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Digital interventions for sustainable mobility behaviour: Gender bias in innovation

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Abstract: For the motivation of more sustainable mobility behaviour, interventions based on behavioural sciences such as psychology and behavioural economics are being used to effectively reduce individual car use. Urban mobility apps offer new opportunities to use digital interventions in a targeted way to promote sustainable mobility behaviour (e.g. bicycling apps) through gamification approaches or motivational methods. We discuss how gender aspects are very rarely considered in the design of such urban mobility apps, both in terms of needs and preferences in mobility behaviour and the effects of digital behavioural interventions, and how these shortcomings leave behind a big group of users. Based on this, we present results from a participatory design with female-only focus groups and conclude by recommendations on how digital interventions for sustainable mobility could be improved to make them more inclusive for female users, but also for people with caretaking roles in families and marginalized groups.

Keywords: behaviour change; digital interventions; mobility behaviour; urban mobility; gender, mobile apps; digital innovations; sustainable mobility.

1 Changing behaviour towards sustainable mobility

Action needs to be urgently taken in order to fight climate change. While multiple problems are related to the issue of global greenhouse gas emissions, the choices for individual mobility are certainly contributing to the problem: Transport accounts for a quarter of Europe's GHG emissions (European Environment Agency, 2018). However, even in cities, where alternative, more sustainable options would be available (in contrast to more rural areas where options are limited and infrastructure is less developed), there is still a large dominance of car use in the modal split of transport in the cities and their surroundings (European Platform on Mobility Management, 2018). It is essential to motivate people to use more sustainable forms of transport instead of individual car use (e.g. walking, bicycling, public transport), as 'hard' measures such as regulations, restrictions or laws are not always possible, effective or desired by governments or policy makers. Therefore, researchers are exploring other means for motivating individual behaviour change ('soft' measures), but it appears that sole promotion or information on more sustainable ways alone does not motivate people enough to choose differently (Huber et al., 2017). In light of the need for behaviour change, interventions based on behavioural sciences (such as psychology and behavioural economics) have been proposed to increase policy effectiveness (Ewert, 2019; OECD, 2017). Under the umbrella term of behavioural interventions, different methods have been discussed, most famously, the concept of nudging (Thaler & Sunstein, 2008), but also other methods for motivation, such as gamification approaches. In recent years, digital methods to change behaviour have come to the center of attention (Schneider et al., 2018), as use of digital tools (e.g. smartphones) have risen rapidly in society. Behavioural interventions in a digital environment means that a digital tool (e.g. a website or an app) is used to influence decisions either in the digital or the analogue environment, for example, a notification within an app is used to motivate a person for a healthier lunch choice (Lembcke et al., 2019). Mobile applications on smartphones offer new opportunities to use digital interventions in a targeted way to promote sustainable mobility behaviour.

New, digital solutions for changing mobility behaviour have taken the form of smartphone apps in the field of urban mobility (Luger-Bazinger et al., 2023). These urban mobility apps are developed by cities or governmental services, private companies or within research projects to support and motivate the use of bicycling or public transport or other sustainable mobility modes within cities. Typical behavioural interventions that can be found in those urban mobility apps are travel feedback that provide information on relevant aspects of taken trips with different modes of mobility, such as greenhouse gas emissions, routing suggestions with the most environmentally-friendly mode of mobility, information about ecological footprint and social elements such as leaderboards or communities. Implemented gamification elements usually reward sustainable trips with prices such as vouchers or money.

In this article, we discuss how gender aspects are very rarely considered in the design of such urban mobility apps, both in terms of needs and preferences in mobility behaviour and in terms of the effects of digital behavioural interventions. Therefore, we offer insights on how aspects arising from gender differences need to be considered in digital

interventions, and show results from a co-creative process with female-only focus groups. To conclude, we summarize our insights in how digital interventions for sustainable mobility could be improved to make them more inclusive for a bigger group of users.

2 Gender and mobility behaviour

Recent urban mobility studies highlight that mobility patterns of those who take care of children or elderly and perform household errands have been overlooked in the past and must be integrated as a key consideration in urban mobility design. Statistical data reveal that women still predominantly take a larger share of household responsibilities, "across Europe, the division of responsibilities at home is highly gendered, with women spending much more time in unpaid housework and care work for children and adult dependents" (Civitas, 2020, p. 14).

Urban areas are occupied by roughly 50% of women, yet cities are not designed to accommodate their needs (UNDP, 2021). In the Gender and Smart Mobility Research published by Ramboll (2021), travel behaviour differences of men and women have been highlighted; one of their surveys reveal that women consider two main challenges that are not necessarily shared by men in terms of walking: carrying of grocery items and safety (fear of harassment). Bicycling is seen by both men and women as a sustainable mode of transport, however, women identify road safety as a main challenge for bicycling (Ramboll, 2021). As for public transport, women have identified safety, fear of harassment and assault as key challenges for using this mode of transport (Ramboll, 2021).

Ng and Acker (2018) assert that a closer look at the gender aspect in developing user needs in the urban sector is needed, "transport services that provide equal benefits across genders can only be provided if there is a better understanding of the needs of all users" (p. 7). Recent studies in the urban mobility sector have regarded the lack of consideration of the gender differences in urban mobility patterns to result in the marginalization of women's needs in the design of urban spaces. Catering to the needs of women can help address the disproportionality caused by lack of consideration of this gender dimension.

3 Gender in digital interventions

Digital interventions, based on behavioural science, seem like an effective and appropriate solution to motivating more sustainable mobility. Mobile apps play a key role in the urban mobility strategic plans to increase awareness and engage citizens towards adopting sustainable mobility habits and transforming our social consciousness towards a more sustainable path. This shift to environment-conscious urban mobility choices can be achieved by motivating citizens to adopt sustainable modes of transport; mobile apps specifically created for this are now being used in many cities (Luger-Bazinger, Geser, Hornung-Prähauser, 2023). Indeed, studies showed that behavioural interventions and gamification can be used to foster sustainable behaviour (Douglas & Brauer, 2021; Semenescu et al., 2020). At the same time, gender-relevant mobility needs and preferences, which sometimes differ greatly between groups, must be taken into account in order to

make these efforts inclusive. In addition, it cannot be assumed that the methods employed within mobile apps used for motivating sustainable mobility work in the same way for all genders.

Mobile apps are known to implement digital behavioural interventions to guide users into performing certain tasks. In the case of urban mobility apps, this comes in the form of promoting active modes such as bicycling or walking or the use of public transport (Di Dio et al., 2020). Urban mobility apps are now being deployed by urban mobility experts and industry players to make urban travelling more efficient and sustainable. It is usually integrated with navigational tools, route options, mode of transport options and sustainable trackers are actively promoted as an app feature to enable citizens to adopt a more sustainable and environment-friendly mobility behaviour (Andersson et al., 2018; Luger-Bazinger, Geser & Hornung-Prähauser, 2023). Gamification methods are now commonly found in mobile apps to entice users to keep using the app (Daniel et al., 2022; Kazhamiakin et al., 2015).

While behaviour change and gamification methods can be effective in motivating individuals, studies already indicate that these methods might work differently for genders. Still, many of these approaches are often stereotypically geared to the habits and preferences of a single group, namely, male users. Gender bias in innovation processes and for new technological products (Schroeder et al., 2016) has been previously observed in various fields and digital solutions for fostering sustainable mobility are no exception to this bias. As one example, a common motivational approach is the system of leaderboards, that is, a ranking of the most active or 'best' users within an online community. While all genders are receptive to elements of gamification to some degree, this element of competition is not rewarding for all, as female users prefer more supportive aspects of community rather than competition. For example, women seem to be less motivated from leaderboards alone and desire supportive feedback (Lovász et al., 2023), and leaderboards that are male-dominated can even lead to anxiety in female users (Albuquerque et al., 2017)—however, especially in urban mobility apps with an active focus (e.g. bicycling), the leaderboards are often dominated by men who are very physically active.

With all innovative solutions, gender in innovation has remained invisible due to the fact that most studies on innovation are concerned with products, processes or organisations, and not with preferences and needs of customers (Alsos et al., 2013). In the case of digital interventions for sustainable mobility, this becomes very clear, as urban mobility apps are very rarely concerned with an inclusive approach, but rather with a male perspective. With gender bias in product innovation, it is usually recommended to follow a co-creation and participatory approach (Schroeder et al., 2016), which is currently not applied. To make ethical design improvements in mobile apps, inclusion of the needs of all users should be considered. The lack of attention of women as users are echoed by the gendered innovations concept purported by the European Commission (2020): In its policy recommendations, co-creation and participatory design is encouraged to be implemented in the urban and transport planning to accommodate the needs of users who undertake household work. Participatory design allows us to look at power and participation as key

factors that influence how mobile applications are designed and for whom is it most beneficial. In the research of Steen (2011) on the different types of human-centered design, participatory design is described as a design tradition rooted on giving power and agency to users and advocates for reflection and reflexivity on the part of the designers. This design approach is crucial in looking at the relationship between gender and technology and how power dynamics that are still embedded in our society are resiliently exhibited in the design of mobile applications inadvertently alienating the needs of marginalized users.

3 The present research

Our research aims to contribute knowledge on user needs of developing mobile app features that intend to help citizens adopt sustainable mobility behaviour. In-depth analysis of mobility patterns and preferences of women and care-takers can deliver innovative solutions, help local governments, urban mobility researchers and mobile app designers create a more user inclusive digital choice architecture in mobile apps. Therefore, within our research, we want to explore the practical considerations in designing mobile applications that seek to influence users to adopt sustainable mobility behaviour from the perspective of female end users, but our results can be expanded to users who take care of families or marginalized groups. Further, we want to explore what app functionalities can be integrated into the urban mobility apps design to make it more responsive and inclusive for a broader group of users. Finally, we want to show an overall perception of female end users to the different gamification elements and data-driven nudging methods utilized in mobility apps to promote sustainable urban mobility.

For this, two online focus groups with female-only participants were conducted. Within the focus groups, we wanted to gain a better understanding of female users' needs in urban mobility apps to enable their transition to sustainable forms of transportation. We discussed their mobility habits, preferences, wishes and demands for an urban mobility app as well as their view on behavioural interventions and gamification methods currently present in these apps in order to uncover shortcomings as well as potentials for these digital solutions.

3.1 Method

A total of eight female participants attended the two sessions that were held online via Zoom. The sessions were designed to be interactive and condensed into a 60-minute session to guarantee attendance and lively exchange of ideas. Padlet was used during the sessions where all participants can simultaneously write their thoughts and view the responses of their fellow participants prior to entering each discussion.

3.2 Participants

Diversity in terms of geographic location (city of residence) and nationalities was taken into account during the selection process. The female participants resided in seven different

EU cities, 50% of the participants were non-EU citizens (see Table 1), age ranged from 26 to 38 years old. Another consideration in the participant selection process was whether they were currently a guardian or a parent of a child, which was true for only one participant. Hence during the discussion, participants were asked to imagine the considerations and urban mobility concerns of their female relatives who undertake child-rearing and elderly-related responsibilities.

Table 1. Participants profile in focus groups

Participant Number	Age	Nationality	Current city of residence
P1	26	German	Barcelona
P2	27	German	Linz
P3	37	Brazilian	Kortenberg
P4	34	Filipino	Amsterdam
P5	36	Ukrainian	Vienna
P6	38	Dutch	Brussels
P7	26	Polish	Copenhagen
P8	29	Cuban	Brussels

3.3. Discussion in Focus Groups

The theme of the workshop was 'Smart, Safe, Sustainable: Designing a gender-inclusive urban mobility app'. The focus group sessions were divided into eight sections and were designed to be interactive, Padlet was used by the participants to write down their thoughts. The focus groups were designed to be interactive to ensure that all participants were given opportunities to share their insights. Key concepts were introduced and contextualized for the participants at the beginning, such as concepts of sustainable mobility and discussion

of gender differences in mobility, before guiding them towards the central questions. The sections and guide questions (in parenthesis) were:

- Introduction
- Sustainable urban mobility and mode of transport
- Gender difference in urban mobility patterns
- Smart and inclusive ("what would you like to see in future urban mobility apps that you think could help women navigate more efficiently in the city?")
- Safety features ("What kind of app features or information could you think of that would help women feel safer?")
- Sustainability aspects ("What kind of information about the environmental impact of your mobility choices would you personally like to receive that would encourage you to use private vehicles less?")
- App Features with Gamification Elements ("What are your general sentiments on the gamification features, such as leaderboards or challenges, used in mobility apps?")

3.4 Data Analysis

Preliminary (raw) transcription files of the focus group discussions were extracted from Zoom. The files were manually reviewed, edited and labelled in Microsoft Word prior to running the analysis using MAXQDA. Thematic coding was used using MAXQDA, related concepts were grouped to create categorizations. Themes that emerged in the analysis run in MAXQDA are as follows, relationships between the themes that emerged

were analysed in relation to the different modes of transport (bicycling, walking, use of public transport and carpooling):

- App design
- Behavioural interventions
- Sustainability
- Community
- Sharing of user location
- Transport options
- Route options
- Weather
- Efficiency
- Safety

5 Results

Perception to different modes of transport
Four modes of transport were presented to the participants as alternatives to individual car use: (1) bicycling, (2) walking, (3) use of public transport and (4) carpooling. They were asked to reflect on these modes of transport in relation to developing sustainable urban mobility habits and were asked which were the top two alternatives they consider as an alternative to cars, public transport was the most preferred alternative, followed by bicycling.

Each mode of transport were discussed as viable means of transport in urban areas in terms of time and costs:

- **Bicycling:** Participants associated bicycling in positive terms such as ‘independence’, ‘free and efficient’ and ‘cost effective’. Weather and road safety are two factors that deter participants from using bicycling as a mode of transport. Participants mentioned weather (e.g. rain) as a reason for not using their bikes as often as they would like to. Road conditions is another key factor, one participant stated that bicycling can be ‘dangerous’ especially in areas that do not have properly defined bicycle lanes; this was supported by other participants who stated that they would like to have an app feature that can provide information on bike trails and how well streets are lit for safe navigation.
- **Walking:** Walking was described as ‘relaxing’ and ‘healthy’, in general it was not perceived by participants as a practical mobility of choice. It is however associated with leisurely activities such as ‘grocery’, ‘shopping’ and ‘exercising’,

but it is not deemed efficient for activities that have time-constraints such as getting to work.

- **Public Transport:** Participants have mixed reactions to public transport which is generally linked to the state of public transportation in the city they reside in. One participant described the public transportation in the area she lives in as 'horrible', but further stated it is generally 'fair for everybody, but only if we have it in enough places. Another participant affirmed that public transport is an 'efficient' means of transport however she also remarked that it 'can be at times unreliable'; public transport is also regarded as 'expensive' by one participant who mentioned that she saves a lot of money by taking her bike instead of taking public transport.
- **Carpooling:** Carpooling is mainly associated with positive terms such as 'eco-friendly', 'sustainable', and a good step towards shifting to a shared mobility mindset. However, participants have pointed out the lack of available and legitimate platforms available in their areas prevents them from using it as an option. One participant mentioned that it is 'difficult to access' while another stated that she 'likes it a lot, but actually it's something I'm not doing that often'. Overall, participants commented that it would be nice to have access to information such as car seats for babies and kids to increase the likelihood of female users to use this mobility option.

Perception of Safety

Responses for this topic can be characterized as subjective and consistent with how participants perceive safety in their city, and heavily influenced by their own experiences. A sub-theme that emerged was to have an app feature that has the capacity to alert authorities or close contacts instantly in case of emergency. Participants in the focus group discussions regarded safety as an issue that can be addressed through interconnectivity by having the ability to share user location to trusted contacts. In addition, for some forms of mobility, such as car-pooling, participants thought that a mobile app would help in building trust with the people sharing a car. Crowdsourced information on levels of safety of public areas also appeared in the focus group discussion as a needed feature that can empower users to plan their urban travels.

Care-related aspects

Participants mentioned 'care-related' app features for carpooling and shared mobility services that would be useful for users who travel with children or take care of elderly people, for example, information about the possibility to take the stroller in public transport, information about accessible public transport, to have a bicycle seat available when renting a bicycle or to have information about access to cargo e-bikes for transporting groceries. In addition, participants underlined the importance of considering trip-chain related features: When planning a journey, a helpful possibility would be to plan multiple

stops (e.g. grocery store, child care, school) and to get an estimation on time while still considering sustainable aspects.

Perception of behavioural interventions and gamification methods

Various behavioural interventions and gamification elements are utilized in urban mobility apps, the feature of leaderboards was particularly shown to participants to understand how female users respond to behavioural interventions that utilize competitiveness as a motivation element.

Some participants did not construe leaderboards as a motivating feature as it made them feel judged or annoyed by the notion of competing with other users. Based on the focus group discussions, community (e.g. friends supporting each other's behaviour) is an important aspect for safe and sustainable mobility to be realized. Fostering interconnectivity within the community is an aspect that is crucial to be integrated in the design of urban mobility apps.

Participants expressed instead that they would feel motivated by relatable information on how their mobility choices impact the environment. The concept of rewards came about during the discussion and can be categorized into monetary and non-monetary rewards. Monetary-related rewards pertain to freebies, discounts or vouchers users can be entitled to that would motivate them to keep using sustainable modes of transport. Non-monetary rewards pertain to getting the recognition for their efforts, and the fun element of 'competing' with friends in the app; community emerged as a non-monetary aspect that participants expressed as a motivating element (e.g. socializing with other users in form of sustainability tips) for app usability.

Another key observation in the focus group discussion was the propensity of users to relate gamification with tangible rewards. Rewards for CO2 points were offered in some of the urban mobility apps reviewed in this study. Focus group participants expressed that receiving rewards in the form of freebies (e.g. coffee, free passes on social events, discounts) would elicit positive attitudes about sustainable mobility.

6 Recommendations: App features based on participatory process

Previous studies as well as the results of our focus group showed that female app users have different mobility needs than male app users, which are mainly related to feelings of safety, but also to different roles in care taking. In addition, some traditional features in urban mobility apps such as leaderboards are not motivating for all users. For designing a more inclusive urban mobility app that takes into account the different needs and allows women and caretakers to make sustainable mobility choices in their daily routines, these are our recommendations for app features, identified by the analysis of focus group discussion. We want to underline that these insights are not only relevant for female app users, but can be transferred to people with caretaking roles (of children or elderly relatives) and marginalized groups (especially when it comes to safety from harassment).

Information on mobility options and modes of transport: Features of urban mobility apps can be improved by providing viable means to travel more efficiently in urban areas from a more inclusive perspective:

- Integration of shared cargo bikes or e-bikes option (e.g. for childcare, grocery shopping)
- Information on accessibility and room of childcare-related and elderly equipment in public transports
- Carpool option with trusted contacts (e.g. neighbours)

Information on safety: Urban mobility apps can help enable users to feel safer in public transport by providing avenues for users to interact and rate the level of safety of public spaces. This includes both safety from harassment as well as road safety and the following information was identified to be useful:

- Crowdsourced information: Safety of routes based on other users
- SOS feature and location sharing feature
- Information on road conditions of bicycle and pedestrian trails (e.g. infrastructural elements of safety, well functioning street lighting)
- Availability of driver and vehicle information in case of emergencies

Gamification and behavioural interventions: Participants in the focus groups expressed their interests in receiving information and using features to motivate them for sustainable mobility choices through

- support systems instead of leaderboards for ensuring sustainable behaviour change and mutual motivation
- receiving information on sustainability and motivational reminders to choose sustainable mobility option and
- reward schemes for CO2 emissions saved or gamified elements (e.g. freebies, discounts, vouchers).

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