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RESEARCH ARTICLE

A micromobility buffet: e-scooters in the context of multimodal spaces and practices in Greater Manchester

Graeme Sherriff, Michael J. Lomas, Luke Blazejewski and Harriet Larrington-Spencer

School of Health and Society, University of Salford, UK

Corresponding author: Graeme Sherriff (g.sherriff@salford.ac.uk)

We use the Capabilities Approach to understand the ways in which e-scooters, as transportation resources, provide qualities that contribute to the ability of the transport system to enable people to participate in society. Government-led trials have been taking place in the UK since autumn 2020, focused on the provision of sharing schemes and with the intention of creating an evidence base on usership and contextual issues. This paper draws from a mixed-methods study in Greater Manchester, combining online surveys, reference groups and qualitative interviews.

The findings suggest that e-scooters have a potential role in expanding the reach and boosting the reliability and flexibility of the transport system. Their relationship with safety is complex. Road safety concerns and issues relating to sharing space present barriers. Conversely, in relation to personal safety, e-scooters provide an alternative to walking through areas in which people may otherwise feel unsafe. For some, e-scooters offer a more affordable alternative to public transport and ride-hailing, but the unpredictability of cost, stemming from the per-minute costing model, can pose challenges for others. The low level of exertion can distinguish e-scooters from other micromobility options and, whilst some might therefore question their value in health terms when compared with other active modes of transport, people with conditions that mean they need to carefully manage their energy expenditure can therefore find e-scooters useful. These potential benefits should however be considered in the context of challenges relating to shared space for walking, cycling and e-scooting.

Keywords: e-scooters; micromobility; multimodal; capabilities approach; active travel

1 Introduction

In the last five years there has been a rapid growth in the use of e-scooters as personal vehicles and the deployment of e-scooter sharing schemes around the world (Gössling, 2020). The rapid growth in private and shared e-scooter use has been accompanied by a body of research and media coverage around the potential role of these vehicles and the extent to which they

can address environmental and social issues related to transport systems (Hollingsworth, Copeland and Johnson, 2019). The rapid development has brought challenges around the mix of e-scooters and other urban practices (Wallius et al., 2022, p94), as shown in media coverage of conflicts with other road and pavement users in relation to the use of public space for riding, parking and docking (Kale, 2022).

The UK Government authorised a trial of e-scooter sharing schemes in England in 2020. Until then the growth in e-scooter use in the UK had largely been centered around private use (Winchcomb, 2022), despite the privately-owned vehicles being illegal to ride in any public spaces (BBC News, 2021). With over 50 trial e-scooter share schemes now in operation in the UK, there is an opportunity to explore their contribution to, and impact on, mobility practices.

In this paper, we draw on data collected through interviews and focus groups as part of a mixed methods study of e-scooter use in Greater Manchester, focusing primarily on the qualitative elements. Whilst the larger study from which we draw investigated the use of e-scooters and their impact upon Greater Manchester in a broad sense (Sherriff, Blazejewski and Lomas, 2022), this paper seeks to address a specific aspect. It focuses on the ways in which e-scooter use connects with transport practices in a wider sense and considers the ways in which they complement, augment, and come into conflict with, transport provision across the conurbation.

We utilise the Capabilities Approach (CA), which emphasises autonomy as a central element of human functioning and conceptualises wellbeing as a set of related elements that provide this freedom. Within this approach, *conversion factors* enable people to make use of the *resources* available to them and equip them to achieve *wellbeing* (Robeyns, 2011). We refer to the Transport Conversion Factor (TCF) as the potential for the transport system as a whole to enable people to thrive. We then place e-scooters in the context of other mobility resources and practices with the aim of understanding the potential contribution of e-scooters to the development of sustainable transport systems.

Our aim is to understand the ways in which e-scooter use and provision impacts and shapes mobility practices and to explore the value of conceptualising these new vehicles as resources within the transport system. Whilst focused on a UK case study, our evidence will be valuable to any city grappling with the challenges and opportunities that stem from the rapid growth in e-scooter use. Our conceptual development contributes to the understanding of shared micromobility, a sector growing rapidly across the globe.

2 Context

2.1 E-scooters

Gössling (2020) dates shared e-scooters systems to 2017 in Los Angeles and points to a rapid growth in provision globally since then, comparable to that of public bike sharing (Spinney, 2020), another element of shared micromobility (Shaheen et al., 2020). With the rise in popularity of e-scooters there has been a growing body of research into their use, potential application and impact on cities and on mobility systems and practices (Caspi, Smart and Noland, 2020; Krier et al., 2021), examining how e-scooters might fit within and contribute to broader transport systems (Gössling, 2020; Rose et al., 2020) and how they are being used in, for example, Paris (Christoforou et al., 2021), Chicago (Mehzabin Tuli, Mitra and Crews, 2021), Munich and other German cities (Hardt and Bogenberger, 2019; König et al., 2022), Brisbane (Haworth, Schramm and Twisk, 2021), and Greater Manchester (Sherriff, Blazejewski and Lomas, 2022). Here we provide an overview of literature on their environmental impact, health implications, and challenges involved in sharing space with other road users.

Much of the interest in the relationship e-scooters have with other modes of transport relates to the potential for modal shift away from private car use and therefore the potential to reduce the air pollution and climate change emissions associated with the transport sector (Hollingsworth, Copeland and Johnson, 2019). Evidence to date has tended to suggest,

however, that e-scooter use is most likely to replace journeys that would have otherwise been made by foot, bike or public transport (Nikiforiadis et al., 2021; Wang et al., 2021). McQueen and Clifton (2022) looked at the potential for e-scooters to be a first and last mile solution but found that the potential for this is currently "overstated" and called for policy changes relating to both e-scooters and public transport. In terms of the wider environment impact, Orozco-Fontalvo et al. (2022) argue that the impact of e-scooters should be considered within the context of their service life and associated logistical operations.

Glenn et al. (2020) observe that there is little research on the health impact of e-scooters. Some argue that e-scooters are not genuinely active transport (Cook et al., 2022; Sustrans, 2021) since motion is sustained by a motor rather than the rider. PACTS (2020) suggest that e-scooters are "bad for active travel", with their use requiring lower physical exertion compared with walking and cycling. Although some literature suggests e-scooter use could be a "gateway activity" for further exercise, Glenn et al. (2020) argue that this narrative is largely driven by the industry.

The relationship between e-scooter use and health is complicated further by the risk of injury. A body of work has explored this and associates the implementation of e-scooters schemes with increases in physical injury (Badeau et al., 2019; Glenn et al., 2020; Factor et al., 2021; Uluk et al., 2021). The European Transport Safety Council (ETSC) is developing guidelines (ETSC, 2021) and the UK Parliamentary Advisory Council on Transport Safety (PACTS) is investigating privately-owned e-scooters (Winchcomb, 2022).

The potential impact of e-scooters' use on other road and pavement users has also drawn attention, with implications for how people use urban space (Fitt and Curl, 2019; Gibson, Curl and Thompson, 2021). Pavement use and inconsiderate parking could impede pedestrians (James et al., 2019), particularly those with mobility and/or visual impairments (Brown et al., 2020; Guide Dogs for the Blind, 2021; RNIB, 2020). Sustrans (2021) has published a statement calling for e-scooter legislation to include measures to protect other road and pavement users, including limitations on speed and power and a ban on their use on public footways. The House of Commons Transport Select Committee (2020) highlighted issues of 'street clutter' in their review of e-scooters, something that has also been associated with dockless bike share (Sherriff et al., 2018). In response to concerns about people with visual impairments, some European and US regulations require electric vehicles to emit discrete warning tones (Torija Martinez and Elliot, 2021). Some e-scooter operators are working on providing effective warning sounds (Topham, 2022) and research has shown these to reduce the reaction times of observers (Torija Martinez and Elliot, 2021).

2.2 The UK and Greater Manchester

At present, in the UK the use of privately-owned e-scooters is illegal except on private land. Irrespective of this restriction, e-scooters are available from retailers and are evident on roads and pavements (BBC News, 2021; Winchcomb, 2022). In 2020, the UK Government authorised a trial of shared e-scooter schemes in England and commissioned an evaluation (Busby et al., 2020). To date, around 50 local authorities have introduced such schemes (Winchcomb, 2022). Shared e-scooters are legal only in the areas designated for these trials, and are subject to regulations that determine maximum speed and other factors, including lights and braking.

In collaboration with Transport for Greater Manchester and Salford City Council, and as part of the trials in England, Lime has been running an e-scooter scheme through which e-scooters are available from virtual docks. This commenced in Salford in Autumn 2020 and, at the time of publication, continues to operate. It has been expanded from a restricted first phase, focused on the University of Salford's campus, to cover, in Phase 4, a larger area reaching the border of neighbouring Manchester and including major employers MediaCityUK and Salford Royal Hospital (**Figure 1**). A smaller scheme was operational in Rochdale for one year from March 2021.

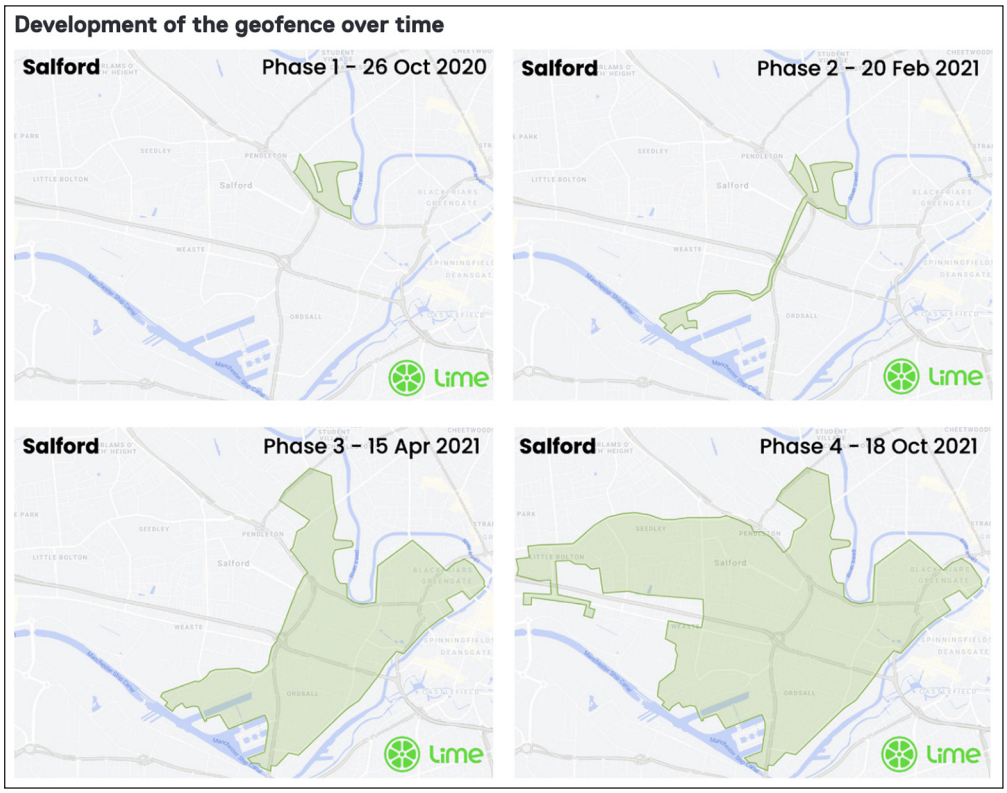

Figure 1: The Lime e-scooter share scheme in Greater Manchester: development of the trial areas in Salford.

2.3 Capabilities Approach

Having set the scene in terms of the literature on e-scooters and the current regulatory picture in the UK, we turn to our conceptual framework. The Capabilities Approach (CA) is premised on the notion that the most important part of a person's life is that they have freedom to choose how to live. Whilst mobility is not discussed explicitly within the main theoretical development of the approach, its importance is implied when referring to the "ability to freely move from place to place" (Vecchio and Martens, 2021, p835).

CA conceptualises wellbeing as a set of related elements that provide this freedom: *resources, conversion factors, capabilities, choices* and *functionings*. Broadly speaking, *conversion factors* enable people to make use of the *resources* available to them to develop *capabilities* that in turn give them choices and enable them to achieve wellbeing through *functionings* (Robeyns, 2011). The conceptualisation of conversion factors reflects the reality that vulnerable or otherwise excluded people may need additional resources to help them achieve similar levels of functioning (Cao and Hickman, 2019).

There is a growing literature applying the CA to transport and the related field of energy consumption (Day, Walker and Simcock, 2016; Middlemiss et al., 2019). Cao and Hickman map Nussbaum's ten categories of "central human capability" to qualities of transport planning (2019), and others bring together the approach with notions of fairness and inclusion in transport (Hananel and Berechman, 2016; Oviedo and Guzman, 2020; Randal et al., 2020; Vecchio and Martens, 2021). Sheller (2018) considers the approach in building up her conceptualisation of "mobility justice". Applications to specific groups affected by mobility

policy include older people (Nordbakke, 2013; Ryan, Wretstrand and Schmidt, 2015) and disabled people (Burchardt, 2004).

We follow Randel et al. in their suggestion of approaching transport policy, and the provision of transport in the broadest sense, as a (social) conversion factor: it "acts as a social determinant of health and impacts on wellbeing through a range of capabilities" (2020, p10). The potential for people to make use of these resources relates to broader personal and social conversion factors (Kaufmann, Bergmann, & Joye, 2004): for example, age, gender, disability, confidence and socioeconomic status (Robeyns, 2011).

In this paper, we use this approach to look at transport provision and its constituent parts, with a focus on e-scooters. We discuss the *qualities* that different mobility resources contribute with a view to understanding the extent to which e-scooters increase the potential for people to be mobile and access the services they need. Private and shared e-scooters are relatively recent additions to the stock of transport resources available and, like other modes, have particular *qualities* that help to shape the potential of transport as a Conversion Factor. Robeyns defends this emphasis on the *qualities* that enable a resource to facilitate mobility, and we might replace "bicycle" with "e-scooter": "we are not interested in a bicycle because it is an object made from certain materials with a specific shape and colour, but because it can take us to places where we want to go, and in a faster way than if we were walking" (2005, p98).

For the sake of brevity and readability, we use the term Transport Conversion Factor (TCF) to refer to the potential of transport provision as a whole to act as a Conversion Factor that enables people to achieve the functionings they want or need. Understood in this way, e-scooters are one of the mobility resources that contribute towards the TCF. We visualise this relationship in **Figure 2**.

3 Methodology

Our empirical context is drawn from a study of e-scooters in Greater Manchester conducted from spring 2021 to summer 2022. The full project is documented elsewhere (Sherriff, Blazejewski and Lomas, 2022). This paper draws upon the data to look specifically at the relationship between e-scooters and the transport system as a whole. The wider study comprised three iterative phases, each with three elements: online surveys, explorative interviews, and reference groups. The dates of the stages, the level of participation and the ranges of interview identification numbers are shown in **Table 1**.

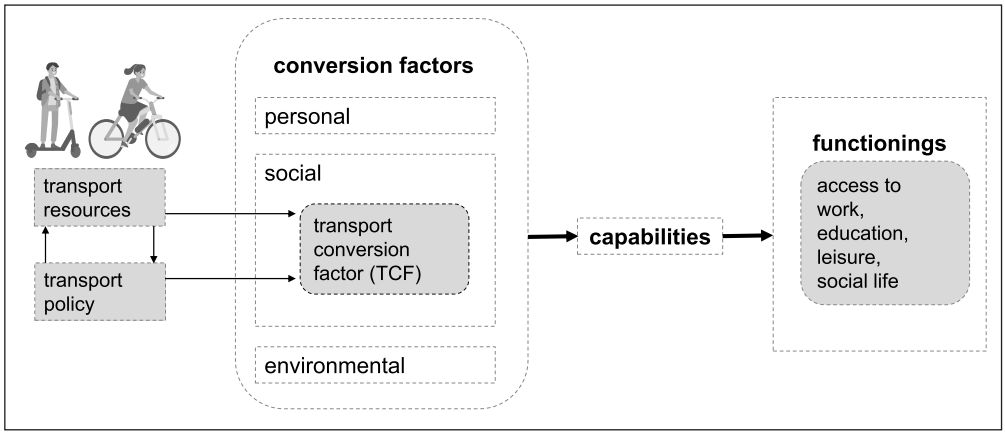

Figure 2: Schematic diagram of the relationship between transport resources and policy shaping the Transport Conversions Factor (TCF) and, in turn, capabilities and functionings.

Table 1: Stages of the research and extent of data collection.

	Stage 1	Stage 2	Stage 3	Totals
Surveys dates	2nd March to 28th March 2021	19th July to 18th August 2021	23rd March to 24th May 2022	
responses	741	199	1,514	2454(*)
Interviews dates	22nd March to 23rd March 2021	11th August to 20th October 2021	4th April to 22nd June 2022	
count	11	20	18	49
IDs	1 to 11	12 to 31	32 to 49	
Reference groups count	6	4	1	13

(*) some respondents took part in more than one of the surveys.

Respondents to Surveys 1 and 3 were recruited through a combination of email lists (including employers, community networks and participants from previous research and events), posts on social media (primarily Twitter, Facebook and LinkedIn), and direct contact with Lime customers through email and in-app messages. For practical purposes, Survey 2 recruitment was restricted to respondents of Survey 1: resources were available for only two large-scale surveys promoted on social media, and Survey 2 was intended as a short follow-up to Survey 1.

Interviewees were selected from the sample of participants across the three online surveys with a view to constructing a diverse sample that included people across genders and age groups, reached current and potential e-scooter users, and created the opportunity to follow up on points raised by specific survey respondents. The qualitative sample was limited to those who expressed, as part of the online survey, willingness to take part. The reference groups were selected from this sub-sample, with additions from existing policy and research networks. The reference groups complemented the interviews by enabling discussion of themes that transcended individual experiences, such as gender, disability, research directions, and transport planning challenges.

Through iterative design, ideas and concepts from the reference groups were fed into survey design and interview question guides, and the findings from each stage informed the preparation of subsequent stages. A mixed methods analysis was conducted, combining statistical analysis of the survey data with thematic qualitative analysis of interviews and reference groups as well as the free text comments received through the survey. The mixed methods approach was particularly valuable for this relatively new mode of transport: we were able to identify priorities and trends whilst also exploring the complexity of practices, perceptions and experiences. Note that the CA emerged as a conceptual framework during analysis: the research was not designed around this framework.

In reporting descriptive statistics in this paper, we draw upon the third online survey. The first and second online surveys are considered interim studies that formed part of our iterative approach, whereas the third received the most responses and was conducted at a time when the Salford e-scooter trial had expanded to cover a larger area, Covid-19 restrictions had been largely lifted, and residents had had more time to become aware of the scheme. **Table 2** provides a breakdown of the responses to Survey 3 and similar data for the other surveys are available in interim reports (Sherriff et al., 2021, 2022). In presenting qualitative data, in the form of interview and survey quotes, we have drawn from the whole sample of interviewees, which were selected from the participants of the three surveys.

Table 2: Distribution of respondents to Survey 3 (N = 1514).

Question	Group	N	Percentage of Sample
E-scooter use	A Lime rental e-scooter in Salford or Rochdale	382	25
	A privately-owned e-scooter	63	4
	Both of the above	41	3
	Neither of the above	1028	68
Gender	Male	851	56
	Female	611	40
	Prefer not to say or prefer to self-describe	52	4
Age Group	18–25	274	18
	26–35	318	21
	36–45	296	20
	46–55	295	19
	56–64	182	12
	65–74	111	7
	75 or over	8	1
	Prefer not to say	30	2
Ethnicity	White	1252	83
	Asian or Asian British	97	6
	Black/African/Caribbean/Black British	38	3
	Mixed or multiple ethnic groups	43	3
	Prefer not to say or prefer to self-describe	84	5
Relationship with Greater Manchester	Live in the area	1282	85
	Work in the area	1125	74
	Study in the area	293	19
Has a long-term illness or health condition that affects mobility	Yes	171	11
	No	1267	84
	Prefer not to say	76	5
Access to transport	Bicycle or other cycle	897	59
	Car, van, or motorbike	992	66
	Privately-owned e-scooter	68	4
	None of the above	274	18

4 Findings

4.1 Introduction

We use the findings from our study to explore how e-scooters add to and interact with transport practices and provision. We look at this through the lenses of reach, flexibility, reliability, safety and security, cost, and experience. These lenses are each factors that determine perceptions of e-scooters and propensity for use and, in turn, shape the ability of e-scooters to

increase the TCF. In seeking to understand nuances that link and separate privately-owned e-scooters and those accessed through the sharing scheme, we refer to 'private' and 'shared' e-scooters respectively. Whilst some of the qualities of e-scooters apply to both of these modes of operation, some are distinct and apply to one or the other.

We draw primarily from qualitative data and use these to identify themes arising from the study. Whilst we include descriptive statistics from our third survey when these are useful in demonstrating the weight of specific factors, we do not set out to quantify e-scooter use and related impacts. Interview quotes are labelled with the interviewee number and comments from the survey are labelled Survey 1, 2 or 3.

4.2 Reach

Any transport system is bounded by the area it covers and its times of operation. We refer to these qualities as 'reach'. Reach limits the TCF, both spatially and chronologically. In the case of the Greater Manchester e-scooters share scheme, and the current generation of similar schemes, the operational area is determined by the geofence. GPS technology limits where e-scooters will operate and facilitates localised speed restrictions.

Whilst the geofence was expanded over the course of the trial, at the time of writing it remains limited to an area of Salford. The potential for the e-scooter share scheme to boost the TCF was therefore limited to a spatial area and to people with journeys likely to be within or connecting with that area:

> I'm just outside the boundary of where they are located or where the pick-up points are convenient for me... That is the only reason I've not used it because on a lot of occasions I've wanted to go a short distance... I would have rather got a scooter, because I know how to use them. I'm familiar with them and I think that would be a better more economical way than getting a taxi which is what I do now. (Interview 27)

In a large urban area, in which people travel into and out of Salford from the neighbouring city of Manchester and the boroughs of Greater Manchester, this meant that there were people and mobility practices for which the shared e-scooters were not relevant: 'They're there; I can see them. They're available, but not to me, because I have to go into Manchester for work' (Interview 29).

This limitation notwithstanding, some respondents found that the availability of shared e-scooters could extend the reach of other services: making journeys possible that could not be made on buses, trams or trains alone. This related to space, in the sense of locations of the networks, and also to time, in relation to periods when public transport availability was non-existent or limited, such as late night and early morning. Forty-two per cent of survey respondents who had used a Lime e-scooter had used one to make a journey they would otherwise have made with public transport.[1] The inclusion of e-scooter share in the transport system could therefore overcome some of its spatial and temporal limitations and boost the TCF:

> The way that I get into work, there's not really another public transport option. If I'm running late or don't fancy walking that day, usually I would just jump on the scooter. There's not really another good option that is direct. (Interview 40).

[1] Amongst Lime users completing Survey 3 (N = 382), 30% had used an e-scooter to make at least one journey that they would otherwise have made by bus. The equivalent figures for coach, train and tram (Metrolink) were 2%, 10%, 19% respectively. Taken together, 42% had replaced at least one journey made by one or more of these forms of public transport (Sherriff et al 2022, p28).

> Sometimes I may need to be at a place very early in the morning and maybe there are no buses yet, so maybe in my area, the buses start activities by 4:45 or 4:50 thereabouts and I need to be at my destination before five o'clock, so I would have to find an alternative means... (Interview 35)

Forty-one per cent of survey respondents had used a shared e-scooter to make at least one journey they would otherwise have made by taxi or ride-hailing.[2] There were several references to using an e-scooter as a point-to-point service in place of a taxi or ride-hailing, often on grounds of cost or reflecting gaps in public transport:

> Getting to work. At the time buses would be heavily delayed by road works/traffic on Chapel Street. I would ride from Frederick Road where I lived at the time to the furthest point into Manchester, then walk the rest. I worked in Northern Quarter as a bartender therefore finish late, Taxis/Ubers would be expensive, and no buses would be on. (Survey 3)

4.3 Reliability

In offering the potential to connect with and replace public transport journeys, the presence of e-scooter sharing increased, for some, the overall reliability of the transport services available to them, and therefore also increased the TCF. This reflected issues with reliability and connectivity of services:

> I need to change trains in Manchester city centre to get out to my office in Salford. 9 times out of 10 my first train is delayed so I miss my connection. Now I have the option to walk to the Salford border from Deansgate to pick up an e-scooter and then nip up the A6... saves me being late for work... (Survey 3)

Whilst e-scooters have a potential role in overcoming issues of unreliability with public transport, this is not to say that e-scooter provision is without its own reliability and useability issues. The impact on the TCF is therefore mixed:

> I will wake up... I'll look to see if there are any available first because, if I'm relying on getting the scooter... If I know I can get one, I know that it's going to take me about 15 minutes to get to work. If they're not available, then I have to change my plans and I'll have to get an Uber or I'll have to set off very quickly. There's a little bit of unreliability about them, but more often than not there are scooters available. (Interview 42)

With an unfamiliar system, difficulties knowing where to ride, and at what points speed limitations might be applied, can also make it challenging to anticipate the total journey time:

> On several rentals had to push for half a mile as alarm stated no riding zone, even though I'd already travelled through the area on the initial journey. (Survey 3)

Even if e-scooters increase the TCF, then, these challenges add a level of complexity that impact individual experiences and potentially limit the likelihood of them being seen as a viable mobility option.

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[2] Amongst Lime users completely Survey 3 (N = 382), 41% had replaced at least one journey that they would have made by Taxi or ride-hailing services, such as Uber (Sherriff et al 2022, p28).

4.4 Flexibility

For those who had access to the shared e-scooters, they offered a degree of flexibility:

> I go and swim at The Quays and there's been a couple of times where I've gone part of the way home on them, like started walking home with a friend and then he's gone off one way, and I've just got on the scooter to get the rest of the way home just more quickly. (Interview 18)

This particular type of "pick up and drop off" flexibility applies to shared e-scooters rather than their privately-owned counterparts, but we did see examples of people using private e-scooters to afford flexibility, aided in this example by the compactness of the e-scooter and the ability to be able to store it in a car.

> If I'm going to the pub I'll take the bike, and to be honest, what I do with the scooter is: if we've driven to the pub, I'll leave the car there and take the scooter the next day and go and get it because I can put the scooter in the back of the car. (Interview 43)

4.5 Safety and security

Overview

Safety is a consideration when making decisions about mobility and can therefore be considered key to the TCF. In relation to e-scooters there are three pertinent dimensions to safety.

Firstly, concern about road safety is a barrier to use. This resonates with cycling research, in which this barrier is well established (Pooley et al., 2013). Over half of respondents indicated that concerns about road safety would likely limit their e-scooter use.[3] Concerns about safety therefore limit the potential for people to use e-scooters and, in turn, any boost in the TCF: however useful they might be, they do not help people who do not have the confidence to ride them.

Secondly, and conversely, another aspect of safety related to the ability to travel fast and to pick up a shared e-scooter when needed. This could help people avoid situations in which they feel at risk, particularly at night. The availability of e-scooters could also alleviate some of the personal safety concerns associated with using public transport (Gardner, Cui and Coiacetto, 2017; Chowdhury and van Wee, 2020). In this case, the availability of e-scooters increases the ability of some people to feel safe when travelling and therefore affects the TCF of transport provision positively.

Thirdly, it is important to be aware of the impact of e-scooters, either moving or parked, on the experiences of other road and pavement users. The implication here is that other individuals may feel less confident walking in public spaces and that the TCF, as it is experienced by them, might decrease.

Road safety

In terms of road safety, participants drew parallels with cycling: it is clear that this well-established barrier to cycling is also a deterrent to e-scooter use.

> My main concern is the same reason I don't cycle in Manchester anymore. The cycle lanes are absolutely awful, and the drivers are aggressive and arrogant. E-scooters are

[3] Across all respondents to Survey 3 (N = 1514), 59% selected "ROAD SAFETY – Concern about road safety (threat from vehicles)" from a list of options in response to the question "Which of the following are likely to limit how much you use an e-scooter? Select all that apply." (Sherriff et al 2022, p48).

> dangerous on the pavement but on the road, they are at risk from car drivers. We need segregated lanes for cyclists and scooters. (Survey 3)

In addition to these issues, there is a sense that there are additional concerns that relate to e-scooters. In this example, the interviewee notes the small wheels as a factor in their decision to use an e-scooter on pavements.

> I do ride on the pavement more frequently with an e-scooter than I would on a bike. I would rarely really ride on the pavement with a bike, unless it was completely empty... Maybe it's a safety thing because, like I said, the wheels are quite small. The pavements are a lot smoother to ride on and the roads can be quite bumpy. It feels safer, I think... (Interview 36)

To some extent, this issue relates to both private and shared e-scooters. Perceptions varied, however. In this example, the interviewee feels that they would feel safer if they could buy a private e-scooter and therefore have more control over the specifications.[4]

> That's with the presumably solid tyres on the Lime scooters, made it for a really lot of vibration. It was not a comfortable ride, at all. So, I told myself that as and when you guys manage to make them legal, which I hope you do, I would certainly buy one that had got bigger tyres or pneumatic tyres or something, because the ride quality itself wasn't very good. (Interview 16)

Whilst individuals may feel that they have, or would have, more control over a private e-scooter, shared schemes in the UK are subject to regulations on standards that apply to wheels, braking and speed. Whilst some private e-scooters may match these standards, the range of what is available is much wider.

Not all respondents felt less safe on e-scooters. Some mentioned qualities of e-scooters that would help them feel safer, including the sense of being able to accelerate out of difficult situations and the ability to step off if needing to escape from the vehicle. On balance, though, the data indicates not only that e-scooters share the barrier of road safety with cycling but also that there are instances in which people will feel less safe on an e-scooter than they would on a bike.

Fear of traffic is likely to be one of the main factors limiting use and may also, in part, explain the prevalence of pavement use. For those for whom fear of traffic is a barrier, the addition of e-scooters into the mobility mix would therefore not significantly increase the TCF since they would not see e-scooting as an option for them.

Personal safety

There is an indication that the ability to travel fast and to pick up an e-scooter when needed could help in alleviating concerns about attack and harassment. In so far as this relates to the ability to travel fast, this relates to some extent to both private and shared e-scooters. There is an implication in our interviews, however, that it is the sharing element that is the useful quality here, rather than the use of an e-scooter per se.

> I'm not someone who's particularly worried about walking at night, or whatever, I do it, but it does feel safer to be on a bike or a scooter because you're on the road moving faster... (Interview 13)

[4] Note that the Lime e-scooters available in Salford do have pneumatic tyres.

> ...it would be useful to have a scooter, especially when it's darker and when it gets to wintertime, to be able to feel a bit safer nipping to the shop and back. (Interview 21)

An additional consideration, as mentioned in our reference group discussion focused on women and transport, is the ability, by picking up a shared e-scooter, to avoid waiting at public transport interchanges at night.

The relationship with personal safety is, however, complex and it appears that some might feel less safe as a result of "standing out" whilst using an e-scooter:

> I wouldn't be very confident going away from the university on them, just because you stand out, don't you? I think anything where you stand out you could become a bit of a target around Salford. (Interview 5)

Personal safety and road safety are related. Concerns about road safety could limit the extent to which people feel able to make use of e-scooters in order to feel at less risk of attack or harassment. This interviewee considers these two aspects of safety together:

> I think I'd be more confident once I'd had, well once I knew how to use it properly, and it wasn't like my first or second time, kind of thing, then I'd feel safer on it, because if I did get any hassle, I could just zoom off, can't I? (Interview 30)

Whilst there may be advantages relating to personal safety that might increase the TCF for some people, then, these need to be understood in the context of concerns about road safety as these concerns tend to limit the potential for e-scooters to increase the TCF, for some people at least.

Other road and pavement users

The relationship between e-scooter users and others using roads and pavements is an important consideration: e-scooters might increase the TCF for some people, but what if their presence means that others are less confident when making journeys by foot?

We asked respondents about their perceptions and experiences of sharing spaces with e-scooters when walking or cycling. Our survey responses evidence a division of opinion but show a moderate level of concern.[5] They also indicate that people, when walking, have experienced various issues concerning e-scooter use. Around two-thirds indicated that they had at some time felt unsafe around an e-scooter whilst walking in Greater Manchester, had to move out of the way of an e-scooter ride, been "passed too close" by an e-scooter rider, or experienced a near miss.[6] A much smaller proportion (1%) had suffered an injury relating to these experiences and, whilst this is reassuring to some extent, we would not want to discount the wider concerns, especially if it means that other people feel unsafe when walking in some areas.

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[5] Of the respondents to Survey 3 (N = 1514), 49% "strongly agree" or "agree" that "E-scooters are a risk to public safety", 44% "strongly disagree" or "somewhat disagree", and 8% are undecided. (Sherriff et al 2022, p38).

[6] Of the respondents to Survey 3 who said that they walk for any of their journeys (N = 1223), 62% selected that they had experienced one or more of "felt unsafe around an e-scooter rider", "had to move out of the way of an e-scooter rider", "had a near miss with an e-scooter rider", "had a crash involving an e-scooter rider", "tripped over a parked e-scooter and fell", "been blocked or inconvenienced by a parked e-scooter", "suffered an injury relating to an e-scooter", or "been passed too close by an e-scooter rider" (Sherriff 2022, p39).

This comment and interview quote illustrate the strength of feeling, the level of concern and the potential impact on vulnerable people:

> They are dangerous. They go too fast, and people use them dangerously. It is hard to walk by myself with e-scooters around, it is worse when I am walking the dog and I can't imagine having small children (at least with the dog I can quickly pull them out of the way, a child's reaction time and size may put them in greater danger). (Survey 3)

> I have a neighbour downstairs who's blind, and he's brilliant with it, he knows the neighbourhood now so he can walk on his own… [but if] he comes round the corner and there's a cyclist coming towards him or a scooter coming towards him, he won't stand a chance, will he? (Interview 11)

These concerns related in part to the speed of e-scooters, but also to their quietness:

> As e-scooters are quiet, if they come up behind deaf or hard of hearing, blind or visually impaired people it can be quite shocking, and the pavement can become a hostile area rather than a safe pedestrian haven. (Reference Group – Disabled and Vulnerable People)

Other road and pavement users can also be affected by parked e-scooters. This is something that only really applies to *shared* e-scooters. Whilst the Salford scheme has designated virtual docking stations and these should mean that the e-scooters are parked neatly, our responses demonstrate concern about shared e-scooters taking up space on pavements and potentially blocking the way, something of particular concern to those with visual or mobility impairments:

> You see the Lime scooters everywhere just thrown on the floor and there doesn't seem to be anything they can do to stop that. (Interview 44)

> I've seen lots of abandoned e-scooters down the back roads which look a mess and block the pavements. (Survey 3)

In the context of transport provision as a whole, this potential 'clutter' can be seen as an addition to existing conditions and part of the broader challenge of managing competing calls on public space:

> …the extent to which spaces intended to be reserved for pedestrians [are] overtaken by cars and vans makes it much more likely that the odd thoughtlessly placed Lime scooter will make a path unusable for a wheelchair user, so it is a compounding problem. (Survey 3)

4.6 Cost and affordability

Cost is likely to be a consideration in any decision making around transport. If some people are excluded from e-scooter use due to their ability to pay, then the potential benefits of e-scooters are not evenly spread across the population. The addition of e-scooter sharing could make transport provision more affordable, but only if it is competitive in comparison with other services.

Our data aids understanding of the role of cost in how people perceive e-scooters and compare them to other modes. These respondents, for example, have used e-scooters instead of public transport, taxis and ride-hailing in order to save money:

> I used to use train to get to Uni or my friend's house or to city centre and every time I had to pay £4.50 per ride however since I found out about like and e-scooter I now save a lot. I would use the e-scooter from my accommodation to city centre and continue by foot for at least 5 minutes to get to my destination. (Survey 3)

> If I hadn't used the scooter to get home fairly quickly like at ten o'clock at night, I probably would have got a taxi rather than walk home, so that was definitely a cheaper way to get home. (Interview 13)

Potential savings will depend on the context. As this quote illustrates, travelling in groups may mean that taxis and ride-hailing are more competitive and other factors, such as convenience and weather, combine to make them more attractive:

> As an example, my partner and I both took an E-Scooter from Salford University campus to Media City to trial them. Our journey cost just below £6 each, which is £12 between us. The same journey by Uber would have cost circa £8.50, which would be not only cheaper, but faster, more convenient and less weather dependent. (Survey 3)

The sense of how expensive something is will also relate to its frequency of use. If starting to use something on a frequent basis, one might start thinking more carefully about budgeting:

> In terms of the cost, it's not too bad. I think, on average, it usually costs about £3.20, for me, for one journey. Because I'm only in the office a couple of times a week, I think, oh, it's not so bad. (Interview 41)

There is a further dimension to affordability and that is the ability to predict the cost of a journey in advance. This is likely to be particularly important to those who need to budget carefully or travel daily. The per-minute charge means that it can be difficult to ascertain the total cost in advance of the journey. Unlike public transport, shared e-scooter use is charged by the minute:

> …but I know I'm going to get on the bus and spend my £1.90 and then I'm in town whereas if I get on the scooter and I'm not sure how much it's going to cost me. (Interview 13)

E-scooter journeys could be subject to factors, such as traffic lights, that means that the duration, and cost, of a journey are difficult to predict:

> Cost-wise that seems quite expensive if we're trying to encourage a modal shift. I don't know, 20p a minute. You could spend minutes just at traffic lights, couldn't you? (Interview 19)

This difficulty in predicting costs can be accentuated by unfamiliarity with the sharing scheme, particularly when users are still learning about routes and parking spaces:

> There have been a couple of times where mid-ride you kind of have to stop and check where it is you're going, and obviously then, as well, like that's costing you money because it's the time thing. (Interview 13)

> ...the App says you can't leave it at this place so you're then looking, it's maybe another 20p, 40p or whatever clocking up while you're finding somewhere where you can leave it. (Interview 14)

Another issue, specific to shared e-scooters, related to battery life. Some users found that battery capacity drained more quickly than expected and it became difficult to predict whether one e-scooter could be used to make the whole journey or if they would have to find a virtual dock and move over to a different vehicle at an additional cost. These experiences added to concerns about being able to predict journey time and cost: "I also wish we could see on the scooter how far the battery would take... because it would help me avoid battery anxiety" (Survey 3).

The pricing model is one of the characteristics that most clearly differentiates privately owned and shared e-scooters. For those who are using shared e-scooters relatively frequently, private ownership may become more attractive in a financial sense in the longer term:

> So far, I'm not really taking into account the cost, but I think I should. I think it's one of the reasons why I probably need to get one of my own because I think the cost might eventually just buy me one. (Interview 35)

The TCF's relationship with cost is therefore complex. Shared e-scooters appear to be more affordable for some journeys, but the difficulties in predicting the exact cost of journeys could be problematic, especially for those needing to budget carefully.

4.7 The e-scooting experience

In the early stages of the research, the UK was subject to Covid-19 lockdown and people therefore had significantly reduced mobility, with few travelling to work, social, sport or cultural activities. This meant that fun and curiosity were the dominant reasons for using the vehicles. To some extent this reflected the novelty of the vehicles and the sharing scheme*:* "if I'm being totally blunt and honest, I find them fun" (Interview 8); "You get your 12 mile an hour up and you get a bit of wind in your hair. They feel fun to use" (Interview 13); "They were just such a laugh!" (Interview 9). This theme continued into the later stages when there was more functional travel. This sense of fun was not limited to a journey purpose in itself (riding for the sake of it) but was a consideration in their choice of transport (riding to get somewhere, and wanting to enjoy the journey):

> I use them because I love them. I don't really need to. If I get off at Victoria Station and I walk to work, there's usually a bank of scooters outside of Sainsbury's, just on the other side of the Irwell. It's a two-minute journey to work, but I use it...

> ...it adds a fun element to what can sometimes just be a bit of a tedious experience commuting... That bit where you break out of the train station and if you can just jump on a tram for a little bit it adds an element of fun to something that you just have to do. It's the same when I cycle to work, it's the same feeling really. (Interview 38)

The interviewee made a connection with cycling, providing a reminder that enjoyment is also a consideration in relation to more established modes of transport. In the following, enjoyment is a consideration, as are other less tangible factors such as "get[ing] more fresh air", avoiding unwanted conversations when car sharing, and feeling in control of the journey:

> I used to get a lot of Ubers before the scooters came in. The scooters to me were a cheaper alternative... Also, just getting a bit of air as well and stuff. I found it a much more pleasant, I don't know, morning than going in in a car where someone's potentially just going to talk my ear off for the entire journey and I don't want to! (Interview 42)

Whilst these points about the e-scooting experience have a less instrumental relationship with the TCF, in that it does not relate to access to services, it does connect to wellbeing and mental health, which is something that is important in the CA literature.

4.8 Exertion

Another quality of the experience of e-scooting relates to the low level of exertion that is required. This has two particular advantages. Firstly, in comparison with walking and cycling, e-scooter use is less likely to result in arriving sweaty and this is something mentioned in relation to commuting and travelling to business meetings: "If I walk or cycle I perspire a lot, an e-scooter would take away the inconvenience of being damp and sticky for the rest of the day" (Survey 1).

Secondly, e-scooters may be relevant to people who would not otherwise be able to walk or cycle, at least as much as they would like, and for whom e-scooters offer a way of getting around that involves little exertion:

> I'm just in pain most of the time. Walking far distances can be quite hard for me sometimes, so I was just looking to find something that wasn't a car essentially, and that could get around places that the buses weren't going to. For me personally, it was just fun. It's kind of like riding a bike, but without the effort. (Interview 49)

> Journey to university campus – for studying, social activities and the gym. I have CFS[7]/ME and it means I can go to campus more often than if I had to walk the whole way or get an uber. I walk from [home location] to closest e-scooter parking on [e-scooter parking location] (0.3 mi). I then get an e-scooter to campus (0.4 mi). I then take this journey in reverse if I haven't had alcohol, or walk the whole way back if I have. (Survey 3)

In terms of CA, this means that e-scooters could have a role in increasing the TCF for those with health conditions that limit their mobility. We might also ask, however, why other transport provision is not already meeting the needs of people in this position.

5 Discussion

5.1 Introduction

We have described the ways in which the addition of a new transport resource, e-scooters, has affected the ability of the transport system to give people capabilities to thrive. We have referred to this potential as the Transport Conversion Factor (TCF). Each element of transport provision, whether a vehicle type or a form of infrastructure, has qualities that contribute to the overall TCF and these will be experienced differently across the diverse population. In

[7] Chronic Fatigue Syndrome.

bringing our findings together, we start by considering the relationship between e-scooters and other forms of transport.

5.2 A multimodal transport conversion factor

Public transport, taxis and ride-hailing

The availability of e-scooters can increase the TCF, but this is mediated through a complex relationship. One of the qualities through which e-scooters can increase the TCF is the *reach* of the transport system: they can enable people to fill in gaps in public transport provision, for example at times and in areas that buses, trams and trains are not available. This also relates to *reliability* in that e-scooters are used as part of multistage journeys to fall back on when services are delayed and/or connections are missed. E-scooters can also help people to feel *safer* when using transport systems: through the provision of a hop-on-hop-off service, to reduce time spent waiting at interchanges, particularly at night, and therefore help people to feel that they are reducing their risk of attack or harassment.

Whilst they are sometimes cheaper than public transport and sometimes have shorter journey times, it is also the case that the pricing regime of the shared e-scooters can mean that journey costs are difficult to predict and therefore to budget for. The relationship with cost is complex and whilst the sharing element means there are per-minute costs that are difficult to predict, it reduces the need invest in a private vehicle and to risk it being stolen. Notwithstanding this complexity, *affordability* is a factor for some in choosing to use e-scooters. The choice to use them in place of or in combination with public transport and ride-hailing services is a reflection of the interplay of reach, reliability and cost.

Walking and Cycling

Given their size, speed, and where they tend to be ridden, e-scooters are readily compared with cycling. For journeys that might otherwise be cycled, e-scooters offered a form of mobility that would make it less likely that the rider would arrive sweaty. For those with health conditions that limited their mobility, their quality of requiring little energy from the rider could mean that e-scooters made journeys possible that they would otherwise not have made, something that increases the TCF for a group of people who might otherwise rely on car travel. The shared nature of the scheme means that e-scooters are available in ways that bikes are currently not and in ways that allow for the e-scooters to be built into multimodal journeys.

The relationship with walking is comparable, in that e-scooters provide a way of travel that involves expending less energy. The flexibility of the sharing system enables them to be combined with walking: knowing that an e-scooter would be available if feeling tired or otherwise unable to complete a journey.

Conversely, we have discussed the potential for e-scooter use on pavements and shared spaces to cause people walking to feel uncomfortable and at risk of collision. Whilst actual reported injuries have been relatively low, this remains a cause for concern, especially if it results in people feeling they cannot use public spaces. In this way, e-scooters could increase the TCF for some people, by adding a layer of flexibility, but decrease it for others, by adding to the challenge of sharing pedestrian spaces.

Shared and private e-scooters

Vecchio and Martens (2021) place importance on the relationship between private and public mobility when applying the CA to transport. Private and shared e-scooters, whilst related, offer a different set of qualities that determine their impact on the TCF. Whilst private and shared e-scooters offer a similar riding experience, there are differences in terms of how people access the vehicles and way they pay for them.

Although it is currently illegal to ride privately-owned e-scooters in public spaces in the UK, their use is evident. There are some particular restrictions that apply to sharing schemes but not to privately-owned e-scooters, namely the geofence, no ride zones and per-minute cost. Shared e-scooters, on the other hand, provide a flexible approach without the need for ownership or storage, or to have to carry the vehicle around. From a governance point of view, an emphasis on shared schemes allows local authorities to regulate features that relate to safety and wider impact: such qualities include speed, lights, breaks, (no-)ride zones. The relationship is not simple: patterns of private use may indicate where people would like to use a share scheme if the geofence enabled them to; regular shared journeys give rise to purchase of a private scooter; a positive, or negative, experience of either mode of use may affect a person's attitudes and openness to e-scooters overall.

5.3 Diverse experiences

The CA helps us see that the TCF is not experienced uniformly. It is well established (Lucas and Mattioli, 2016; Simcock et al., 2021) that the potential of transport provision is not spatially even and access to it and the capabilities it facilitates will depend on where a person lives. We have also seen that personal and social factors shape the ways in which people have the potential to benefit from e-scooters. If individuals have low levels of confidence using an e-scooter on the road, then they may not feel they can benefit from their introduction, even if the vehicles could help them go where public transport does not. If people are managing money carefully and need to budget, they may not be able to accept the unpredictability of per-minute charging. If individuals have limited access to suitably modern mobile phones to run the necessary App, they may not be able to benefit. If people have conditions that affect their mobility, sight or hearing, then they may feel vulnerable when sharing spaces with e-scooters and this could affect their level of mobility.

Our data also highlights a potential role for e-scooters in providing an accessible form of mobility for people who would otherwise not be able to travel independently, and this deserves further exploration. It implies that e-scooters could be part of a set of measures that could make transport provision more inclusive for disabled people. By way of context, Larrington-Spencer et al. (2021, p17) observe that fatigue can lead to reliance on energy-intensive forms of transport, people can face difficulties using public transport due to panic attacks, and that requiring a car to participate in society is a financial burden for disabled people, who are less likely to have a vehicle in their household (Department for Transport, 2021). Concerns around fatigue are particularly relevant in the context of long-covid. In this sense, e-bikes and other electrically-powered or electrically-assisted vehicles have a role as mobility aids (Andrews and Clement, 2021). Another potentially positive role realtes to concerns about personal safety when getting around: the availability of e-scooters may help individuals feel more confident getting around and making connections on public transport.

5.4 Broader questions of welfare

In these examples, CA aids description and conceptualisation of the ways in which e-scooters add a new layer to transport provision and how that layer interacts with and augments existing services. A potential limitation in applying CA, which Sheller (2018, p26) refers to in her development of mobility justice, is that the framework tends to be narrowed to "practical questions of how transport access is distributed" and does not, therefore, extend to broader questions of welfare associated with transport provision, such as air pollution, injuries, deaths and climate change – or the "direct and indirect health, environmental and wellbeing impacts of the transport system" (Randal et al., 2020, p10). At this macro level, the impact of e-scooters relates to the potential for modal shift away from private car use. Whilst CA might

help to show that e-scooters are creating opportunities to fill the gaps in transport provision, active travel advocates might argue that this should not be achieved to the detriment of walking and cycling and their associated health benefits.

This focus on the distribution of transport access might also limit consideration of the impact, on health and wellbeing, of the travel itself. The repeated references in this study to enjoyment as a factor in decision-making around e-scooter use is intriguing. When considering the conversion factor of transport provision, we might think only of its ability to give people the capability to reach the services they need, therefore discounting the contribution to wellbeing of the journey itself. Handy and Lee (2020) explore this theme in the context of cycling, observing that enjoyment of cycling not only contributes to wellbeing, it also helps to increase its relative appeal against other modes, including the car, and argue that "transportation planners should pay attention to the embodied experience of bicycling" (Handy and Lee, 2020, p355). Spinney (2020, p95) builds upon this, arguing that "cycling does not adhere to the traditional logics of utility maximisation". It seems that this may also hold for e-scooters and this acts as a reminder not to forget, or discount, the role of enjoyment in mobility-related decision-making.

5.5 A broader picture: a micromobility buffet

It is worth noting that many of the qualities of e-scooters that increase the TCF relate to them being available through a share scheme, rather than being e-scooters per se. This is an emergent finding: whilst the scope of our study was limited to e-scooters, it is clear that the ability to pick them up for short journeys was part of their attraction and that this service might also be provided by other modes. By learning about e-scooters, we therefore learn about shared micromobility in a more general sense.

There is evidence, for example, that bike share could also "fill the gaps" in public transport (Leth, Shibayama and Brezina, 2017; Radzimski and Dzięcielski, 2021) or provide an alternative to taxis and ride-hailing in the same way that e-scooters do. For those who enjoy the "wind in your hair" aspect of e-scooters, cycling could be equivalent (Handy and Lee, 2020). For those for whom exertion is an issue, whether due to health or concerns about arriving sweaty, e-bikes might offer a similar solution (Rérat, 2021).

In the Greater Manchester example, there are now shared e-scooters, bikes, e-bikes and e-cargo bikes, the operational areas of which to some extent overlap. This opens the intriguing prospect of a 'buffet' of different shared mobility resources in different places, each with different qualities. Different options may therefore suit at various times, depending on whether someone is travelling alone or with others, needing to carry heavy items, or is feeling tired after a day at work. It is therefore valuable to understand private and shared e-scooters as resources with distinct but overlapping sets of qualities that contribute to the transport system.

Bringing micromobility into a combined offer in this way helps to highlight commonalities. On the one hand, there are attractive qualities like novelty, enjoyment, and flexibility that apply across micromobility options, if to different extents. On the other, limiting factors such as road safety and personal safety are likely to act across these different modes, and apply to both shared and privately-owned vehicles. Looking across micromobility modes can help to shed light on the types of infrastructure improvements and costing regimes that could enable people to make more use of them.

Considering shared micromobility as a combined offer also prompts some intriguing possibilities. Firstly, as we noted above, there has been some discussion on the extent to which e-scooters can be seen to be active. Even if e-scooters are themselves not active in the sense that walking and cycling are, their positioning as part of a shared micromobility offer that contains other active elements means that they could potentially still help to facilitate active travel. An example of this would be someone using bike share regularly and enjoying

the reassurance that on a day they are feeling tired they could access an e-scooter or e-bike from the same micromobility system. Secondly, research has tended to indicate that shared e-scooters are being patronised by younger parts of the population. This may prompt a concern about social exclusion, but this could potentially be mitigated by the provision of e-bikes in the same virtual docks, given that these might appeal more to older parts of the population (Behrendt, 2018). Thirdly, and potentially contradictory, is the possibility that there is something distinct about e-scooters that gives them a unique appeal. Given the references to novelty as a motivating factor for use within the current findings, some observers might question the longevity of this appeal.

6 Conclusion

Research on e-scooters does not start from the normative position that walking and cycling scholarship currently enjoys: they are not seen as the "Miracle Pill" (Walker, 2021) that cities cannot get enough of. What is currently required is a more nuanced consideration of their role in, and potential influence on, mobility systems and practices.

Rather than look at e-scooters in isolation, we have considered the ways in which e-scooters link with and interact with other forms of mobility. This has been fruitful and revealed that e-scooters are not *only* a replacement for short walking journeys but also a way of expanding the reach and potential of transport provision in a broader sense. Taking this system-wide view, however, also shows the potentially problematic relationship with other road and pavement users and highlights the need for care to be taken to ensure e-scooter use does not make pedestrian areas less welcoming, particularly to people with vulnerabilities that relate to mobility, sight and hearing.

By looking at their qualities as mobility resources, we can see that private and shared e-scooters have overlapping and distinct characteristics that shape their contribution to the potential of the transport system to enable participation in society. Shared transport is a growing sector and many of the ways in which e-scooters in the Greater Manchester scheme contribute to mobility stem from their shared nature. Although our data relates to e-scooters, our findings imply that bike share and other forms of shared micromobility could also help to improve the reach of public transport and that the provision of e-bikes could help to make the offer more inclusive. E-scooters could then be seen as one element of a micromobility buffet from which users could choose depending on specific capabilities and requirements at the time of travel.

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Competing Interests

The authors have no competing interests to declare.

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