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From Mobike to no bike in Greater Manchester: Using the capabilities approach to explore Europe's first wave of dockless bike share

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A B S T R A C T

Globally, bike share schemes are an element of a rapidly changing urban transport landscape. Whilst many docked schemes are now embedded in cities around the world, the recent explosion of dockless systems provides an opportunity to evaluate claims that this form of shared mobility has the potential to alleviate common barriers to cycling, relieve congestion, boost low carbon travel, get people active, and reduce social exclusion. Drawing on a mixed methods study of 2270 online survey respondents and 27 interviews, all living in, working in or visiting Greater Manchester during a trial of dockless bike share, we explore the ways in which the technological, spatial and practical configuration of bike share schemes relate to a city's infrastructure and existing cycling practices. We question assertions that bike share provision necessarily results in increased rates of cycling and enhanced social inclusion.

By using a capabilities approach and utlilising the concept of 'conversion factors' to describe the differing capacities or opportunities that people have to convert resources at their disposal into 'capabilities' or 'functionings', we show how the practice of bike sharing can influence a population's propensity to cycle, as well as how bike share interacts with established barriers to cycling. We find that many established barriers to cycling remain relevant, especially environmental factors, and that bike share creates its own additional challenges.

We conclude that bike share operators must recognise the role of personal and social conversion factors more explicitly and be sensitive to the social and physical geography of cities, rather than assuming that a 'one size fits all' approach is adequate. To do this they should engage more closely with existing bodies, including transport authorities and local authorities, in co-creating bike share systems. Using the capabilities approach enables us to identify ways in which it could be made relevant and accessible to a more diverse population.

1. Introduction

Bike share schemes, whereby bikes are rented for one-way trips or within designated areas (Médard de Chardon, 2019), are increasingly evident in towns and cities worldwide. From a few start-ups in the late 1990s, bike share has grown into a global industry (Scott and Ciuro, 2019). In comparison with conventional cycling centred around bike ownership, such schemes offer the user greater flexibility for both cycle and multimodal journeys.

Claims about the benefits of cycling focus on its role in addressing numerous contemporary challenges that are evident in cities throughout the world, including urban congestion, inactivity, physical and mental ill-health, air pollution, climate change and environmental unsustainability (Blondiau et al., 2016; Deenihan and Caulfield, 2014; Seale, 2018). To urban planners, bike share offers ways to facilitate cycling, promote urban investment in active travel, normalise the image of cycling (Scott and Ciuro, 2019) and provide a potential solution to the 'last mile problem' for many journeys (Chen, 2019).

The geographical expansion of bike share has been underpinned by the technological development of an idea proven in London, Paris and other cities since 2007 (Médard de Chardon, 2019). The Global Positioning System (GPS), smartphones and online payments have helped make possible a new dockless form of bike share, initially implemented in China in 2016 (Spinney and Lin, 2018). This means that hire bikes can be positioned throughout cities without the financial and administrative overheads of the fixed docking stations that characterised earlier schemes.

These systems are a component of micromobility, a term gaining traction in academic (Davies et al., 2020; Shaheen et al., 2020) and industry[1] discourse and evident in cities in the form of e-scooters and e-bikes. Bike share can also be viewed as an element of the sharing economy, defined as the sharing of consumption mediated through online platforms such as the popular applications Uber and Airbnb (Standing et al., 2019).

These developments have given rise to a 'substantial technical literature' (Spinney and Lin, 2018, p. 66) including detailed research on usage patterns that has begun to elucidate the social and geographical parameters of bike sharing (Faghih-Imani and Eluru, 2015), explore

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[1] See for example the Micromobility Newsletter: https://micromobility.substack.com.

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logistical and operational factors (Shi et al., 2018), estimate potential health impacts (Bauman et al., 2017) and elicit lessons from particular schemes (Dudley et al., 2019; Sherriff et al., 2018; Wang and Akar, 2019).

Research has tended to consider bike share as an isolated phenomenon rather than another form of cycling. In this study we position it within literature on cycling. There is a substantial literature on barriers, or 'systemic sticking points' (Watson, 2013), to cycling, and it is well established that the most prominent barriers are fear of motor traffic and a lack of dedicated infrastructure (Handy, 2020, p. 9; Jacobsen et al., 2009; Pooley et al., 2013). Other barriers include expectations relating to appropriate clothing (including helmets), unpredictable weather and wider perceptions of 'cyclists' by other road users (Félix et al., 2019; Iwińska et al., 2018). There are also systemic barriers relating to policy and governance, which relate to pressures on budgets and urban space (Yeboah et al., 2015). We address concerns about environmental and social benefits (Médard de Chardon, 2019), including putting into context assertions that bike share provision necessarily results in increased rates of cycling and enhanced social inclusion.

With the increased international prevalence of micromobility technologies (Shaheen et al., 2020), there is a need to conceptualise and understand their impacts, including their relationships with other modes and mobility practices. We utilise the capabilities approach (Sen and Nussbaum, 1993) to consider how the practice of bike sharing interacts with that of cycling and to investigate the extent to which bike share can dissolve, reshape or even multiply and strengthen barriers to cycling. We add to the weight of evidence on the roles of gender, age and income in shaping propensity to cycle and argue that bike share tends to continue, rather than challenge, existing social exclusions.

In the UK, cycling levels remain relatively low despite increasing policy-level interest. There is some local variation, with London showing positive signs of a shift away from car ownership towards more active modes of transport (Dias and Ribeiro, 2020). Greater Manchester's cycling rates are more typical, with the overall modal share for cycling remaining low (Sustrans and TfGM, 2017). The conurbation has, however, an aspiration to be 'the very first city region in the UK to have a fully joined up cycling and walking network' (Boardman, 2018, p. 2). The recently completed Oxford Road cycling corridor (Manchester City Council, 2019) and the current development of the 'Bee Network' (Boardman, 2018) of walking and cycling routes are evidence of steps towards this.

In 2017 Mobike chose Manchester to be their 100th city, and the first outside Asia, to host their dockless service (Mobike, 2017). The arrival of their first-generation bikes in Greater Manchester in 2017 (Pidd and Lavelle, 2017) marked the beginning of a wave of dockless bike share schemes in Europe, North America and Australia, much as the company's departure in the autumn of the following year (Pidd, 2018) appeared symptomatic of receding global enthusiasm for the technology (McIntyre and Kollewe, 2019).

This international situation highlighted a need to better understand the processes through which dockless bike share schemes can most effectively be implemented and attracted the first comprehensive studies of dockless systems in the UK (Dudley et al., 2019; Sherriff et al., 2018). As interest in active travel and micromobility continues to grow, our research provides insights for cities across the world that wish to develop future waves of bike share that better realise environmental and social benefits. As a study focused on the application of a global technology in a city experiencing mobility challenges and transitions that will be familiar to many, it has both local specificity and international relevance. In developing and applying the capabilities approach to cycling in this particular spatial and technological context, we address calls in the literature that demand a better understanding of cycling practice in the context of social diversity and urban development. We add to the nascent literature that is demonstrating the utility of this theoretical framework in relation to mobility and sustainable practices.

2. Methodology

2.1. Research method

This mixed-methods study sought to understand experiences and patterns of bike share patronage and motivations for, barriers to and decision-making surrounding bike share use. A questionnaire was co-designed in June 2018 in a workshop with active travel stakeholders. The questionnaire, detailed in Sherriff et al. (2018), reflected the underlying dynamics of travel behaviour with respect to both cycling and bike share, other modes of transport combined with bike share, other mobility practices, and demographic characteristics. We avoided the technical terminology of 'docked' and 'dockless' in favour of outlining the respective characteristics and asking about factors that would act as enablers or deterrents to using bike share.

The questionnaire was administered as an online survey and was distributed through a range of networks including the University of Salford, British Cycling membership and Transport for Greater Manchester mailing lists. The responses were screened to remove any respondents who had not lived in, worked in or visited Greater Manchester during the previous 12 months. This non-probability sampling approach, which resulted in a self-selecting volunteer sample, was a pragmatic choice that took into account the lack of a sampling frame and the limited resources available. Additional efforts were made through local employers and social media to reach people who did not already cycle. A free prize draw with a cash prize was provided as an incentive to enlarge and diversify the sample.

In terms of statistical analysis, the relationships between two categorical variables (e.g. gender and the factors affecting the use of bike share schemes) were analysed using the chi-squared test. One-way between-groups analysis of variance (ANOVA) was used to analyse differences in the mean value of one dependent continuous variable (e.g. age) between three or more groups (e.g. those who would be more, less or equally likely to use a service). The results of all statistical tests in this paper are reported using the conventional format, i.e. the results of chi-squared tests are reported as χ^2 (degrees of freedom, N = sample size) = chi-squared statistic value, p = p-value, and the results of one-way ANOVA are presented as F (between-groups degrees of freedom, within-groups degrees of freedom) = F-value, p = p-value.

Phone interviews (n = 27) were conducted with respondents selected on the basis of gender, age, location and level of participation in bike share to gain more in-depth insights into cycling behaviours and decisions. Using the framing of the capabilities approach (Sen, 1992; Sen and Nussbaum, 1993), interview transcripts were analysed with 'conversion factors' as the unit of analysis.

2.2. Conceptualising capabilities

The capabilities approach presents human life as a set of 'doings and beings', also termed 'functionings'. It relates people's quality of life and wellbeing to their capability to function (Sen, 2003, p. 43) and has aided our exploration of use and non-use of bike share and its potential to provide more equitable access to cycling.

A functioning is what a person manages to do or be (Clark, 2005) and includes being adequately nourished, being mobile and being able to travel from A to B. *Achieving* a functioning, such as doing an activity or being in a desired state of health, requires a person to have a bundle of opportunities at their disposal and the freedom to choose whether to access them or not. This ability to achieve a functioning is called a 'capability' (Baldascino and Mosca, 2016). In focusing on capabilities, attention is drawn to the things that enable or suppress a person's ability to perform an activity or action. These include 'external characteristics and circumstances', which include inherited wealth and poverty and other social characteristics, 'personal characteristics' such as gender and age and the 'natural environments' people live in (Sen, 1992, pp. 20–21).

Table 1
Grouping of conversion factors (adapted from Robeyns, 2011).

Personal conversion factors	Physical condition (disability or fitness), sex, reading skills, intelligence, specific skills (e.g. ability to cycle)
Social conversion factors	Public policies, social norms, practices that discriminate, societal hierarchies, power relations
Environmental conversion factors	Geographical location, climate, pollution, built environment, roads, transportation, communication

Operationalising the capabilities approach at an analytical level is challenging (Karimi et al., 2016; Middlemiss et al., 2019). Following Sen, Robeyns (2011) developed the concept of 'conversion factors' to describe the differing capacities or opportunities that people have to convert resources into capabilities and functionings. She categorised these into personal, social and environmental conversion factors (Table 1). They are useful for identifying specific capacities and powers that people need in order to achieve a particular functioning.

A nascent literature deploying this approach has emerged in relation to sustainability, mobilities and energy (Day et al., 2016; Middlemiss et al., 2019; Wood and Roelich, 2019). In the case of cycling, the three conversion factors reflect the physical ability to ride a bike (personal), the acceptability of cycling as a practice (social) and the extent to which infrastructure supports cycling (environmental) (Middlemiss et al., 2019).

Middlemiss et al. (2019) argued that a focus on conversion factors can be limiting because it 'essentially allows us to describe the mechanisms that enable capabilities to be achieved, rather than the richer social context in which they occur'. However, we use them as a way of operationalising capabilities theory and unpacking bike share use with the intention of illuminating, rather than obscuring, that social context. In relation to understanding whether bike share can provide more equitable access to cycling, they provide important insights into whether bike share overcomes any of the social structures that shape and hinder capacity to cycle.

We can illustrate the usefulness of conversion factors by presenting a picture of the differing factors that shape functioning as a cyclist. For example, Individual A might live in a typical UK town with relatively little cycling infrastructure. They can afford a bike, but their friends and family do not often cycle, and their confidence cycling in traffic is low. They therefore have a relatively low environmental conversion factor, a high social conversion factor and a low personal conversion factor. Individual B, on the other hand, lives in a Dutch city with a segregated cycle network and has access to a bike, and, whilst they also have little confidence to cycle in traffic, their friends and family cycle for most of their journeys. They therefore also have a low personal conversion factor, but their social and environmental context means that their conversion factor as a whole is higher and cycling is something that they would consider.

We use conversion factors to clarify the capacity of bike share bikes to deliver the functioning of mobility and to distinguish between the capacity and potential of 'bike share' bikes, in comparison with 'normal' bikes, to deliver that functioning.

3. Results

3.1. The sample

Our 2270 respondents have been categorised into three groups:

- **'Users'** had used bike share at some point during the preceding 12 months. In Table 2, these are further divided by frequency.
- **'Deciders'** had not used bike share in the preceding 12 months but had indicated that they might use it in the subsequent 12 months.[2]
- **'Avoiders'** had not used bike share in the preceding 12 months and had indicated that they were 'not at all likely' to use it in the subsequent 12 months

Table 2
Categorisation of respondents into Avoiders, Deciders and Users and frequency of use by Users.

Category	Frequency of use (previous 12 months)	Respondents (N)	Respondents (%)
Avoiders	Never	815	35.9
Deciders	Never	958	42.2
Users	Less than once a month	363	16.0
	Once a month	85	3.7
	Fortnightly	20	0.9
	Weekly	14	0.6
	More than once a week	13	0.6
	Daily	2	0.1

Table 2 shows the relationship between group membership and stated frequency of bike share use.

We make no claims to representativeness of those who had lived in, worked in or visited Greater Manchester in the preceeding 12 months. There is some indication of bias, with a higher proportion of males (58%) than in the UK population (49.7%) and a higher proportion of people with access to a bike (84.1%) than the UK average (35%) (Evans et al., 2019; O'Keefe, 2017), but there is a spread across gender, age groups and the boroughs of the conurbation (Sherriff et al., 2018). Through categorisation into our three groups, the data facilitated analysis towards understanding the behavioural and attitudinal processes associated with bike share.

To preserve anonymity, in reporting qualitative data sequential interviewee numbers with the prefix 'I' are used when quoting respondents. Comments received through the online survey are labelled 'comment'.

3.2. Who is using bike share?

The survey showed significant relationships between gender and age and both interest in and use of bike share. While there was little difference between the numbers of males and females in the Avoiders group (Fig. 1), overall female respondents were significantly more likely to be Deciders and less likely to be Users. This suggests that females are as likely to be interested in bike share as males are but are more likely to be deterred from using it. It is also the case that Avoiders and Deciders were significantly older (mean [M] = 41.72 years, standard deviation [SD] = 12.83; M = 46.58, SD = 12.65, respectively) than Users (M = 38.3, SD = 11.54) [$F(2, 2239) = 72.2$, $p < .001$] (Fig. 2).

Taken together, these observations imply that the potential user base of bike share is not dissimilar to that of cycling. Studies in the UK imply that those who cycle are more likely to be younger and male (Sustrans, 2017; Sustrans and TfGM, 2017). It is therefore unsurprising that those who had access to a bike (Fig. 3 Distribution (%) of bike ownership and access and actual bike share use over preceding 12 months and potential use over subsequent 12 months [$\chi^2(4, N = 2008) = 21.04$, $p < .001$].) were statistically more likely to be Users than those who had no access and that those for whom a car was the only mode used for regular journeys were less likely to use bike

[2] These answered the question 'How likely is it that you would use bike share in the next 12 months?' on a scale of 0 ('not at all likely') to 10 ('will definitely') with a non-zero answer.

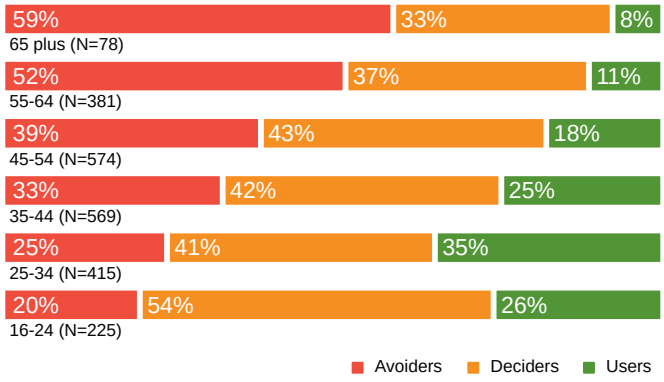

Fig. 1. Gender distribution (%) of actual bike share use over preceding 12 months and potential use over subsequent 12 months [$\chi^2(2, N = 2224) = 18.19, p < .001$]. (Key applies to Figs. 1, 2, 3 and 4.)

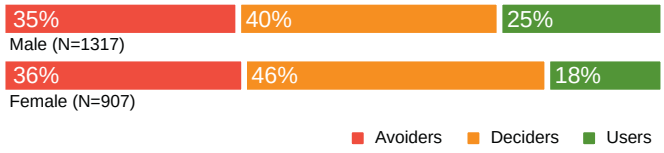

Fig. 2. Age distribution (%) of actual bike share use over preceding 12 months and potential use over subsequent 12 months.

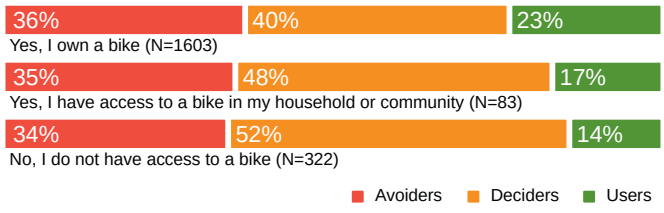

Fig. 3. Distribution (%) of bike ownership and access and actual bike share use over preceding 12 months and potential use over subsequent 12 months [$\chi^2(4, N = 2008) = 21.04, p < .001$].

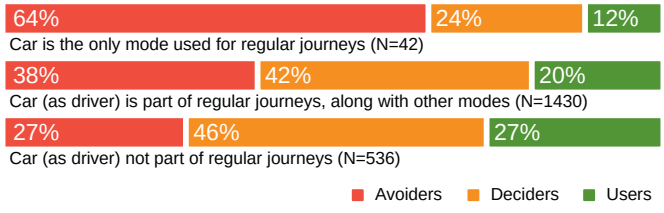

Fig. 4. Distribution (%) of car use and actual bike share use over preceding 12 months and potential use over subsequent 12 months [$\chi^2(2, N = 2270) = 21.34, p < .001$].

share than those using other modes (Fig. 4).

In the language of the capabilities approach, gender and age are personal conversion factors and access to a bike and the use of a car are social conversion factors. In the following subsections we discuss how these conversion factors are manifested in the ways in which people approach, use and experience bike share and argue that, in designing an equitable bike share provision, personal (gender and age) and social (access to a bike and use of a car) conversion factors must be given at least as much weight as environmental factors.

3.3. Using bike share

Respondents recognised that bike share is distinct from conventional cycling. Users and Deciders were asked to select up to three statements as reasons for why they had used or would use bike share (Table 3a). The most frequent responses were spontaneity of use, wanting to use bike share in combination with public transport, needing to cycle somewhere other than one's hometown or city and avoiding the need to look after a bike all day.

Interviewee **I2** elaborated that bike share enabled spontaneity linked to multimodal journeys: *'I didn't cycle. I very occasionally now use Mobike to cycle, or cycle half the way and got the bus halfway, or cycled and walked, some combination of that'* **(I2, male, User)**. A survey respondent reported considering bike share after moving house, as her new route home involved crossing the city centre from Piccadilly to Victoria station: *'Bike share could be a very useful option should the right infrastructure be in place'* **(comment, female, Decider)**.

Although fear of bike theft and limitations of storage space at home were lower priorities for survey respondents (Table 3a), they were nonetheless not inconsequential: *'There's quite a lot of crime around our way in terms of bikes getting nicked. We've heard of a shed broken into and bikes stolen before'* **(I2, male, User)**; *'an excellent way of getting around the city during or after the working day when I cannot store my own bike at the destination'* **(comment, male, User)**.

Although 'I want to try cycling' was given relatively low priority as a reason for using bike share (Table 4a), this theme recurred in the interviews and comments. One interviewee commented: *'it definitely made it much easier for me to get started. I was using them for quite a while because I had quite a restricted budget for getting a bike'* **(I11, male, User)**. Another recognised this opportunity since they *'couldn't afford to buy this type of bike myself, so this would also be an incentive to try it'* **(comment, male, Decider)**

Bike share offers some of the benefits of bike ownership along with added flexibility and spontaneity and potentially redefines relationships with the bike. Its presence increases the environmental conversion factor for everyone, enabling individuals to cycle without owning a bike or needing storage space or to make journeys by bike when their own bike is not available. In the language of the capabilities approach, it enhances the cycling environment by offering a new or additional 'means of transport and communication' (Robeyns, 2011) and can therefore facilitate cycling as part of multimodal journeys.

3.4. Riding bike share bikes

Whilst bike share offers some benefits over conventional cycling, particularly in the form of improved environmental conversion factors, it does not necessarily transcend existing environmental barriers to cycling. Our analysis indicates that the established barriers to cycling remain relevant and that gender disparities persist.

Concerns about the level and behaviour of traffic and the limitations of separated cycle routes were evident, reflecting well-documented barriers to cycling. As shown in Table 3c, 46% of Deciders, in comparison with 33% of Users, said they were unlikely to use bike share because 'I am concerned about safety when cycling in traffic'. This indicates that addressing this environmental factor may persuade Deciders to cycle. Other prominent reasons selected were 'I don't want to arrive at my destination sweaty' and 'The weather is off-putting', also common barriers to cycling.

Table 4 breaks down the results for the barriers to uptake (in Table 3c) by gender and shows that, across all groups, females were more concerned than males about safety when cycling in traffic, the impact of weather, not knowing which routes to take and their confidence in their ability to cycle. Additionally, amongst Avoiders, females were significantly more likely than males to give the reason 'I do not enjoy cycling'.

These concerns were highlighted during interviews. **I15** had cycled previously but on moving to Greater Manchester felt unsafe: *"Once I moved here and saw the roads, I just thought 'No'"* **(I15, female, Decider)**. Another female Decider said: *'I just think it's too dangerous. I'm too*

Table 3
Reasons for using bike share (a) and barriers to use (b and c) amongst the whole sample, Avoiders, Deciders and Users. Respondents were asked to select up to three items from each list.

a. Which of the following best describe your reasons for using bike share/why you would use bike share in the future? (Select up to 3.)	Whole sample %	Avoiders %	Deciders %	Users %
1. It would be a spontaneous decision	41		43	38
2. I want to use bike share in combination with public transport	37		36	38
3. I need to cycle in places away from my hometown or city	27		25	31
4. I don't want to be stuck with a bike all day	22		23	20
5. It is cheaper than other transport options	19		16	23
6. I am worried about my bike being stolen	18		20	14
7. I want to have access to a bike when mine is broken	13		13	11
8. I do not cycle enough to buy my own bike	10		12	6
9. I want to try cycling	9		11	5
10. I do not have storage space at home	8		9	6

b. Which, if any, of the following are likely to limit the amount you use bike share? (Select up to 3.)	Whole sample %	Avoiders %	Deciders %	Users %
1. I now own a bike	39	51	41	17
2. I don't see myself needing to use one	38	58	32	18
3. Uncertainty over availability at the location I need it	30	14	35	47
4. I like to wear a helmet when I'm cycling	18	16	23	10
5. Not suitable for length of trip	15	11	13	24
6. The size of the bike means they are not comfortable for me	11	6	10	22
7. I don't find the bike(s) easy to ride	9	4	6	24
8. I don't like using an app	8	7	10	7
9. The service is too expensive	6	4	8	6
10. I can't hire bikes for a group	2	0	1	5

c. In addition, do any of the following limit how likely you are to use bike share? (Select up to 3.)	Whole sample %	Avoiders %	Deciders %	Users %
1. I am concerned about safety when cycling in traffic	41	39	46	33
2. I don't want to arrive at my destination sweaty	28	23	33	26
3. The weather is off-putting	22	16	24	28
4. I don't know what routes to take	14	9	20	11
5. It would take me longer than other modes of transport	12	16	12	8
6. I am not confident in my ability to cycle	8	8	10	4
7. I am not physically able or fit enough to cycle	3	4	2	2
8. I do not enjoy cycling	2	4	1	1
9. I cannot cycle	1	2	1	0

concerned about being knocked off my bike. That's why I use the car' **(I5, female, Decider)**. Another female respondent commented on the need for separate cycle lanes:

> *Although I would like to cycle more, I would never cycle on the roads today as I would not feel safe. I know numerous people who have been knocked off their bike, and I wouldn't risk it without separate cycle lanes on main roads***(comment, female, Avoider)**.

In contrast, a male cyclist, whilst acknowledging that some aspects of the road infrastructure are 'a bit hairy', felt confident enough to cycle nonetheless: '*I always feel reasonably safe in Manchester. I find junctions on big main roads a little bit hairy… but I mostly feel fairly safe on the roads in Manchester*' **(I11, male, User)**.

This demonstrates the need to reflect on personal conversion factors such as gender when considering the rollout of cycling infrastructure such as road layouts and bike share provision. Gender greatly influences

Table 4
Perceived barriers to bike share use. Percentages selecting statement as answer to question 'In addition, do any of the following limit how likely you are to use bike share? (Select up to 3.)'.

	Users		Deciders		Avoiders	
	Male%	Female%	Male%	Female%	Male%	Female%
I am concerned about safety when cycling in traffic	29.8*	40*	34.2***	61.2***	27.9***	56.5***
The weather is off-putting	25.3*	34.4*	19.9***	29.2***	11.2***	24***
It would take me longer than other modes of transport	7	8.8	9.8*	14.4*	10.9***	23.1***
I don't want to arrive at my destination sweaty	23.5	30	29.6*	36.8*	18.5***	30.1***
I don't know what routes to take	8.5**	17.5**	13***	28.5***	6.4***	13.1***
I am not confident in my ability to cycle	1.8***	8.8***	3.6***	17***	1.9***	17.6***
I am not physically able or fit enough to cycle	0.9	3.1	1.9	3.1	1.5***	8.2***
I do not enjoy cycling	0*	1.3*	0.2	1	2.1***	7.9***
I cannot cycle	0	0	0.2	1.2	1.5	3
N	488		941		795	

Analysis: Chi-squared tests.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

perceptions of safety and willingness to cycle and needs to be acknowledged more directly when bike share schemes are rolled out. The provision of bikes, while increasing the environmental conversion factor, is limited in its ability to convert the population, and females in particular, to cycling if the cycling infrastructure remains unchanged.

3.5. Bike share bikes

The survey found that two of the main factors that limited people's use of bike share were 'I don't see myself needing to use one' and 'uncertainty over availability at the location I need it' (Table 3b). However, a closer examination of the survey and interview data together showed that the design of bike share bikes and the provision of helmets influenced perceptions of safety, affected the experience of riding the bikes and, in turn, had an impact on people's willingness to use them.

Of most relevance to our understanding of how the design of the bikes influenced the environmental conversion factor is the finding that Deciders selected the statement 'I don't find the bikes easy to ride' more frequently than Users and Avoiders. Aspects of the design of Mobike bikes were specifically mentioned by Users. **I7** commented that *'I think they're quite heavy and clunky and slow, and it's just a bit tiring'* **(I7, female, User)**, and **I12** said, *'It's hard cycling, the tyres are really hard, it's not a comfortable position. It feels like your feet have got to go round really, really fast to get you anywhere. It doesn't feel efficient. It doesn't feel pleasurable'* **(I12, female, User)**. Others commented that the single gear was uncomfortable and felt unsafe as it meant they could not keep up with the traffic: *'it's impossible to get a decent speed, and you just end up sweating from spinning your legs so much, but still going REALLY slow'* **(comment, male, User)**.

Commenting on the combination of poor cycling infrastructure and poor bike design in Greater Manchester, one User reflected that *'Mobikes are pretty awful. Tiny bikes that are uncomfortable to ride on our terrible roads in Manchester'* **(comment, male, User)**. Another, who described themselves as an experienced, confident cyclist, emphasised feelings of vulnerability:

> *Then you get on one of those, and then you have that experience of what it's like to be a 12-year-old on a bike… Then when you translate that on to being on a Mobike, where you suddenly realise quite how vulnerable you are, it gives a bit of an insight into people who may be starting to cycle!***(I19, female, User)**.

While it is worth noting that the quality of bike share bikes differs across providers and that the Mobike bikes in Manchester were the -now superceded -first-generation model, the pertinent issue is that if the design of the bike can have a negative impact on the experience of Users it may put off Deciders who are otherwise open to bike share from using bike share again. If bike share is to be considered an entry point to cycling, it is important that the bikes do not provide a negative experience when people are trying out or returning to cycling: *'The bikes are so terribly cumbersome to ride that I feel they're a bad advert for cycling for people who might be using them to trial using cycling to get about the city'* **(comment, male, User)**.

Although these qualitative findings do not lend themselves to statistical analysis, we have shown in the previous section the importance of personal conversion factors and that perceptions of danger from traffic are more likely to deter females. The provision of bike share, if well designed, has the potential to increase the environmental conversion factor for everyone. However, unless this is done alongside the development of other environmental infrastructure to make cyclists feel safer, the uptake of bike share and the impact on cycling practice may be limited.

3.6. Accessing helmets

The survey indicated that the (un)availability of helmets also limited people's use of bike share, with 39% of respondents identifying 'not being able to hire a helmet at the same time as a bike' as a deterrent (Fig. 5): *"No access to a helmet is extremely unsafe. I don't have my own bike, so I sometimes think of using one, but I don't want to carry a helmet with me 'just in case'"* **(comment, female, Decider)**; and '*I think the lack of being able to access a helmet would be an issue for me and, I guess, people who aren't so confident on a bike in city traffic'* **(comment, female, Avoider)**.

Females (46%) were significantly more likely than males (32%) to say that the unavailability of helmets would deter them ($\chi^2(2, N = 2142) = 46.67$, $p < .001$). There was also a smaller but still statistically significant difference between age groups. Those who were less likely to use bike share if it was not possible to hire a helmet were on average younger ($M = 38.83$, $SD = 14.14$) than those for whom this was of little importance ($M = 42.74$, $SD = 12.4$ no effect; $M = 43.07$, $SD = 13.16$ more likely, $F(2, 2156) = 5.4$, $p = .004$). Being able to hire a helmet was slightly more important to lower-income groups ($\chi^2(12, N = 1799) = 22.06$, $p = .04$).

There has been lively and ongoing debate on helmet use and legislation (Hoye, 2018; Molina-García et al., 2018), with some arguing that helmets give people protection when cycling, and others that mandating helmet use places responsibility for safety on individuals rather than the wider cycling and transport environment.

This highlights a situation where a person's social conversion factor can be low because of a belief that wearing a helmet is essential in a society where helmet wearing is not mandatory. This could be resolved by providing access to helmets, which would increase the environmental conversion factor but may have little impact on changing social norms around cycling. The provision of safe and hygienic helmets is a logistical challenge for bike share providers. Ignoring these concerns could result in the exclusion of a sizeable group from bike share, and this group would be disproportionately female.

3.7. Spatiality of bike share

The utility of a bike share service is dependent on accessibility and availability of the bikes. The location of bikes is therefore an important consideration. Table 3b shows that 30% of respondents selected 'uncertainty over availability at the location I need it' as limiting their use; this figure rose to 41% amongst Deciders.

Availability is related to the spatial density of the bikes and the spatial area of operation. In Greater Manchester, Mobike operated within a geofence demarcating the boundary within which the bikes could be picked up and returned; this varied during the trial (Fig. 6a). The initial scheme operated across a large area, including Manchester city centre, the Oxford Road corridor and much of Salford. This operational area changed multiple times, restricting use at one point to Manchester city centre and the adjoining part of Salford. By August 2018, shortly before Mobike withdrew the service, the geofence was reduced further and almost entirely excluded Salford (Fig. 6b). This had implications for staff at major employers such as MediaCityUK and the University of Salford, which were not within all iterations of the geofence. Additional policies to regulate the spatial distribution of Mobike bikes were introduced during the trial, including preferred parking zones and charges for leaving bikes outside the geofence.

These boundary changes affected many Users; one interviewee had started using Mobike bikes when they were available outside their apartment and stopped when they ceased being so readily available. They reflected that they would use the bikes again if the service were available, as they enjoyed cycling and did not have space to store a bike of their own. Another commented on not being able to park the bikes near their destination: *'They… massively condensed down the area where you can put the bikes, which took it out too far outside of Salford for me to warrant using it…'* **(I4, female, User)**. Another observed that the quantity of bikes had decreased: *'I don't know what's happened with it – whether the stock of bikes has gone massively – but I don't tend to see many Mobikes around'* **(I27, male, User)**.

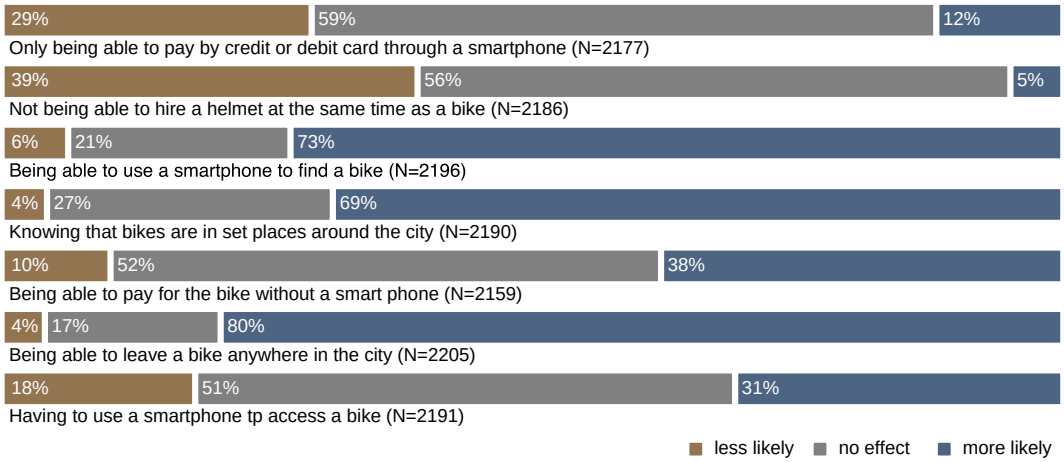

Fig. 5. Preferences relating to bike share systems. The question asked was 'To what extent do the following features affect how likely you are to use a particular bike share service?'.

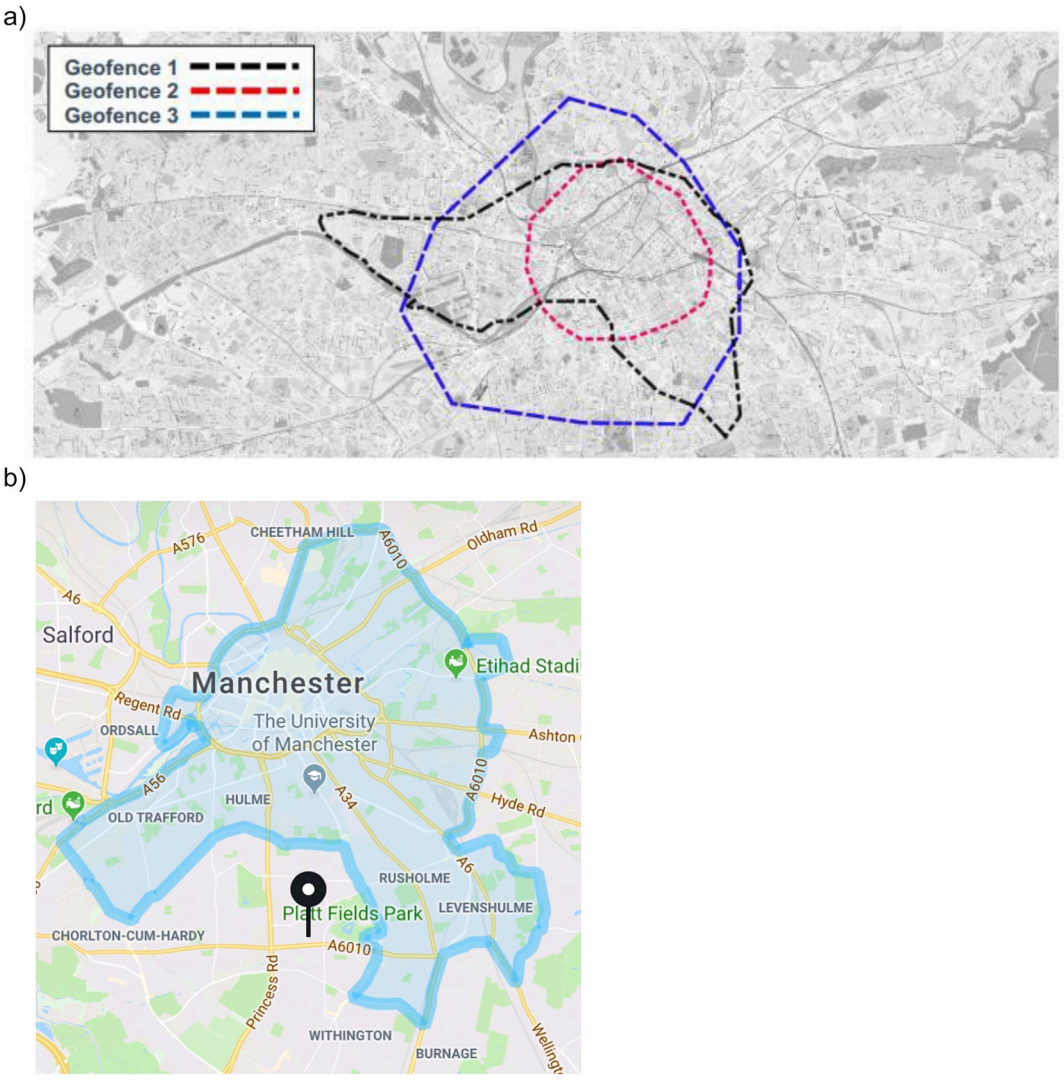

Fig. 6. a. Changes in the geofence over the period of Mobike's operation in Greater Manchester (Geofence 1 - Black, Geofence 2 - Purple, Geofence 3- Blue) Source: Transport for Greater Manchester. b. The final geofence during Mobike's operations in Greater Manchester. Mobike App screenshot, 31st August 2018. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

For some Users the reduced geofence made the service inconvenient: *'The operating zone now excludes Salford, which is where I live, so I actually have to walk into the city centre to find a bike and then continue my journey to work on the bike'* **(comment, male, User)**. For others it became unusable: *'…the area for Mobikes is much smaller than the original area. I have not used the scheme since this as I now live outside the parking zone'* **(comment, female, User)**. Unannounced penalties also had an impact on people's perceptions of the service:

> *I think more alerts need to be made when changing the areas you are allowed to park the bikes in, as I found this out when coming home from work and being charged for leaving [it an] area that was previously a parking spot for the bikes***(comment, female, User)**.

Mobike ran a dockless system in Greater Manchester whereby bikes could be left and picked up anywhere within the operational area. The characteristic differences between docked and dockless systems were experienced in different ways. Many respondents (69%) were more likely to use a scheme 'knowing that bikes are in set places around the city', while a similar proportion (80%) favoured 'being able to leave a bike anywhere in the city' (Fig. 5). One respondent commented: *'I have found dockless to provide a less reliable integration of multiple modes of transport. I want to have confidence that there will be a bike nearby when I get off a tram in Manchester'* **(comment, male, User)**. In contrast, some docked systems, including those in London and Paris, offer pre-booking through an app, but the bike must then be returned to another docking station. This indicates that some combination of docked, at the start of the journey, and dockless, at the end, may be optimal.

Our analysis suggests that the value of picking up from fixed locations and dropping off anywhere was perceived differently across social groups. Females were significantly more likely to be concerned about both aspects. This may relate to concerns over personal safety, i.e. when spending time cycling or walking around to look for a dock or a bike: *'I get a bit worried about safety from people (not traffic) when cycling around the Salford side where I work. Kids/people possibly throwing things scare me a bit. I was harassed once by a group of youths when cycling'* **(comment, female, User)**.

Dockless schemes, such as Mobike, use an app on a smartphone with payment by card, while some docked bike schemes use both card and cash payments. We found that the acceptable methods for finding and paying for a bike differed by demographic group. People who said they were less likely to use bike share that required a smartphone were older ($M = 45.54$, $SD = 13.89$) than those who were neutral ($M = 42.74$, $SD = 12.4$) or positive ($M = 38.80$, $SD = 11.98$) about this. Having to use a smartphone to use bike share was more likely to be seen as a deterrent by lower-income groups ($\chi^2(12, N = 1785) = 63.19$, $p < .001$) and more likely to be seen positively by higher-income groups ($\chi^2(12, N = 1813) = 29.16$, $p = .04$). Having to pay by credit or debit card was also more likely to deter lower-income groups, whilst higher-income groups were more likely to say it had no effect ($\chi^2(12, N = 1820) = 76.34$, $p < .001$).

The geofence, drop-off and pick-up options and requirements for a smartphone and payment card all had an impact on overall conversion factors. The changing geofence, which was neither evenly distributed nor stable, meant the environmental conversion factor increased for some users while decreasing for others; access was not equitable. The same can be said of the need for smartphones and payment cards to gain access. In order to increase the social conversion factor for all users, potentially discriminatory practices based on geography and access to technology need to be discouraged.

4. Bike share through a capabilities approach lens

We have used the capabilities approach and the concept of conversion factors to place bike share in the context of cycling practice, identifying where aspects of the provision of bike share improve and hinder the ability of users to function as cyclists. We have shown that bike share can boost the environmental conversion factor of an individual (through its availability) but that the extent to which this factor is increased is dependent not only on other aspects of the environmental conversion factor (such as cycling infrastructure and geofencing) but also on personal and social conversion factors (such as gender and social norms around cycling and helmet use).

In comparison with 'conventional' cycling centred around bike ownership, bike share offers distinct advantages that shape and improve environmental conversion factors in particular: there is no need for bike storage in the home, cycling can more easily be combined with other forms of transport and the initial outlay of ownership is replaced with per-journey running costs. Whilst therefore overcoming some of the entry-point barriers to cycling, it introduces potential additional barriers: the requirement to use a smartphone and a credit or debit card, the lack of helmet provision at source, the quality of the bikes and the process of locating and returning the bike.

These latter barriers relate to social and personal conversion factors. People have different abilities to convert resources into activities, often related to income. If someone cannot afford a smartphone or is not eligible for a credit or debit card their personal conversion factor is low. This is an important barrier about which more research would be valuable. There are instances such as in Portland, Oregon (Biketown, 2020) where this has been addressed by enabling cash purchases, but these are scarce.

Additionally, gendered aspects of perceptions of safety make personal conversion factors low and are related to using a helmet or locating and returning a bike in a safe, visible location. A perception that helmets are an essential safety requirement for cycling is an issue that bike share providers are yet to address.

Personal and social characteristics interact with and shape the environmental conversion factor. There was a clear relationship between gender and bike share use, with females significantly more likely to be Deciders, open to but not yet partaking in bike share. Females were also more likely to express concern about the lack of access to a helmet, place emphasis on safety issues in traffic as a barrier to bike share use and be concerned about having difficulty finding or returning a bike share bike. Older people were also less likely to see bike share as an option for them and to express concerns about safety in traffic. Older people and those on lower incomes were more likely to see the requirement to use a smartphone to access bikes as problematic. In places where social conversion factors are higher as a result of public policies and social norms that 'normalise' cycling across demographic groups, conversion factors may increase.

These personal and social dimensions notwithstanding, the provision of bike share has the potential to increase the environmental conversion factor of all individuals who live or work in or in some way interact with the areas covered by the scheme. Provision is, however, only one element of the environmental conversion factor. The conversion factor boost is not uniform: those who live or work outside the geofence or do not have a docking station close by do not benefit to the same extent. In the Greater Manchester case, it was also not constant, with changes to the geofence over time creating an inconsistent experience during which Mobike came into and out of relevance to different individuals. The geofence changes could be interpreted as a discriminatory practice that sought to exclude some of the more deprived areas of Greater Manchester from the operational area, in line with public rhetoric by Mobike about vandalism and theft. When such power relations are in play, people living and working in those areas see a reduction in their social conversion factor.

The environmental conversion factor comprises interlocking elements, and therefore a boost in one aspect cannot be assumed to result in an overall increase in propensity to cycle. Whilst bike share addresses some barriers to cycling, perceptions of safety in traffic – the most prominent barrier – remain a deterrent. Moreover, we found that the experience of riding a bike share bike can be off-putting. The low specification of some bikes in relation to weight, height and simple gear

provision can heighten the perceived vulnerability of the user, more so than with a 'conventional' bike, and particularly in traffic. A poor first experience of bike share could act as a deterrent to continued bike share use and limit future engagement with cycling.

5. Conclusions

Bike share is part of a rapidly changing urban mobility landscape. Greater Manchester's Mobike scheme was part of a wave of interest in dockless bike share. Our research has provided a snapshot of perceptions and practices in relation to such schemes. We have used the capabilities approach as a lens through which to view and understand the contribution bike share can make to increasing cycling numbers. We have shown that bike share has the potential to provide access to a practice that is similar to but distinct from conventional cycling predicated on bike ownership. The extent to which people can benefit from it is, however, related to the spatial distribution and density of the bikes, the quality of the bikes, the cost of hire and the ease of use and accessibility of the online platforms. Across these factors run contours of potential exclusion relating to gender, age and income, which are in turn connected to existing levels of smartphone and data accessibility, confidence in cycling and the nature of the urban cycling environment.

We started this paper noting the claims being made around the potential for bike share and other forms of micromobility to transform mobility practices. We do not wish to discount these or indeed detract attention from the importance of disruptions in mobility that move society towards healthier and less polluting travel. Our analysis contributes a degree of caution that moves the focus away from an assumption that micromobility is a simple technological solution to the complex mobility needs of our cities and towards an appreciation of the ways in which micromobility technologies interact with established infrastructure, enduring practices and ingrained perceptions.

In practical terms, this means that bike share needs to be viewed in the context of existing infrastructure and practice; not only should the cycling environment be attractive for any type of cycling, but bike share bikes should be appropriate for that cycling environment. If bike share is to boost cycling numbers, it needs to be an ambassador for a high-quality and enjoyable cycling experience, and our research shows that this was not always the experience of Greater Manchester users. Our research raises concerns that bike share perpetuates, rather than challenges, gender imbalances in cycling participation and that purposive action is therefore needed from local authorities and bike share providers to address this. In pointing to implications for social exclusion related to gender, age, income and location, it highlights the importance of bike share operators being sensitive to the social and physical geography of cities, rather than assuming that a 'one size fits all' approach is adequate, and of engaging with existing bodies, including transport authorities and local authorities, in co-creating bike share systems. By recognising the roles personal and social conversion factors play, decision-makers should be able to improve the 'doing' of cycling in a more nuanced way than simply focusing on changes to the built environment.

Author credit statement

The authors have collaborated on all sections of this paper, contributed to the development of the overall argument and agreed the final version.

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