# Can Mobility as a Service really contribute to transport sustainability and equity?

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## SUMMARY

Mobility as a Service (MaaS) aims to facilitate multi-modal, non-car travel by integrating various forms of transportation services into a single, accessible journey-planning and ticketing platform. Literature on MaaS is growing; however, questions remain concerning the features, requirements, and information elements that potential end users themselves consider most important or useful for customer facing MaaS apps, and how those needs depend on factors like gender, age, and where a person lives. This article reports on an on-going project exploring these issues, giving an overview of results from an employer questionnaire and a large focus group study, and introducing a follow-up questionnaire that is gathering end-user priorities for MaaS systems and interfaces.

## KEYWORDS

Mobility as a Service, sustainable travel, user requirements

## Introduction

Mobility as a Service (MaaS) has become a hot topic in transport policy, practice, and academic circles. Its proponents argue that by integrating ticketing and journey planning across private, public, and shared transport modes, it can facilitate multi-modal journeys, i.e., those that involve the combination of more than one transport mode in one trip. In doing so, it can "provide an alternative to using the private car that may be as convenient, more sustainable, help reduce congestion and constraints in transport capacity, and be even cheaper" (MaaS Alliance, 2023). To some, however, much of the attention given to MaaS is largely rhetoric, with the concept a mere extension of the on-going pursuit for integrated transport (e.g., Lyons et al., 2019). It has been 10 years since its first discussion in the academic literature (Heikkilä, 2014) yet we are still yet to see full MaaS implementations beyond relatively limited pilots, with governance, competition, and service integration challenges proving difficult to overcome (Hensher, Mulley, et al., 2021).

One of the most significant challenges relates to end-users. Even if we can make MaaS work functionally, will people actually use it? Specifically, can MaaS help people swap some of their car journeys for public transport and/or active travel trips? Some have suggested that mode shift is only encouraged by subscription-based MaaS systems (i.e., one monthly charge for fixed or unlimited use of different transport services; Hensher, Ho, et al., 2021); however, the same researchers point out elsewhere that most people only want pay-as-you-go systems (PAYG; Hensher, Mulley, et al., 2021). The question, therefore, is how (or even if) we can design MaaS systems and customer-facing apps that satisfy customer needs and encourage modal shift away from the private car.

Although some work has gone into identifying what people would want from MaaS (Lopez-Carreiro et al., 2020), research specifically engaging with potential end-users to generate MaaS system and information requirements is lacking. There is also a lack of work exploring how the

requirements generated might differ based on a person's age, gender, and residential location. Given the danger that MaaS could end up most suited to young, able-bodied urbanites who make unencumbered journeys, and therefore contribute to greater transport inequity (Pangbourne et al., 2020), input from all groups, and a concerted effort to support those with more complex journey requirements (e.g., in rural areas, trip-chaining with children), is required.

The Solent Future Transport Zone (FTZ) project, one of four such Department for Transport-funded projects in the UK, is addressing these challenges by exploring the barriers and incentives to non-car travel, as well as people's perceptions of MaaS, in order to inform design iterations of an app (and the underlying MaaS ecosystem; Polydoropoulou et al., 2020) that is currently being trialled in southern England. The project is now in its fourth year and after a review of the status quo in MaaS research, data from two large employer surveys (with over 2,500 respondents) and a series of focus groups involving 146 participants have been analysed. At the time of writing, further data is being collected via questionnaire that elicits the views of potential end-users regarding the types of information they would find useful in a MaaS app and the kinds of requirements any MaaS system would need to fulfil for it to be successful. Result analysed so far are summarised, and a brief synthesis of findings offered, followed by a summary of the current data collection activity. The article ends with some conclusions for MaaS, transport equity, and sustainability.

### Reviewing the status quo

Two of the core purposes of the Solent FTZ project and of MaaS more broadly are 1) to improve transport accessibility to those currently underserved by existing transport systems, and 2) to contribute to a more sustainable transport system by facilitating non-car travel. Of the many ways of exploring transport inequity, gender is a universal factor that has received increasing attention in recent years. This was chosen as a starting point for exploring barriers and incentives to MaaS, and a review of the MaaS literature was undertaken with a view to exploring the extent to which gender is or has been considered in MaaS research, policy, and practice. Covering a period between the first mention of MaaS in an academic journal article (Sochor et al., 2015) and the 15th of March 2023 (when the last literature search was undertaken), 420 distinct, MaaS-related academic journal articles were identified (for more detial, see McIlroy, 2023a).

Table 1. Summarising the potential, and some of the challenges, for MaaS to contribute to gender equity in transport, as identified in the MaaS literature published up to the 15th of March 2023.

| | Positive for gender equity | MaaS unlikely to help |
|---|---|---|
| **Inherent to MaaS** | **Strengths**<br>• MaaS already supports women's current travel behaviours:<br>   ○ Use public transport more.<br>   ○ More likely to combine modes.<br>   ○ Less likely to commute 'traditionally'.<br>• Aligns with women's higher environmental values.<br>• Aligns with women's lower value placed on car ownership. | **Weaknesses**<br>• MaaS unlikely to counter entrenched division of family care and stereotyped societal roles.<br>• MaaS cannot take away all the difficulties associated with being 'encumbered'.<br>• MaaS is not about bike lanes (or other infrastructure).<br>• MaaS unlikely to change biases in desire to engage with vehicle technologies. |

| | Opportunities | Threats |
|---|---|---|
| **Potential for the future** | • To capitalise on strengths and facilitate access to mobility modes and behaviours already favoured by women.<br>• Differences in MaaS package preferences imply that subscription models could be designed to reduce inequity.<br>• MaaS could help with perceptions of safety by including shared and on-demand services.<br>• In-app information on security and safety (safety from attack, safety from collisions) can help address mobility security issues. | • Getting bundle design wrong could increase inequity.<br>• A focus on micromobility could favour men.<br>• MaaS could push women into less sustainable travel.<br>• MaaS uptake highly influenced by existing habits.<br>• Inappropriate technology (app) design could represent an additional barrier to women.<br>• Going for low hanging fruit (for mode shift) could be at the cost of equity. |

Each article was thematically coded according to its perspective (e.g., business, travel demand, etc.) and approach (e.g., review, questionnaire, interviews etc.) then searched for terms relating to gender (e.g., male, female, woman, etc.). The 177 articles containing some reference to gender were each considered in terms of the extent to which gender was included as a research variable or topic of discussion. Most of the articles that did not consider gender were technical in nature (e.g., algorithm design) or focussed on governance or business structures. Of the 171 discussing gender in some way, 129 collected or used human-derived data (e.g., questionnaire, interviews, etc.). Twenty-one of those failed to report their samples. Further, 62 of the 225 articles not referring to gender in any way did also involve research with human participants. Gender was included in analyses in 66 articles, the results reported in 57 of those, and described (in the text) in 52. In only 31 was gender further considered as a discussion point. Those 31 were further scrutinised, and results and discussions synthesised and framed as a form of SWOT analysis, shown in Table 1, above.

**Exploring commuting behaviours**

In parallel with the literature review, an exploration of current commuter views was undertaken via the analysis of free text responses provided to two questions included in a workplace travel survey disseminated in 2019 and then again in 2022. In addition to demographic and commuting behaviour questions (including the distance typically travelled to and from work), the survey asked staff and post-graduate members of the University of Southampton *"If you drive to the University, why is having access to a car important for you?"* and (for those answering that they typically drive) *"What incentives would encourage you to try a different mode of travel to the University?"*. In 2019, 1752 individuals responded to the survey (equating to a response rate of approximately 13%), while in 2022, 804 responded (response rate ≈ 6%). In the 2019 survey, 738 individuals stated that they typically drove to work (42%). This was 401 in 2022 (50%). Of the drivers that responded to the 2019 survey, 678 provided responses to the car access question and 607 provided responses to the incentives question. In the 2022 survey, 372 provided responses to the car access question and 337 provided responses to the incentives question. Those text responses were subjected to thematic analysis, with the aim of shedding light on the reasons people drive to work, what might help them choose other modes, and how these factors differ between those living closer to and farther from the workplace.

Unsurprisingly, the cost, speed, and convenience of the private vehicle were found to be primary motivators for its use, with access to the public transport network a barrier to many. This was particularly true for those travelling more than five miles to work. Having caring responsibilities (including childcare and school runs) was an influential reason for car use among those that live less than five miles from the workplace, with the perceived quality of active travel infrastructure and at-work facilities (e.g., bike storage and showers) also a more influential barrier for those living closer to work. Suggested incentives mirrored the reasons people stated for using their car, with cost and

time reductions, and greater convenience of public transport featuring highly in the responses of those travelling farther to work.

Reasons for car use changed little across the two data collection periods; however, there were notable changes in responses to the incentives question, with differences therein between those living closer to or farther from work. Reference to electric vehicle purchasing and hire schemes as incentives to travel sustainably were seen to a greater extent in 2022 responses, especially among those living closer to work. Similarly, bicycle-related incentives were mentioned to a greater extent in 2022 responses, especially from those commuting between five and ten miles.

**Gathering end user views of multi-modal MaaS**

Building on the MaaS-focussed literature review and on the more general commuter behaviour survey, an online focus group study was designed to gather input directly from residents of the region covered by the Solent FTZ. Insights were sought concerning the barriers people face when making multi-modal journeys (i.e., those journeys requiring two or more transport modes), people's thoughts on MaaS and the Breeze app (the customer-facing app currently being trialled in the region), and on gender inequity in people's experiences with transport systems. Asynchronous Online Focus Groups (AOFG; Sweet, 2001) were used to collect data from Solent residents, a method that involves the use of internet forums or discussion boards to gather input from a target population. Five questions were posed in the forums over the course of 17 days, responses to four of which were analysed: one relating to multi-modal travel, one to potential incentives and failure points for Breeze, one to information requirements, and one to gender inequity in transport (for more detail, see: McIlroy, 2023b; McIlroy, 2023c).

Participant recruitment occurred primarily through Facebook community groups. A total of 146 individuals contributed, 59 of whom were male, 86 female, and one non-binary. Mean age was 46.3 (SD = 13.7). Approximately 67,000 words of text were subjected to thematic analysis in a bottom-up fashion, with common themes identified in the responses to the different questions. The prominence of each theme identified in participants' responses was explored, in relation to three factors: gender, age, and residential location (whether urban, rural, or peri-urban, the latter being defined here as the suburban areas on the edge of a city or town or between cities or towns).

Results clearly showed that multi-modal travel is a challenge for all, with the perceived additional cost and time incurred (over car use), difficulties in matching timetables, and the criticality of service reliability similarly impacting all participants. Moreover, live, accurate, and reliable data is critical for any MaaS app to be successful, as is the inclusion of all ticket types, including passes, discounts, and, ideally, a 'never undersold' guarantee. Regarding the impact of residential location on responses, those in rural areas were affected most by a lack of basic services, while those in urban and peri-urban areas were more affected by the complexities of planning journeys, and by the facilities available at stations and stops. Peri-urban residents especially would benefit from better mapping that includes the short-cuts available and information on the quality of infrastructure and services linking active travel with public transport. Rural residents were most likely to say they wouldn't use a MaaS app, with urban residents being the most positive. Peri-urban residents expressed negative attitudes towards MaaS but in a way that suggests those attitudes to be open to change.

Looking into differences between men and women (the only non-binary respondent's responses having been excluded for this aspect of the analysis), it was clear that multi-modal travel is more challenging for women, with greater physical and psychological barriers relating to accessibility for those with children, and perceptions of safety and security on services and at connections. Women

discussed a concern for personal safety on public transport to a much greater extent than men, discussing lived experiences and the precautions they take to avoid certain situations. Women were also more positive about MaaS and provided more suggestions for the information that would help them, with men being more dismissive or negative towards the idea of MaaS. Most men acknowledged the greater challenge for women, though did also report negative experiences on transport systems. Women typically did not acknowledge the issues faced by men.

Regarding age, older people were more negative about MaaS. They were more cynical, more likely to dismiss the concept, state that they would not use it, criticise the public transport services on which it depends, and were less likely to offer suggestions for the types of information they might find useful from a MaaS app. Regarding suggestions that were made, older people were more likely to discuss parking and EV charging information that would facilitate linking private and public transport. Conversely, younger people placed greater emphasis on information about the cost of journeys, journey time, and the presentation of multiple route options to allow them to make informed decisions about the most suitable mode combination. Younger people were also less likely to report negative experiences on public transport services, but reported fear and anxiety related to harassment or aggression to a greater extent.

**Implications for MaaS**

Several lessons can be drawn from the results of the research activities undertaken thus far. The design of a MaaS system, in terms of its business structure, service offering to customers, and in the design of the customer facing app itself (Kim et al., 2022; Richardson et al., 2022), will impact upon the extent to which it will support or encourage non-car mobility in men and women, older and younger individuals, and those living in the centres, on the edges, or outside of towns and cities. Some of these issues are related, with younger individuals more likely to live in urban centres and rural communities comprised to a greater extent of older individuals.

Although older individuals could benefit from MaaS, targeted marketing will need to convince them of this, as there is a risk that they will not engage with MaaS to nearly the same extent as younger individuals. Moreover, mode shift towards sustainable travel modes in rural residents is unlikely to be driven by a MaaS system that only provides information on currently available options. Novel services (e.g., dynamic, demand-responsive transport) and improved infrastructure to link active travel with public transport will be required (Milne et al., 2024). That said, small gains might be made by better supporting the integration of driving and public transport, through enhanced parking and electric vehicle charging at train stations (and providing such information through a MaaS app). This could encourage older individuals in rural areas to use public transport as a form of park and ride (Halldórsdóttir et al., 2017). Although the impact on overall vehicle kilometres of park and ride systems has attracted debate (Duncan & Cook, 2014) there is evidence to suggest they work well in linking more rural regions to city centres (Mingardo, 2013).

Nevertheless, the advance of electric vehicle technology represents a possible danger for MaaS, as people perceive it to be a sustainable mode in its own right. EVs may satisfy a desire to act sustainably, but they miss the far greater benefits of non-car travel. To mitigate this, MaaS could include information on the impact of EVs, compared to the impact of petrol/diesel cars and to non-car travel. That said, EVs do bring some benefit where car travel is unavoidable, hence could feature in car share/car club offers supporting mobility in rural areas.

Whereas the rural challenge will not be easily solved by an app that does little more than provide information on (the scant) services that already exist, urban residents represent the low-hanging fruit for MaaS systems, with the information already provided by most MaaS apps (like service

availability, real-time updates, and mode combination suggestions) having significant potential to encourage uptake and continued use of the app and of non-car travel. These groups, however, already use public and active modes to a relatively large extent. The people in between these rural and urban zones, i.e., the commuting populations of the suburban and peri-urban areas on the edges of towns, are therefore the key target groups for any scheme aiming to contribute to a more sustainable transport system. If some additional features can be included (e.g., information about stops and stations, better mapping), MaaS apps have significant potential to reduce car travel among commuters.

One way this might be achieved is in better support for active travel. Since the pandemic, this has increased in prominence, and public transport decreased, in the minds of those living in suburban areas. Extension of micromobility schemes (e.g., shared e-bikes and e-scooters) to these areas, greater emphasis in MaaS apps of these modes, and more detailed mapping, with crowd-sourced reviews on available active travel infrastructure and facilities, could motivate a shift away from the car and towards sustainable travel among commuting populations. Such information would also benefit women, contributing to greater gender equity in a system that currently supports male travel patterns to a greater extent (Parnell et al., 2022). For example, safety and security information, including lighting, active travel route information, and the presence of staff at a given transport node, would especially benefit women, as would information that specifically supports travel with children (more commonly undertaken by women), such as accessibility information and information on the facilities available at stations and stops (including toilets, seating, and food and drink outlets).

A clear message arising from the literature review, survey, and focus group efforts described above is that different people want different things. A great many suggestions were made in the survey and focus groups not only for the types of incentives that would encourage people to use MaaS, but in terms of the information and features they would want from a customer facing MaaS app. The broad variety of suggestions that were gathered highlights the importance of allowing users to choose what to include, to make the app serve them best.

**On-going work**

The large volume of suggestions from potential end users of MaaS included characteristics that a MaaS system should have (e.g., that the app should be free to download), features that the app could include (e.g., that it provides space for people to publicly review transport services), and information elements that the app's interface could or should contain (e.g., train station security information or the $CO_2$ impact of different journey options). Although the sample sizes of the focus group and survey studies allowed for some quantitative exploration of the relative importance of each requirement or information element (e.g., in terms of the numbers of men, women, older people, etc. mentioning a particular feature), an idea raised by fewer voices in a qualitative setting is not necessarily an idea of lesser validity or importance. The current stage of the project therefore involves a quantitative prioritisation exercise, employing a questionnaire that asks individuals to rate, in terms of usefulness and/or importance, the features and requirements generated from the preceding qualitative work. The goal of the research is to quantitatively examine the priorities people give to different types of information or app features, and how these priorities differ for men and women, older and younger people, and those in urban, peri-urban, or rural areas.

To design the questionnaire, the thematic analyses of the survey and focus group studies were revisited and 84 distinct information elements, features, or requirements for MaaS were identified. Those 84 factors were then condensed into 70 after removing repetition. A short pilot study was undertaken (in which eight individuals participated) to gather input on questionnaire structure and

question wording. Several elements were thought to combine more than one distinct feature, and hence were separated, resulting a total of 82 distinct elements to be included in the questionnaire for respondents to rate in terms of usefulness or importance.

At the time of writing (i.e., early February 2024), approximately 1,100 individuals had responded to the questionnaire, with the data collection period approaching completion. Results will be analysed with respect to age, gender, and residential location, whilst also respondents' currently mobility behaviours. Whether a respondent has dependent children or any type of disability will also be considered. The aim is to provide a comprehensive set of recommendations for MaaS system and app design that considers the broad range of needs across different members of society.

This will provide stakeholders with an understanding of the potential interface and broader system design solutions that might be implemented to maximise the chance for MaaS to succeed, as a going concern and in terms of encouraging modal shift away from the car.

## Conclusions

A guiding aim of the work described above, and of the Solent Future Transport Zone project more broadly, is to encourage more sustainable travel and to facilitate access to mobility in those currently underserved by existing transport systems. One limitation, however, is that the MaaS system being trialled in the region is limited to the provision of journey planning information and the support for ticket purchasing through one interface. Although both have been highlighted as useful and important, many of the needs of people in the region, especially those in less urban areas or those travelling further for their work journeys, rely on improvements to public transport and active travel infrastructure and facilities. The design of the interface is important (Kim et al., 2022; Richardson et al., 2022), and the impact on perceived safety of having service busyness or station lighting and security information could well benefit female travellers in particular; however, with public transport touted as the backbone of MaaS (Mulley et al., 2023), without improvements (and likely further subsidies) to fundamental services, MaaS is not likely to have significant impact on travel behaviours outside of urban cores already well served by public transport.

While Mobility as a Service (MaaS) presents a chance to encourage people to move away from using personal cars, end users emphasize that a journey planning and ticketing application aids rather than compels a shift in travel behaviour. This holds especially true for individuals residing outside urban areas. People view MaaS as a beneficial and practical element within a comprehensive transport system; nevertheless, it is just one element. Various other obstacles to adopting active and multi-modal travel need to be tackled as well.

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