking' (11%). There are virtually no 'illegal parking' decisions (444 out of 995,911 decisions, or 0.045%), and just over 1% are classified as 'bad photos'.

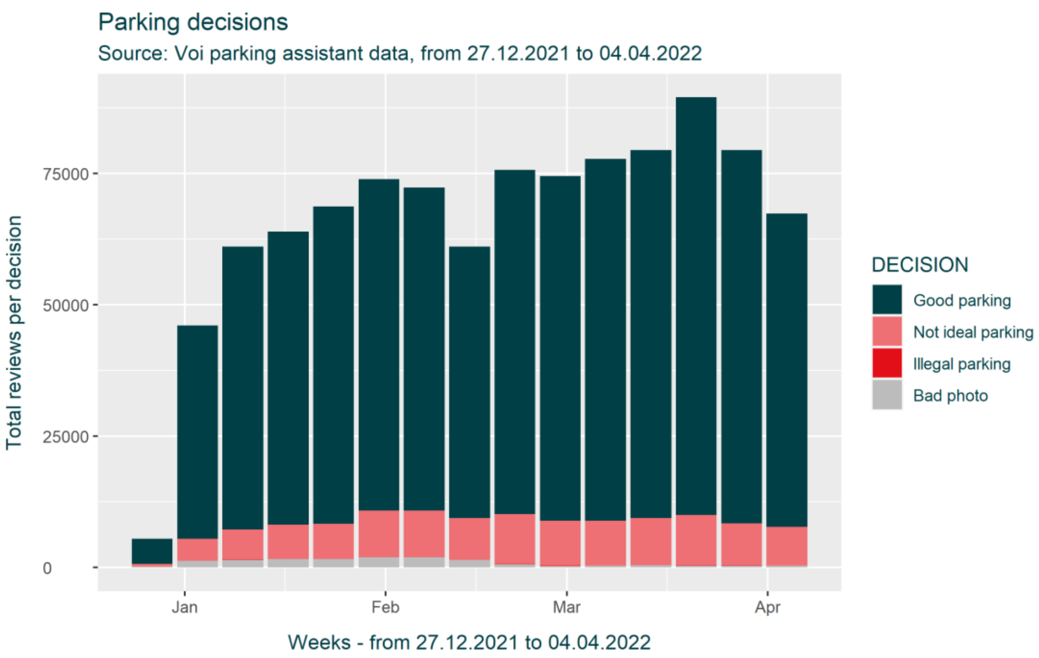


Figure 9-7: Parking decisions by week

The proportion of parking decisions of each type has remained largely constant throughout the period for which the data were available, as shown in Figure 9-8.

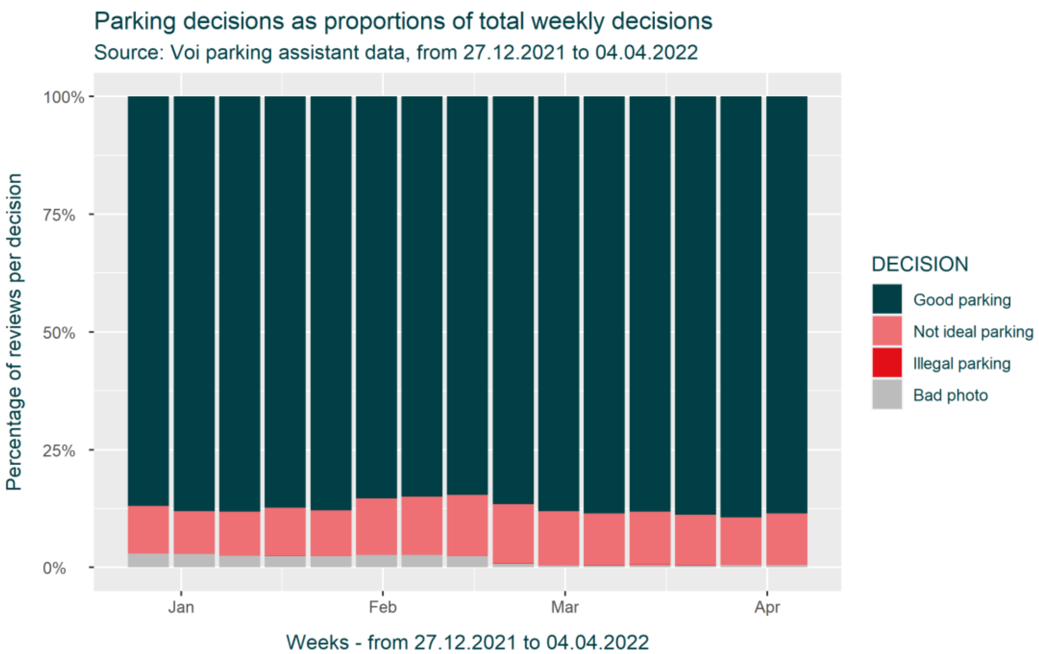


Figure 9-8: Parking decisions by week as proportions of total weekly decisions

Evidence from general observation of the evaluators suggests, however, that instances of e-scooters parked in a way that could block the passage of a person using a wheelchair or a mobility scooter are not as exceptional as the data suggests. Further investigation, examining pedestrians' perceptions of barriers, is therefore needed to put into perspective the parking decisions recorded in the trial operator's system. Accessibility audits on the ground, including objective measures of space available, will build a more comprehensive picture of the quality of parking. These surveys are discussed in subsequent sections.

It should be noted that while 'ideal' parking is theoretically neutral to pedestrians (i.e., it does not decrease or improve the quality of the walking environment), less-than-ideal parking can decrease the pedestrian amenity or even constitute barriers to walking. In the case of e-scooters, the assessment of the nature of good parking relies on the photograph-based subjective evaluation based on a simple set of rules which do not include important aspects such as the manoeuvring needs of people using mobility scooters or assistance dogs, or the fact that e-scooters, while leaving sufficient space to pass, might force people to deviate (which is particularly complicated for visually impaired people).

Photos are not available to the evaluation team and so it is not possible to match the decisions that have been taken with the resulting category applied. Thus, it has not been possible so far to cross-check the qualitative assessment. However, the information gleaned from the analysis of the trial operator data has been used to assist in planning primary data collection in relation to parking.

9.4.2 On-street surveys

Data collection has been described in Section 2.1.6. and comprised of beats at three locations. Across the surveys, 842 e-scooters were recorded. Of these, 11 (1.3%) blocked the pathway (i.e. leaving less than 900mm of usable footway width) and 133 (15.8%) were located on pedestrian pathways (leaving enough space to pass but forcing people walking to deviate around them). The proportion of e-scooters parked on major pedestrian pathways (either blocking or forcing a swerve) varied from 12% of the e-scooters present (Broadmead, on the 18th June 2022) to 21% (Stokes Croft, on 30th June 2022). An overview is presented in Figure 9-9. It should be noted that the Broadmead circuit encompassed mainly wide footways, often with locations for e-scooter parking away from the main pedestrian paths. Stokes Croft, on the other hand, has narrower footways of widths more comparable to those found more widely within Bristol. The designation 'present' indicate the number of e-scooters present on site at the time of the survey.

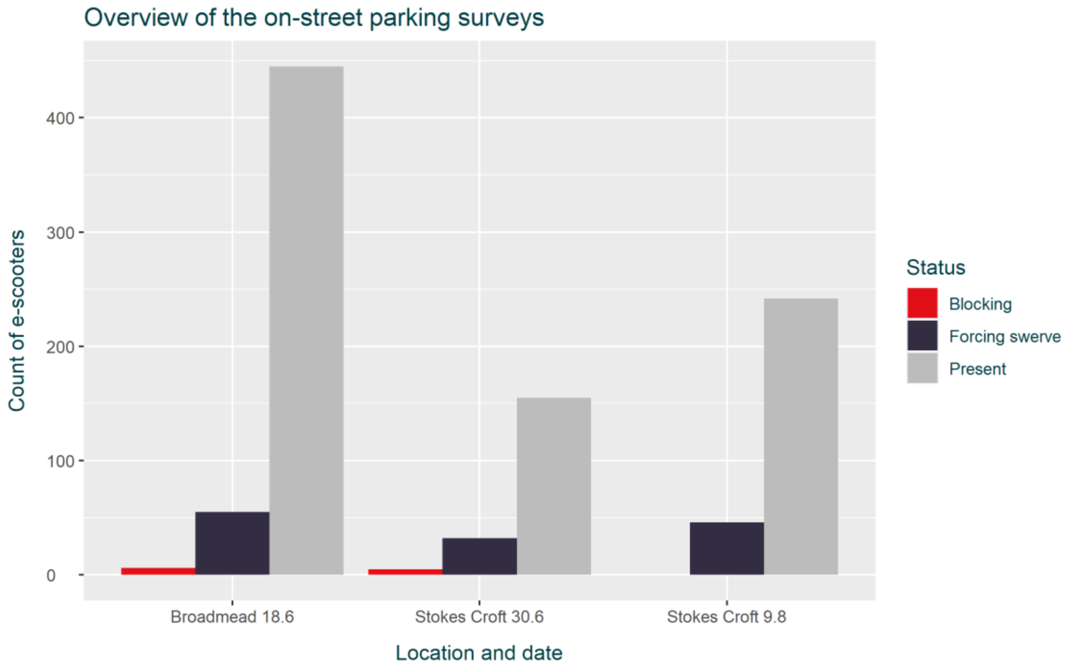


Figure 9-9: Numbers of e-scooters causing blocking and swerving at the survey sites

As noted previously, the assessment of whether e-scooters were parked within pedestrian pathways relied on the researcher's assessment of both the e-scooters' position and the walking pathways, as observed in the field.

Given the results from this exploratory study, which reveals up to 21% of e-scooters parked within pedestrian pathways on narrower footways, the investigation of e-scooter parking disposition was pursued further by examining in more detail four parking locations over periods of three to four days, using video footage. This analysis is presented below.

9.4.3 Video surveys of parking locations

Analysing parking locations over a period of time reveals insights into the 'life' of the e-scooters in public space. While data from the trial operator could provide a full overview of the positions and statuses of the e-scooters (so-called ping data), video footage of e-scooter parking provides a much richer source of data about how users and non-users interact with the e-scooters when parked.

The results are summarised inTable 9-1: Overview of the sites, filmed periods, and obstruction periods Table 9-1. There was a wide range of proportions of the overall period when e-scooters were interfering with the walkway, from 5% (intersection of Castle Park and Bristol Bridge) to 100% of the period observed (intersection of Queen's Avenue and Queen's Road, and intersection of Zetland Road, Gloucester Road, Elton Road and Cheltenham Road). These disparate proportions of time when there was interference indicate that there is an important role to play in the selection of parking locations and the definition of their boundaries. Users' behaviours and to a lesser extent the behaviours of passers-by also influences interference.

Table 9-1: Overview of the sites, filmed periods, and obstruction periods

Location		Videoed period						Interferences w walkway	
		Start		End		Time [h]	Time [days]	Time [h]	Time [%]
Castle Park at Bristol Bridge		29/6/22	23:06	4/7/22	00:37	98	4.1	4.9	5%
Queen's Road	by RWA*	29/6/22	23:04	4/7/22	00:29	97	4.1	54.6	56%
	Queen's Ave	29/6/22	22:56	2/7/22	17:43	67	2.8	66.7	100%
Gloucester at Elton Rd		29/6/22	19:50	2/7/22	14:35	67	2.8	66.7	100%
Total						**328**	**14**	**192.9**	**59%**

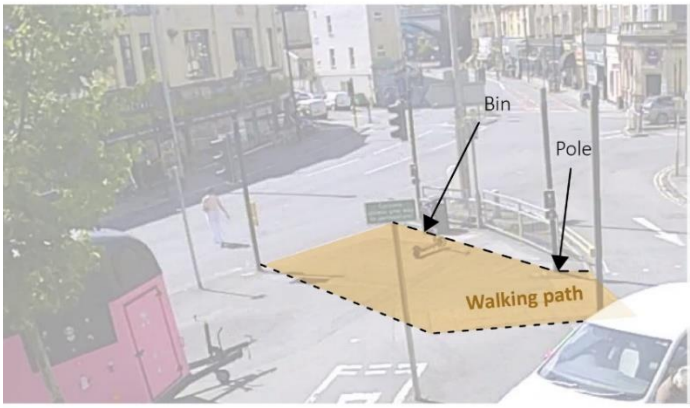
* Royal West of England Academy

Figure 9-10 presents a discussion of the design of the e-scooter parking at the intersection of Zetland Road, Gloucester Road, Elton Road and Cheltenham Road. It also provides a 'story-board' relating to the action of one person ending a ride at this location and the story-board of non-users at the intersection of Castle Park and Bristol Bridge. Appendix 4 provides similar images and discussion of design and behaviour at other sites. Design and behaviour related issues are now discussed in turn.

Design-related issues include parking locations positioned in a way that leave insufficient space for walking, and force pedestrians to deviate from their desired path. This is illustrated in the first example in Figure 9-10 below at the intersection of Zetland Road, Gloucester Road, Elton Road and Cheltenham Road. Amongst the four parking spots observed, two (Gloucester Rd and Queen's Rd by Queen's Ave) are designed in a way that makes it almost inevitable that parked e-scooters will interfere with the pedestrians' desire lines.

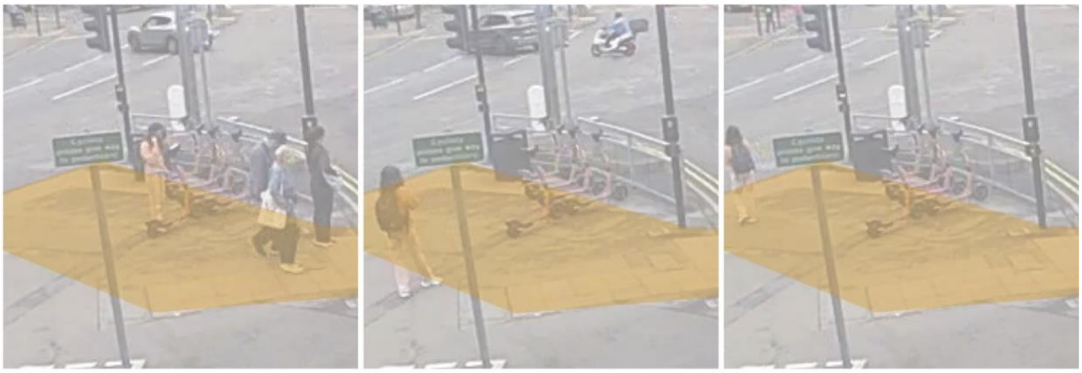
Illustration of issues relative to design, users' actions, and passers-by actions

Design as systemic issue - example: Zetland Rd, Gloucester Rd, Elton Rd and Cheltenham Rd



The e-scooter parking is intended to be along the pedestrian barrier. Scooters positioned closest to the railing and perpendicularly to it are almost automatically partly impinging on the direct walking path between the two crossings (delimited on the railing side by the the two poles and the bin).
In this case, users were also observed to leave scooters by the pink trailer, probably assuming this was the correct location. This behaviour also points to deficiencies in marking boundaries only by geofences.

Users's actions - location described above, 1.7.2022, 14:02



A person left their e-scooter in the way after a ride, although enough space was available (and other scooters were present). The absence of a physical marking might contribute to users not being clear where the intended parking areas are. The whole body of the e-scooter is on the defined walking path (which was previously reduced by the rear part of the e-scooters parked as intended).

Passers-by actions - example: intersection of Castle Park and Bristol Bridge, 3.7.2022, 01:36

A person (part of a group of three) pushed one of the parked e-scooters over a short distance and toppled it onto the defined walkway. A number of people walked past / around until someone moved the e-scooter out of the way.

Figure 9-10: Examples of issues relative to design, users' actions, and passers-by actions

Users' actions also have an impact on the walking space. This is because users decide how to park the e-scooter. The result can be seen as more or less (according to the operator's terminology) 'neat' parking, with neat parking being positioned wholly within the parking location and aligned with other e-scooters. Poor parking may result from simple negligence on the part of the rider. However, it may result from a general lack of observation and understanding of ways that the e-scooter might obstruct the walking path. In the absence of physically marked parking areas, users might struggle to be sure about where they are supposed to leave the e-scooter.

Actions of passers-by were relatively rare, that is to say most of the people observed in the footage walked past parked e-scooters without interfering with them. However, sometimes a passer-by needed to move around e-scooters either parked within a designated parking zone or left partially or fully across the walking path. Sometimes that had to walk around e-scooters that had toppled. Relatively few examples of interaction were noted, but where they were observed, they included toppling an e-scooter (last example in Figure 9-10 above), falling onto a row of e-scooters and walking away (see Appendix 4), or the pro-social behaviour of picking up e-scooters others had left in the way (also see Appendix 4).

Issues relating to parking location choice and extent, users' actions, and passers-by actions are inter-connected. This is because parking locations that leave little room for error also requires users to park in an extra-careful way. This is compounded by the absence of marked parking areas which may make it difficult for users to ensure they have parked fully within the parking location boundary. Similarly, the proximity of the parking location to the walking pathway increases the risk of an e-scooter being toppled accidentally by a passer-by. Users' actions might exacerbate the problems of such proximity as a result of e-scooters 'sticking out' (as shown in the last example in Figure 9-10 above: the e-scooter moved by a passer-by was already standing perpendicularly to the others and away from them, just on the edge of the defined walkway).

While the methodology adopted for this analysis is objective and reproductible, there is a limitation. While e-scooters' positions are examined in relationship to assumed boundaries of the walkway, which are often the same as built environment boundaries, pedestrians' pathways may not always be parallel to, or reference from, such boundaries. So, while these boundaries are precise and objectively measurable, the typical boundaries of a pedestrian's pathway may not be so precisely objectively measurable. This was observed in Castle Park, where, having the space, pedestrians often deviated from the most direct route: they veered sometimes towards the river and sometimes away from the river and this was possibly linked with the direction of their general gaze at the time. By contrast, visually impaired pedestrians will rely more heavily on built environment boundaries to assist them in navigating a pathway. Hence, overall, it may not be possible when defining a parking location and its boundary simply to make that definition in relation to other features of the built environment, but rather also with reference to the actual pathways that pedestrians might typically adopt in that locality.

9.5 Summary

E-scooters are required to be parked within geofenced areas. The distribution of parking bays is non-uniform across the region, with the majority being concentrated in Bristol City Centre. The trial operator classifies parking for compliance purposes as either ‘good’, ‘not ideal’, or ‘illegal’. This is judged from photographs submitted by the user. The parking decisions taken by the trial operator show that 88% of all submitted photos were classified as ‘good parking’, with a minority of ‘not ideal parking’ (11%), virtually no ‘illegal parking’ decisions (less than 1%), and just over 1% of ‘bad photos’.

While ‘ideal’ parking should have no impact on pedestrians, there are occasions where such parking may have an impact. Anything less than ideal parking is likely to reduce the quality of the walking environment to some extent. The methodology and data (including, for example, photographs) used by the operator to judge parking quality are not available to the evaluation team, and so it is not possible to judge the quality of the assessments being made by the operator.

The observations undertaken on street and using video footage show that e-scooters can interfere with pathways for walking, sometimes for extended periods of time. This interference is caused by the locations and the boundary of the parking location being inappropriately close to pedestrians’ pathways, and this can be exacerbated by users’ parking badly, and also sometimes the actions of passers-by. This aspect is particularly important in the light of inputs gathered from walk-along interviews, suggesting that some people might have difficulties navigating around those e-scooters while for others the situation gives an “unkempt” look to their streets. Ideally, parking locations should be defined in relation to pathways pedestrians adopt rather than just in relation to fixed built environment boundaries.

10 INTERVIEWS WITH STAKEHOLDERS

This chapter summarises the interviews that took place with stakeholders. The interviews were designed to provide primary data and supplement other forms of analysis undertaken in the evaluation. They provide evidence relating to the following research questions.

2f Network performance: How have e-scooters impacted the operation of the road network?

3c Complementary applications: How has the e-scooter fleet provided data and information for other applications and initiatives? (e.g., air quality monitoring)

4a Parking: What different parking measures have worked best (and less well) and why?

4b Highway: What highway characteristics (e.g., traffic volume, speed, provision of a cycle lane etc.) have affected e-scooter operation and safety?

4c Digital infrastructure: How well has the e-scooter monitoring systems worked to give us the information we need?

4d Licensing and regulations: How effective have the legislative, regulatory, and licensing frameworks been?

4e Commercial models: How commercially sustainable has the trial been for the operator, the West of England Combined Authority, and the Unitary Authorities?

4f Operations and governance: How has the management, operation and governance contributed to a successful trial?

4g Communications / education: How effective has engagement been with both e-scooter users and wider stakeholders?

Chapter 2 outlines the methodology for stakeholder selection, the processes of the interviews and the method of analysis. In addition to that, the outline of the interview questions is given below.

Safety (2f and 4b)

- What is your opinion of the suitability of different types of highway infrastructure for e-scooters? (e.g. on-carriageway cycle lanes, separated cycle tracks, spaces that are shared with pedestrians)
- How do you think different highway features have affected e-scooter operation and safety? (e.g. specific junction types, types of crossing)
- (4b) What highway characteristics have affected e-scooter operation and safety (e.g. traffic volume and speed, specific aspects of infrastructure provision of lack of provision)?
- (2f) Have e-scooters impacted the operation of the network, if so, how?

Parking (4a)

- What is your opinion of the different measures to provide for and manage and control e-scooter parking that have been introduced during the trial? (e.g. designated parking on footways, on carriageways, in e-scooter racks etc.)
- (4a) Which measures have worked best and why?

Digital infrastructure, applications and user engagement (3c, 4c and 4g)

- (4c) How effective do you think the digital infrastructure underpinning the trial has been? (the app, the payment mechanisms)
- (3c) Has the e-scooter fleet provided data for other and information for other applications and initiatives? If so how?
- (3c) Do you have any thoughts on opportunities for linking e-scooter data/info to other novel transport applications?
- (4g) How do you think different forms of engagement between e-scooter users and the operator/WECA/local authorities have affected the performance of the trial?
- How effective do you think messaging (e.g. in-app safety messages) has been?

Regulation, commercial and management issues (4d, 4e and 4f)

- (4d) How effective have regulatory and licensing arrangements been? (e.g. the process of determining the area of operation, parking locations etc.)
- (4e) How well do you think the trial has performed financially for the operator, WECA and the UAs?
- What future commercial potential do you think the scheme has?
- (4f) What is your opinion of the way the trial has been managed?
- How well has the scheme operated overall?
- How well do you think the trial has been monitored? (e.g. by the highway authority, the police, WECA etc.)

In summary, 15 stakeholders were interviewed in ten interviews drawn from seven organisations (Bristol City Council, South Gloucestershire Council and Bath and North East Somerset Council), the West of England Combined Authority, Avon and Somerset Police and Fire and Rescue, and the trial operator. The interviews took place on-line by video conference between the 11th and 27th October 2022. Notes were taken of the interviews, and these were supported by transcripts generated by the on-line software.

The notes and verbatim quotes from each transcript were written up thematically under the headings of each of the evaluation questions noted above. The rest of the chapter is grouped into four sections as follows: Safety and network performance (which deals with evaluation questions 2f and 4b); Parking (4a); Digital infrastructure, applications and user engagement (3c, 4c, 4g); and Regulation, commercial and management issues (4d, 4e, 4f).

The chapter reports factually what was said in the interviews. Discussion of the findings takes place in the discussion chapter, which is ordered according to the evaluation questions. Other relevant evidence, drawn from other evidence gathered as part of the evaluation, is also discussed in that chapter.

10.7 Safety and network performance (evaluation question 4b and 2f)

Safety was the subject discussed, along with parking, to the greatest extent by stakeholders in the interviews. This section is divided into comments relating to infrastructure, rider behaviour, rider skill, speeds and gradients, the recording of collisions, and finally network operation.

Infrastructure

Stakeholders generally did not see any problems with e-scooters using the same infrastructure as cycles. This was based on the risks being imposed by e-scooters on other road users being seen as similar to those imposed by cycles. A stakeholder noted that they are 'way off the provision' of wide scale infrastructure that is needed for e-scooters.

Design standards. One stakeholder noted that anything that meets the Local Transport Note 1/20 Cycle Infrastructure Design standard (LTN 1/20) is 'absolutely fine' for e-scooters. By contrast, another stakeholder suggested that there is no evidence that LTN 1/20 design principles are transferable to e-scooters, and this, in their eyes, is linked with the e-scooter's size, and centre of gravity. Another stakeholder noted that 'even a very small lip on a flat kerb, it's enough to have you off a scooter'. This was linked with a realisation that such transitions should be flush for cycle traffic and that designers and installers do not 'get it right' for cycle traffic a lot of the time. One stakeholder made the point about the adequacy of the infrastructure in relation to the volume of e-scooters that are being used, and that stakeholder suggested that the current infrastructure is not fit to deal with these volumes.

Surface quality. There was concern from other stakeholders that the smaller wheels of an e-scooter, as compared with a cycle, result in less stability because of the smaller resulting gyroscopic effect. The consequence is that e-scooters are more susceptible to poorly maintained infrastructure than cycles. The point was made that local authorities are challenged by a lack of funding and so are limited in the amount of maintenance they can undertake on roads for drivers 'let alone' cyclists. A stakeholder noted that e-scooters need to fit into a hierarchy for matters such as maintenance, and that would then be a further policy issue for local authorities to deal with and make decisions on. Another stakeholder pointed out that the standard of reinstatement by utility companies is not good enough currently for human-scale vehicles and needs to improve.

Separation from other street users. One stakeholder noted that shared space has the 'most likelihood of being sub-standard for anyone wishing to ride an e-scooter'. Conflict with pedestrians was noted as an issue unless there is a separate 'path' which is clearly split so that one part is for pedestrians and the other for cycles and e-scooters.

Another stakeholder noted that e-scooters ought to be provided with separate lanes from motor traffic. The same stakeholder made the point that some roads are 'technically' not 'wide enough to allow for extra modes to be travelling along' them. Based on a separated network of routes, one stakeholder made the point that there needs to be thought given to the locations of crossing points within the network, using signalised and other types of crossings.

Scheme extent relating to road rurality. The extent of the scheme was discussed in relation to the rurality of some roads, especially in the South Gloucestershire area. The points made by stakeholders about needing to limit the geographical extent of the e-scooter trial area were based on posted speed limits, and the geometry and other layout features of rural roads, such as the absence of footways. One stakeholder graphically made a point about the consequences of speed differential between e-scooters and speeds of other vehicles on rural roads.

Junctions. One stakeholder noted that, as for cyclists, roundabouts are locations where e-scooter riders are likely to feel more vulnerable. In the context of a recognition that infrastructure needs to be improved in extent and quality, one stakeholder said that efforts need to focus on junctions.

Rider behaviour

The point was made that, as well as having appropriate infrastructure, there needs to be appropriate use of the infrastructure by the rider, and a recognition by the rider that they are using a motor vehicle, and hence that the rider needs to abide by the relevant regulations.

One stakeholder noted that most people they see are riding well. Another stakeholder categorised users in three ways: a) 'the ones that wear a helmet and are a little bit more understanding of other road users'; b) 'other people that think they're just on a scooter'; c) 'those that deliberately just use the scooter as a means for them to get from A to B as quickly as possible, irrespective of what traffic and infrastructure there is [around them]'.

Another stakeholder noted that it is a 'lot harder to predict' e-scooter rider behaviour than driver behaviour, implying there is a greater degree of variability in behaviour amongst e-scooter riders than drivers of motor vehicles. They also noted that in the UK there is a 'very loose and free way' of behaving as pedestrians as compared with pedestrians in other countries. The suggestion was then that e-scooter rider behaviour will also slip into a mode of the rider asking themselves "'can I do this?' rather than 'should I [do this]'".

These observations about behaviour were corroborated by another stakeholder who suggested that there is a natural part of human psychology that makes people behave like a pedestrian, and suggested that this may explain why e-scooter riders may appear to behave like pedestrians. This cross-over behaviour was corroborated by another stakeholder who noted observing e-scooter users who, when the traffic signal aspect is at red, will use the pedestrian crossing and then re-join the carriageway on the other side of the junction. One stakeholder noted that there is a prevalence of footway riding which causes issues for pedestrians. Another noted that this has been one of the biggest issues for the trial. There was concern expressed by another stakeholder at the lack of reporting of this, restricting the ability to take action.

A stakeholder suggested that e-scooter riders seem to take up the road space more naturally, whereas cyclists are more hesitant to move into a dominant position in the road. Despite this quite appropriate behaviour, another stakeholder noted the potential for a lack of understanding that an e-scooter rider is in charge of a motor vehicle. Indeed, in relation to riding while intoxicated, some users, it was suggested by one stakeholder, may think they are 'doing the right thing' by using an e-scooter rather than driving.

Two stakeholders discussed the apparent (to them) greater tendency, compared with cyclists, for e-scooter users to be in a group. The suggestion was that there are no particular problems with this. Another stakeholder did see issues with group riding because of the natural urge of someone at the rear of a group not wanting to be left behind when, for example, a signal aspect changes to red. On the other hand, one stakeholder noted that there is no evidence from the data available that group riding is particularly prevalent or an issue, but this was in relation to problems which may arise at the ride end linked with parking.

One stakeholder noted that there is 'no regimented requirement for safety equipment' use. The issue of personal protective equipment was not however a topic that was frequently brought up by stakeholders.

While one stakeholder suggested that most of the issues with safety are to do with rider behaviour rather than infrastructure design, **most stakeholders recognised the interplay between design and**

behaviour. One stakeholder said that in 'areas where there is really good infrastructure, you tend to see a very different culture in terms of usage of micromobility.'

Rider skill

One stakeholder noted that they see riders 'wobbling all over the place' and they thought this may be linked with the need to re-familiarise with the technique of riding when a rider first steps back on an e-scooter. One stakeholder noted, interestingly, that when riding a cycle and they have potential worries about a following driver's behaviour, they tend to deliberately wobble to encourage the driver to give them a 'bit more space'.

An app-based reaction test was brought in by the trial operator to assist in reducing riding while under the influence of alcohol. The test is for guidance to the would-be rider, and it is not mandatory to pass the test before riding. One stakeholder noted that it is possible to undertake the test a number of times and that it is therefore possible that people may be able to ultimately pass the test as a result of simply keeping on re-testing themselves. By contrast, another stakeholder noted that the reaction test seems to have had an impact, which is why it has been rolled out and used more. One stakeholder summed the matter up as being that **a mandatory reaction test is something that needs to be worked on.**

Speed and gradients

One stakeholder emphasised the problem of risk linked with speed as being 'if the difference between the average speed of two vehicle types is too wide, it becomes problematic'. A number of stakeholders picked up on differences in speed between e-scooters and motor traffic. The case where an e-scooter might be passing traffic in a queue of motor traffic, which then itself picks up speed was noted. The stakeholder thought that the driver may then consider that they 'can and should in their mind overtake e-scooters that are going slowly'. The stakeholder noted that this is a problem.

One stakeholder noted that e-scooters 'solve' the issue with non-powered bicycles because they 'even out the topography and mean that you can maintain a more steady (sic) speed'. It was noted by a stakeholder that there appears to have been social media discussion on the capabilities of the e-scooter in relation to hills. The same stakeholder noted that there is probably more potential for people to take up e-scooters compared to pedal cycles just because they need less effort from the rider when travelling uphill. Another stakeholder noted that a pedal cycle is limited to however fast that person can pedal uphill, but it is possible to travel downhill much faster, hence leading to a large speed distribution. By contrast, it was suggested, an e-scooter travels at a more consistent speed. Another stakeholder thought that most serious injury may be occurring on downhill sections of route. They also thought that even though the motor will not be powering an e-scooter to more than 12.5 mph, the e-scooter itself may travel faster than that due to gravity, even without being powered.

The West of England trial has capped e-scooter speeds at 12.5 miles an hour rather than the nationally allowable 15.5 miles an hour. Although a direct question about the maximum speed was not posed to stakeholders, **there was no sense from any stakeholder that the current maximum of 12.5 miles and hour should be changed**.

Recording of collisions and infringements

The police have been establishing protocols for extracting data on e-scooters from their Accident Record Book (data from which feeds into the national STATS19 collision record). One stakeholder noted the additional 'manual slog' required to identify e-scooter collisions in the record because they are not a separate vehicle type.

The fact was noted that it is highly unlikely that people riding non-trial e-scooters, that is to say, illegal e-scooters, are going to report these to the police. While there are reports of footway riding, two-up riding and anti-social riding, the data on these issues is not available through any system, but these data are unavailable anyway mainly because of lack of reporting to the police.

In summary, one stakeholder noted that the appropriate dialogue for the trial in relation to safety and collision reporting was not really in place. They also said that they were being told directly via the trial operator about collisions that had occurred, and that aspect of trial operator feedback has been very good.

Network operation

There were generally no concerns from stakeholders about the operation of the network in respect of all other motor traffic resulting from the presence of e-scooters. A more nuanced view was that the numbers of e-scooters in certain areas may cause issues at certain times of the day. One exception is in relation to a possible slightly greater impact on bus operations. Another stakeholder noted that it would be good to get the views of bus companies.

One stakeholder suggested that 'e-scooters will have increased the overall capacity on the network'. They recognised they had no evidence to back this statement up. They also noted that slightly longer journeys on foot would be quicker on an e-scooter and that e-scooters allow a traveller to reach closer to their ultimate origin and destination than other modes do, both of which are effectively network efficiency improvements.

10.8 Parking (4a)

Along with safety, the parking of e-scooters has been a common talking point in relation to the e-scooter trial. A major part of the discussion time in the stakeholder interviews was devoted to parking. The order of procedure in this section is as follows: parking location decision making, demarcation of parking boundaries, capacity management and management of parking behaviour.

Parking location decision making

Several stakeholders noted that development has taken place around the issue of parking over the duration of the trial. One stakeholder said that the trial was set up in a rush and footway parking was the only real option available at that time. The operator was not initially ready to set up a system that included parking locations. Note that the locations where parking occurs have variously been called areas, hubs, spots, zones and places by stakeholders. For the purposes of this reporting the generic word 'location' is used.

The highway authorities, who are responsible for managing the highway and therefore safe operation of parking locations, began the process of defining and agreeing them with the operators. Firstly, users could park anywhere, and then it evolved into a situation where the trial operator was able to put a parking location anywhere, but now it is quite tightly controlled.

The process now is that the trial operator assesses a location for suitability, and an application is submitted to the highway authority. The comment made was that whilst the governance is good, some flexibility has been lost. The challenges for the operator are navigating a rigid procedure. Originally, if someone had requested a parking location outside their house, then this would have been quick and easy to instigate, but with a procedure in place this can take a month or two to agree. By contrast, one stakeholder suggested that parking has worked better at locations where more thought has gone into its location. The implication being made is that the highway authority needs to reflect on its processes, especially in the light of the responsiveness offered as a result of the technology for setting parking locations (see the comments below on the topic of technology and boundaries). Another stakeholder noted that a **service level agreement relating to parking location decision making between the highway authority and the operator would help**.

Many stakeholders were aware that members of the public and disability groups have been unhappy about where e-scooters are **parked on the footway**. The experience of footway parking has led one stakeholder to note that it is not ideal, and the highway authority does want to move e-scooter parking into the carriageway. One stakeholder said they had a 'huge issue' around the issue of partially sighted people or people with mobility issues working their way around parked e-scooters. The stakeholder noted how much activity is geared to making streets safer and suggested the introduction of e-scooters has had a negative effect.

In relation to parking locations in the **carriageway**, one stakeholder noted that there may often be local pressure not to remove motor vehicle parking spaces within the carriageway and 'even the loss of one [motor vehicle] parking space can be really fought over'. On this basis officers were tasked to find places where there was no need to remove street parking for motor vehicles. If a regulated parking space, such as a residents' parking space is proposed to be removed to create e-scooter parking, then a change to a traffic regulation order may be required. This clearly indicates that the highway authority has a central role to play in identifying and agreeing parking locations.

There was a sense from one stakeholder that, if the scheme becomes permanent, there would be a move to carriageway parking, and for that, the corral (a metal frame which assists in demarcating a parking location boundary) would be a better solution because it would reduce the chances of e-scooters falling into the carriageway or onto parked cars. It would also funnel e-scooter users clearly towards the correct approach to the corral, and hence provide an additional degree of guidance.

One stakeholder suggested that the operator could be pro-active in approaching **third party land-owners** to agree parking locations. In this respect, supermarkets were specifically mentioned and this may require national level collaboration. As a planning matter, the creation of space within housing developments, and financial contribution towards costs from housing developers, was mentioned as a next step to be considered.

Frequency of locations. At a more holistic level, one stakeholder noted that the more parking locations there are, the better. This is because, they suggested, a higher frequency may assist in adjusting behaviours in a way that means more users are obeying the rules relating to considerate park. It would also enhance convenience for users who will be nearer to their ultimate origin and destination.

A stakeholder noted that there are places where parking provision has 'just been lacking', and that there is not a clear enough methodology for assessing where parking should be located. The point was made that there is a balance between the commercial and operational side of provision, with the suggestion being that **parking locations should deliver services within an 'integrated transport system' and be planned in that light**.

Principles. The conclusion arrived at by one stakeholder is that there needs to be an agreed set of principles for parking location approval which deals with physical matters (maintaining a certain footway width), residential density and so on. Overall, this stakeholder thought that parking could be managed a lot better through more precise **service level agreement between the operator and highway authorities to manage the location, form and management of e-scooter parking**. The main point would be **to place a requirement on the operator to keep parking 'tidy'**.

The premise has been that e-scooter parking should be additional to, and separate from, public cycle parking. One stakeholder asked the open question as to whether it should remain separate or whether in some locations it could be co-located. The answer proffered was that the decision would rest on demand for each type of parking, and this may vary by location.

Tender and contract. While some stakeholders thought that the definition and provision of parking locations was a requirement on the operator from the outset, this had not been clear in the trial tender. One stakeholder noted that any re-tender process would need to ensure that it teases out whether the operator can '[get] the parking right'.

One stakeholder noted that despite having given clear guidance on parking locations to the operator, there were many instances where unsuitable locations were being suggested, or sites suitable for a lower number were having larger numbers of e-scooters allowed to park. Problems typically occurred at these parking locations with the stakeholder saying 'the vast majority of hubs we've had issues and complaints at were ones that didn't meet our standards'. This reinforces the need to ensure that an operator can comply with standards that need to be specified in the tender.

One stakeholder said that **any further contract with an operator would need to be more explicit about parking** and **the tender process should 'tease out' operators who can and will manage the parking effectively**. In addition, th**e contract ought to have 'some teeth' in it to influence the operator's actions using financial incentives**. In a slightly different direction, one stakeholder summed up the issue as being one of the need to develop 'partnership working' between the operator and highway authorities.

One stakeholder noted that authorities generate income from car parking control. This raises the idea of payments from an e-scooter operator for the use of space within the highway for parking. Another stakeholder noted that an operator using street space for commercial services, such as a car club, is charged for use of that space.

Demarcation of parking boundaries

One stakeholder summed up the issue of the need for demarcation as 'mitigating the risk for obstruction that inconveniences people or risk of injury'. There are five ways that parking boundaries have been demarcated: a) within locations demarcated by digitally defined geofences using global positioning systems (GPS); b) white paint on the footway; c) corrals (as noted above a metal frame which assist in demarcating a parking location boundary), d) the establishment of temporary parking locations for events, and e) 'fly' parking, that is to say parking which has occurred outside defined parking areas and is against e-scooter hire rules.

Geofence systems. The quality of the GPS signal and receivers has meant that a geofence may not remain precisely static, which then means a rider cannot park within the pre-determined actual geofence. A ride that ends with the e-scooter being parked in a geofence that has moved results in more e-scooters being parked at, or around and beyond, a parking location than it is designed for.

One stakeholder said that ‘pretty much every operator I’ve spoken to says you can’t manage parking solely by GPS’. One stakeholder pointed out that it is more expensive to have devices on the e-scooter that can then receive and process more satellite signals. The stakeholder suggested the solution was alternatives and complementary systems for defining digital boundaries including transponders at parking locations, visual methods based on three-dimensional imagery, and end of ride photography. One stakeholder wondered whether there is an incumbency on the part of the public sector to assist in providing better GPS, although this was not picked up by any other stakeholders. One stakeholder suggested that GPS technologies are evolving rapidly and hence the wandering boundary problem may be reduced in future.

Even if the geofence boundary were accurate and stable, one stakeholder noted that the tolerances are such that the e-scooter may be deemed by the system to be within the boundary, but there could be a part of the e-scooter that is lying beyond the boundary. This may not be an issue in some spacious locations, but in constrained locations it could present a hazard for pedestrians.

Further to this, another stakeholder noted the seeming lack of stability of e-scooters as evidenced by the number which fall over. The point was made that the space taken up by a fallen L-shaped e-scooter is quite significant.

Physically demarcated parking. Most parking locations have not had their boundaries physically demarcated, but there are some exceptions, and these have typically been marked with white paint on the footway, and in some cases, for example on the UWE campus, using corrals. E-scooter operation has been a trial, and so the establishment of physically marked parking areas has been limited. However, there was a recognition generally amongst stakeholders that, with a permanent scheme, this may change.

Corrals. One stakeholder suggested that the corral would be the preferable solution for parking within the footway because of its greater ‘legibility’ (than simple white paint on the surface of the footway) for other footway users. The physical barrier of the corral structure ‘protects people who are walking towards these e-scooters before they get to the trip hazard place’. That stakeholder did also note that there is no horizontal ‘piece of structure’ as part of the corral on the side where e-scooters enter. The point was made that for ‘those with visual impairments who use sticks, they may miss the vertical poles at the corners’. The suggestion was that part of the physical structure of the corral running along the ground at its entrance would be identified by a long cane user. Some stakeholders were in favour of racks where the e-scooter needs to be placed in the rack and this would then mean the e-scooter is parked in a much ‘tighter position’ on the footway.

Summary. One stakeholder noted that, from research that had been undertaken, users park ‘a lot closer to the intended point’ within physically demarcated infrastructure than virtually demarcated infrastructure. Further, infrastructure, because of the capital costs, would be much better focussed on locations where there is a high demand for parking and at locations where there is high footfall.

By contrast, another stakeholder suggested that the challenges that have been experienced in relation to parking are ‘forcing us down the costly infrastructure route’, but that if parking was better managed, and users were encouraged to comply, then it is possible that infrastructure would not be needed. Another stakeholder noted that any physical demarcation of parking creates an asset in the highway and there are then issues with costs and inspections. A further suggestion by another **stakeholder was that geofencing could be used to create a parking location and, if this works well, it ought then to be formalised with physical marking**.

One stakeholder made the point that there is a lack of clarity provided to members of the public about where e-scooter parking is allowed, and this is because of the absence of any physical markings or the presence of corrals. The implication is that the general street user may be unsure about the legality of a 'bunch of scooters all parked up' on the footway.

Capacity management

Management of parking capacity. One stakeholder discussed the issue of parking caps, which is the upper limit on the number of e-scooters that can park within a geofenced area. The intention is to prevent over-crowding at a parking location. Another stakeholder suggested that a parking location should be monitored so that, if a location regularly reaches its cap, action could be taken to solve the problem, perhaps by creating a physically marked bay, or by creating other parking spaces nearby. One stakeholder said that when the capping systems works, then it is 'definitely helping'.

One stakeholder noted that there is no open data platform where someone, such as a highway authority officer, could review parking over recent time periods at a specific location. The suggestion was that that sort of 'intelligence led planning of parking' would be required if a lot of money is to be spent on creating 'formalised' parking.

Another stakeholder noted that the maximum parking cap feature within the software was developed specifically for Bristol, and that it has been improving and will continue to be a focus for development.

Public events. The public used the e-scooters in large numbers to assess public events such as the Downs Festival, the Harbourside Festival and Tokyo World. Lessons have been learned by festival organisers, the trial operator, the police and local authorities in relation to the need to plan parking for these events, and manage e-scooter provision carefully. A benefit of geofencing used for parking has been that parking provision could be adjusted to accommodate the unusual travel patterns taking place for the duration of the festival. An important point is that event organisers need to provide the trial operator with space where e-scooter parking can be located. Based on the way that e-scooters have been used at events, one stakeholder thinks that e-scooters are now 'part of the infrastructure and make up' of Bristol.

Other aspects of event management related to the disabling of e-scooters after a certain time in the evening as a preventative measure in relation to riding under the influence of alcohol, with a reaction test being brought in from a time earlier in the evening (5pm). It was noted that the disabling of e-scooters was undertaken manually, with the observation from one stakeholder that, based on this methodology, some e-scooters were overlooked and remained available for use.

One stakeholder noted that as part of the operational interventions for some events, parking near to, but not at the event location was prevented, and this was possible because of the definition of parking locations by geofence rather than physically. If they have been created physically, then this would have been confusing for users.

Managing parking behaviour

Parking quality. There are contentions around what may be defined as 'good' parking. One stakeholder noted that the definitions of good parking as used by the trial operator do not correlate with the wishes of the West of England authorities. This is because the trial operator is using a centralised system of assessing parking for all the cities where it has operations. Examples of divergence include parking that is 'next to crossings and in bus stops', which may not be picked up as poor parking by the operator, but is poor parking so far as highway authorities are concerned. On this basis the stakeholder suggested that the 'actual standard of good parking and the amount of parking in the correct place is a lot lower than [the operator's figures would suggest]'.

At one level the issue of parking quality relates to the agreed and defined locations of parking, and it was important for one unitary authority from the start that parking should not be co-located at cycle parking, but this was a less important consideration for other unitary authorities. A further issue is around the standard and behaviours of parking as executed by the riders at the end of a ride. The operator monitors the quality of parking, but many stakeholders commented that the level of poor parking appears to exceed the levels reported by the trial operator.

One stakeholder noted that more needs to be developed in relation to measures of parking quality, and this relates to the reasons why poor parking is occurring. They thought that the trial operator system is too generous to the rider when they have parked inappropriately, and it is not clear what proportion of poorly parked e-scooters are a result of abandoned rides, or not being able to finish the ride, or battery failure. One stakeholder suggested that most abandoned e-scooters are likely to be because of battery failure. This stakeholder suggested public messaging should take place in relation to abandoned e-scooters because this would assist the public in understanding why there are so many e-scooters which are seemingly abandoned.

One stakeholder noted that any technology for enhancing the quality of the parking that relies on the user to undertake a 'couple of additional steps' is when the user then ceases to engage and may simply walk away. One example is the requirement to take an end-of-ride 360° video so the location can be pinpointed.

One stakeholder suggested that it was possible to tell how recently trial operator operatives had visited the parking location, based on how tidy the parking was. That same stakeholder made the point that a parking fine or strike may be a deterrent to further use the e-scooter, with the user possibly not returning to the system in the future. If this is the case, **the implication is that it would make more sense to lay responsibility on the operator to ensure tidy parking**, rather than the operator relying on the users through instruction and dis-incentives, which may result in less future e-scooter riding by a disincentivised user.

Behavioural prompts. One stakeholder suggested prompting at the time of the parking with an image sent to the app of the precise parking location and a request to 'park it neatly'. This should assist users in knowing more precisely where they should park the e-scooters. One stakeholder noted that if e-scooter users become 'frustrated, they are likely to act more inappropriately'. The suggestion from one stakeholder was that there has been a positive behaviour change over time in relation to parking, and this is something that needs to continue to be developed through user education.

Reporting a badly parked e-scooter. One stakeholder suggested that it is not commonly known that there is a unique identifier, or registration number on the e-scooter and the suggestion was to make them slightly larger so people are aware that they are there. This is linked with reporting issues in relation to an e-scooter to the trial operator: if reporting an e-scooter, the first item requested on the trial operator website is 'Identify the vehicle you want to report by entering the 4-digit QR code located on the handle bar'. It is not clear that this is the same as the letter and number code on the rear of the e-scooter, the side of the footplate and the stem to the handlebar. A further suggestion from this stakeholder was to use the footplate as a place for clearly writing some of the most important rules for use. One stakeholder suggested that perhaps the cost of collecting e-scooters from non-designated parking areas may be a factor in what appear to be quite significant delays in removal of such e-scooters.

Control of parking by the highway authority. One stakeholder noted that it would be very useful for highway authorities to have powers to issue penalties to e-scooter users who had not parked in designated locations. However, that suggestion was recognised as coming 'with a whole can of worms', because not only does the vehicle need a registration, but there needs to be a method to link the person who committed the parking offence to the vehicle.

10.9 Digital infrastructure, applications and user engagement (3c, 4c, 4g)

This section considers digital infrastructure, links with other applications and initiatives and engagement with e-scooter users.

10.9.1 Digital infrastructure (4c)

Most stakeholders commented positively on the way that digital infrastructure has been used. It, they suggested, has provided a good showcase of how transport can be facilitated by technology to benefit users and non-users. Technology is at a point where a great deal of granular data can now be obtained, and this is valuable for planning, management and operational purposes. There are opportunities for integrating data with other applications such as mobility-as-a-service information systems and mapping companies.

Digital management. One stakeholder said that the trial has been a very useful step into realising the benefits of geofencing. This is something that the public has never seen used before on such a wide scale. There remain issues with accuracy of the GPS signal in defining boundaries for parking (as noted above), slow ride and no ride zones. This results from issues relating intrinsically to the signal and to topography and built environment features. One stakeholder suggested that these issues reflect a need for strengthening GPS at a national level, and the suggestion was that planning for GPS enhancement needs to be done in the same way as planning has been undertaken for the roll-out of fibre broadband.

The e-scooter operator manages the fleet remote from Bristol and this is on the basis that they do not need to physically go to an e-scooter to decommission it, for example. One stakeholder noted that this allows for rapid response times and could allow mass action to decommission many e-scooters if required by the highway authority.

One stakeholder pointed out that a further potential advantage of the digital nature of the whole e-scooter journey is that the location of the rider when they first consult the app can be used to identify their ultimate origin, rather than just the origin of the ride. This can assist in parking location planning, for example.

Implications for transport provision more generally. One stakeholder noted the question as to why the e-scooter alone is being singled out as a mode which is being controlled by no-ride zones and slow riding zones. In relation to a housing development a stakeholder recounted that a developer had wanted to geofence their development to eliminate e-scooters. There hence arose what the stakeholder described as ethical issues in relation to the status of e-scooters relative to other modes simply as a result of their being able to be controlled in a digital manner. Another stakeholder suggested that the app could also provide riders with a suggested route for their journey, which may vary by time of day. The implication was that the routing could be linked with comfort, safety and security considerations.

Challenges of 'digital only'. The reaction test is for guidance to a would-be rider, and it is not mandatory to pass the test before riding. One stakeholder raised the issue that it is possible to complete the test a number of times, and there is a high probability that a would-be user may pass the test on one of those occasions. The suggestion was that this is then not a useful or effective guide to users, and, on the basis that it is not a mandatory requirement to pass the test, it does not perform any sort of useful digital gatekeeping role. The suggestion was that the reaction test perhaps could be used in a more effective way. Conversely, there are opportunities, another stakeholder suggested, for more prompts at appropriate times to reinforce the message that the e-scooter is a motor vehicle and needs therefore to be used properly in relation to the rules of the road.

10.9.2 Links with other applications and initiatives (3c)

Travel data and planning. One stakeholder suggested that there is a lot that can be gleaned from using the large data sets available on travel from the trial. Data of principal benefit would be in relation to mapping routes that are popular. Other stakeholders made the point that there is a link with other modes and the link can be through a mobility-as-a-service information platform (as noted above). The suggestion is that there is a duty on the West of England Combined Authority and the unitary authorities to engage with public transport operators and taxis about any multi-model developments. The other link mentioned by a stakeholder is with mobility hubs, which are being developed as part of the future transport zone project.

Highway and traffic engineering applications. The point was made by one stakeholder that e-scooters are potentially very good monitoring devices for environmental measurements such as air quality, and infrastructure measurements such as road condition monitoring. One stakeholder noted that the trial operator had indicated that they have a pavement detection system but that it has not been operationalised in the trial area.

One stakeholder noted the potential power for investigating locations where collisions and injuries had taken place using data on e-scooter performance near the location of such collisions. These data could relate to speed, swerves and acceleration / deceleration. Such analysis could point to a need for layout changes or highway pavement maintenance. One stakeholder noted that no additional government funding had been received to deal with road surface defects such as potholes in relation to the trial. A further burden on the local authority has been in relation to insurance claims resulting from e-scooter use.

One stakeholder noted that the analysis of the data that can be collected from the rides is a massive undertaking.

Furthering evaluation. As part of the next stage of implementation of e-scooters in the West of England area, the proposal is that e-scooter hire is part of the same package as e-bike hire and e-cargo bike hire. This provides the possibility for monitoring travel behaviours, such as journey lengths and origins and destinations, on the same basis. It also provides a powerful methodology for comparing incidents per distance travelled between modes.

10.9.3 Engagement with e-scooter users (4g)

In-app communications. The primary methodology for the trial operator to communicate with users is through the app. One stakeholder noted that they were encouraged by the types of message that the trial operator has put out both in-app and on social media. They thought that it ‘hit the right note’. The messages have not been too condescending, while being kept ‘fairly young and loose’. They also thought that that the trial operator had taken responsibility to engage with users on the important topic of adhering to the rules. Messaging was used when riding under the influence of alcohol and two-up riding seemed to become an issue.

There was concern expressed by one stakeholder about whether the messaging might have reached a saturation point. However, another stakeholder noted that people seem happy with the frequency and the messages they are receiving, and that what is being ‘landed’ through the app is what is hoped would be being landed. The communication is one-way from the trial operator to the user and there is usually no comeback from riders, and, on that basis, it is not possible to say how the messaging is being received.

As noted above, one stakeholder suggested that it may be appropriate to have the rules clearly written on the footplate of the e-scooter. An especially important point made by the stakeholder in this respect is that an offence against the rules of the road is a driving offence, and hence subject to penalty.

Message acknowledgement and comprehension. Two stakeholders were concerned about whether messages are being read and understood, and the suggestion was that some messages ought to be acknowledged by the rider. The point was made that if a message is sent, for example about an issue relating to road safety or rules of the road, then acknowledgement of that message provides an enhanced legal binding on the rider. The primary concern of this stakeholder was trying to ensure that riders are aware that they are using a motor vehicle on the public highway, and this has implications. This was a concern shared by a few stakeholders.

Advice and information. One stakeholder noted the potential value in messaging through the app to tell e-scooter users about new cycle infrastructure that they should be aware of. This was extended by another stakeholder to include messaging about events, and the way these may affect the e-scooter service. The example of a half-marathon running race with road closures was given.

Areas for improvement. One stakeholder noted that the trial operator was the gatekeeper for messages, and this was problematic because the other relevant stakeholders were less able to influence message content. The implication behind this comment was that there would be benefits if it were possible for a wider range of relevant parties could take advantage of the messaging function.

In-depth surveys. Some stakeholders commented on the summer and winter surveys. Overall, there was frustration concerning the nature of some of the questions used and it was suggested that they would have benefited from discussion with a wider range of stakeholders to ensure question neutrality. One stakeholder expressed some concern at the interpretations being placed on some of the outcomes by the trial operator, because they were not seen as being neutral interpretations.

Personal training. Some users really like the engagement offered by personal training. It helps people 'enter into' using the service, especially those who may otherwise have felt uncomfortable. Another stakeholder suggested that there have not been enough follow-up surveys.

10.10 Regulation, commercial and management issues (4d, 4e, 4f)

This section summarises responses from stakeholders on the topics of regulation and licensing, commercial sustainability, and management and operations of shared e-scooters.

10.10.1 Regulation and licensing (evaluation question 4d)

Responses relating to regulation and licensing are summarised in relation to the status of the rider and the vehicle, and traffic regulation relating both the real world and the digital world.

Rider and vehicle status

One stakeholder noted that the classification of the e-scooter as a motor vehicle provided a degree of control within the trial in relation to the types of people who could use e-scooters. The stakeholder welcomed the fact that requiring a provisional driving licence to ride an e-scooter and placing a lower age bound of 18 on use, means the rider is subject to laws and regulations in relation to, for example, riding while under the influence of alcohol. The status of the rider also has implications for how parking is enforced, as noted in the section on parking above.

Another stakeholder, while presuming that any forthcoming national legislation would legalise hire e-scooters but not private e-scooters, suggested that the way to control private e-scooters is to make their sale illegal.

Traffic regulation

As part of the trial, e-scooters have been allowed to travel within the public highway on both carriageways and cycle tracks. The advice from the Department for Transport did not cover the effects of local traffic orders, such as 'except cycles' plates on 'no entry' signs. Consequently, this implied that e-scooters could use some parts of the network that cyclists can use, but not other parts. There was no national instrument put in place for the trial that covered these issues. This absence led highway authorities into making blanket traffic regulation orders (TROs, either temporary or experimental) to create an equivalence between e-scooters and cycles where otherwise one would not exist.

Two stakeholders pointed to the challenges faced by highway authorities if they need in the future to make permanent traffic regulation orders, which are subject to consultation, to allow for e-scooters. The process is costly and may invite adverse comment from some sections of the public. On this basis, there was a strong view that **any further forthcoming national legislation should properly and fully cover all the issues relating to local regulation of e-scooters in such a way that there is no additional need for action from, or costs placed on, highway authorities**.

One stakeholder discussed the challenges of the relation between a service that is operated within the public highway in real-space, but also partially managed using geofencing in digital-space. The Highway Authority has jurisdiction over the physical highway, and this raised the question as to the jurisdiction highway authorities may, or ought to, have over an operator defining virtual geofences within the highway. It was suggested that national legislation would need to deal with these issues. The reason for such additional virtual jurisdiction of a highway authority is based on the need to ensure public safety, and the need to decide on which spaces are safe for which purposes. An analogy the stakeholder mentioned is the agreement on (physical) bus stop locations, which result from discussions between the highway authority and the transport authority.

For off-highway routes, one stakeholder pointed to the noticeable local issue of the exclusion of e-scooters from the Bristol Bath Railway Path, with the implication that this **limitation of use on off-carriageway routes may be an issue for e-scooter users.**

10.10.2 Commercial sustainability (4e)

Responses relating to commercial sustainability are summarised in relation to the market for e-scooters, operational cost burdens and the organisations on which these burdens fall, the relationship between private e-scooters and public transport, and finally the potential for wider economic benefits linked with tourism.

Size and constituency of the market

One stakeholder suggested that the indications are that the West of England is an attractive market for e-scooter operations. Another stakeholder raised the issue of reaching as wide a proportion of the population of potential users as possible with a view to ensuring commercial sustainability. A particular consideration of this stakeholder was the potential users' abilities, with the suggestion that an e-scooter with a seat to allow wider participation may be of benefit. The possibility of allowing children to access e-scooters was also raised by the stakeholder, but this should be set against the comments in the previous section about the value of the requirement to hold a provisional licence. Finally, and in relation to socio-economic classifications, another stakeholder noted that the trial areas appear to be focussed on more affluent areas and areas populated by students.

One stakeholder suggested that a combined e-scooter and e-bike scheme may be more beneficial in transport terms because of the potentially greater switching from car to e-bikes than from car to e-scooters. The combination of the two modes in one scheme would offset one mode against the other.

Overall, there was also a recognition that there is a balance between scheme coverage and profitability, and this was compared with the same issue that is evident with private sector bus operation where profitability, rather than social benefit, is maximised. **The comments of the stakeholders point to a desire to see e-scooter hire operations distributed as equitably as possible by area, by socio-economic grouping and by ability of the user, and this may be enhanced by adopting a hire model that links e-scooter hire with e-bike hire**.

Operational cost burdens

The costs of running the scheme are not in the public domain. There was a recognition amongst stakeholders that the trial is 'operationally heavy' to run, and as a result a balance needs to be struck to ensure scheme viability. This plays out in relation to possibilities about the extent of the scheme, and how it is operated and managed.

One stakeholder made the point that the unitary authorities, as a result of the time and effort they are expending on the trial, are in effect subsidising its operation. This was expressed in monetary terms by stakeholders in different ways, with one stakeholder noting that there is no 'profit share' in the current trial. **The main point being made by these stakeholders was that highway authorities, as a minimum, need to cover their costs incurred in assisting e-scooter hire**.

The relationship with private e-scooters

Two stakeholders noted that the (illegal) private e-scooter market may be influencing the commercial success of the trial. One the one hand, owning a private e-scooter may reduce demand for the use of trial e-scooters, and the trial itself may be driving people towards buying their own e-scooter. On the other hand, the trial may in fact be reducing demand for private e-scooter purchase. There has been no study of the private e-scooter market per se, or in relation to the hire e-scooter market in the West of England and therefore no conclusions may be drawn on this point.

The relationship with public transport

Some stakeholders noted the possible relationship between level of public transport and its reliability on the one hand, and e-scooter use on the other. Young people, it was suggested, are using the trial e-scooters because they are cheap, reliable and available. Another stakeholder had a perception that it is likely that full potential is not being reached for multi-leg public transport journeys combined with e-scooter journeys. Another stakeholder suggested that the operator should go further and enter partnerships with public transport operators.

Wider economic benefits

One stakeholder noted that e-scooter use may have an impact on tourist spend, especially in destinations such as Bath. The point made was that a day visitor to Bath may be able, with the aid of an e-scooter, to visit more destinations and therefore spend more than may otherwise be the case.

10.10.3 Management and operations (4f)

Responses relating to management and operations are summarised in this section.

Management

One stakeholder reported themselves to be generally satisfied with the way the trial has been managed and that the trial operator has responded flexibly and responsively. Another noted that the West of England Combined Authority had done a good job.

A further stakeholder mentioned that management at the start of the trial was limited to simply achieving the goal of having e-scooters on the streets and operating. The point being made was that this was to the exclusion of considerations relating to how e-scooters fitted into the urban realm and possible travel behaviours.

Some stakeholders noted that the memoranda of understanding between the relevant authorities remained incomplete and unsigned. The suggestion was made by one stakeholder that inter-authority agreements are a more effective tool for co-operation than memoranda of understanding. Another stakeholder noted that, as a result of the absence of agreements between the authorities, a ‘veto’ methodology had in effect been adopted as the default mode of operation, where something is done only if there is consensus. One stakeholder noted that whilst there may be no legal responsibility to include the fire and rescue service as part of any current or future e-scooter licensing arrangement considerations, consultation with them should take place. The conclusion is that more precise and detailed agreements need to be in place between all relevant authorities at the outset and before tender award to an operator.

A stakeholder suggested that a much firmer approach was needed in contract management, and this in turn demands a more precise contract to be in place. It was pointed out that the relatively loose form of tender for the trial and the relative lack of application of the terms of the contract has resulted in some significant additional work for local authorities. The suggestion was made that a more tightly specified contract may well include the exchange of money. On this basis, both performance incentives and penalties are possibilities. The stakeholder noted the example of a penalty from the American model where an e-scooter seized by a public agency as a result of improper parking may be released back to the operator on the payment of a penalty. The conclusion is that the contract with the operator needs to contain appropriate clauses in relation to remedies for poor performance by the operator.

One stakeholder noted that there has been an expectation that the trial operator should undertake certain actions on the basis that the technology is in place to make those things possible. The suggestion was that these actions were perhaps sometimes attempting to solve problems that did not really exist. The ability, for example, to move parking by moving geofences quickly, because it is possible to do that, is the sort of rapid action that operators of other services may not be asked to undertake.

Operations

One stakeholder suggested that the e-scooter operational data ought to be more widely available publicly as part of a service level agreement. This could, for example, relate to information on how many rides end outside designated parking locations.

One stakeholder noted that the contract with the trial operator was lacking in precision on requirements in relation to data sharing for monitoring of operational performance. This sentiment was widely held by the stakeholders. It was suggested that this has been a challenge for the management of the trial, and its evaluation. An example was given of attempting to find a new parking location, and better availability of data would have assisted in decision making.

What monitoring that now takes place and is reported has taken some time to evolve, but the comment was that evolution was probably inevitable because of the novelty of the nature of the trial. The knowledge from the challenges this posed is being used to develop ensuing contracts for micromobility operation. One stakeholder noted that such a contract will include more specificity in relation to how a scheme should operate and what the user experience should be.

One stakeholder emphasised the need for the trial operator to understand the ‘local picture’ in terms of the travel environment and local authorities, including transport and highway authorities and town and parish councils. The recommendation was that an e-scooter scheme project manager should be locally based in order to have a familiarity with the local context.

10.11 Summary

This chapter has reported the comments received from stakeholders. This evidence in now drawn forward into the discussion chapter, where it is set alongside evidence from other aspects of the trial.

11 DISCUSSION

This chapter draws together the threads of the evaluation and does so in a structure determined by the evaluation questions. It draws out, and compares and contrasts, findings from each of the relevant data sources and analysis sections in the foregoing chapters. The order of procedure is the same as the structure of the themes for the evaluation questions and hence Section 11.2 discusses Safety and Comfort, Section 11.2 discusses Transport Policy, Section 11.3 discusses Wider Impacts and Section 11.4 discusses Management.

11.1 Safety and comfort

The evaluation questions dealt with in this section are as follows:

1a **Riders**: How does the safety of riding an e-scooter in the region compare with cycling?

1b **Perceptions**: How do perceptions of e-scooter safety vary by gender, age, and ethnicity?

1c **Other road users**: How is the safety and comfort of other road users (including pedestrians) impacted by e-scooters?

1d **Equality**: To what extent do e-scooters discriminate against the Equality Act 2010 Protected Characteristics?

1a Riders: How does the safety of riding an e-scooter in the region compare with cycling?

To answer this question, firstly a summary is presented of the number of collisions and injuries and their rates reported from different sources. Then, a comparison of the rates for e-scooters is made with cycles. The issue of the way highway characteristics have affected e-scooter operation and safety is given in Section 11.4 Management, in response to evaluation Question 4b Highway: What highway characteristics have affected e-scooter operation.

Number of collisions from trial operator, police and hospital sources

There were 1,021 injuries in total reported by users to the trial operator in the period 29th October 2020 up until 17th April 2022. These injuries were defined in three user-reported levels as: Level 1, Minor injuries such as cuts and bruising (84.7%); Level 2, major injuries which include broken bones, sprains, lacerations, concussions, fractures to the body (15.0%); and Level 3, severe injuries requiring surgery or serious medical treatment (0.3%).

The comparison of rates from data from different sources has been undertaken for the year 2021. This is because there is a variable and sometimes long time-lag for data recording and verification of the STATS19 police reported data. The start-up phase in Autumn 2020 was excluded from the analysis because the trial was in its early stages and patterns of movement and risk may not have settled down at that time.

Based on a total number of injuries of 768 in 2021 only, and a total distance ridden of 5.39 million miles (8.67 million kms) for that year, the injury rate is estimated to be 8.86 injuries per 100,000 km ridden. For purposes of comparison with injury rates that may appear in reportable road traffic collisions, it may be more appropriate to estimate an injury rate based only on Level 2 and Level 3 injuries. For 2021 only, the Level 2 and 3 number of injuries was 119, hence giving a rate of **1.37 injuries per 100,000 km from the trial operator data**.

97 casualties were reported in 86 collisions which were reported to the Avon and Somerset Police and are reported in the STATS19 data, and these include trial and non-trial e-scooters. 46 casualties are reported in 43 collisions reported to involve trial e-scooters. Thirty-three (72%) of the casualties were trial e-scooter riders. Overall, 53 (64%) collisions were not at junctions, and 30 (36%) were at junctions. By comparison, in 2017 to 2019 in Great Britain, the proportion of injury collisions not at junctions for cyclists was 26.2% (Bastock, 2022). There may be some over-representation of collisions away from junctions as compared with cycling.

For a sub-period of four weeks across May and June 2021 a prospective study of patients presenting at emergency rooms at Bristol Royal Infirmary and Southmead Hospital are available. There were 65 e-scooter riders presenting as patients with injuries. By comparison, there are 13 e-scooter injuries recorded in the STATS19 records in May and June 2021. There were 24 recorded Level 2 and 3 injuries in the trial operator data. Dividing the STATS19 and trial operator data by two to equate approximately to a four week period suggests that **the ratio of the number of injuries is in the proportions 1:1.8 (STATS19 to operator data) and 1:10 (STATS19 to hospital data)**. It should be noted that trial operator data covers the whole of the trial operating area, including Bath and North East Somerset, whereas the hospital data is likely to include injuries only from within the Bristol and South Gloucestershire areas.

Hospital data suggests that more men than women are typically injured, the age of patients is generally young. There are low rates of helmet use (7% compared with 9% from the observations in the video-based interactions data) and a high prevalence of alcohol intoxication. Most injuries result from falls, and injuries occur to the upper and lower limbs and the head and face.

Casualty rate for e-scooters compared with cycles

For comparison purposes with cycling, the e-scooter casualty rate in Bristol for trial e-scooters can be estimated from a combination of the STATS19 recorded trial e-scooter related number injuries and the trial operator distance ridden. This is estimated to be **0.530 STATS19 reported casualties per 100,000 km ridden on e-scooters**.

There is no estimate of cycle kilometres ridden in the trial area and so it is not possible to provide a comparator estimate for the trial area, hence it is possible only to make comparisons at a different geographical scale. The Great Britain 2021 STATS19 cycle injury rate is **0.294 per 100,000km cycled on urban roads**. This suggests **the e-scooter injuries may be more prevalent by kilometre ridden in Bristol as compared with cycling in Great Britain by a factor of approximately 1.8**. It should be stressed that this is a comparison of e-scooter injury rates in Bristol with the Great Britain urban cycling rate. It was a requirement of the evaluation that such a comparison be made, and it should be used with caution. The major issue with this comparison is that it is known that STATS19 data under-reports collisions and injuries, especially for cycling. This study has revealed this to be true also for e-scooters, noted above.

This higher rate of injury for e-scooter riders contrasts with the video observations at eight sites in Bristol which indicates that, based on relative flow, e-scooters near-misses occurred at a lower rate than cycle near-misses. This near-miss finding is not necessarily inconsistent with a higher injury rate for e-scooters, and may point to a greater proportion of e-scooter near-misses resulting in collisions and injury.

To make a more accurate estimate of the difference between e-scooter and cycling injury rates, the same protocol needs to be adopted for collecting the data for both the numerator (the number of casualties) and the denominator (the distance ridden) for both e-scooters and cycles. The denominator for the Bristol e-scooter estimate has been the trial operator's data on distance ridden and this is presumed to be a good estimate. The Great Britain cycle collision estimate is derived from the National Road Traffic Estimates. It is known that the estimate for cycle traffic within these estimates has wide margins.

An example of a study protocol that would provide a more accurate estimates of collision and casualty rates per distance ridden would be a joint e-scooter and e-bike hire system, with accurate distance data collected in the same way for all rides, and injury data collected in the same way as self-reports from the riders.

The West of England Combined Authority is letting a tender for a combined e-scooter, e-bike and e-cargo bike hire scheme. The resulting contract will allow for comparisons between cycles and e-scooters in relation to risky highway locations and actual collision locations. In addition to that, there is a good basis for estimating collision rates accurately for the two modes because there is an accurate measurement of kilometres ridden.

STATS20 is the document which sets out the reporting requirements for STATS19 data. Note B in Section 2 of the STATS20 document states the following 'The STATS19 requirement is clear that all accidents involving non-motor vehicles such as pedal cycles and ridden horses on 'public roads' (see 2.4) should be reported, regardless of motor vehicle or pedestrian involvement'. As a result, an injury resulting from a collision on a pedal cycle or an e-scooter has to be reported. It also has to be reported to the Incident and Crime Recording Registrar for the police area under the National Standard for Incident Recording which states that a road traffic collision or incident that causes death or injury includes single vehicle incidents where no collision takes place. A single vehicle collision however does not have to be reported as a 'recordable and reportable offence' under the Road Traffic Act 1988. Single vehicle collisions within Avon and Somerset Police area are recorded as 'no further action' from an offence point of view, and on that basis the Accident Record Book does not get filled in. The Accident Record Book is the source data for filling in STATS19 records and hence single vehicle collisions are not appearing in the STATS19 data within the West of England.

1b Perceptions: How do perceptions of e-scooter safety vary by gender, age, and ethnicity?

First considering e-scooter riders, **perceived safety of riding is relatively high among users with only about one in ten saying they feel unsafe riding an e-scooter and nearly seven in ten saying they felt safe**. There are differences between demographic groups with **older people, women and infrequent users feeling less safe**. Infrastructure (quality of roads, having enough cycle lanes) is regarded as important for safety while riding an e-scooter by most users (about four in five) with a minority dissatisfied with it (about one in four). This importance demonstrates that users are seeing the quality of infrastructure as a part of the e-scooter system.

Regarding non-users, most respondents to the Experience Survey feel safe (56%) and comfortable (58%) around e-scooter riders, with approaching a third feeling unsafe (30%) or uncomfortable (28%). A larger majority (73%) felt comfortable around parked e-scooters, while 13% did not.

So far as **gender** is concerned women are less likely than men to feel safe around people riding (50% vs 64%) and less likely to feel comfortable walking near people who ride (52% vs 65%). So far as age is concerned, younger respondents aged 18-29 (66%) feel safer around people riding than those aged 30-59 (49%) and those aged 60+ (27%). Younger respondents also feel more comfortable walking around people riding or around parked e-scooters (80%) than those aged 60+ (49% around parked e-scooters).

So far as **disability,** is concerned disabled people are less likely to feel safe around people riding (46% vs 60%), less likely to feel comfortable walking near people who ride (47% vs 63%) and less likely to feel comfortable walking around parked e-scooters (56% vs 81%).

Factors that influence people feeling unsafe are both riders' behaviours (people who ride too fast / too close to them / recklessly–- words used by several respondents) and infrastructure (narrow footways but also the nature of road infrastructure more generally). Behaviour and infrastructure are inter-related, because poor alternatives to the footway within the highway can prompt riders to use the footway (e.g., when the carriageway feels unsafe for riding and there is no cycle lane).

1c Other road users: How is the safety and comfort of other road users (including pedestrians) impacted by e-scooters?

The video-based analysis of interactions in the street environment has shown that in the 36 hours of observations at eight sites, 6% of e-scooter riding was on the footway as compared with 5% of cycle riding. It was noted in the video analysis that it can be ambiguous to cyclists and e-scooter riders whether part of, or all of, the footway is given over to a shared or segregated cycle facility, and this is especially the case when there is a lack of clarity in the signing of such shared use.

The walk-along surveys revealed participants having much empathy and understanding for other citizens, and a deep consideration of the difficulties in travelling that others might have. Despite this there was evidence of the challenges of the proportion of e-scooter users who ride on the footway. One respondent reported that e-scooters make their world, and we quote, a 'frightening' place. Interesting broader questions were raised about the ethics of the use of public space and accountability of private company operation in the public realm. This was linked with not only 'hogging' space, but also in relation to responsibility over riders' misbehaviour.

1d Equality: To what extent do e-scooters discriminate against the Equality Act 2010 Protected Characteristics?

A minority of respondents to the Experience Survey suggested they feel discriminated against by the presence of hire e-scooters. Disabled people were more likely to feel discriminated against than non-disabled people (21% versus 13%). Disabled people were also more likely to feel that the deployment discriminates against others (31% vs 25%). Those identifying as BAME or other non-white ethic groups were also more likely to feel discriminated against (18% of BAME respondents and 36% of those of other ethnicities, compared to 11% for white people).

Younger respondents (18-29) were less likely to feel discriminated against (11% versus 16% for the 30-59 group and 33% for those aged 60+). Younger respondents (18-29) were also less likely to think that the deployment might discriminate against others (20% versus 31% for the 30-59 and 45% for those aged 60+).

Most worded responses to the survey (103 out of 156, 66%) relate to the pedestrian perspective, and included comments about risk, discomfort, and obstructions. These perspectives were similar across gender, but older respondents and disabled people were more likely to mention pedestrian-related concerns (74% and 73% of responses). Younger people feel discriminated against because e-scooter use needs the rider to hold a provisional driving licence.

A particular consideration of one stakeholder was allowing access to e-scooters for people of all abilities. The suggestion was made that an e-scooter with a seat would allow wider participation. The possibility of allowing children to access e-scooters was also raised by this stakeholder, but this should be set against other comments from stakeholders which were generally supportive of the need for riders to hold a provisional driving licence.

11.2 Transport policy

2a Usage: Who, why, when, how and where are e-scooters being used?

Overall usage. The shared e-scooter trial has registered over 8,650,692 rides in Bristol by 345,450 unique users and 429,017 rides in Bath by 57,437 unique users from the start of the trial in October 2020 to the end of February 2023. The number of rides per day and per user has been steadily increasing in Bristol during the trial, but this is not the case for Bath where usage peaked in the first months before dropping and remaining broadly constant until rising again after expansion of the operating area in June 2022.

Who. In relation to the nature of the demography of e-scooter riders, 49% of all rides across the trial areas have been made by 18-24 year-olds up to April 2022. Only 1% of rides have been made by those 55 and above. There are 1.8 times more males than females signed up to use the system and 2.8 times more rides have been made by males than females. While there is slight under-representation of those of non-white ethnicity in those signed up to use the e-scooters, they are more frequent users than those of white ethnicity. More than half of e-scooters have access to a car (63%) and to a bicycle (64%), but this varies strongly with age with only 34% of 18-24 year olds reporting access to a car and 41% access to a bicycle. Frequent riders had much lower availability of each of these forms of personal mobility. This highlights that shared e-scooters are tending to serve young adults without access to personal transport options.

Why. E-scooters are used to a similar extent for work and education purposes and for social and leisure purposes (about four in ten trips for each). Personal business such as shopping, errands and medical appointments account for about two in ten trips. The main reasons given for using e-scooters are convenience ("easier travel"), enjoyability, sustainability, affordability and reliability.

When. The number of rides per month increased rapidly in Bristol, especially in Spring and early Summer 2021. Rides declined in the winter months of December 2021 and January/February 2022 but increased after that to reach a peak level in October 2022. The Winter reduction in the number of rides reflects seasonality in use, the pattern of which would need to be confirmed by a longer time series. Such a seasonality would be akin to the seasonality of cycle traffic flows. Fridays and Saturdays have the highest levels of use. In Bristol, the two days together comprise of a third of all rides. Use is lowest on Sundays (30% lower than on Fridays and Saturdays) and Mondays (26% lower). Weekdays have a noticeable morning and afternoon peak. The afternoon peak is more intense with 28% of all rides occurring between 4pm and 7pm, as compared with 14% between 7am and 10 am.

How. Long-Term Rental (LTR) users contribute to 5% of total rides and distance travelled in the trial area even though they only make up 1% of total users. About 15% of registered e-scooter users are active users who use the e-scooters at least once per week but this still represents a substantial number of people (42,200 people in April 2022). Most rides have been paid for on a pay-as-you-go basis (56%). Daily and monthly passes represented respectively 18% and 26% of the rides. Rides made with passes are more common in Bristol compared to Bath, which is consistent with the higher frequency of use of e-scooters by individual users in Bristol. Average trip distances ridden in Bristol were longer than those ridden in Bath. The median trip distance was 2.1 km in Bristol and 1.7 km in Bath. Three-quarters of trips were less than 3.3 km in Bristol and three-quarters of trips were less than 2.5 km in Bath.

Where. In Bristol, the e-scooters are used for trips within dense urban areas throughout the day with an addition of movements towards the centre in the morning and exiting the centre in the afternoon/evening. Younger users (aged 18-24 years) predominantly start rides in the vicinity of the main urban centres, especially Broadmead, the University of Bristol area, Temple Meads, the Arches area and Cotham Hill. While the urban centres remain important for all age groups, older users' trips start less exclusively in the centre with a larger proportion starting in residential areas.

2b Modal shift: Of the e-scooter trips, how many are new? If transferred, from/to which modes?

Available data from trial operator surveys suggests that about 60% (range of 59% - 70%) of e-scooter trips are replacing walking, cycling and bus use with about 30% (range of 27% - 37%) replacing car, taxi and ride-hailing. The latest data from the trial operator's 2022 Winter Survey suggests that the modes replaced by an e-scooter in Bristol in descending order are walking (35%), bus (19%), car (17%), bicycle (15%), taxi and ride-hail (10%). Only a small minority of trips (1%) would not have been made if an e-scooter was not available. It is important to note that the survey data had an under-representation of young e-scooter users and younger people are less likely to have used a car instead of an e-scooter. Car replacement is greater amongst older users and less frequent users while bus replacement is more common among 18–34-year-olds and more frequent users. This points to the survey mode substitution figures overestimating car and taxi substitution and underestimating bus substitution.

In-depth interviews of 13 e-scooter users, selected to be typical of e-scooter users in general, showed how e-scooters are being incorporated into daily travel routines and gave a more sophisticated appreciation of how e-scooter use interacts with the use of other transport modes. E-scooters are replacing walking, cycling and bus and taxi use. The replacement of bus use was more commonly mentioned than other modes and was particularly notable for students and younger adults who disliked the unreliability of buses. There were some interviewees who reported they had mainly got around by bicycle in the past but preferred e-scooters over cycling to avoid getting tired, sweaty and wet and to avoid leaving bicycles in unsecure locations. While for some interviewees, it is clear that the e-scooter has become the first mode of choice for travel within Bristol, for others it is an option that is selectively chosen for particular situations. Rental e-scooters have been added to people's urban transport menu of options with the relative amount they are used varying from person to person.

The interviews also revealed how e-scooter use has changed over time. There were some interviewees who had been curious to try the e-scooters soon after they were introduced with others taking longer to give them a go. Some interviewees were no longer actively using e-scooters and did not seem to have become very confident in using them on roads in the city. Some were cutting back their use due to them becoming more costly and less competitive against the bus and due to a wish to be more physically active and cycle. One interviewee mentioned the availability of shared e-scooters and his frequent use of them was delaying his interest in getting a car.

2c Transport integration and interchange: How are people using e-scooters to integrate with other forms of transport?

When were asked what mode(s) they used to get to the start of their last ride and to travel between the e-scooter parking and their destination, walking constituted 75% of all the mentions and was noted by 82% of respondents as a mode used at the start and/or the end of the ride. Public transport was the second mode indicated, with this time some differences across ages (13% users aged 18-29 vs 17% older users) and impairments (25% users with functional impairments vs 11% without). In the trial operator's 2022 Winter Survey, participants were asked if they had combined e-scooter with public transport with a minority (16%) answering positively. The data available suggests that e-scooters are being used with public transport for between 10% and 20% of journeys involving e-scooters. In a number of cases, the in-depth interviews revealed that e-scooters are a very useful form of transport for getting to and from a railway station where long distance travel is involved, as this avoids stress from unreliable bus connections and having to leave a bicycle at the station where it may not be secure.

2d Population variation in access and use: Which groups and areas are restricted in their access to e-scooters?

There is a greater concentration of e-scooter provision in the centre of the city and a corridor connecting the centre to the northern suburbs of Bristol. An assessment of how e-scooter provision, measured in terms of parking zone density, varies with neighbourhood-based deprivation in Bristol shows there is no clear pattern. Suburban and peripheral areas have been relatively less well served, particularly in the north-west and south of the city and these include some of the most deprived areas of the city. Expansion of the operating zone to the north-west in March 2022 and to the south in December 2022 has resulted in a more equitable distribution of e-scooter parking zones across the city. In Bath the operating zone covered a central part of the city before being expanded to cover most of the city in the summer of 2022. With regard to users, access to e-scooters is perceived overall as easy (87% of responses), with some differences across ages and disabilities: younger users (aged 18-29) find access easier than older users, and non-disabled find it easier to access e-scooters than disabled users.

2e Employment & economy: How has the trial managed to facilitate transport to jobs and support the wider economy?

The high proportion of work-related trips (36%) demonstrates that the rental e-scooters are directly supporting economic activity, while the use of e-scooters for running errands (e.g. shopping) and visiting gym/sports venues (combined total of 19%) shows they are indirectly supporting businesses in the area. Trips for social engagements and leisure (combined total of 39%) might also support businesses.

Four in ten Bristol respondents (39%) to the trial operator's surveys said that e-scooters enabled travel to places not previously possible and 31% of Bath respondents. In Bristol, this figure is highest in the 18-24 age group (53%) and decreases with age. This provides an indication that e–scooters are widening the travel horizons of younger users and enabling them to access new opportunities.

Interviews explored in greater depth how the trial had benefitted e-scooter user accessing opportunities. A number of interviewees highlighted that e-scooters facilitated them exploring the city and discovering new places. Students who were interviewed noted e-scooters helped them take on temporary jobs which wouldn't have been possible otherwise.

2f Network performance: How have e-scooters impacted the operation of the road network?

There was no evidence from the video-based interactions study that there were any situations when the presence of e-scooter riders on the carriageway impacted on the flow of motor traffic. There were rare occasions when there may have been momentary motor traffic slowing, but that traffic soon caught back up with the general flow of traffic, and may then have been impeded by the volume of general traffic.

This objective evidence is supported by the views of stakeholders who generally had no concerns about the operation of the network with the additional presence of e-scooters, although there was a lone more nuanced view was that the numbers may cause issues at certain times of the day in some locations. Concern was also expressed in relation to the potential impact on buses.

One stakeholder suggested that e-scooters will have increased the overall capacity on the network, and this would be as a result of e-scooters take up less space within the highway. This is supported by evidence from the videos which suggests that at the eight sites observed half of the flow was of human scale movement, that is to say, cyclists, e-scooter riders and pedestrians. If each of this half of the street users was in a vehicle, there would be severe congestion.

As well as enhancing network efficiency, it was noted that e-scooters enhance individual trip efficiency because they are faster than walking for trips that switch from walking, and reach nearer to ultimate origins and destinations typically than other modes.

A point that arose in a stakeholder interview was about the adequacy of the infrastructure for cycles and e-scooters in relation to the volume of both cycles and e-scooters combined and made the point that current infrastructure is not fit to deal with these volumes. Infrastructure adequacy is further discussed at evaluation question 4b, below.

11.3 Wider impacts

3a Health impacts: How does riding an e-scooter contribute to an individual's health and wellbeing?

23% of Experience Survey respondents thought that e-scooters contribute to health. It was recognised in interviews with e-scooter users that using an e-scooter is less exercise than walking and cycling, but some interviewees said that e-scooters encouraged them to go out when they might not have otherwise (not just for leisure but also for education, work or personal business reasons) and this should be recognised along with active travel modes being substituted by an e-scooter.

Almost half of e-scooter users (45%) thought that e-scooters contribute to their well-being. Enhanced well-being was attributed to the 'fun' factor of riding e-scooters, the increased ease of reaching destinations and the pleasure of being outside. Interviews explored in greater depth how the trial had benefitted broader well-being. A number of interviewees highlighted that e-scooters facilitated them exploring the city and discovering new places. For some interviewees the e-scooters made it easier to visit family and friends in other parts of the city.

3b Carbon: What has been the carbon footprint of the e-scooter trial?

Chapter 8 summarised the estimation undertaken of the net carbon dioxide emissions changes as a result of the e-scooter trial. A range of estimates has been made based on five different survey results for mode replacement by e-scooters. These are Summer 2021 and Winter 2022 surveys in Bristol and Bath (four surveys) and the Experience Survey in Bristol in Summer 2022. The lifecycle carbon emissions per passenger kilometre have been estimated from the literature for the e-scooter, and the modes from which e-scooter riders have been drawn. The e-scooter lifecycle emissions factor adopted has been 65.2 gCO_2eq per passenger kilometre.

The lowest net saving estimated for the 4.15 million rides for the scheme in the Bristol between 28th October 2020 and 27th April 2022, as derived from the Summer 2022 Survey, is 6 tonnes of carbon dioxide equivalent. The main modes replaced by e-scooter rides that are driving this estimate are 37% from walk, 38% from bus and 8% from car. Higher proportions of car, bus or taxi use, as suggested in some of the other surveys from Summer 2021 and Winter 2022 would suggest higher carbon savings. The Summer 2021 survey for Bristol would suggest a net carbon dioxide emissions reduction of 238 tonnes, the Winter 2022 survey a net reduction of 117 tonnes. The number of rides in Bath in the period were 206,000, and the net carbon dioxide emissions reductions estimated are between 5 and 7 tonnes for the Summer 2021 and Winter 2022 surveys respectively. These estimates are based on mean lifecycle estimates.

As a context, it is worth realising that BEIS (2022) estimates 1,362 KtCO_2e was emitted in Bristol, Bath and Northeast Somerset and South Gloucestershire from road transport in 2020. The reduction in transport related emissions resulting from the e-scooters in Bristol for 2021 has been estimated as between 6 to 238 tonnes for 4.15 million rides, and between 5 to 7 tonnes in Bath for 206,000 rides. This represents a saving of a fraction of a percent of transport emissions of approximately 0.0008% to 0.01%. The government is working towards its commitment to reduce emissions in 2030 by at least 68% compared to 1990. In 2019, UK territorial greenhouse gas emissions were 44% lower in 2019 than in 1990. A further reduction of 24% in required by 2030. Net savings from the e-scooter trial will assist, but much more needs to be done to achieve the targets.

3c Complementary applications: How has the e-scooter fleet provided data and information for other applications and initiatives? (e.g., air quality monitoring)

There was some recognition amongst some stakeholders that an e-scooter is potentially a good monitoring device for environmental measurements such as air quality, and infrastructure measurements such as road condition monitoring. Other applications include the collection of data to investigate locations where collisions and injuries have the potential to take place. These data could relate to speed, swerves and acceleration / deceleration. Such analysis could point to a need for infrastructure improvements, such as layout changes or highway pavement maintenance.

It was recognised by one stakeholder that the analysis of these types of environmental data is a massive undertaking. Such additional data could be of great benefit to highway authorities, but the question arises as to why a new mode of transport is given the additional burden of providing to highway authorities with complex data that is hard to analyse.

The issue with introducing methods for collecting additional data is mainly concerned with where the costs lie. The operator would need to be required through its contract to carry a specialist data sub-contractor's hardware for installation on its e-scooters. That equipment may be funded by the transport or highway authority, or perhaps the costs may be shared in partnership with the operator. Alternatively, the operator may wish to offer that service free as part of its bid to run an e-scooter scheme.

Analysis of the data would typically be undertaken by a specialist sub-contractor, and this would logically be at a transport or highway authority's expense. The specialist sub-contractor would highlight locations where swerving or hard braking occurs, and where there are road surface defects. The data collection and analysis may be for an initial period of a few months, with analysis then being undertaken to prove the value of the data to the authority. If the value of the data is demonstrated, there could be agreements put in place where the services of a specialist sub-contractor could be engaged on an on-going basis.

11.4 Management

4a Parking: What different parking measures have worked best (and less well) and why?

Developments in relation to how parking is provided for e-scooters has taken place over the duration of the trial. The only real option for parking locations at the start of the trial was described by stakeholders as being the footway, and this was because of the speed of the set-up of the trial. While parking originally was allowed anywhere on the footway, it soon became necessary for a process to be put in place to define specific parking locations. Hence, the highway authorities began the process of defining and agreeing parking locations with the operator. While parking locations are likely to be much more suitable at locations approved by the highway authorities, there was a suggestion from stakeholders that this process of agreement needs to be the responsive.

There is an acknowledgement from some stakeholders that, for a future permanent scheme, there needs to be a move to e-scooter parking in the carriageway. This may require highway authorities to take actions possibly including amendments to traffic regulation orders, and to consider whether such carriageway parking is protected in some way, for example with e-scooter parking corrals or kerb build-outs. There would be costs associated with these actions for the highway authority. One stakeholder suggested that the operator could be pro-active in approaching third party land-owners to agree parking location, such as at supermarkets.

E-scooters are parked either within a (virtual) geofence, a white painted boundary, a corral, or a temporary event parking location. For various reasons e-scooters are commonly observed parked outside a defined parking boundary. E-scooter parking locations that have physically marked boundaries reduce the risk of e-scooters being parked outside their defined locations and hence reduce the risk for obstruction, inconvenience to others, and injury.

Geofences have not been accurate in defining a parking boundary, with the boundaries varying by perhaps up to 20 metres. This means parking can spread beyond the boundary agreed with the local authority. There is a view that additional technology would be needed to improve the accuracy of such geofences, for example, by using local transponders. Even with stable boundaries, it appears quite possible that e-scooters could be parked in such a way that part of the vehicle is outside the boundary. This variability in both the boundary location itself, and the parking of e-scooters at the boundary can lead, in situations where there is little space beyond the boundary, to significant problems for pedestrians. These parking problems are likely to be reduced by a) having enough parking locations of adequate sizes suitably distributed across the area of operation, and b) active management of parking quality by the operator.

There was a consensus that the flexibility of parking using geofences has had benefits in relation to large public events in Bristol. There has been a lot of multi-agency working in respect of large scale public events and much has been learned about the benefits of travel to these events using e-scooters. The value of e-scooters in relation to event such as these led one stakeholder to comment that e-scooters are now 'part of the infrastructure and make up' of Bristol.

Parking of motor vehicles is an income generator for highway authorities and some stakeholders expressed the view that this ought to also apply to e-scooters, if for no other reason than users of highway space for commercial purposes, such as car clubs, are charged. So far as the management of parking for example, the tidiness of parking, there were views expressed by stakeholders in relation to financial incentives and penalties for the operator. This requires that there is a clear definition within any future contract about what is and what is not acceptable in relation to e-scooter parking.

4b Highway: What highway characteristics (e.g., traffic volume, speed, provision of a cycle lane etc.) have affected e-scooter operation and safety?

The footway and the carriageway are both part of the highway. The prevalence of e-scooter footway riding has been found to vary greatly across the eight different sites in the video-based analysis of interactions (from 2% to 18%). Those sites with the lowest rates have separated cycle infrastructure, whereas sites with higher proportions of footway riding have poor cycle infrastructure such as advisory cycle lanes in the carriageway combined with large motor traffic flows and wide footways. These differences in the nature of the infrastructure, and high motor traffic flows in the carriageway, appear to act as an incentive for e-scooter rides to use the footway.

The video-based interactions analysis has revealed a very high number of 39,369 occasions when near-misses involving e-scooters or cyclists occurred in 36 hours of video at eight sites. This number is almost as high as the total number of e-scooters and cyclists passing through the site and reflect multiple near-misses within the frame of the video. They include near-misses when the paths were crossed, or when a rider passed within a door's width (1.0 metres) of a parked car. The data suggest that e-scooters are less likely to have interactions with pedestrians than cyclists are, and that e-scooters are less likely to be closed passed by motor vehicle drivers than cyclists. The number of near-misses between e-scooters is very high during carriageway riding, with a total of 37,305 near-misses being with motor vehicles (95%).

Cycle tracks provide the most appropriate infrastructure for e-scooters because their characteristics are most like cycles. A total of 30 collisions occurred on the carriageway (36%), 11 on the footway (13%), and 6 on cycle tracks (7%). The low proportion of collisions on cycle tracks may reflect the lack of suitable infrastructure for e-scooters in the area of the trial. 30 (36%) collisions occurred at junctions, with 17 (57% of junction collisions) at priority junctions, 6 (20%) at roundabouts and 7 (23%) at signal-controlled junctions.

Stakeholders generally did not see any problems with e-scooters sharing infrastructure with cycle traffic. While some thought Local Transport Note 1/20 Cycle Infrastructure Design (LTN 1/20) standards are sufficient for e-scooters, others suggested the smaller wheel size and stability thought this would mean even tighter tolerances than for cycle traffic, such as flush transitions.

Junctions are the usual points of conflict in a network and hence collisions tend to be more prevalent at junctions. Overall, 53 (64%) collisions were not at junctions, and 30 (36%) were at junctions. By comparison, in 2017 to 2019 in Great Britain, the proportion of injury collisions not at junctions for cyclists was 26.2% (Bastock, 2022). There therefore may be some over-representation of e-scooter collisions away from junctions as compared with cycling, but it is not clear why this may be the case.

The video-based interactions study suggests that 25% of e-scooter riders passed through a red signal, compared with 24% of cyclists. These data include signal-controlled junctions at St James Barton Roundabout, the Baldwin Street / Castle Park signal controlled junction, and toucan crossings. The deduction from these observations is that there is a high prevalence of red-light-running, however, there are issues with the design of some signal-controlled junctions, and this may be influencing e-scooter rider (and cyclists) behaviour.

Maintenance of highway infrastructure is a major concern of some stakeholders. Surface roughness and potholes, and inadequate reinstatements of the highway pavement by utilities, mean there is a greater likelihood of falls from e-scooters. While there is no direct evidence from the STATS19 data concerning maintenance, the high prevalence of falls from e-scooters as noted in the hospital data points to possible highway pavement surface issues. It is known that there have been insurance claims against the authorities.

In relation to risk and rider behaviour and skill, most stakeholders thought that users were riding well, but there are some riders have a deliberately disrespect for the infrastructure or those around them. The most frequent comment from stakeholders about riders was that they need to recognise that they are riding a motor vehicle and that the rules of the road, and that penalties associated with breaking the rules, apply to them. The corollary is that the infrastructure needs to allow them to proceed legally along all of the pathways that they take, especially at junctions which include arms with dedicated cycle infrastructure.

There was no sense from stakeholders that the current maximum of 12.5 mph should be changed. This was despite a recognition that there could be differences in speed between cycle traffic and e-scooter traffic resulting from this limitation, and even greater differences in speed between motor traffic and e-scooter traffic.

From the point of view of e-scooter users, a better infrastructure for e-scooters and other micro-mobility transport was identified as urgent by interviewees if e-scooters are to thrive. From the trial operator’s Summer 2021 Survey, infrastructure (quality of roads, having enough cycle lanes) is regarded as important for safety while riding an e-scooter by most users (about four in five) with a significant minority dissatisfied with it (about one in four). This suggests it as a priority for intervention if usage is to increase. Safer infrastructure could also attract people who are not confident to use e-scooters currently.

4c Digital infrastructure: How well has the e-scooter monitoring systems worked to give us the information we need?

Most stakeholders commented positively on the way that digital infrastructure has been used. There is a recognition of the value of digital data for planning, management and operational purposes, including integration with other applications such as mobility-as-a-service information systems.

From the point of view of users and the stakeholders, geofencing has been one of the more obvious digital developments as part of the trial. While their benefits have been recognized, such as flexibility, there are concerns about their lack of consistency and accuracy from stakeholders and users, as noted above in relation to parking (evaluation question 4a).

Further advantages are in relation to the greater amount of detail potentially available for transport planning purposes. Two examples are enhanced knowledge about the ultimate origin of the journey because it is possible to know where a user first opened the app in order to locate a free e-scooter, and good knowledge about routes taken by e-scooter riders. However, many stakeholders suggested that this data was not as available to them as they would have liked. A further planning benefit, but for users rather than the transport planning profession is the potential to provide riders with a suggested route for their journey, which may vary by time of day. This suggested route could be linked with comfort, safety and security considerations.

Widening beyond transport planning to operations, other stakeholders made the link with other modes at an operational level in relation to mobility-as-a-service information platforms. There remains an open question as to whether it would be the duty of a transport authority, such as the West of England Combined Authority, or the operator themselves to make the links necessary with complementary modes.

Many stakeholders saw value in other digital aspects of the trial relating to safety, but that full advantage of these had not been taken. One, relating to safety, was the reaction test. While this is for guidance only for the prospective rider, stakeholders thought that it could perhaps be used in a more effectively. Similarly, some stakeholders thought there are opportunities for more prompts to riders at appropriate times.

4d Licensing and regulations: How effective have the legislative, regulatory, and licensing frameworks been?

There is a relationship between the national and local level for licencing and regulation. Most stakeholders stopped short of clearly suggesting what ought to appear in national legislation resulting from the trial. This is perhaps wise based on knowledge of only one trial. However, it has been clear that the knowledge and experience of all stakeholders is now very high in relation e-scooter usage for travel purposes.

Despite that, there was welcome amongst stakeholder for the fact that riders are required to hold a provisional driving licence. Extending any permanent scheme beyond provisional licence holders encapsulated in national law and regulation would create conditions that have not been seen in the trial. There was no sense amongst stakeholders about wanting to abandon a provisional driving licence holding requirement, rather the responses were framed in relation to the advantages, for example, it means riders are subject to the same penalties in law in relation to riding while under the influence of alcohol.

There were no stakeholders calling for private e-scooters to be made legal (the question was not explicitly asked however). In this respect, one stakeholder noted that the most effective methodology may be to make their sale illegal, which would be a trading standards offence.

There was significant concern from some stakeholders in relation to local traffic regulation orders. The advice from the Department for Transport did not cover some matters of highway use in as much detail as it should have done. This resulted in some local authorities, for example, seeing the need to make blanket temporary orders to allow e-scooters to be covered by ‘except cycles’ plates on ‘no entry’ signs.

A further issue recognised by stakeholders is the interesting relation between the physical highway, and control of that highway by digital means, such as through the use of geofencing. The suggestion was made that there is no reference in legislation to control by such virtual means, and any future legislation needs to deal with this issue. The matter relates to public safety, and decision on use of space. This may be a broader issue about highway authority powers in relation to ‘the digital highway’ than those that relate just to e-scooters.

A further local point was made in relation to the exclusion of the Bristol to Bath Railway Path, and potentially other non-highway active travel route, from the network that e-scooters are allowed to use. It may be noted that there have been recent marginal improvements to the separation afforded between pedestrians and cycle traffic on the Bristol to Bath Railway Path route. It is recommended that it would be appropriate to review the exclusion of any non-highway active travel routes from the e-scooter network in the West of England area.

Overall, the above stakeholder responses may be classified as relatively modest suggestions for development and improvement, with perhaps the greatest concern being in relation to local traffic regulation orders. On this basis, it may be concluded that the legislative, regulatory, and licensing frameworks have been effective.

From the point of view of e-scooter users, interviewees felt shared e-scooters could make a valuable contribution to cleaner urban mobility but were concerned misuse of the scheme could lead to it being withdrawn and would welcome better enforcement of illegal practices. They were also keen to see the removal of no-ride zones unable to be used by e-scooter users but permitted for use by other road users (e.g. Bristol to Bath Railway Path).

4e Commercial models: How commercially sustainable has the trial been for the operator, the West of England Combined Authority, and the Unitary Authorities?

Some stakeholders recognised the need for equity reasons of ensuring a hire scheme is available to as many people of all ages and abilities as possible, and as many geographic areas and socio-economic groupings as possible. In this context, there was support for a scheme that combines e-scooters and e-bikes. Overall, stakeholders recognised the balance between scheme coverage and profitability, and comparisons were made with the privatised bus industry which seeks to maximise profit rather than social benefit. It is challenging with a free-floating hire scheme, despite designated parking locations, to manage supply for equitability of access to the system.

Some stakeholders made the point strongly that the unitary authorities, as a result of the time and effort they are expending on the trial, are in effect subsidising its operation. The point was made that highway authorities need to cover additional costs incurred as a result of assisting e-scooter hire schemes. It is recommended that a future contract would allow provision for the costs of authorities to be met.

Some discussion took place with stakeholders in relation to the impacts of the illegal e-scooter market on the hire marker and vice versa. No studies have been undertaken on any possible relationships, however. Some stakeholders thought that the full potential for multi-leg public transport journeys combined with e-scooter journeys has not been fully realised. There were some differences of opinion amongst stakeholders as to whether the operator ought to be charged with developing closer links with public transport operators, or whether this was a task for the transport authorities.

4f Operations and governance: How has the management, operation and governance contributed to a successful trial?

Some stakeholders reported themselves satisfied with the way the way the trial has been managed. Most stakeholders recognised the developments that had occurred during the trial, which moved on from a focus on simply ensuring the e-scooters were operating to wider considerations about how the e-scooters fit into the urban realm.

Many stakeholders were concerned at the absence of a formalised agreement between the transport and highway authorities relating to the trial and, as a consequence, actions were taken only if all authorities agreed. It is recommended that agreements need to be in place between all relevant authorities at the outset and before tender award to an operator.

There was general recognition that a more tightly specified contract with an e-scooter operator is required. Further, some suggested that this contract would benefit from performance incentives and penalties. It is recommended that the contract with an operator needs to include remedies for poor performance by the operator.

One stakeholder noted that the technology associated with the e-sooter trial allows a range of flexibilities and actions not otherwise possible, for example linked with geofencing. The concern was that taking such action, sometimes rapidly, just because it is possible may not be a reasonable request to make to an operator. It is recommended that a contract with an operator needs to identify the flexibilities in management and operation of the scheme that are expected from the operator as a result of the available technology.

The reporting of monitoring data has taken time to evolve, and some stakeholders thought this evolution was probably inevitable because of the novelty of the trial. Stakeholders widely shared the view that data sharing for monitoring of operational performance could be further enhanced. In relation to parking for example, such operational data on parking levels and compliance could help confirm to stakeholders the need for new or revised parking locations. Additionally, there was some discussion about whether some aspects of operational data should be shared with the public in the same manner as rail operational statistics are shared. It is recommended that a future contract will need to be more specific in relation to monitoring data, especially where that affects users and non-users.

One stakeholder thought that the operator needed to better understand the local travel environment and local authorities. It is recommended that a future contract would require local presence of a project manager.

From the point of view of e-scooter users, interviewees felt operational matters requiring attention were the management of parking, the existence of no-ride zones and rules and messaging implying e-scooters are aimed at a young demographic. A number of interviewees noted that the cost of using e-scooters needs to be competitive with the bus if they are to continue using them and that recent price increases were threatening that.

4g Communications / education: How effective has engagement been with both e-scooter users and wider stakeholders?

The primary methodology for the trial operator to communicate with users has been through the mobile application. The messaging has been used to engage with users on topics relating to adhering e-scooter use rules, including not riding while under the influence of alcohol and two-up riding.

The stakeholders have been encouraged by the types and style of messages that the trial operator has put out both in-app and on social media. There were conflicting views from stakeholders about whether the messaging had reached saturation point, but there was concern that it is not possible to say how the messaging is being received by users. One stakeholder suggested that there should be a requirement for safety critical or rule-based messaging to be acknowledged because this would place, to some extent at least, enhanced legal obligation on the rider.

More generally, stakeholders saw the value in messaging about events and temporary and permanent changes to infrastructure. In this context, some stakeholders could see an enhanced role, compared to the trial, for the transport and highway authorities in message provision.

Other stakeholders see a role for transport and highway authorities in relation to surveys of e-scooter users undertaken via the app. These surveys could provide valuable information relating to monitoring and evaluation so long as they are appropriately specified.

12 CONCLUSION

The e-scooter trial in the West of England region has been very popular. There have been just over nine million rides since the start of the trial in October 2020 to the end of February 2023. The users are predominantly younger adults and there are nearly three times more rides by men than women. The trial has enhanced the mobility options available to a segment of the population that do not have car and bicycle access and has provided a better option than otherwise available for specific journey situations (such as travel to the city centre), even for those with car or bicycle access.

The trial has assisted in reducing net emissions from travel. The risk of e-scooter riding is about 1.8 times greater per kilometre ridden than on a cycle. The location of parking on the footway has resulted in problems for pedestrians, and especially disabled people.

The travel benefits of the trial suggest that e-scooters have been a worthwhile addition to travel options in the West of England area. There is a need to significantly develop infrastructure suitable for e-scooters (and cycles) within the West of England area to properly accommodate them. This and other measures are required to ensure e-scooters and micromobility in general are attractive to a wider range of the population than currently the case. Shared e-scooter parking standards need to be developed to eliminate adverse effects on pedestrians.

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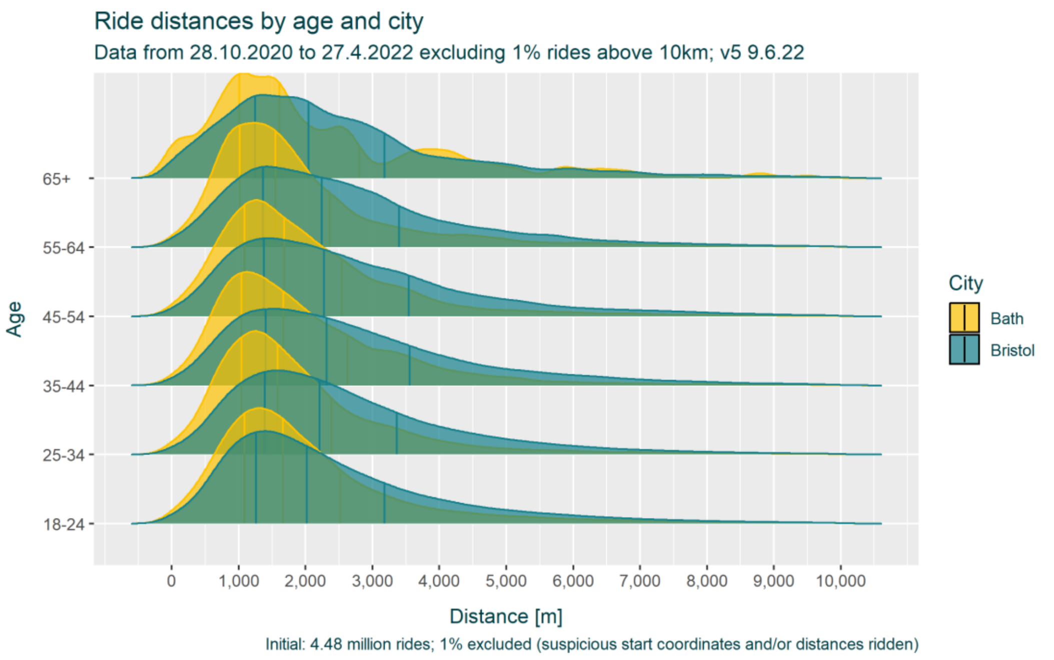
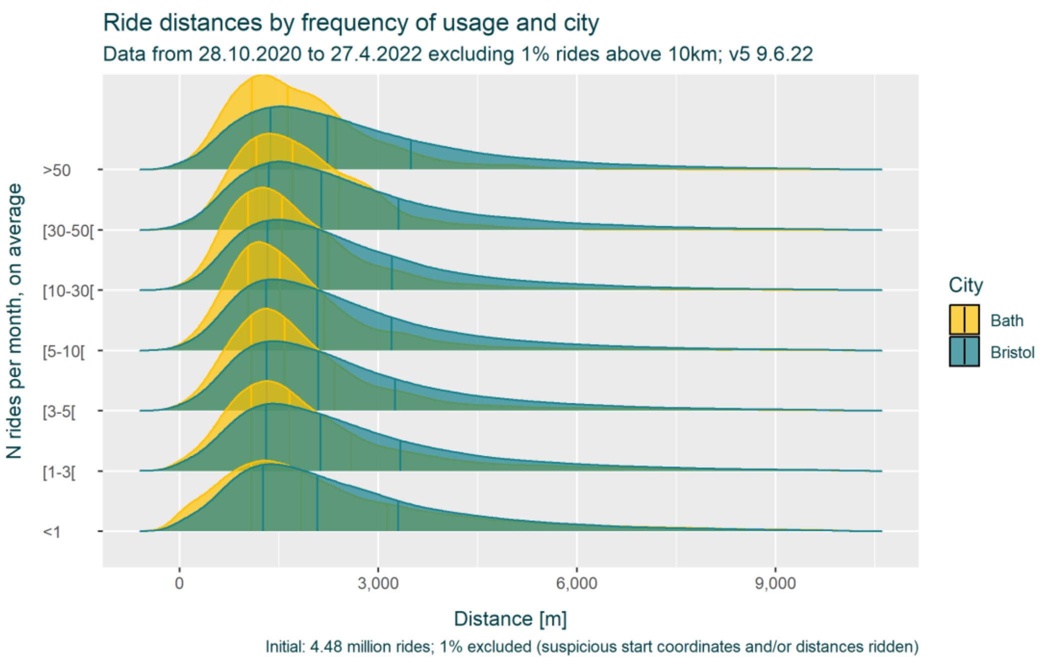
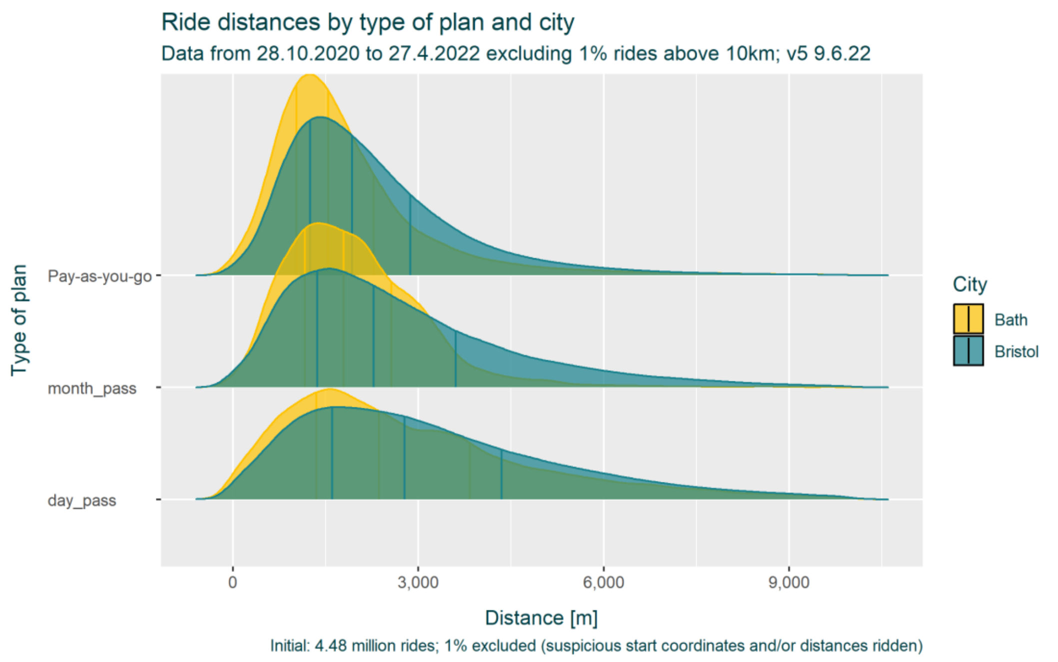
14 APPENDICES

14.7 Appendix 1: Additional graphs showing ride distance distributions






Ride distances by type of plan and city
Data from 28.10.2020 to 27.4.2022 excluding 1% rides above 10km; v5 9.6.22
Type of plan
Pay-as-you-go
month_pass
day_pass
0
3,000
6,000
9,000
Distance [m]
City
Bath
Bristol
Initial: 4.48 million rides; 1% excluded (suspicious start coordinates and/or distances ridden)

14.8 Appendix 2: Additional tables of results from Summer Survey

Bristol - new opportunities enabled? Proportions by age, frequency of use, gender					
	Categories	**No**	**Yes**	**[NA]**	**Total**
Age groups	**18-24**	40%	44%	16%	**100%**
	25-34	55%	32%	13%	**100%**
	35-44	63%	25%	13%	**100%**
	45-54	68%	19%	13%	**100%**
	55-64	74%	16%	11%	**100%**
	65+	67%	22%	11%	**100%**
Frequency (rides / month)	I used Voi once	64%	24%	12%	**100%**
	Less than once a month	68%	22%	10%	**100%**
	Once a month	61%	25%	14%	**100%**
	A few times a month	57%	33%	10%	**100%**
	About once a week	51%	33%	16%	**100%**
	A few times a week	42%	40%	17%	**100%**
	Every day	33%	50%	17%	**100%**
Gender	[Prefer not to answer]	65%	15%	19%	**100%**
	F	52%	34%	13%	**100%**
	M	55%	32%	14%	**100%**
Bristol, overall		**54%**	**33%**	**13%**	**100%**

Agreement with ‘I feel safe riding a Voi scooter’, both cities, proportions

	Categories	Agreement with ‘I feel safe riding a Voi scooter’, both cities									Overview	
		Strongly Disagree	2	3	4	5	6	Strongly Agree	NA	Total	% disagree	% agree
Gender	F	2%	3%	8%	18%	25%	15%	16%	13%	100%	12%	57%
	M	2%	2%	5%	16%	25%	14%	23%	14%	100%	9%	62%
	Non-binary, gender-fluid, or agender	5%	0%	5%	20%	30%	15%	15%	10%	100%	10%	60%
	[Prefer not to answer]	7%	4%	11%	25%	14%	7%	14%	18%	100%	21%	36%
Age	18-24	1%	2%	6%	14%	24%	14%	24%	15%	100%	9%	62%
	25-34	2%	2%	6%	17%	24%	15%	21%	13%	100%	9%	61%
	35-44	2%	2%	5%	17%	30%	14%	17%	13%	100%	9%	62%
	45-54	4%	3%	7%	21%	24%	15%	15%	13%	100%	14%	53%
	55+	2%	5%	13%	26%	19%	13%	10%	11%		20%	42%
Ethnic group	BAME	2%	1%	7%	16%	21%	12%	23%	19%	100%	10%	55%
	Other	7%	2%	11%	18%	18%	9%	27%	9%	100%	20%	54%
	White	2%	2%	6%	17%	26%	15%	20%	13%	100%	10%	61%

14.9 Appendix 3: Additional insights from the intercept and at-home surveys

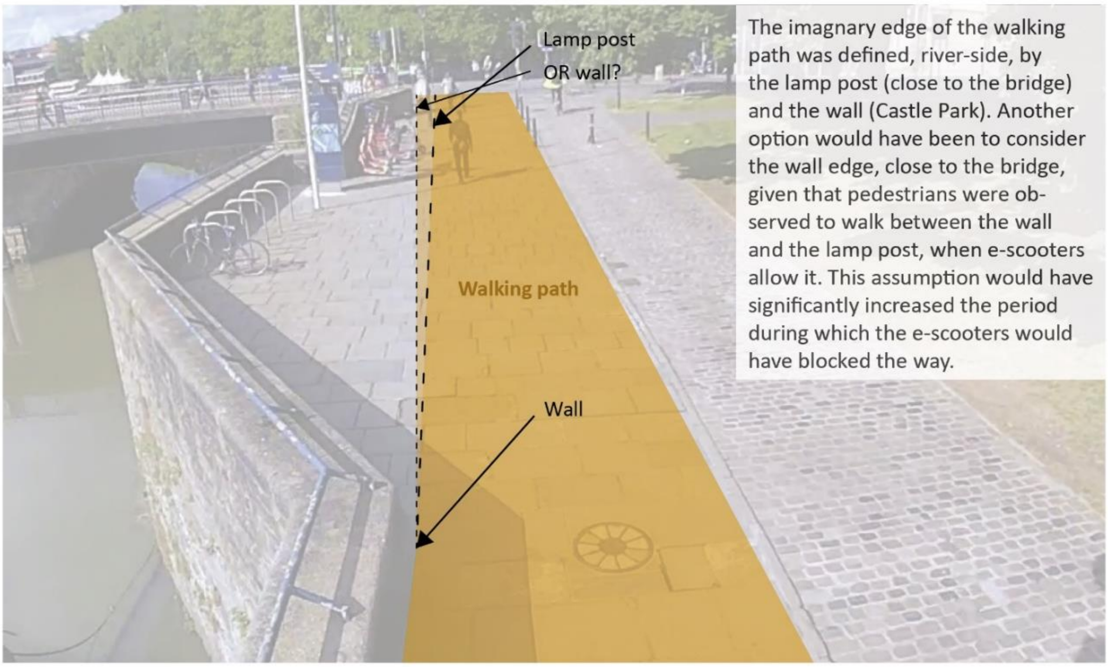
Overall perceptions by age, gender, and disability, for users and non-users.

Statement	Demography		Users				Non-users				Chi2p
	Dimension	Levels	Agree	Disagree	N total	% agree	Agree	Disagree	N total	% agree	<0.05
X1 'I feel safe around people riding Voi e-scooters'	Age	18-29	99	12	125	79%	121	53	208	58%	**
		30+	39	13	58	67%	69	97	194	36%	**
	Disability	Disabled (see definition)	23	8	40	58%	67	59	154	44%	**
		Non-disabled	116	19	146	79%	129	95	261	49%	**
	Gender	Female	39	8	58	67%	77	71	172	45%	**
		Male	95	14	115	83%	108	65	203	53%	**
		Agender / other / NA	5	5	13	38%	11	18	40	28%	ns
X2 'I feel comfortable walking around people riding Voi e-scooters'	Age	18-29	54	6	67	81%	47	16	84	56%	**
		30+	27	6	38	71%	46	56	110	42%	**
	Disability	Disabled (see definition)	14	4	20	70%	35	38	85	41%	**
		Non-disabled	68	9	87	78%	60	36	115	52%	**
	Gender	Female	26	3	32	81%	32	36	80	40%	**
		Male	54	8	70	77%	55	31	97	57%	**
		Agender / other / NA	2	2	5	40%	8	7	23	35%	ns
X3 'I feel comfortable walking around parked e-scooters'	Age	18-29	66	2	68	97%	53	10	81	65%	**
		30+	31	1	36	86%	64	25	109	59%	**
	Disability	Disabled (see definition)	17	1	20	85%	41	26	83	49%	**
		Non-disabled	17	1	20	85%	41	26	83	49%	**
	Gender	Female	31	1	32	97%	52	12	79	66%	**
		Male	64	2	69	93%	63	16	93	68%	**
		Agender / other / NA	4	0	5	80%	5	9	23	22%	**

14.10 Appendix 4: Additional insights from the video observation of parking spots

E-scooters blocking the footway - Bristol Bridge (site 2, camera 4)

Definition of the walking path and its boundaries



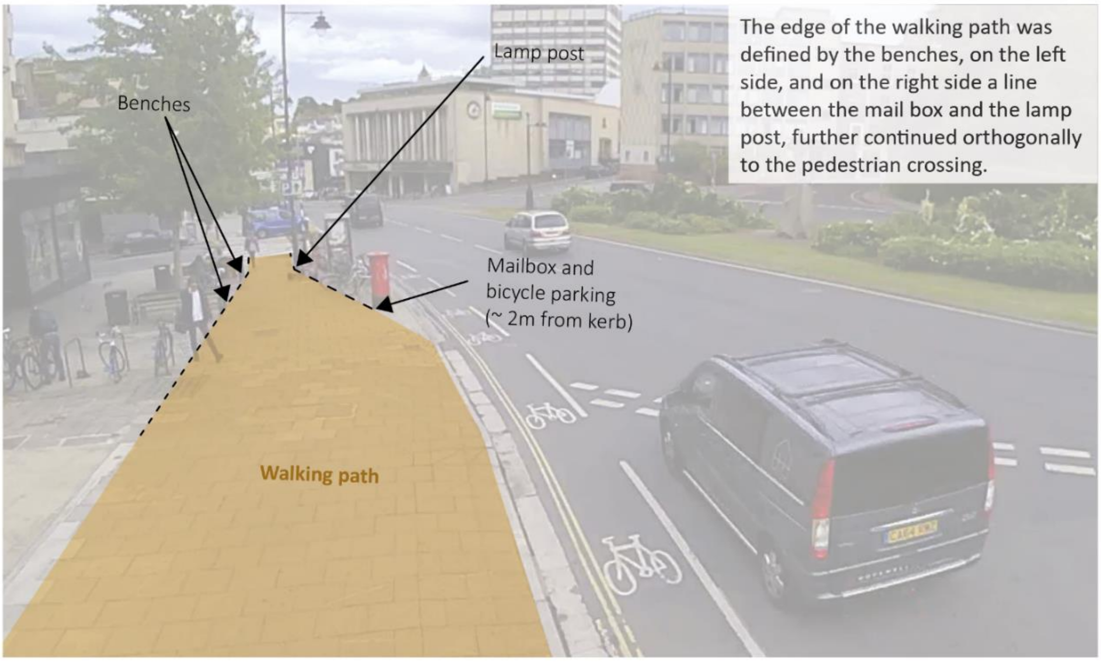
The imagnary edge of the walking path was defined, river-side, by the lamp post (close to the bridge) and the wall (Castle Park). Another option would have been to consider the wall edge, close to the bridge, given that pedestrians were observed to walk between the wall and the lamp post, when e-scooters allow it. This assumption would have significantly increased the period during which the e-scooters would have blocked the way.

Screenshots from the video footage

Throughout the observed period, the footway was obstructed on five occasions, the obstructing e-scooter(s) staying in place for 40 minutes up to 2h. Four of the cases were related to parking, with the rear part of the e-scooter sticking out by approx. 10 to 40 cm onto the footway. The last illustration is an e-scooter moved by passers-by and dropped onto the footway. The e-scooter was picked up and replaced out of the way by other people just before 3am.

E-scooters blocking the footway - Queen's Road by RWA (site 13, camera 1)

Definition of the walking path and its boundaries



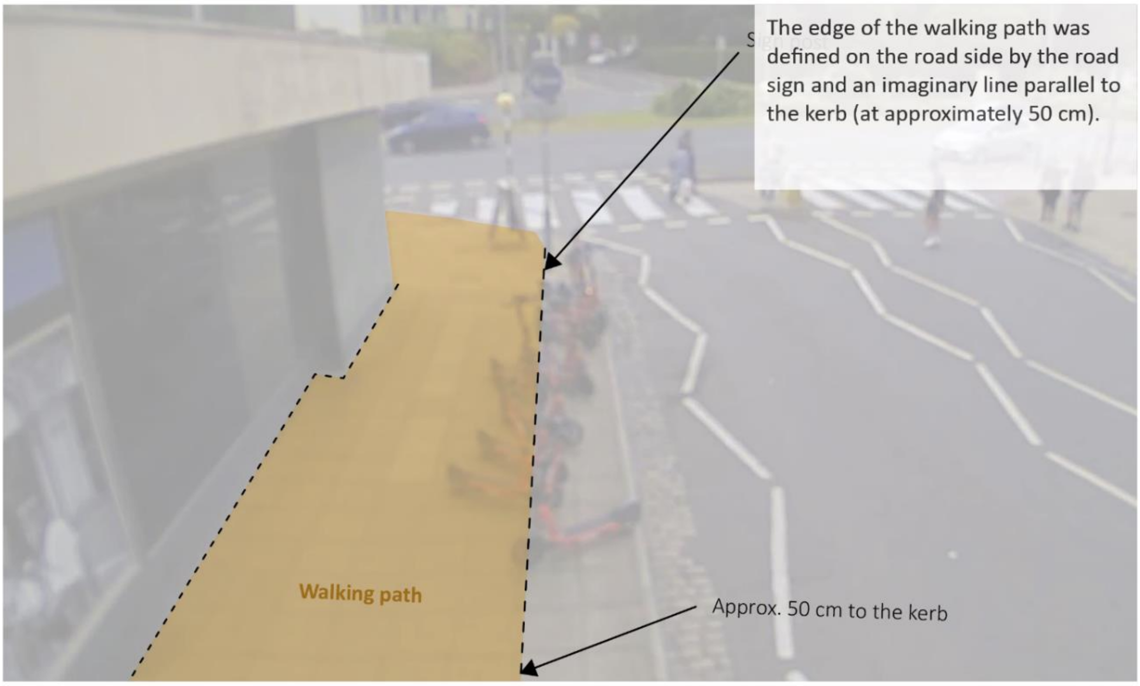
The edge of the walking path was defined by the benches, on the left side, and on the right side a line between the mail box and the lamp post, further continued orthogonally to the pedestrian crossing.

Screenshots from the video footage

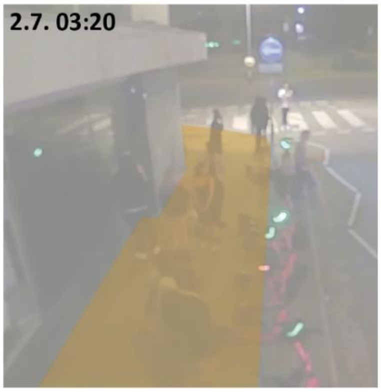
The entire period observed had instances of e-scooters within the walking path. These were mostly e-scooters parked next to others (usually aligned, wich would be rated as "tidy") but with the rear part of the e-scooter sticking out on the walkway.

E-scooters blocking the footway - Queen's Ave (site 13, camera 2)

Definition of the walking path and its boundaries



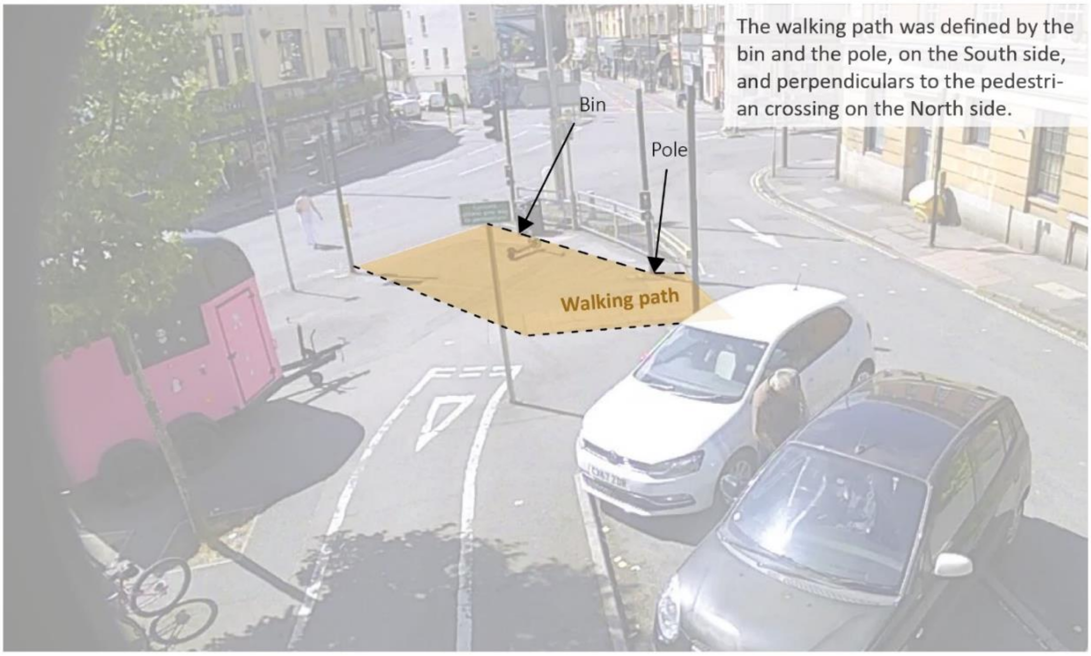
Screenshots from the video footage



The entire period observed had instances of e-scooters within the walking path. These were e-scooters parked roughly perpendicularly to the kerb, with at best the rear wheel part sticking out (as seen in the 4th image, fleet re-arranged by the logistics team) and at worst with most of the body standing on the path.

E-scooters blocking the footway - Gloucester x Elton Rd (site 20, camera 1)

Definition of the walking path and its boundaries



The walking path was defined by the bin and the pole, on the South side, and perpendiculars to the pedestrian crossing on the North side.

Screenshots from the video footage

E-scooters were present during the whole filming period, and impinging on the footway the whole time. The toppled scooters (1.7. 07:37) are the result of a person falling on them and walking away.

Behaviours illustrated - poor parking

Leaving the scooter in the way - Gloucester x Elton Road, 30.6.2022, 15:09

A person arrived in the parking area riding a scooter and carrying a bicycle tyre on the handlebars. They parked the e-scooter in the way of the pedestrian crossing, sat to have a phone conversation (middle picture) and left using another e-scooter, leaving the first one in the way (last picture).

Leaving the scooter in the way - Gloucester x Elton Road, 1.7.2022, 14:02

E-scooter left in the way after a ride, although enough space was available (and other scooters were present “for example”).

Parking a scooter and letting it fall - Queen’s Ave, 1.7.2022, 17:28

A person parks an e-scooter, which falls. The person walks away.

Behaviours illustrated - toppling e-scooters (unrelated to a ride)

Toppling a row of e-scooters - Gloucester x Elton Road, 1.7.2022, 03:05

A person, chatting with two others, falls and topples the e-scooters like dominos. The group walks away, leaving the scooters on the ground. The scooters remain there until users pick them up or put them straight, in the morning.

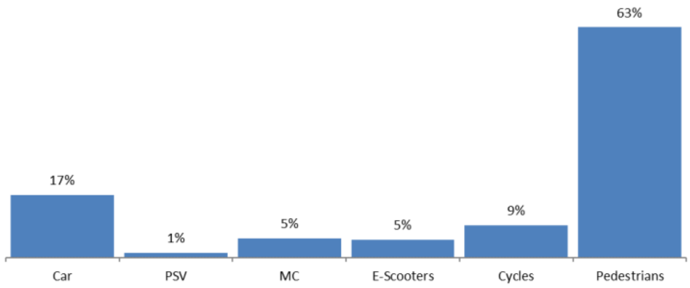
Moving and toppling a parked e-scooter - Bristol Bridge, 3.7.2022, 01:36

A person (part of a group of three) pushed the e-scooter over a short distance and toppled it onto the walkway. Number of people walked past / around until one person picked the scooter up and moved it out of the way.

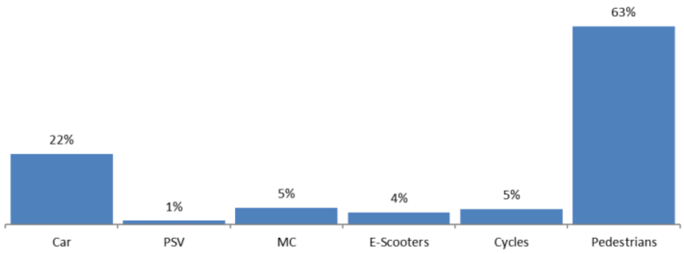
14.11 Appendix 5 - percentage of trips by classed vehicles 06h00-00h00, by site and date

Type 1

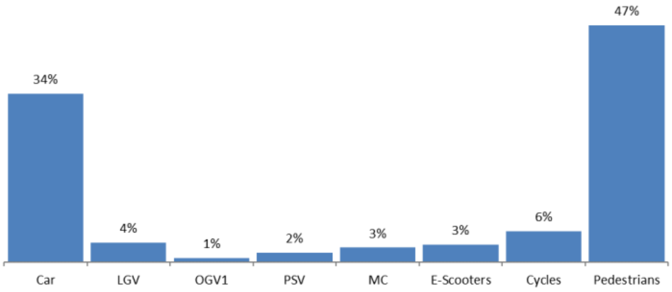
Site 1, Friday 1/7/22 (n = 35,016):



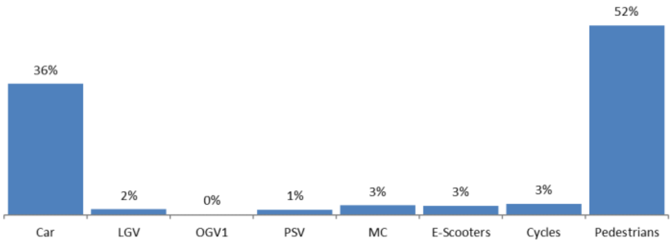
Site 1, Saturday 2/7/22 (n = 30,616):



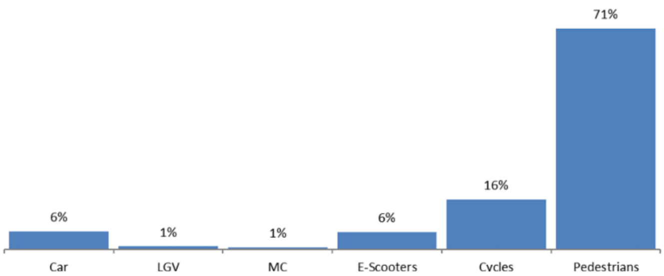
Site 2, Friday 1/7/22 (n = 62,171):



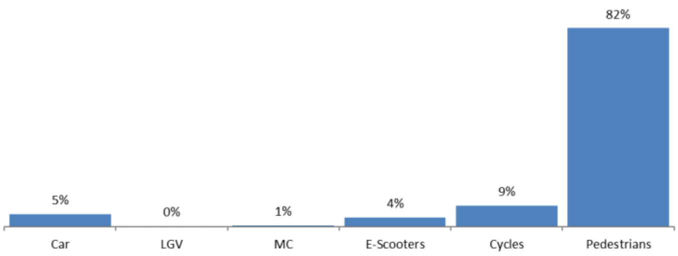
Site 2, Saturday 2/7/22 (n = 58,977):



Site 3, Friday 1/7/22 (n = 21,912):

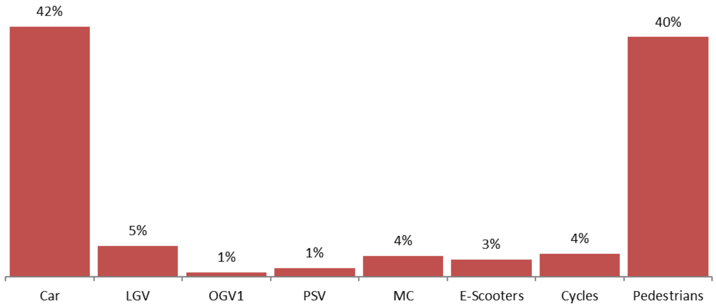


Site 3, Saturday 2/7/22 (n = 22,270):

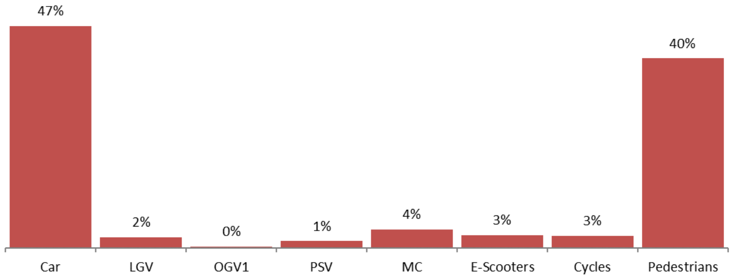


Type 2

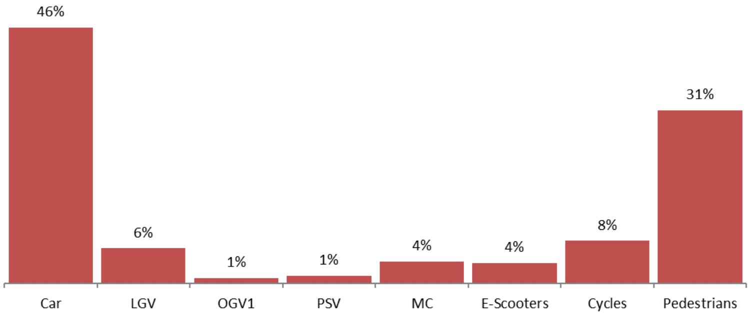
Site 4, Friday 1/7/22 (n = 46,590):



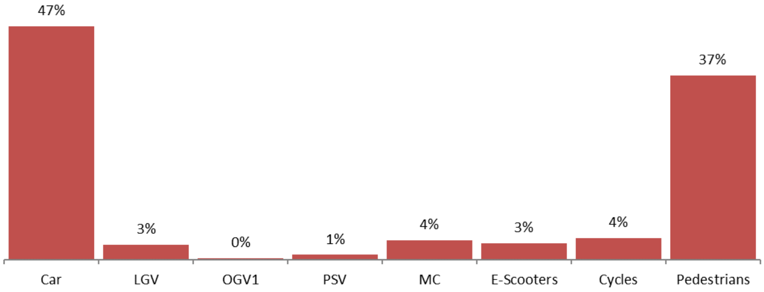
Site 4, Saturday 2/7/22 (n = 37,019):



Site 5, Friday 1/7/22 (n = 38,196):

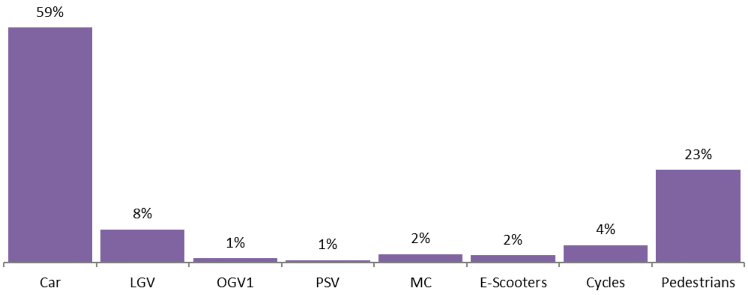


Site 5, Saturday 2/7/22 (n = 33,509):

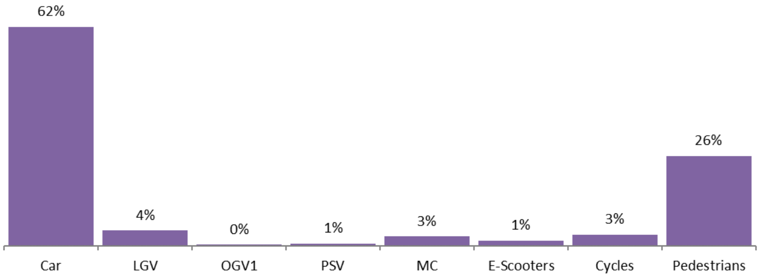


Type 3

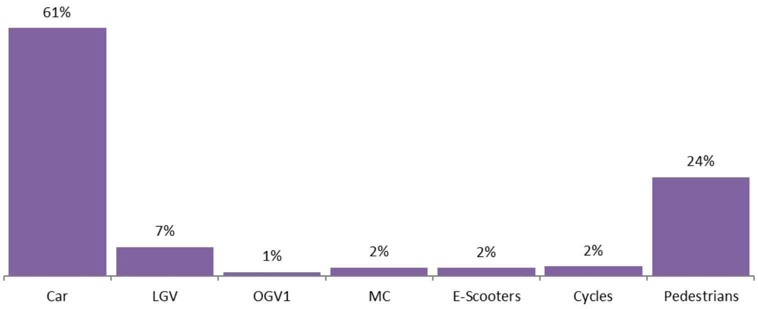
Site 6, Friday 1/7/22 (n = 25,793):



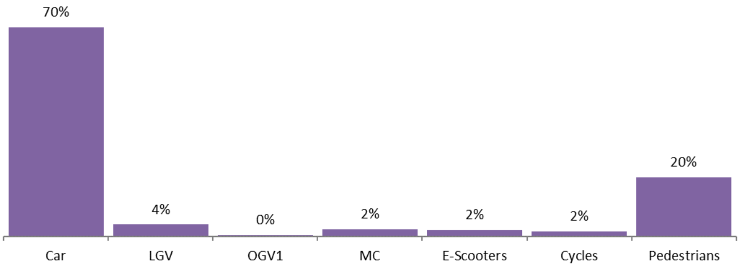
Site 6, Saturday 2/7/22 (n = 21,334):



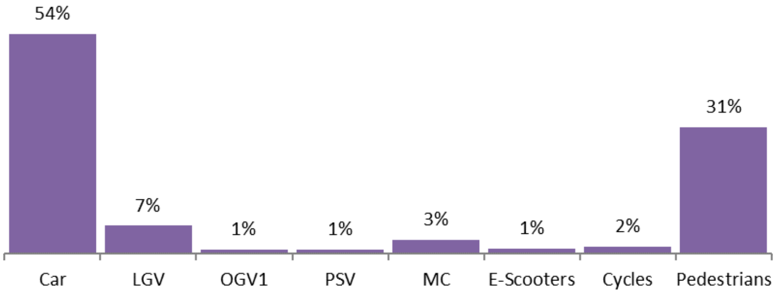
Site 7, Friday 1/7/22 (n = 32,994):



Site 7, Saturday 2/7/22 (n = 25,786):



Site 8, Friday 1/7/22 (n = 34,001):



Site 8, Saturday 2/7/22 (n = 32,535):