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# Exploring the gender inclusivity of mobility as a service through the access based consumption framework: A UK case study

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#### ABSTRACT

This paper explores the issues of inclusivity and safety that women encounter when using Mobility as a Service (MaaS), a transport offering which enables users to book, manage and pay for diverse multimodal options through smartphone apps. Personal mobility modes can include public transport, car hire, bicycle sharing and automated vehicles, amongst others. The diffusion of MaaS has the potential to make a significant contribution to decarbonisation of personal mobility and provide greater social inclusivity, but it is experiencing resistance to its uptake.

This study, in the context of the United Kingdom, draws on the cultural perspective of Practice Theory (PT), a theory which adopts social practices as the main unit of analysis, and focuses on mobility practices performed by female MaaS users.

Despite its potential benefits, participants associate using MaaS with concerns about personal safety and the use of "apps" with intrusiveness. A particular concern is that women appear disadvantaged in terms of using MaaS platforms when compared to men.

Suggested solutions to such concerns include vetting of service users and, whenever possible, recruiting female personnel as drivers; using on-board cameras and recording devices and the inclusion of app safety features may also help women feel safer. MaaS providers should encourage the formation of communities around MaaS brands, with female-only groups to reassure women. Significant changes to social practices and infrastructure are needed, and these will require changes in urban and rural mobility governance.

#### 1. Introduction

Although women use public transport more than men (Gekoski *et al.*, 2017), they are more hesitant to adopt Mobility as a Service (MaaS) (Weinreich *et al.*, 2021), a "digital interface to source and manage provision of transport related service(s) which meets mobility requirements of a customer" (Enoch & Potter, 2023: 32). This paper contributes to recent debates relating to mobility equality (Torrao *et al.*, 2024). Personal transport by private vehicles accounts for a considerable share of the impact of human activities on the environment (Whittle *et al.*, 2019), even when those vehicles are powered by low-carbon technologies. The lower emissions of such vehicles are offset by the dispersal of rubber particles from their brakes and tyres into the atmosphere and the water cycle (Fuller, 2016). MaaS offers opportunities to reduce the

number of private vehicles in circulation, and thereby the environmental impact of transport (Athanasopoulou *et al.*, 2022).

Government policy in western countries is to incentivise the provision of funding for research in shared mobility, such as MaaS, and investigation of how diffusion of these offerings can be supported, e.g., see Transport Government Scotland (2018). MaaS is a gateway that enables users to integrate and manage a broad palette of means of mobility, including public transport, cycling, ridesharing and car sharing. The user can access these as a bundle through an interface provided by an operator or broker and pays for the service by means of a Pay as You Go plan or monthly purchases (Pangbourne et al., 2020). This "supported management" is what makes MaaS a valuable object of analysis.

However, MaaS is experiencing implementation problems and

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"unanticipated consequences" of its implementation (Ibid: 46), and researchers see it as a demonstrator project that is "hard to sell". Many MaaS projects that were intended as exemplars have been discontinued, either before launch or soon after, or have only run as small-scale pilot schemes (Hensher *et al.*, 2020). MaaS' implementation issues are particularly relevant to women, as this group accounts for approximately 50 % of mobility users and therefore the effects would be significant if they were to resist the diffusion of MaaS. Here, diffusion is defined as the process by which an innovation is communicated via certain channels over time among members of a social system (Rogers, 1995).

More women than men consider personal cars to be damaging to the environment, with this gap ranging from 9 % in Singapore to 107 % in Sweden (Weinreich et al., 2021). Women tend to have higher environmental awareness than men (do Prado & Moraes, 2020) and environmental awareness has an important role in MaaS adoption (Tang et al., 2025). Therefore, women might be more inclined than men to adopt MaaS, which they perceive as being more sustainable. Adoption is defined here as an individual process detailing the series of stages individuals undergo from first hearing about a product to finally adopting it (Rogers, 1995). Lack of individual adoption leads to the failure of that product to be diffused in the open market. Therefore, encouraging women to adopt MaaS and other public transport services (Beyazit *et al.*, 2023) may help deliver more sustainable transport systems.

The adoption of MaaS would also benefit women because, in general, they have less access to private cars than men (Weinreich et al., 2021; Gekoski et al., 2017). This disadvantage could be offset if women had the option of using MaaS offerings for their travel needs. However, factors such as hesitancy to adopt MaaS and reduced access either to shared mobility or private cars might contribute to making women "transport captives" (Gekoski et al., 2017: 3). For women on low incomes, this means they are disadvantaged in terms of accessing employment and education opportunities, as well as when it comes to using healthcare and childcare services. Some policymakers seek to encourage research in the inclusivity of transport (europa.eu, 2021). Weinreich et al. (2021); Bizgan et al. (2020) and Gekoski et al. (2017) suggest that women are deterred from adopting MaaS by challenges such as concerns about the harassment they might encounter when using these resource-efficient mobility offerings. These challenges contribute to a long-standing equity imbalance in transport services (Gekoski et al., 2017). McIlroy (2023) suggests that this equity imbalance has implications for urban mobility governance and could be addressed by ensuring that more women participate in developing governance structures (Beyazit et al., 2023). The introduction of the MaaS Code of Practice by the UK Department for Transport (DfT) underscores the government's level of attention to this aspect of urban mobility governance and the fact that it places the onus to guarantee safety on mobility providers (Department for Transport, 2023). This may include a gender impact assessment of MaaS (Fazia et al., 2023).

This paper draws on the theoretical notion of Access-Based Consumption, or "market-mediated transactions which provide customers with temporarily limited access to goods in return for an access fee, while the legal ownership remains with the service provider" (Stough and Carter, 2023: 833), with which it seeks to bring about a greater understanding of the challenges faced by women in this context. To use MaaS, users need to sequentially access modes of transport. Access is a process by which consumers book and pay for the temporary use of products or services (Rifkin, 2000). Bardhi and Eckhardt (2012) described how use of a car-sharing offering, such as Zipcar, is a type of access-based consumption and this can be extended to MaaS.

Some studies have found that women and disadvantaged groups such as older and disabled people are "excluded by design" from MaaS (Fazia et al., 2023; Sopjani, 2021; Heiskanen et al., 2005). MaaS designers overlook these users' needs when it comes to performing access to transport offerings. This paper aims to map these issues. The question this paper addresses is as follows: How can the mobility-access challenges that women encounter when accessing shared mobility modes be investigated and addressed to facilitate the adoption of Mobility as a Service by women?

The contribution to knowledge this paper aims to make, answering Giorgi et al. (2021)'s call for research on the needs of vulnerable and excluded users, with a focus on women as invited by McIlroy, (2023), is to shed light on how access to MaaS might be better integrated into women's mobility practices. This is a novel empirical contribution, following Ibid. A further contribution is its novel use of the analytical framework of access; this construct helps map the challenges of using shared transport offerings in terms of their inclusivity and the implications of these for its diffusion, as well as responses to these challenges on the part of policymakers and MaaS providers. The paper sets out to improve providers' and policymakers' understanding and control of the "unintended consequences" of MaaS that Pangbourne et al. (2020) have identified.

The paper is structured as follows. It begins with a summary of the topic of women and MaaS. The next section provides an explanation of the paper's perspective and methods. Next, its findings are presented, followed by discussion and conclusions.

#### 2. Mobility as a service and consumers

In this paper, we propose a demand as well as a supply side definition of MaaS, by considering consumer trends in younger generations such as the millennials as reported by Kuhnimhof et al. (2012) in Germany, away from car ownership and towards multimodal mobility (Ibid) and public transport. These groups treat mobility as they would a service. More recent research (cf. Fronteli and Pacheco Paladini, 2022; Jarvis, 2022) suggests that this change is linked to economic and demographic factors. However, a tendency to use ride-hailing apps in millennials (Jarvis, 2022), and the greater diffusion of apps to manage travel in general (Fronteli and Pacheco Paladini, 2022), suggest that users use means of travel as a service. In this respect, this paper frames use of transport apps by consumers as a precursor to MaaS. This approach allows us to focus on consumers' travel practices, with a particular emphasis on women. This can anticipate the stricter supply side definition of MaaS, which may have the benefit to facilitate its acceptance.

To use MaaS, travellers must perform tasks that include booking and ticketing, planning and using the functions "*remembering me*" and "*help me*" to enhance services (Athanasopoulou et al., 2022). Since all these activities require an internet connection, in locations without access to broadband, such as rural areas, MaaS use is difficult for all travellers, regardless of their type (Giorgi et al., 2021). Furthermore, mobility apps often fail to match geographical realities (ibid.). For example, services shown as available on an app may not actually exist, and some roads might not feature on electronic maps (ibid.).

For all users, safety is one of four key priorities underpinning their transport decisions, the others being convenience, cost and comfort (Bizgan et al., 2020). Users can be deterred from sharing vehicles by concerns about other drivers' driving skills and behaviour (Ibid.). Another concern is that vehicles might not be available when needed (Firnkorn and Müller, 2012). However, it is women who are concerned by direct threats of harassment (Bizgan et al., 2020).

Modes of transport are perceived as having various levels of safety. Taxis are often perceived as safer because of the presence of a licensed driver (Ibid.). Human contact may help to generate trust in MaaS, as the presence of trained staff can reassure users (Giorgi *et al.*, 2021).

Consumers who have used MaaS are more likely to trust it than those who never have (ibid.). However, adverse incidents can and do occur when using shared mobility. Be as it may, in some western countries, 40 % of MaaS users are women and 49 % are men. The same study also found that women in these countries account for 29 % of car sharing and 15 % of e-scooter use, whereas for men, these figures were 71 and 69 % per cent respectively (Weinreich et al., 2021). The next section attempts to shed light on the reasons for these differences in use.

#### 3. Mobility as a service and women

There are real barriers to the adoption of MaaS by women (McDonald, 2020). When they travel between locations for work, shopping or leisure, women experience distinct mobility challenges compared to men, which makes mobility inequitable (Sopjani, 2021). Fewer women than men have access to private vehicles, for economic or other reasons (Gekoski et al., 2017) and women use public transport more than men (Weinreich et al., 2021). In this respect, adoption of MaaS by women could be a beneficial alternative to private cars for them. However, MaaS presents women with challenges. Women on lower incomes might not be able to access MaaS, because they may not own smartphones (Choudrie et al., 2018) and therefore may not have experience or knowledge of MaaS apps (Durand et al., 2018). Furthermore, women may be less likely than men to have online banking facilities (Pangbourne et al., 2020), which are necessary to use MaaS. According to Choudrie et al. (2018) and Durand et al. (2018), women are in general disadvantaged in that they have less access to smartphone apps. However, it is worth bearing in mind that those claims were made in 2018. In 2024, this disparity might have changed because of technological developments. These issues are relevant to all locations but there are significant geographical differences, for example when comparing India with European Union (EU) countries (Weinreich et al., 2021).

In practical terms, there are some differences between men and women's use of transport. Women are more likely to carry loads such as shopping and to make short, sequential trips (ibid.), such as from shopping venues to the gym or to children's healthcare appointments. Socially constructed gender roles and caregiving responsibilities contribute to the overrepresentation of women among those who transport children and accompany individuals requiring assistance, with a 13 % disparity in the EU (Torrao et al., 2024). The needs associated with such journeys are not accommodated by the design of transport challenges to women because of their choice of clothing (Fazia et al., 2023). Finally, women are less willing than men to use Automated Vehicles (Torrao et al., 2024). This makes it more challenging for women to travel via MaaS.

Women are far more concerned about personal safety than men when using public and/or shared transport (Weinreich *et al.*, 2021; Matyas, 2020). With bicycle use, the risks include having an accident as well as experiencing aggressive behaviour. Researchers have found that women travellers experience harassment or aggressive behaviour more often than men (Weinreich *et al.*, 2021). In the UK, 37 % of women reported experiencing incidents in which they felt unsafe when using public transport (McDonald, 2020) and 15 % reported experiencing sexual harassment by men while using shared transport (Gekoski *et al.*, 2017). Although some consider sharing mobility as an opportunity to socialise with others (Marshall et al., 2019), in public transport environments, many women express a preference for personal space and seek to avoid unsolicited, awkward interactions (Weinreich *et al.*, 2021; Marshall *et al.*, 2019).

The transition between vehicles – switching from a mode of transport such as a shared car to another such as a train service – creates a sense of vulnerability and real risk, particularly at night (Weinreich *et al.*, 2021). Time of travel itself can be seen as a challenge; women may feel isolated when they are in an empty bus, but also vulnerable when vehicles are too crowded (ibid.), as the recent example of Covid-19 illustrates (Hensher, 2020). When car- and ridesharing, women may feel unsafe about travelling with strangers (Weinreich *et al.*, 2021), so they are less likely than men to use such mobility modes (Pigalle and Aguiléra, 2023).

Women may also be reluctant to use locations that are perceived as unsafe (Duchène, 2011). Such unsafe "space," in Giorgi *et al.*'s (2021: 267) terminology, includes isolated, neglected areas (ibid.), or those with a lack of policing presence or company staff that could protect them; this is especially the case on public transport (Bizgan et al., 2020).

Women are more likely to be concerned than men about being stranded alone in remote areas without a phone connection that they can use to book transport services (Giorgi et al., 2021). Criado-Perez (2019) asserts that transport routes are often less inclusive of women, who have needs that differ from those of men. In some places, MaaS may help overcome these limitations, but on balance, women might be more drawn to use private cars.

Literature on shared mobility suggests that additional factors that can affect adoption of MaaS by women include fear of risk of infection from disease (e.g. Covid-19, as mentioned above), and that women may be more discouraged by this than men (Hensher, 2020; Weinreich *et al.*, 2021). As to the comparative safety of vehicles, bicycles booked through MaaS are perceived as a safer option than others, as women can just "pedal away" in the case of unwanted attention (Weinreich *et al.*, 2021), although there is a risk of accidents occurring in collisions with other vehicles (ibid.). In contrast, women perceive buses, trains (ibid.) and car- and ridesharing as of greater concern, because they involve sharing rides with people they do not know (Bizgan *et al.*, 2020). In short, women are likely to exclude MaaS from their choices if these issues are not addressed (ibid.).

The concerns described above shape women's travel practices. Women utilise a range of actions to deal with their safety concerns, from avoiding areas perceived as risky (Duchène, 2011) and not staying out late to choosing to wear shoes they can run in and carrying their keys between their fingers in their pockets to use for self-defence (Weinreich et al., 2021). Weinreich et al. report that women might not carry cash, cards or other valuables with them, as most purchases can be made with their smartphone. Women may enable their friends to track them via apps or just inform them of where they are, especially in the evening; they may also refrain from listening to music while travelling, and try to sit close to other women, and to the driver when on a bus (ibid.).

In summary, due to the risks of accessing MaaS, women prefer private cars where possible. Female users consider a private car to be safer (Weinreich *et al.*, 2021; Duchène, 2011) and see it as a comfortable "cocoon" (Pudane et al., 2019), compared with shared mobility options.

#### 4. Safety strategies providers could adopt

Giorgi et al. (2021) contend that establishing trust between users and providers is essential for delivering effective support to the former. With respect to the providers' staff (mentioned in 2.1), trained staff need not only to be on vehicles, but also to have a standardised appearance (e.g., wearing a uniform) and effective communication skills and to display professional behaviour (Giorgi et al., 2021). Segregation of women from men may be an appropriate way of addressing safety challenges (Weinreich et al., 2021). For example, this can be done by operating women-only services with women drivers, or women-only car clubs. The quality of digital connections should be a key area for investment (McDonald, 2020) if safety is to be improved. The aggregated literature suggests several measures that should be taken to address the issues women encounter (Table 1).

Women might also be encouraged to use MaaS if its apps conveyed information on environmental performance (Bizgan et al., 2020). Women's specific needs and journey types should also be addressed (Weinreich et al., 2021). Having considered these potential responses, Giorgi et al. (2021) state that it is not possible to find a solution that suits everyone, as the different socio-technical landscapes involved mean that negotiated sharing of information between users and providers is necessary. *Socio-technical landscape* denotes the external structures of the context of society shaping actors' interactions, e.g., material and spatial arrangements of cities, factories, highways, electricity infrastructures and heterogeneous factors such as economic growth, wars, emigration/immigration, political coalitions, cultural values and environmental problems (Geels, 2002). Information management via apps, whether the information is conveyed to or about women (e.g., their location), has the potential to reassure users; however, some users have

#### Table 1

Proposed measures to make access safer for women.

1	
SUGGESTED MEASURE	AUTHORS
Installing design infrastructure that improves users'	Bizgan et al. (2020)
Installing CCTV and help points, ensuring presence	McDonald (2020)
of security staff and live feeds for journey	
Providing information about the specific location of	Bizgan et al. (2020)
lifts at stations	
Providing route advice and route recommendations,	Bizgan et al. (2020)
such as alternative diversion routes during major	
incidents such as gas leaks or terrorist attacks, or	
identifying the routes with the best lighting	
Including a 'panic button' within the app that could	Bizgan et al. $(2020)$ ,
alert the authorities, specifically by connecting to	McDonald (2020)
City app	
Referring to landmarks as well as road names in	Bizgan et al (2020)
walking routes, to support people with visual	bizgan et al. (2020)
impairments in navigating local areas	
Providing ratings and rankings of drivers, or even	Weinreich et al. (2021),
information and rankings about other users	Bizgan et al. (2020)
Choosing to travel with the same person or driver	Bizgan et al. (2020)
repeatedly, to foster a feeling of familiarity	
Placing trained personnel on trains and autonomous vehicles	Weinreich et al. (2021)
Personalising the MaaS platform for individual	Athanasopoulou et al. (2022)
users' needs, including those of women	

low trust in digital resources (Catulli *et al.*, 2021). Providers need to ensure privacy and prevent the misappropriation or misuse of data (Athanasopoulou *et al.*, 2022).

From a provider's perspective, cases of harassment and violence against women show their brands in a negative light (Hein *et al.*, 2016). In addition to being problems that interest policymakers, the challenges and risks that affect women who use MaaS are of great interest for MaaS providers and their network partners. To address these challenges, providers and policymakers need to understand these women users. To achieve this, Giorgi *et al.* (2021) suggest involving women users in the design stage. In summary, an important level of investment in digital technologies and infrastructure is necessary to improve the design of service delivery sites (ibid.), facilitate use of MaaS and make it safer to access. Having reviewed the literature on women's relationship with MaaS, the next two sections go on to explain the research perspective and methods used.

#### 5. Research perspective

Since the roles, behaviours and even travel needs of women are shaped by the social contexts in which they travel (Criado-Perez, 2019), this study draws on the perspective of Practice Theory (PT), a cultural theory (Reckwitz, 2002) in which social practices are the main unit of analysis (Shove *et al.*, 2012). A practice is "*a routinized type of behaviour which consists of several elements, interconnected to one another: forms of bodily and mental activities, 'things' and their use, [and] a background knowledge in the [relevant] form of understanding, know how, states of emotions and emotional knowledge" (Reckwitz, 2002). Shove <i>et al.* (2012) simplified the constituent elements of practices as consisting of the following:

- *Materials*: the things people use when performing their practices, e. g., the vehicles and smartphones used to access MaaS. This category includes elements that are virtual but are used to perform MaaS mobility, e.g., smartphone software apps.
- *Competences*: the performative skills people need to perform practices. In the case of MaaS, these include using apps and riding bicycles and even the institutionalised competences guaranteed by driving licences.

• *Meanings*: the associations users make between a practice or its components and values and feelings, and the social conventions that shape users' practices.

Practices result from the integration of these elements by practitioners and relate to and depend on each other. For example, work practices are linked to mobility practices, as people need to travel to work. In turn, mobility is linked to other practices such as shopping or travelling to leisure places (Watson, 2012). Indeed, practices are interconnected and form constellations (Schatzki, 2003). This interconnection of practices can make them obdurate and resistant to change, which impedes the diffusion of innovations (Mylan, 2015).

The rationale for selecting PT for this analysis is that as a cultural theory, it helps conceptualising how women in their mobility practices are constrained and this can result in social exclusion (Uteng, 2009). In practical terms, PT enables researchers to study the daily routines human subjects, including users and providers of MaaS, perform in their lives (Shove et al., 2012). Consumers need to access transport modes sequentially to use offerings (Bardhi and Eckhardt, 2012; Retamal, 2017) such as car sharing and other MaaS transport modes. Access requires the use of physical resources (materials) to use products. For example, users of shared vehicles use smartphone apps to access them (Enoch and Potter, 2023). The use of PT enables us to develop an understanding of the challenges users encounter when using MaaS and of how these challenges shape their mobility practices. Shove (2010) also claims that PT enables researchers to gain an improved understanding of everyday sustainability in peoples' lives but where women may have less opportunity to contribute by using transport which is sustainable, but perceived as less safe and accessible (Hanson, 2010). This is relevant to this research because of MaaS' environmental efficiency features.

#### 6. Methods

In keeping with the theoretical framework of PT, the methods used were qualitative. The research involved 31 interviews of female users of mobility offerings and three of male users, adding up to a total of 34. Male participants also offered their perceptions of the challenges women encountered and how they felt they could assist with these. The sample also included a trans woman, and cultural insights on the challenges met by women were enriched as a result. Participants were selected using convenience sampling of students and staff at a UK university and parents of members of a scout club and were all based in the Hertfordshire region. All were recruited through an advertisement on the university's managed learning environment. To complement the sample, a snowball sampling strategy was used, whereby participants from both groups were asked to introduce additional respondents to take part. Table 2 summarises the characteristics of the interview participants. The "P" column is the progressive number of participants, used to identify them in the findings.

The research context is the UK and so the practices we describe are only applicable in that context, which is certainly a limitation of this study. However, the UK is very multicultural and therefore a study in this context can generate insights which can be applied across diverse cultures. When conducting the initial pilot of the interview guide (IG), little awareness of MaaS was observed as could be expected from the limited diffusion of MaaS referred to in section 1. The research team modified the IG to use proxies of MaaS, such as Citymapper and Google Maps as well as transport modes such as car clubs, *Uber* services and bicycle-sharing offerings. We suggest that this is legitimated by our wider supply-side definition of MaaS, following Fronteli and Pacheco Paladini (2022); Jarvis (2022) and Kuhnimhof et al. (2012).

The interviews, semi-structured by the IG (see Appendix 1), were conducted on MS Teams and were video recorded. The IG featured questions about virtual materials (e.g. apps), and the meanings, routines and associations the users connected with their transport behaviour. The aim of this was to encourage participants to describe their practices. The

#### Table 2

The demographic characteristics of the interview participants.

Age	Car owner	Children	Ethnicity	Profession	Р	Sex
30–39	Yes	No	white UK	Lawyer	1	Female
20-29	No	No	white EU	Student	2	Female
20-29	Yes	No	Black	Medical	3	Female
			Afro-			
			Caribbean			
20-29	Yes	No	white UK	Other	4	Female
30–39	Yes	No	Indian UK	Other	5	Female
30–39	No	No	white UK	Lawyer	6	Female
20-29	Yes	Yes	Black	Nurse	7	Female
			Afro-			
			Caribbean			
30–39	No	No	white UK	Other	8	Female
20–29	No	No	white UK	Other	9	Female
20-29	No	No	white UK	Counselling	10	Female
40–49	Yes	Yes	white UK	Tradesman	11	Male
40–49	No	Yes	white UK	Other	12	Female
20–29	No	No	Asian UK	Other	13	Female
50–59	Yes	Yes	white UK	Medical	14	Female
20–29	No	No	Asian UK	Other	15	Female
30–39	No	Yes	Black	Student	16	Female
			Afro-			
			Caribbean			
40–49	No	Yes	white UK	Academic	17	Transgender F
20-29	No	No	Asian UK	Other	18	Female
30–39	No	No	Asian UK	Other	19	Female
20-29	Yes	No	white UK	Student	20	Female
20-29	Yes	No	Black	Medical	21	Female
			Afro-			
			Caribbean			
40–49	No	No	Asian UK	Other	22	Female
20–29	Yes	No	Indian UK	Researcher	23	Female
Over	No	Yes	Asian UK	Retired	24	Female
60			1.1		~-	
20–29	Yes	Yes	white EU	Stay-at-	25	Female
				home mum	06	
30-39	NO	Yes	White EU	Consultant	26	Female
40-49	Yes	NO	Indian UK	Academic	27	Female
20-29	NO	NO	Asian UK	Unassigned	28	Female
30-39	NO	NO	white EU	Other	29	Female
30–39	NO	NO	Black	Other	30	Female
			Alfo-			
30.30	Voc	No	Indian UV	Other	21	Female
20-29	No	No	white UK	Devehologist	30	Female
20-29	Vec	No	white UK	IT	32 32	Male
20-29	1 6 2	110	winte UK	Consultant	55	141010
20_29	No	No	Asian UK	IT	34	Female
20-29	110	110	713idii 010	Consultant	54	1 ciliaic
				constituit		

fact that the interviews were conducted online facilitated the production of video recordings, and the structure made it possible to use shortcuts to leave out questions that were not relevant to the participant. A professional transcription agency then transcribed the video recordings, and the analysts watched these while coding those transcriptions in NVivo, a qualitative analysis software package (Silver and Levins, 2014). To do this, they used the elements of Practice Theory – i.e. a focus on routines, meanings, competences and materials – as a flexible template approach (Miles and Huberman, 1994), seeking to integrate the themes they had identified in the literature with the novel themes that emerged from the analysis. The use of social practices as an analytical framework helped researchers and participants to explore the mobility practices of women when using MaaS or its proxies.

#### 7. Findings

#### 7.1. The challenges of accessing maas

The analysis shows how MaaS enables users to manage varied means

of travel. MaaS elements include diverse types of vehicles, including public transport, shared cars, bicycles and scooters, amongst others. Some findings apply to users of all genders, not only to women. The personal car is still dominant, because participants say they consider it safer than other means; it also provides independence, is dependable and delivers a door-to-door service. With personal cars, users can travel on a whim. In contrast, when using shared mobility, users may just turn up at a bus stop or train station to find their service has already left.

The users reported that they sometimes modified and varied the activities they engaged in during the day based on the availability of shared transport, i.e., depending on whether other people were driving in the same direction, and they could therefore share a means of transport with them. All the respondents used MaaS apps, for example, to plan journeys and manage their costs. Participant P23 reported:

"... even Google Maps now flashes [up] how much an Uber would be, not that I trust the price, (...) I'd always go and double-check, but in terms of usability."

Another participant mentioned that while the quality of information accessible through apps is good, she still needs to buy tickets separately. Therefore, even when the information provided by MaaS is good, people may not use it. Furthermore, the respondents thought that apps cannot replace human service staff. Some also said that booking through apps would box them into using a specific travel mode, and therefore they preferred paying in person. Some participants claimed that they would rather walk than use MaaS.

These findings generated insights into the associations of MaaS for *all* the users from the sample. In the section below, the aspects relevant to female users are described.

#### 7.1.1. The socio-technical landscape

The socio-technical (ST) landscape includes virtual (including social conventions), material and infrastructural elements that support MaaS offerings. Women's travel practices are shaped by the *social convention* that women face more risks than men when using shared transport. Participants claimed that women are

"...socialised to be afraid" (P27), to be concerned about safety and to see transport as dangerous, and that this can be a defining feature of women's identities. As this citation illustrates,

"... every woman I know has this, and it might just be ingrained in us from young ages" (P9).

Media communications contribute to diffusing these meanings. Participants often cited the Sarah Everard case, where a woman was kidnapped and killed by a police officer while she was travelling between locations (Topping, 2022).

From a PT perspective, women are engaged in a complex network of interlinked practices. The female participants described multiple activities which required them to use transport, such as shopping, caring for infants and looking after older relatives, including visits to medical appointments. Combined with travel to gyms and other exercise classes, these practices require many women to take multiple-stop journeys.

Good lighting and CCTV cameras help, as this citation illustrates:

### "Most of the stations have got CCTV, which I think's good. Some trains have got it. (P9)"

Apps are virtual, but they form part of the "materials" women use to navigate the landscape. Apps empower female users by enabling them to track and to be tracked by associates, check where vehicles are and how crowded they are, and access other key information that helps them feel safe. Participants stated that apps could help reassure them by giving them knowledge of the provision available and the landscape of an area, as well as the identity or professional details of the drivers of vehicles when these are manned. On the other hand, apps can also be misleading, because they might give female users "a route that goes through a dark alley or a park instead of a well-lit road simply because it is the shortest route..." (P26) and "most annoying wasn't like, don't go this way on the path. There was a nice path along the side of the A road that just literally came to a stop..." (P26).

This exemplifies lack of correspondence between the maps on the app and the hard landscape (cf. Giorgi et al., 2021).

Participant P2 says that the way to shape the ST landscape positively is not

"... necessarily (...) more policed spaces, and I don't think that (...) changing the rules, necessarily, of certain things would cause people to abide by them."

Most participants contrast human contact and service with artificial intelligence (AI) and apps. When using public transport, whether booked through MaaS or not, female participants reported that they had certain safety-related habits such as travelling on the bottom floor of a double-decker, where there are more people, and they are closer to the driver. Some also said that they found the presence of service people on board, such as the provider's staff, reassuring – especially if these staff members are safety trained and vetted. Some participants reported that they did not see enough security staff on services or at stations, and they would like there to be more.

Drivers may have ID and other quality assurance information that certifies their trustworthiness. Services such as Uber may be personalised:

"... the whole point is that they will send you a picture of John, you know, in his Toyota Prius 12,345, so they give you the registration number, (...) (his) picture, so you know the driver's name and even their phone number" (P11).

Users also receive their vehicle's number plate. Participants explained that the fact that drivers have a licence, or the use of qualityassured shared vehicles reassured them. Most participants mentioned the service-quality rankings accessible through the smartphone apps or the providers' web sites. The features of the vehicles that reassure female users include the ability to lock doors and make the user safer inside – so potential aggressors cannot get in. The traceability of the vehicle also makes users feel better. The ST landscape renders access to MaaS risky as illustrated below.

#### 7.1.2. Perceived and real risks of accessing maas

The appearance of vehicles shapes people's expectations. Shared vehicles might be dirty, which could discourage people from using them:

## "I've seen (that they can) be quite rickety (...), even by the look of them." (P15).

Hygiene and cleanliness are key elements in the safety assurance of vehicles. Cameras and other security hardware can be placed in vehicles and in the landscape, for example inside and around trains and docking stations. Participants consider some vehicles, such as taxis, reassuring, because they can be locked: "nobody can get in" (P15). A potential downside of taxis is that the materials can include fake number plates and certificates, which can mislead users. The women who were interviewed stated that they were aware and afraid of crime. Two participants narrated how the combination of their gender and ethnic identities affected them. For example, an Asian woman felt threatened by other travellers, who were hostile because they associated her Asian appearance with the Covid-19 pandemic. Participants stated that as women, they felt threatened by men. For example:

### "... those experiences where I felt uncomfortable, it has been a male to make me feel uncomfortable." (P12).

Crowded vehicles and participants having to share space with the "wrong" type of people do not inspire safety. Indeed, all participants cited proximity to people who are fighting, or who are affected by physical or mental health issues, drunkenness, or drug use, as alarming situations. The analysis used the framework to identify additional concerns, which are summarised below:

- Suitable attire is needed, limiting the choice of outfit of women when travelling.
- ICT (e.g., cameras) and human (e.g., transport officers and police) vigilance is not always in evidence.
- On transport vehicles, there may be too many people, the wrong people or not enough people.
- Risks from criminal activity are feared.
- The users associate MaaS with having to rely on other people.
- Some users have privacy concerns.
- Hard work and planning are necessary with MaaS.

Women might carry devices to protect them, such as rape alarms. One participant mentioned "Angela," a personal alarm protocol (met. police.uk/police-forces/metropolitan-police) which can be used when visiting public venues such as restaurants and users feel unsafe.

Apps help reassure users by providing them with information and feelings of control. Apps are virtual, but they are manufactured artefacts and therefore can be counted amongst the "materials" women use for their mobility. Generally, apps are a source of perceived safety:

"...it gives me a real sense of security that I know I can just pull out my phone and get Google Maps up or TfL (Transport for London) to see when the next or the last bus or train (...) is going to take me home"; "... you know that the app will at least give you a route or a way to (...) get home and as a woman that's (...) comforting, it gives you a sense of freedom (...) without [... having to] worry about (P7) [how to get home]".

Specialist apps also help: one participant stated that she had "Find my Friend" on her phone. Apps keep users informed on the correct stops, directions and routes, and are therefore empowering. Participants mentioned that they used apps to see what areas they would need to travel through and whether these were dangerous areas. Thus, apps are a useful way to plan journeys in a way that enhances safety.

Uber is seen both as an app and as a taxi service – it has a good reputation. However, apps and smartphones that support them occasionally project meanings of *intrusiveness* and create concerns about privacy. A participant illustrated this by mentioning her suspicions about smaller providers and said that she worried about being tracked.

#### 7.1.3. Cognitive effort

Participants reported that they found it challenging to do the cumulative work needed to learn the skills required to manage mobility apps, including booking, ticketing and planning. One participant said,

"...the other thing that goes through your mind is (...) how many apps have I got? I got to download another app. So, you tend to kind of go back to the apps you've already got and then make it work rather than (download another). (...). You know, spend time working out with the [app] you can connect to the (...) mobile data and download something and how big it will be and how much more new registration information are you gonna have to put in there and to make it work" (P26).

Therefore, she found it difficult to manage all the available (and competing) travel apps. The entry of additional personal information in various databases is a deterrent, because of privacy and long-term commitment concerns. Means of transport such as car clubs and other vehicle-sharing apps are perceived as complicated as this comment illustrates,

### "... there's a load of admin that comes with it and a lot of associated cost." (P7)

Some participants reported that they had learnt to use apps so they could be tracked by friends and track other people, as this citation illustrates: "Danielle's on my app, [...] she will follow me, and I'll follow her. (...) if I get home before her, I'll track where she is, and I can [...] get dinner ready (...) (P11)."

However, the number of smartphone apps required to use MaaS can be overwhelming and induce apps fatigue, where users suffer from "overapp". MaaS apps are perceived as complicated because they need to interface with bank details – this can cause glitches. A participant related that on one occasion, the app would not connect with her bank details and the payment did not go through, which meant she could risk a fine for not having a ticket. Based on Pangbourne et al.'s (2020) observation that women may have less access to online banking facilities, the labour-intensive nature of MaaS may be a greater concern for women than for men.

The complexity of using MaaS apps may also be a deterrent:

"The only thing that would put me off is if, it was too complicated, (...) a mishmash of train booking and scheduling, club cars [and other steps]" (P30).

Apps are downloaded onto smartphones, which can run out of battery. Some women said they had "battery charge anxiety," as battery failure could leave them stranded in a remote area.

Participants said that they were also deterred by the need to plan journeys. Using apps, for example to book a bicycle, much like the distraction caused by reading a book or listening to music on public transport, can take precious attention away from the traveller's surroundings and jeopardise their safety. Although MaaS apps may be labour-intensive for men, women's more complex travel patterns, as explained in section 3, means they are more so for women.

Some women observed that they need to rely on their "street smart" skills to be safe. This suggests that they see a gap in the provider's safety provisions. They use techniques such as making themselves visible by standing in open spaces, to make it difficult for would-be harassers to isolate them. They deploy their own landscape knowledge, for example of where the most isolated stations are. They avoid travelling when it is dark, that is, at night. Many participants also report "self-made" self-defence practices such as carrying bunches of keys in their hand and wedging keys between their knuckles as potential weapons.

#### 7.1.4. Meanings associated with accessing maas

As mentioned in section 7.1, participants associate private cars with safety, independence, dependability and door-to-door service. This is aptly illustrated by the following statement:

"... there are no other people around you... (...). It takes less time to get to [your] point of destination, you don't have to stand at the bus stop, or the tube stop and wait, and you know, you can just, jump into the car, and go where you need to." (P6).

In this respect, private cars are a difficult standard to beat. However, participants seem to associate shared mobility managed via apps with environmental protection,

"...it's better to use because it's better for the environment...(P2)" when users drive their own car, "petrol is really expensive and it's not good for the environment" (P11).

As explained in section 1, women are more motivated by such considerations in their transport choices than men. In this respect, female travellers' perception of MaaS is positive. However, sharing with other people is a two-way street. If these people are strangers, then lack of *trust* is a deterrent. Users can be wary that other people may share information on them. Similarly, a busy area – such as London – might come across as safe but also as risky as public transport is crowded,

"...and there can be both safety and danger in a crowd. (P27)

Apps are associated with safety by most participants, as explained in section 7.1.2. Participants also associated cameras with safety. In

contrast, participants associated darkness, night travel and deserted, isolated locations with meanings of *danger* and *unsafety*. Most participants cited connections between modes, such as switching from a train to a bicycle, as the least safe legs of their journey.

#### 7.1.5. Inclusivity and community aspects of accessing maas

Practices are shaped by identities. The men we interviewed said that they felt confident when travelling. However, these men were concerned about female dependants using MaaS; they also felt that they should protect women and avoid alarming women they did not know by keeping their distance.

Female participants observed that they are too self-conscious to protest if someone bothers them on public transport or to make a complaint about a safety issue, because they do not want to attract attention to themselves. This makes women feel powerless.

The phrase "safety in numbers" seems to reflect the opinion of most of the participants, who said that they preferred travelling where there were other people. If multiple people are sharing services, they know each other and have a common purpose or destination, this helps to reassure users. People rely on other people for safety, as this citation illustrates:

"[if] she goes home after darkness, she usually calls her mum. And so, she's on the call with her mom or at least sometimes she might pretend that (...) she is." (P11)

The support of communities with a shared purpose helps make MaaS a trustworthy service. Examples of these communities include workplaces, e.g., the NHS, schools or other employers. Although this reassurance is not always manageable by MaaS providers, they may still make efforts to aggregate users around communities. When someone might be perceived as more vulnerable, e.g., a girl who is a wheelchair user, people in a community can be protective. Some participants talk about "do-it-yourself safety" when familiar people (boyfriends, parents) support them and each other for safety.

Transport providers' apps may help with this, because they enable people to keep track of where their friends are. Users prefer to use car sharing with friends or other people they know. Finally, the ratio of female to male drivers is important. If there were more female drivers on shared vehicles, women could decide to travel with other females. Some participants said that they would feel better being driven around by a woman, as this statement illustrates:

"I'd much prefer a woman driver to pick up my daughters than a man driver." (P11).

Another safety feature in a shared vehicle could be a free call service, whereby users could push an alarm button to put them in touch with professional assistance.

#### 7.1.6. Lack of freedom due to maas infrastructure and role of women

In comparison with the private car, in a factual sense, MaaS grants users a lower degree of freedom. This is especially the case for women, because of the complex travel practices they might engage in:

"... when you travel in the rush hour, sometimes you'd struggle with (...) children on the train because there will be queues next to the doors." (P25).

Women tend to transport more artefacts – e.g., baby car seats, shopping, prams, amongst others – which makes switching vehicles through MaaS problematic, as this citation illustrates:

" I use my private car (...) for convenience because it's quicker, because you don't have to carry bags, you just put everything you need in the car." (P21).

The attire women wear also shapes their mobility practices. They might wear a business suit at work with skirts and high heels. This would make use of scooters and bicycles difficult. Users explain that some services such as bicycle sharing are associated with getting "*sweaty*", which is not compatible with wearing their business clothes and might necessitate bringing a change of clothes with them. Therefore, the identity-specific artefacts women use can deter them from using MaaS. The prams and car seats that some women take with them to transport infants limit their freedom. Helmets make it safe to use bicycles and scooters but make travel harder for users because of having to carry them and their incompatibility with smart clothes. Accompanying children also limits the ability to use public transport. With a private car

#### "...I go, drop off the boys at school (...) and I collect them." (P.25).

When travelling with elderly relatives, a private car is preferable because it takes the user from door to door. When journeys are urgent, users are more likely to use their private car.

In summary, the multiple switches of vehicles required by MaaS between work, the gym, doctors' surgeries and social venues represent a significant disadvantage of this mode of transport in comparison with the private car, which affects women more than men because of their travel patterns. The next section discusses the findings.

#### 8. Discussion

This paper has drawn on the notion of Access-Based Consumption, first introduced by Bardhi and Eckhardt (2012), and posited that when engaging in mobility through MaaS, users must access multiple transport modes. This creates the challenges that women - and disadvantaged consumer groups - encounter to a different degree than most men. The Practice Theory (PT) - informed analysis here shows that women do encounter challenges when accessing MaaS offerings. The institutionalised roles that often fall to women, as dictated by cultural expectations, such as child-rearing and homemaking (Weinreich et al., 2021), limit their freedom to switch between modes of transport when using MaaS. Performing the necessary practices to use MaaS presents challenges for all users (Giorgi et al., 2021). Using apps to manage one's travel requires digital skills, confidence (Tunn et al., 2021) and cognitive effort (Tang et al., 2025). Mobility through MaaS is less flexible and dependable than travelling with private cars. For people with social, economic, age related and other disadvantages, including the extra cognitive effort, MaaS apps are more c hallenging than using private cars (Choudrie et al., 2018), although our findings do not confirm Ibid. and Durand et al.'s (2018) contention that women have less access and ability to use smartphone apps than men. As already mentioned in section 3, socio-technological changes between 2018 and 2024 may have altered this scenario. Social conventions mean that MaaS is perceived as a riskier option for women than private cars (Criado-Perez, 2019) and this shapes women's mobility practices. The reluctance to adopt novel mobility practices can hinder transition pathways to MaaS (cf. Pangbourne et al., 2020) as social practices are a landscape feature of (in Geels' (2006) terms), the socio-technical landscape, which can significantly hinder transitions (Shove and Walker, 2010). In addition, "physical" landscapes such as isolated and dark places, another feature of the socio-technical landscape, create real risks for women when using MaaS (McIlroy, 2023). MaaS is less inclusive of women than of men, because as they tend to undertake a larger share of caring responsibilities than men (Fazia et al., 2023), they may have difficulties switching between diverse means of transport.

Since women tend to use scooters and car sharing less than men do (Weinreich *et al.*, 2021), MaaS offerings should feature types of mobility that accommodate their needs and policy should tailor the mix of modes of transport, e.g. motorized Vs non- motorized, depending on users and type of urban landscape (Tang et al., 2025), which may shape adoption (Ibid.) by women. Social changes may in time reduce the differences in mobility practices between women and men; however, these changes may not affect all.

Women may overestimate the risks of using MaaS, but although there might be inconsistency between perceived and real risks, such fears are socially rooted, and facts on the ground, such as the evidence of the Sarah Everard and similar cases, prove this. These conventions are not specific only to MaaS. As Criado-Perez (2019) reports, women are banned from some spaces, denied their own spaces, and held responsible for their own safety. These challenges need to be addressed at a social level.

In the specific of MaaS, it is alarming that women perceive a lack of safety provision in shared mobility offerings, as exemplified by the adoption of "self-made" safety measures such as being prepared to use keys as weapons. The fact that these concerns (and perhaps resignation) are ingrained in social conventions is deeply troubling. One strategy to enhance safety may be to enable women to share mobility spaces with other women, although exclusion of user groups from travel on certain services may even be illegal as discriminatory (Dindar and Parkinson).

Changes necessary to the landscape and infrastructure for MaaS diffusion appear as obstacles, particularly in respect to connections between diverse modes of transport. MaaS diffusion requires radical change in social practices (Shove and Walker, 2010), which, as they are part of the social construction of technology, may be influenced by the rhetoric of providers and even government (Pangbourne et al., 2020). Practices also need to be "shaped" by urban mobility governance, which needs greater imput from women to make transport a less male-dominated context (Beyazit et al., 2023). The MaaS Code of Practice introduced by the Department for Transport (2023) has a significant role in shaping this governance and MaaS providers should engage with it, although more direct government intervention may be required to ensure the efficiency, equity and ethics of MaaS (Pangbourne et al., 2020). From a practical perspective, our research confirms the findings of previous literature in terms of the suggested solutions, e.g.: improving app functionality and investment by local authorities and providers in infrastructure and updating of MaaS apps (Giorgi et al., 2021); the use of security devices and personalisation of services (Bizgan et al., 2020; Weinreich et al., 2021); provision of female-targeted services (Athanasopoulou et al., 2022) and community anchoring (Pigalle and Aguiléra, 2023). We suggest that vehicle traceability and the maintenance of human service personnel could be useful additions to this mix. The study's findings related to the usefulness of supporting communities to anchor shared mobility confirms Pigalle and Aguiléra (2023)'s findings and suggests that MaaS providers could contribute to fostering communities around their provision.

#### 9. Conclusion

The challenges women face when accessing MaaS may hinder its adoption and diffusion. Suggested solutions include rigorous vetting of anyone who participates in service delivery and encouraging the recruitment of female personnel, including as drivers, by mitigating the barriers that prevent this and addressing attitudes to what have traditionally been male-dominated jobs. MaaS providers could encourage the formation of communities around MaaS brands, including women's groups to reassure women with fostered familiarity. The reassuring effect of the licensed status of service staff suggests that an important intervention would be a quality certificate or other information vouching for the trustworthiness of drivers or other service staff, underpinned by control and enforcement on the part of the provider. Suggested reassurance practices might include the provision of competent safety staff and technology devices such as alarms and video recording, although the latter has the potential to be intrusive.

While some progress has been made, changes are still needed to improve social practices and infrastructure in such a way as to include women and recognise the diversity of users and their needs. Indeed, users perceive gaps in providers' safety provision and tend to enact "do it yourself' measures, a sign that the current provision does not satisfy the needs of all. Addressing these issues will require considerable investment and governance efforts. On the basis of the proposed analytical framework, this paper recommends that the following actions be taken by providers and policymakers: (1) address issues connected with infrastructure and culture, possibly shaped through communications; (2) address the perceived and real risks of access to MaaS; (3) increase the flexibility of the service; (4) reduce the cognitive effort required by accessing the service, for example through user-friendly and standardized apps; (5) associate access with positive perceptions by means of communications; and (6) make MaaS mobility practices more inclusive.

Further investigation is needed into what MaaS providers are doing now to better understand and facilitate access to MaaS and ensure safety, as well as into how the design of MaaS can be informed by the analytical framework presented in the paper. Research is also needed into the participation in MaaS of disadvantaged groups, including ethnic and gender minorities, and identifying their needs.

#### 10. Limitations

This study of course has limitations, these include the small convenience sample size and the participants being all based in the UK, which precludes the acquisition of insights from countries with diverse levels of gender imbalances. We recommend that comparatives studies are conducted. The participants were also based in Hertfordshire, a region including urban zones in Greater London and peri-urban zones. These participants travelled in the Ultra-Low Emission Zone (ULEZ) in the London area, it would be good to engage women based in central London or other urban centres to investigate their propensity to use MaaS in these areas. It is also recommended that our findings are probed through quantitative data collection using statistical sampling.

#### CRediT authorship contribution statement

Maurizio Catulli: Writing – review & editing, Writing – original draft, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. Robyn Thomas: Project administration, Investigation, Data curation. Russell Fenner: Resources, Project administration, Investigation, Data curation. Scott L. Copsey: Writing – review & editing, Project administration, Funding acquisition, Conceptualization. Sue Walsh: Writing – review & editing.

#### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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#### Supplementary materials

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