HOW CAN IMPROVING THE GENDER INCLUSIVITY OF MOBILITY AS A SERVICE FACILITATE ITS DIFFUSION?

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This paper explores issues of inclusiveness and safety that women encounter when using Mobility as a Service (MaaS), a transport offering which enables users to book, manage and pay diverse modes of transport through smartphone apps. Personal mobility modes may include public transport, car, bicycle sharing, automated vehicles and more. The diffusion of MaaS is desirable because it may contribute to the decarbonisation of personal mobility and yet it is finding resistance.

The study draws on the cultural perspectives of *Practice Theory (PT)*, a theory which focuses on social practices as the main unit of analysis and *Consumer Culture Theory (CCT),* a multidisciplinary approach which studies the dynamic relationships between consumer actions, the marketplace, experiential aspects of consumption and cultural meanings.

Despite benefits, participants associate using MaaS with meanings of unsafety and apps with intrusiveness. Women seem disadvantaged compared to men when using MaaS.

Suggested solutions include rigorous vetting of service personnel and whenever possible, recruit female personnel such as drivers. On board cameras, recording devices and safety features of apps may help women feel safe. MaaS providers could encourage the formation of communities around MaaS brands, with female members to reassure women. Significant changes are needed to social practices and infrastructure, and this requires changes in policy, investment and governance.

Key words: Carbon Neutral Transport; Diffusion; Inclusivity; Mobility as a Service; Safety; Women

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 "user-centric, intelligent mobility management and distribution system, in which an integrator brings together offerings of multiple mobility service providers and provides end-users access to them through a digital interface, allowing them to seamlessly plan and pay for mobility" (Kamargianni et al., 2018).   This paper joins recent debates about mobility equity (Sopjani, 2021). Personal transport by private cars represents a considerable share of the impact of human activities on the environment (Whittle et al., 2019), even when private cars are powered by low carbon technologies. The lower emissions of such vehicles are offset by the dispersal of brake and tires' rubber particles in

the atmosphere and in the water cycle (Fuller, 2016). MaaS offers opportunities to reduce the number of private cars in circulation and therefore the environmental impact of transport (Jittrapirom et al., 2017).

Indeed, Government policy in Western countries encourages funding of research in shared mobility such as MaaS and in how diffusion of these offerings can be supported, e.g., see Transport Government Scotland (2018). However, MaaS is meeting implementation problems and researchers consider it a "hard to sell" demonstrator project, indeed many MaaS exemplars have been discontinued before launch beyond small scale pilots or soon after (Hensher et al., 2020). The implementation issues of MaaS are particularly relevant to women, as they represent approximately 50% of mobility users and might resist the diffusion of MaaS. Here diffusion is defined as the process by which an innovation is communicated through certain channels over time among members of a social system (Rogers, 1995).

More women than men consider personal cars damaging to the environment, with a difference ranging from 9% in Singapore to 107% in Sweden (Weinreich et al., 2021) and adopt means of transport according to environmental considerations (Duchène, 2011). In addition, Ibid. suggests that women also strongly associate the concepts of sustainability and gender parity. Therefore, women might be more inclined than men to adopt MaaS, which is perceived as more sustainable. Adoption is here defined as an individual process detailing the series of stages one undergoes from first hearing about a product to finally adopting it (Rogers, 1995). Lack of individual adoption leads to fail of MaaS to diffuse in the open market. Therefore, encouraging women to adopt MaaS may make transport more sustainable.

The adoption of MaaS would also benefit women because in general they have less access to private cars than men (Ibid.). This disadvantage can be offset if women had the option of using MaaS offerings for their mobility. However, hesitancy to adopt MaaS and having less access either to shared mobility or private cars might make of women "transport captives" (Gekoski et al., 2017: ,3). This, for women on low incomes, results in disadvantage in accessing employment and education opportunities, as well as using healthcare and childcare services. Indeed, policy makers encourage research in the inclusivity of transport, see for example europa.eu (2021). From a design perspective, women and excluded groups are not represented in design processes of transport offerings (Sopjani, 2021; Heiskanen et al., 2005), which means that their needs can be overlooked when designing MaaS offerings, so that women can be "excluded by design" from MaaS and other sustainable innovations (Sopjani, 2021). This paper aims at mapping these issues. The point of departure of the research is that women encounter challenges when using

public transport and shared mobility, therefore the question the paper addresses is,

How can the challenges women encounter when they perform mobility practices shape the diffusion of Mobility as a Service?

The contribution to knowledge is to shed light on how women's mobility practices might incorporate MaaS, map the challenges represented by its inclusivity and implications for its diffusion and responses by policy makers and MaaS providers. In this, we answer Giorgi et al. (2021)'s call for research in the needs of vulnerable and excluded users.

2   LITERATURE REVIEW

Women encounter different challenges than men when they go about traveling between locations of work, shopping or leisure, indeed access to mobility is inequitable (Sopjani, 2021). Fewer women than men have access to cars (Duchène, 2011), because of economic or other reasons (Gekoski et al., 2017) and 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. However, MaaS presents women with challenges of its own.

In some western countries, usage of MaaS offerings is 40% vs 49% for men but women's share of use of elements of MaaS are of 29% for car sharing and 15% for e-scooters versus 71% and 69% respectively for men (Weinreich et al., 2021). Reasons for this include women's carrying loads such as shopping in sequential shorter trips (Ibid.), for example from shopping venues to the gym, to children healthcare. Women on lower incomes might not access MaaS, because they may not own smartphones (Choudrie et al., 2018) or may not be capable to use smartphone apps (Durand et al., 2018), which are necessary to use MaaS. These issues are relevant to all locations but with significant differences, for example when comparing India with EU countries (Weinreich et al., 2021).

For all users, safety is one of four key priorities underpinning transport decisions, the others being convenience, cost and comfort (Bizgan et al., 2020). However, women are far more concerned about personal safety than men when using public and shared transport (Weinreich et al., 2021; Matyas, 2020). With bicycles, this includes risk of accidents as well as aggression. In short, women would exclude MaaS from their choice if the issue was not addressed (Ibid.). This is a real barrier for adoption of MaaS by women (McDonald, 2020). Besides personal safety, there is risk of getting on public transport where other passengers are being rowdy and noisy (Bizgan et al., 2020). Although some consider sharing mobility a way to socialize (Marshall et al., 2019), women just want to be left alone and not to have to have awkward conversations with co-users of shared transport (Weinreich et al., 2021; Marshall et al., 2019). Finally,

literature on shared mobility suggests additional factors that can affect adoption of MaaS by women, such as fear of contagion, where women might be discouraged more than men (Hensher, 2020; Weinreich et al., 2021), not only by risks of infection from disease (e.g. covid-19), but even traces of previous users of a vehicle (Bardhi and Eckhardt, 2012) and concern that vehicles might not be available when needed (Firnkorn and Müller, 2012).

2.1   Situations that make women feel unsafe

The transition between vehicles – switching from a mode of transport such as a shared car to another such as a train service, is vulnerable, particularly at night (Weinreich et al., 2021). Time of traveling itself is a challenge, women may feel isolated, such as when they are in an empty bus of even when a vehicle is too crowded (Ibid.), especially recently because of covid (Hensher, 2020). When car sharing, women may feel unsafe when traveling with strangers (Weinreich et al., 2021; Bizgan et al., 2020), with ride sharing, where direct threats from strangers are compounded by concerns about their driving skills and behaviour (Bizgan et al., 2020). Women may also be concerned by specific locations perceived as unsafe (Duchène, 2011), "space" in Giorgi et al. (2021:267)'s terminology, including isolated, neglected areas (Ibid.) and lack of policing and company staff that could protect them, especially on public transport (Bizgan et al., 2020). Places without access to broadband internet, such as rural areas, affect the relationship of every type of user with MaaS, however women are more concerned than men about being stranded in isolated areas without connection to book services (Giorgi et al., 2021). Criado Perez (2019) even asserts that transport routes are designed to be less inclusive of women, who have dissimilar needs from men. In some places, MaaS may help overcome those limitations, but women may be more drawn to private cars than to MaaS. Women, disproportionately from men, transport children and accompany people who need assistance, which is not accommodated by the design of transport routes (Ibid.). This makes it hard for women to travel.

Mobility apps fail to match real geography (Ibid.), for example a service seen as available on an app may not actually be there, or roads might be not reported on electronic maps (Ibid.). Finally, in some countries it is the" social" aspect of the socio-technical landscape which is exclusive, such as cultural barriers and a hostile atmosphere in Arab countries.

Different modes of transport are perceived as more or less safe. For example, taxis are perceived as safer, because of the presence of a licensed driver (Bizgan et al., 2020). Human contact may help to generate trust in MaaS, as the presence of trained staff can reassure users (Giorgi et al., 2021). In turn, bicycles are perceived as safe as women can just "pedal away" in case of unwanted attention by other users (Weinreich et al., 2021), although there is

risk of being ran over by other vehicles (Ibid.). In contrast, women perceive busses and trains (Ibid.) and car and ride sharing as more concerning, because they could involve sharing rides with people they do not know (Bizgan et al., 2020).

There are differences in attitudes between those who never used MaaS and those who have, who trust MaaS more than the former (Ibid.). However, real incidents do happen. When on public transport or using shared mobility, women may incur harassment and aggression in greater measure than men (Weinreich et al., 2021; Duchène, 2011), for example in overcrowded buses and minibuses (Duchène, 2011). In the UK, 37% of women reported having experienced specific incidents when using public transport (McDonald, 2020) and 15% reported sexual harassment from men when using shared mobility (Gekoski et al., 2017).

These issues shape the transport practices women perform. Women have a range of strategies to deal with safety concerns, from avoiding perceived risky areas (Duchène, 2011) and not staying out late, to choosing shoes they can run with and carrying their keys in between their fingers in their pocket as a potential weapon (Weinreich et al., 2021). Research report that women do not carry cash, cards or other valuables with them as most purchases can be made with a mobile phone (Ibid.). Women may enable their friends to track them via apps or inform them of where they are, especially in the evening, they refrain from listening to music and try to sit close to other women (Ibid.) and the driver in a bus (Ibid.).

One consequence of the risks of using MaaS is a preference for a private car as women consider it a safer (Weinreich et al., 2021; Duchène, 2011) and comfortable "cocoon" (Pudāne et al., 2019) compared with shared mobility.

2.2   Suggested strategies

Giorgi et al. (2021) explain that it is necessary to build trust between users and aid and support them. In respect to the human contact mentioned in 2.1, trained staff needs not only be on vehicles, but also have a standardized appearance (e.g., wearing a uniform), communication skills and behaviour (Giorgi et al., 2021). Segregation from men is a route suggested by research participants (Weinreich et al., 2021) to address the challenges MaaS presents, i.e., having women only services, with women drivers and women only car clubs. The quality of connections needs to improve to address women's concerns, and this is a key area for investment (McDonald, 2020). The literature in aggregate suggests several measures to address the issues women encounter, which is presented in table 1.

Table 1 Proposed measures to protect and reassure women

SUGGESTED MEASURE	AUTHORS

Design infrastructure to improve feelings of safety for users with features such as lighting	Bizgan et al. (2020b)
CCTV, help points, presence of security staff and live feeds for journey planning	McDonald (2020)
providing information about the specific location of lifts at stations	Bizgan et al. (2020b)
route advice and route recommendations, such as alternative diversion routes during major incidents such as gas leaks or terrorist attacks, or routes with the best lighting	Bizgan et al. (2020b)
'Panic button' within the app that could alert authorities specifically connecting to British Transport Police and the 'safe in the city app'	Bizgan et al. (2020b), McDonald (2020)
providing landmarks as well as road names for walking routes to support people with visual impairments in navigating local areas	Bizgan et al. (2020b)
ratings and rankings of drivers or even information and rankings of other users	Weinreich et al. (2021), Bizgan et al. (2020b)
share with the same person to foster familiarity	Bizgan et al. (2020a)
placing trained personnel on trains and autonomous vehicles	Weinreich et al. (2021)

MaaS apps should convey information on their environmental performance, because this is one aspect that might encourage women to use it (Bizgan et al., 2020). The specific needs of women need to be addressed, so they can be and feel safer when they travel in multiple journeys, access retail outlets and carry shopping and travel together with their children or other vulnerable people (Weinreich et al., 2021). Having considered these potential responses, Giorgi et al. (2021) state that a solution that fits all is not possible because of different sociotechnical landscapes, which need negotiated sharing of information between users and providers. 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 have low trust in ICT systems in general and in being enrolled in MaaS offerings (Catulli et al., 2021). Indeed, some women doubt data security (Bizgan et al., 2020). Providers need to ensure privacy and prevent the misappropriation and misuse of data (Giorgi et al., 2021).

From a provider perspective, cases of harassment and violence to women associated their brands with danger (Hein et al., 2016). So, in addition to being a problem that interests policy makers, the challenges and risks affecting women when using MaaS is of great interest for MaaS providers and their network partners. Addressing these issues challenges providers and policy makers to understand women users. To achieve this, Giorgi et al. (2021) suggest involving women users in the design stage. Finally, high investment on informatics technologies and infrastructure are necessary in the design of service delivery sites (Ibid.).

3   PERSPECTIVES AND METHODS

The study draws on the perspective of *Practice Theory (PT)*, a cultural theory (Reckwitz, 2002) in which social practices form 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, a background knowledge in the form of understanding, know how, states of emotions and emotional knowledge"* (Reckwitz, 2002). Shove et al. (2012) simplified the constituent elements of practices as:

- *Materials*, the things people use when performing their practices, e.g., vehicles and smartphones when using 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 are ability to use apps, riding bicycles and even institutionalized competences guaranteed by driving licences. And,
- *Meanings*, associations users make between a practice or its components with values and feelings, and the social conventions shaping users' practices.

Practices are the result of the integration of these elements by practitioners and are connected and dependent on each other. For example, work practices are linked to mobility practices as people need to travel to work. In turn, mobility practices are linked to other practices such as shopping or traveling to leisure places (Watson, 2012). Indeed, practices are interconnected in practice constellations (Schatzki, 2003). This interconnection of practices makes practices obdurate and resistant to change, which impedes diffusion of innovations (Mylan, 2015).

The rationale for selecting PT for the analysis is that it enables researchers to study the daily routines human subjects, including users and providers of MaaS, perform in their lives (Shove et al., 2012). This enables understanding of the challenges people encounter when using MaaS and how these challenges shape users' practices. Shove (2010) also claims that PT enables understanding of everyday sustainability in peoples' lives. This is relevant in this research, because of the environmental efficiency features of MaaS.

Whilst PT is a suitable perspective, understanding of the interplay of consumer identities with their mobility practices is needed, to explain how and why travel practices performed by women differ from those performed by men. To do this, the research draws on *Consumer Culture Theory (CCT),* which focuses on interactions between consumers' identities and their consumption through the association of meanings to products and services they acquire, consume (use) and dispose of (Joy and Li, 2012). PT and CCT are distinct but complementary cultural theories, which this research draws on as separate lenses to respect

their diversity (Stirling, 2011) to investigate how users' identities shape their use of MaaS offerings.

In keeping with the theoretical frameworks of PT and CCT, the methods used were qualitative and included 26 interviews of female users of mobility offerings and three men for comparison, adding up to 29. Participants were selected by convenience sampling amongst students and staff at a UK university and amongst parents of members of a scout club. All were recruited through an advertisement on the university Managed Learning Environment. Participants from both groups were asked to introduce additional participants to complement the sample with a snowball sampling strategy. The interviews were conducted on MS Teams and videorecorded. Recordings were then transcribed by a professional transcription agency, the analysts watched the video recordings whilst coding the transcriptions in NVivo, a qualitative analysis software package (Silver and Levins, 2014), using a flexible template approach (Miles and Huberman, 1994) to integrate existing themes identified through literature with novel themes emerging from analysis.

4   FINDINGS

4.1   Introduction

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 explained in section 1. The research team modified the IG to use proxies of MaaS, such as *Citymapper*, *Google Maps* and transport modes such as car clubs, *Über* services and bicycle sharing offerings. These examples helped researchers and participants to explore the relationship of women with MaaS as reported below.

4.2   Identities

Practices are shaped by identities. CCT informed analysis reveals the interplay between the identities of women and their shared mobility practices. The men we interviewed said that they feel confident when travelling. However, men are concerned about dependants using MaaS, indeed they feel that they should protect women and avoid alarming women they do not know by keeping their distance.

Participants observe that they may be self-conscious, by attracting the attention to themselves because of complaining. This makes women feel powerless. Women state that they are aware and afraid of crime. Two participants narrate how gender and ethnic identity combined affect them. For example, an Asian woman felt threatened by other travellers, who were hostile because they associated their Asian appearance with the Covid-19 pandemic. Participants

stated that as women, they feel threatened by men, e.g., "*…those experiences where I felt uncomfortable, it has been a male to make me feel uncomfortable*."

Liminality - being in a transition in life - shapes practices, e.g., transgender identities, a result of identity transition, exemplify differences between genders. A participant who transitioned to a woman reports how she was "…*always a little worried occasionally walking around at night, but never that worried, now [that I have transitioned to a woman], it just takes someone who decides that I don't look quite right (cause) an issue, (…) and so I'm much more careful than I ever used to be*". Students might be more likely to try novel offerings, "*as a student you're probably more carefree and you just want to save money*." they would therefore be more likely to try out MaaS.

4.3   Links between practices
From a PT perspective, women are engaged in complexes of interlinked practices. In comparison with men, women perform more activities, such as shopping, infant caring and looking after older relatives, including visits to medical appointments. Combined with travel to gyms and other exercise classes, these practices make women travel on multiple stop journeys. Women tend to transport more artefacts, e.g., baby car seats, shopping, prams and more, which makes switching vehicles through MaaS problematic, as these citations illustrate, " *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".* Accompanying children is problematic and limits the ability to use public transport. With a private car "*…I go, drop off the boys at school (…) and I collect them.*" With elderly relatives, a private car is preferable because it takes the user door to door and when journeys are urgent, users are more likely to use their private car. Women may modify and vary activities they get involved with during the day based on the availability of shared transport, i.e., whether other people are driving in a certain direction so they can share with them. This availability may shape user's travel plan. The following sections describe the constituting elements of women shared mobility practices.

4.4   Materials
MaaS elements include a range of vehicles, including private cars, public transport and shared cars, bicycles and scooters. The personal car is still dominant, because participants say they consider it safer, independent, dependable and it delivers door-to-door service.
Shared vehicles might be dirty and therefore discourage people from using them, *"I've seen (that they can) be quite rickety (…), even by the look of them."* Hygiene and cleanliness are key assurance of vehicles. Cameras and other security hardware can be placed in the vehicles and 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*". On the downside, materials can include fake number plates and certificates, which mislead users.

Use of artifacts in women's consumption defines their identities (Richins, 1994) and shapes their practices. The attire women wear shapes their mobility practices. They could wear a business suit but also skirts and high heels. This would make use of scooters and bicycles difficult. Therefore, identity-specific artefacts women use deter them from using MaaS. As shown in section 4.3, prams and car seats that 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 end the incompatibility with smart clothes.

Women might carry devices to protect them, such as rape alarms. Further, specialist apps help, a participant states that she has "*Find my Friend on my phone*". Apps are virtual, but they are manufactured artefacts and therefore "material" women use for their mobility. One participant mentioned a "help app", Angela, a personal alarm device (heresangela.com) which can be used when users feel unsafe. Apps help reassure users through information and feelings of control. Uber is seen as an app and as a taxi service - it has a good reputation. Means such as car clubs and other sharing are perceived as complicated as this comment illustrates, *"…there's a load of admin that comes with it and a lot of associated cost."*
One participant says that the quality of information accessible through apps is good and yet she needs to buy tickets separately. This can clash with users' practices. With personal cars, users might travel on a whim. In contrast, with shared mobility they may just turn up at a bus stop or a train station and their service is gone. This says what even when information is good, people do not use it. Furthermore, users think apps cannot replace the human element.

4.5   Competences
Generally, apps are a source of perceived safety, "...i*t 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*". Apps keep users informed on stops, direction and routes and therefore are empowering*.* Participants narrate that they use apps to see what areas they travel through and whether these are dangerous areas. Apps are useful to plan journeys and manage their costs. A participant says, *"…e*ven *Google Maps now flashes how much an Uber would be, not that I trust the price, (…) I'd always go and double-check, but in terms of usability.*"

Participants report how they learnt to use apps to 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 (…).*" However, smartphone apps required by MaaS can overwhelm 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 narrates that the app would not connect with her bank details and the payment would not go through, which means she could risk a fine for not having a ticket. "*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, a sequential booking of different modes. This complexity is a deterrent to adopt MaaS. Apps are downloaded in smartphones, which can run out of charge and women said they had "battery charge anxiety."

The cumulative work to learn skills required to manage mobility apps is challenging. A participant narrated that she wondered how many apps she has and often would have to download more. Each time she would have to input more personal registration information. It is difficult to manage all the available (and competing) apps. The entry of additional personal information in various databases is a deterrent because of privacy and long-term commitment concerns.

Participants say that they would be deterred by the need to plan journeys. Using apps, for example to book a bicycle, takes precious attention away from surroundings and jeopardizes safety. Users may even be distracted by reading a book or listening to music. They also say that booking through apps would box them on a specific travel mode, therefore they prefer paying in person. Some participants claim that they would rather walk.

Women observe that they need to rely on their "street smart" skills to be safe. This suggests that they see a gap in the provider's provision of safety. They say that they make themselves visible, to make it difficult for would be harassers to isolate them. They deploy their own landscape knowledge, such as where the most isolated stations are. They avoid traveling when dark and therefore at night. Many participants also report "self-made" self-defence practices such as carrying bunches of keys in their hand and wedge keys between their knuckles as weapons.

4.6   Meanings

Participants seem to associate shared mobility managed via apps with environmental protection. In this respect, the 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 constraint. 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.

Apps are associated with *safety* by most participants, "…*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 […] worry about" how* they would get home. Participants also associate cameras with safety; however, they associate 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.

Women's travel practices are shaped by the *social convention* that women face more risks than men. Participants claim that women are "socialized to be afraid," concerned about safety and to see transport as dangerous, and 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*." Media communications contribute to diffuse these meanings. Participants all cited the Sarah Everard case, where a woman was kidnapped and killed by a police officer whilst she was traveling between locations (Topping, 2022).
"Safety is in numbers" seems to be the opinion of most participants, who say that they prefer traveling where there are other people. If multiple people are sharing services, they know each other and have common purpose or destination, this helps reassuring users. People rely on other people for safety, as this citation illustrates, "*she goes home after darkness, she usually calls her mom. And so, she's on the call with her mom or at least sometimes she might pretend that (…) she is*." However, crowded vehicles and sharing space with the wrong type of people do not spell safety. Indeed, all participants cited proximity with people affected by physical or mental health, drunkenness, fighting or use of drugs as alarming situations.

Users explain that some services such as bicycle share are associated with getting "*sweaty*" and require equipment such as helmets, which makes it harder to switch between modes. Use of specific types of materials, such as vehicles and smartphones, is associated with a user's *social position* and identity construction. For example, a participant explains that in her country, use of busses is associated with *lower social groups*. Therefore, when using MaaS, some users would feel less likely to book a bus than share a car. Apps and the supporting smartphones occasionally project meanings of *intrusiveness* and create concerns for privacy, a participant illustrates this with suspicion about smaller providers and she says she worries about being tracked.

4.7 Responses users expect of providers.

This section provides a combination of providers' practices and alterations to the infrastructure and socio-technical landscape participants say they expect. One participant says that the solution 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.*" Lighting and cameras help, as this citation illustrates, "*Most of the stations have got CCTV, which I think's good. Some trains have got it.* Participants state that apps can help reassure them by enabling knowledge of the provision available and landscape, and the identity or professional details of the drivers of vehicles when these are manned. On the other hand, apps can be also misleading, because they might be giving users the shortest route, which would go through a dark alley or a park instead of a well-lit road, so local authorities and providers need to invest in infrastructure.

The support of communities with a shared purpose makes the service trustworthy. Examples of these communities are workplaces, e.g., the NHS, schools or other employers. Although this reassurance is not always manageable by MaaS providers, they may still benefit from efforts to aggregate users around communities. When someone has specific problems, e.g., a girl in a wheelchair, people as a community might be protective. Some participants talk about "do it yourself safety" when familiar people (boyfriends, parents) support each other for safety. Providers' apps may help because they enable other people to keep track of where their friends are. Car sharing is better shared with friends or people users know.

Most participants contrast human contact and service Vs Artificial Intelligence (AI) and apps. When using public transport, participants narrate that they have habits such as traveling on the bottom floor of a double decker where there are more people, and they are closer to the driver. The presence of service people on board, such as staff of the providers, would be a good reassurance - especially if they are safety trained and vetted. Some participants report that they do not see enough security staff and they would like more.

Drivers may have ID and other information that supports that they are trustworthy, and this is part of quality assurance. Services such Uber may be personalized, "*…the whole point is that they will send you a picture of John, you know, in his Toyota Prius 12345, so they give you the registration number, (…) (his) picture, so you know the driver's name and even their phone number*" and their vehicle's number plate*. Participants explained that the fact that drivers have a licence or share vehicles that adhere to quality standards reassured them. Most participants mentioned service quality rankings accessible through the smartphone apps or the providers' web sites. The features of the vehicles that reassure users are opportunities 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.

Finally, the ratio of female to male driver is important. If there were more female drivers on shared vehicles, women could decide to share with other females. 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.*" Another safety feature in a shared vehicle could be a free call service - where users could push an alarm button to put them in touch with professional assistance.

4.8   Summary

The identities of women shape their mobility practices, and the complexes of practices they are immerse in shape their ability and feelings of safety when using MaaS. Apps are virtual, but they are 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 makes them feel safe. Women can manage less means of transport through apps than men. Although apps are useful, they challenge users to learn to plan and create app fatigue. Despite benefits, participants associate using shared mobility with meanings of unsafety and apps with intrusiveness. Table 2 presents a summary of the concerns.

Table 2 Summary of safety concerns

- Battery anxiety
- Suitable attire needed
- ICT (e.g., cameras) and human (e.g., transport officers and police) vigilance
- Too many people / wrong people / not enough people
- Risks from criminal activity
- Having to rely on other people
- Privacy concerns
- Hard work and planning are a necessity of MaaS

5   DISCUSSION

The point of departure of the research was that the challenges women encounter when using shared mobility shape their practices, which affects the adoption and diffusion of MaaS. One insight of the research is that users are not aware of MaaS in the real world, but they do use a range of smartphone apps to navigate the landscape. Findings show that women do encounter challenges when using MaaS offerings and this shapes their mobility practices. The institutionalized roles of women, such as child rearing and homemaking

(Weinreich et al., 2021) limit their freedom to switch between modes of transport when using MaaS.

Social changes may reduce differences in mobility practices between women and men, however this change may not affect all. Table 3 summarizes the possible responses to the challenges identified and a comparison with the literature. The shaded boxes are responses suggested by participants and not in the literature.

Table 3 Response and comparison with literature

Response	Examples	Compare literature
App functionality	Route advice, ability to track other users and be tracked	Bizgan et al. (2020b)
Community anchoring	The MaaS offering can be connected to communities such as residential estates, workplaces, clubs, and brand communities	Catulli et al. (2021)
Quality Assurance	Third party endorsement, regular monitoring, qualifications of staff	Catulli et al. (2021)
Personalization of service	Name and photo of service staff given, ranking on web pages	Bizgan et al. (2020b), Weinreich et al. (2021)
Female targeted service	Female drivers and sharing partners	
Various security devices	Lockable doors on taxis, security cameras, locking devices, panic buttons	Bizgan et al. (2020b), McDonald (2020)
Traceability of vehicles	Visible brand and identification, help lines	
Human contact instead of Artificial Intelligence	Service personnel present during service delivery	

One crucial insight is that social conventions around the danger of traveling shape women's travel practices. This suggests that women may overestimate the risks of using MaaS but the facts on the ground, e.g., the Sarah Everard and similar cases make this social rooted. These conventions are not specific only to MaaS. They are challenges that from a Consumer Culture Theory perspective affect and constrain the identifies and practices of women in all facets of life. 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 linkages between diverse modes of transport. MaaS diffusion requires radical change in social practices (Shove and Walker, 2010), which need to be "shaped" by governance (Giddens, 1984). The usefulness of supporting communities to anchor shared mobility confirms research by Catulli et al. (2021) and Bardhi and Eckhardt (2012) and suggest that MaaS providers could contribute to fostering communities around their provision.

6   CONCLUSION

The challenges women face when using MaaS may hinder its adoption and diffusion. Suggested solutions include rigorous vetting of any people who participate in service delivery and whenever possible, recruit female personnel such as drivers. MaaS providers could encourage the formation of communities around MaaS brands, perhaps with women chapters to reassure women with fostered familiarity. It is evident, however, that significant changes are needed to social practices and infrastructure, and this requires considerable investment and governance.

The reassuring effect of the licensed status of the service staff suggests that an important intervention would be a quality certificate or other information vouching for the trustworthiness of the driver or other service staff, underpinned by control and enforcement by the provider. Suggested reassurance includes safety staff and technology devices such as alarm and recording but this has the potential to be intrusive. Users perceive gaps in providers' safety provision and tend to enact "do it yourself" measures.

Further investigation is needed into what MaaS providers are doing now to assure safety and what actions they could consider when presented the findings of this research. Research is also needed in the relationship of MaaS with other disadvantaged groups, including ethnic and gender minorities. One suggestion is that this research could draw on the theory of governance of just transitions as conceptualized in the Multi-Level Perspective.

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