Gender Equitable electric Micromobility (GEM) Guidelines

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1. Introduction

In the UK, the Covid-19 pandemic led to a sharp rise in the popularity of micromobility with the rapid rollout of e-scooter platforms and cycling infrastructure. Yet, the integration of these platforms within the current transport network is concerning. Alongside significant safety concerns [1], there is growing evidence to suggest that shared electric micromobility (e-micromobility) platforms are subject to the gender biases that are prevalent across our road transport systems [2]. Within our current transportation modes, a gender-data gap has led to the design of transportation systems that do not capture the needs and motivations of female travellers [2]. It has already been identified that e-micromobility platforms are more likely to be used by males [3]. Females tend to be more safety conscious, which limits them from feeling comfortable when using micromobility due to the inadequate infrastructure for these modes of travel [4]. Yet, e-micromobility does allow faster personal mobility compared to walking, which is an attractive option at night when women are fearful of using other public travel modes or walking [5]. This project investigated the gender factors in the use and uptake of e-micromobility, focusing on e-scooters and e-bikes. It is the first to apply a sociotechnical systems framework to this area to review the wider systemic factors influencing the use of e-micromobility and how to ensure their use is gender-equitable. These gender factors have been identified within the transport domain (including modes spanning road, rail, air and sea) by a previous literature review [2], see Table 1.

Interviews and focus groups were conducted to provide an insight into public opinions on the use of e-micromobility. Analysis with respect to a sociotechnical system perspective provides recommendations that consider key gender factors to ensure e-micromobility can reach its full potential in enabling a transition to more sustainable transport by being gender inclusive.

Table 1. Gender factors in transportation (from [2])

Top Level Factors		Sub Factors
Family and Community Roles	Gender impacts on the different roles that individuals have within the family and the community. These often relate to caregiving and domestic work which can impact the mode of transport used between genders.	**Dependants**
		Division of work
Safety and Perceived Safety	Gender impacts on how safe and secure individuals feel when travelling on different transport modes which can lead to different travel choices being made.	**Time of day**
		Personal Safety
		Fear
Ergonomic Standards	Gender impacts on ergonometric measurements which are used to accommodate passengers and ensure their safety.	**Injury risk**
		Female body shape
Mobility Needs	Gender impacts on the different needs that individuals may have while travelling due to the different types of trips made.	**Facilities**
		Trip Characteristics
		Encumbered travel
User Behaviour	Gender impacts on the behaviours of individuals, including their perceptions and requirements for systems to perform in certain ways.	**Behavioural Trends**
		Wellbeing
Urban Structures	Gender impacts on the requirements that individuals have for the design of transport infrastructure and how they interact with it.	**Infrastructure**

2. Methodology

2.1 Sociotechnical Systems Modelling

A sociotechnical systems approach draws on complex systems theory, arguing against the importance of individual elements in system performance and instead valuing the interactions between multiple elements and actors, to implement holistic interventions [6]. Through applying sociotechnical systems methods and frameworks, we can identify the role that the designers, regulators, government bodies, national and international committees have in ensuring that the use of e-micromobility travel is inclusive and gender equitable. We conducted a Work Domain Analysis (WDA), to capture the values of e-micromobility use, and an Actor map analysis, to understand the responsible actors within the domain.

2.1.1 Work Domain Analysis

Work domain analysis (WDA) is a method that forms part of a wider methodology known as Cognitive Work Analysis [7]. WDA provides an initial overview of the actors, functions and purposes that comprise a system. The output of this is an abstraction hierarchy that provides a structured framework for mapping the high-level purpose and values of a system onto the individual objects that comprise a system and their individual functions. This is particularly useful when assessing the integration of new technologies within systems to identify the boundaries and constraints of a system, as well as what the ideal outcome of the new system will be. The WDA presented in Figure 1 was conducted by the researcher team and then validated with the transcripts generated from the focus group and interview data. For clarity, the hierarchy is presented without the interconnections between the individual elements (as is typical in a WDA). For further detail on the analysis see [8].

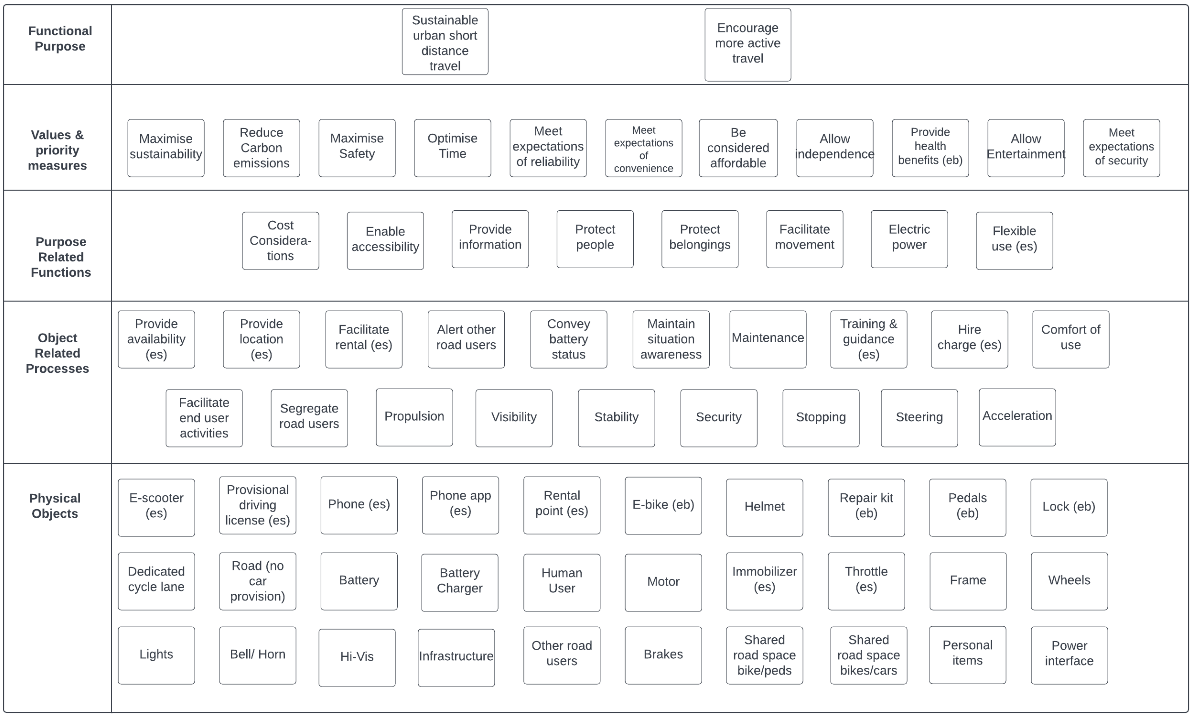

Figure 1. Abstraction hierarchy (without links) of e-micromobility travel, including e-scooters (es) and e-bikes (eb). Where not denoted as either 'es' or 'eb' the content is relevant to both modes.

The two functional purposes of e-micromobility travel were identified as 'Sustainable urban short distance travel' and 'Encourage more active travel'. The values and priorities that relate to these two functional purposes were then identified. These convey the ways in which the use and uptake of e-micromobility can be measured to enable the top-level purpose. They also highlight the key motivations and considerations for using e-micromobility. The bottom three levels present how all the individual objects that are involved in the use and provision of both e-bikes and e-scooters are utilised to achieve the functions and values of the system.

2.1.2 Actor map Analysis

An actor map analysis was conducted to identify all actors involved with e-micromobility use, implementation and up-keep at each of the different levels of system governance [9]. These hierarchical levels of the framework start with the equipment and the environment at the bottom, rising across the end-user, resource providers, industry/local government, regulatory bodies, government policy, national and international committees. The different actors involved in e-scooters and e-bikes were differentiated, as well identifying the actors that cover both modalities. An initial analysis by the research team was conducted before the focus groups and interviews and updated following input from the interview and focus group participants. A total of 86 actors were identified (e-scooters only n=13; e-bikes only n=12; both n=61), see Figure 2.

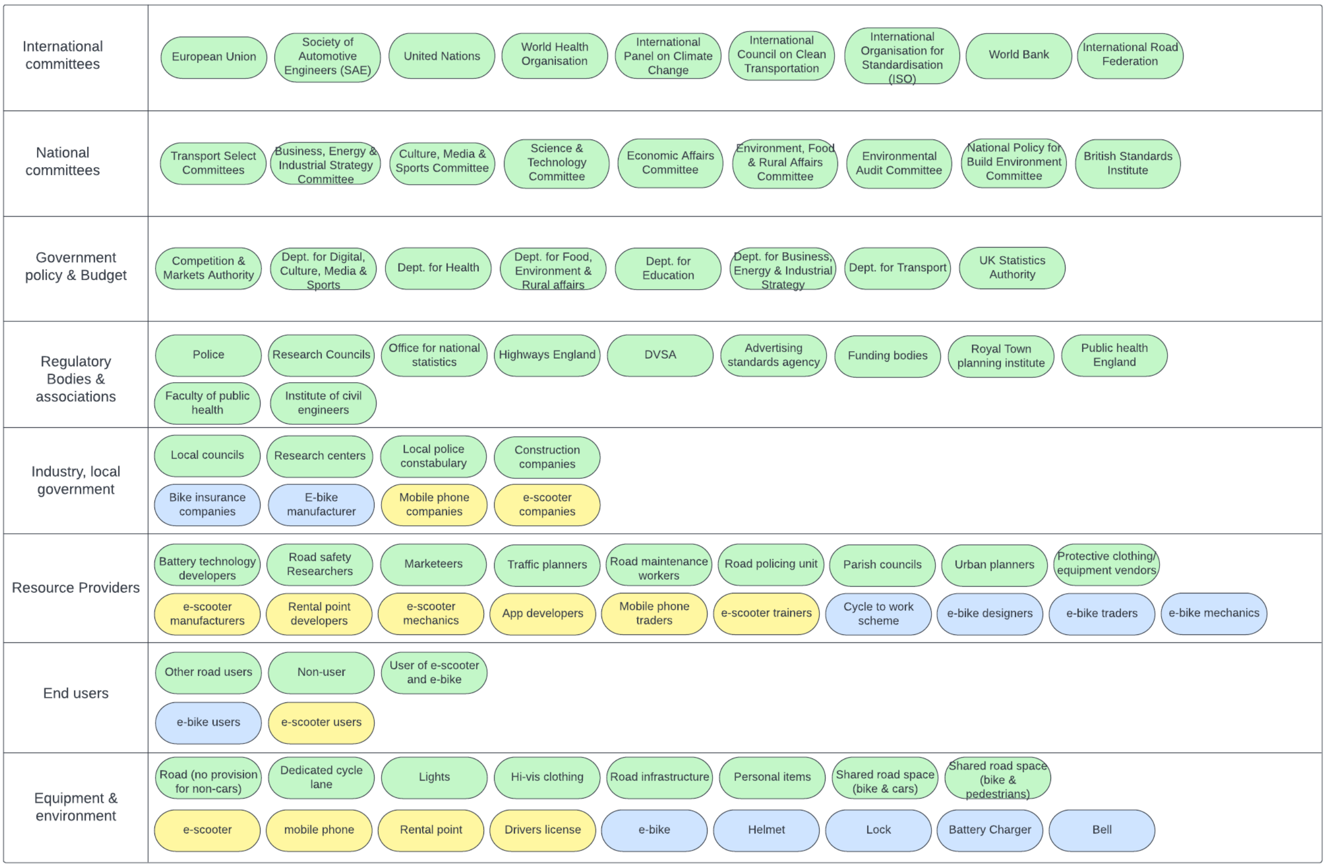

Figure 2. Actor map of all the actors that are involved in the use, design and regulation of e-bikes (shown in blue) and e-scooters (shown in yellow). Green depicts that actors that relate to both e-bikes and e-scooters.

2.2 Focus groups and Interview Data

A total of 24 participants (12 female) were recruited for the interviews and focus groups. The opportunity to participate in person or online was given to the participants to enable inclusive participation. Two focus groups were run. Focus group 1 was conducted in-person and included 6 participants (3 Female) with an average age of 44.33 years (Range: 22-68 years, SD: 19.02 years). Focus group 2 was conducted online and included 4 participants (2 Female), their average age was 47.75 years (Range: 39-59 years, SD: 9.43 years). Fourteen online interviews were conducted with an equal gender split in participants. Participants of different genders were matched on age, with the seven females having an average age of 47.71 years (Range: 31-62 years, SD: 10.50 years) and seven males averaging 44.43 years (Range: 26-65 years, SD: 15.72 years).

Semi-structured questioning relating to the incentives and barriers to the use of e-bikes and e-scooters was used in the focus groups and interviews to understand the participants perceptions and use of e-micromobility. Deductive thematic qualitative coding was conducted on the results, using the gender factors in Table 1 [2] as the thematic framework. Disaggregation of this analysis by gender has enabled the comparison of males and females on their views of e-micromobility use to help close the gender data gap within this transport domain. Figure 3 shows the frequency of references to the gender factors [2] (Table 1) when discussing the motivations and barriers to e-micromobility use, with frequency counts disaggregated by gender.

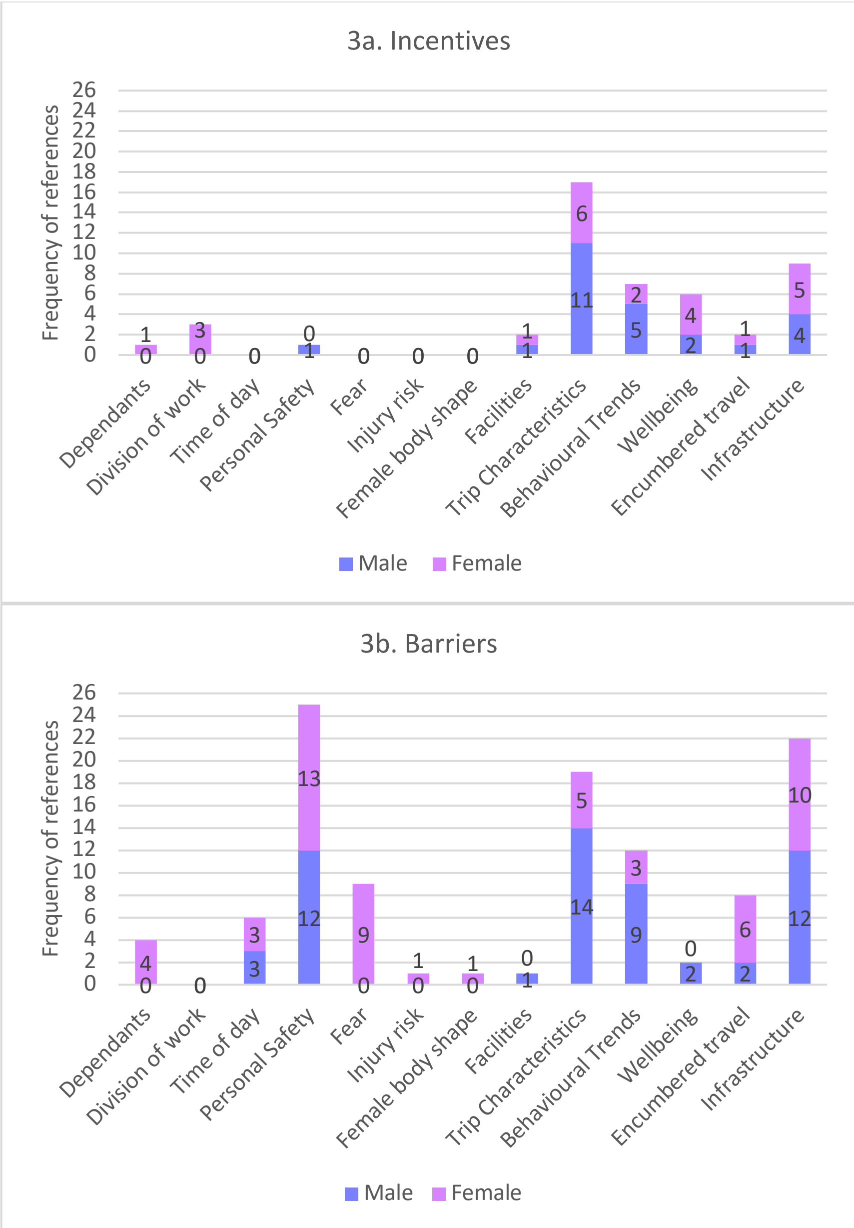

Figure 3. Graphs to show the references to the gender factors for males and females when discussing the motivations (3a) and barriers (3b) to e-micromobility use.

There were some similar and dissimilar trends across males and females in the frequency of references to the different gender factors as incentives and barriers to e-micromobility use. Further detail on this analysis can be found in [8,10]. Some of the key findings include:

Family and Community Values: Males made no references to the Family and Community Roles factors, yet they were cited by females as both incentives and barriers.

Safety and Perceived Safety: Safety perceptions was stated to be a significant a barrier to the use of e-micromobility, specifically e-scooter use with 23 individual references by females across each of the three safety subfactors and 14 references by males.
Ergonomics: There was very limited discussion on the ergonomics and physical size and shape of e-scooters or e-bikes.
Mobility Needs: Provision of storage facilities at destinations is a key factor in incentivising e-bike travel. Trip Characteristics was an influential factor in e-micromobility use, particularly for males. Male participants are incentivised by the ease of use for short-medium journeys. Yet, the battery life and range anxiety can put them off using them for some journeys. Conversely, females undertake a wide variety of journey types which prevent them from using e-micromobility, due in part to the encumbered travel that they undertake.
User Behaviour: Both males and females highlighted the difficulty in initially understanding how to use e-scooters and the use of new technology being an issue. Females talked more of benefits to their wellbeing that e-micromobility can bring. This includes more of a connection to nature.
Urban Structures: A lack of usable infrastructure was a significant barrier to the use of e-micromobility for both males and females.

3. Recommendations

Considering the socio-technical systems analysis and the data from the interviews and focus groups, a set of recommendations for each of the gender factors are suggested. These are detailed in Table 2. The recommendations are categories under the four main areas for intervention within Human Factors research; Legislation, Equipment, Procedures, Training [11].

Table 2. Recommendations for gender-equitable e-micromobility

Recommendations	
Legislation	**Family & Community Values** • The governance and decision-making related to road infrastructure must consider e-micromobility to ensure that people traveling with dependants are fully considered. **Safety and Perceived Safety** • Rules surrounding the safety equipment required for e-scooter use should account for time of day (use of high-vis) and consider the mandating of helmet use. **User Behaviour** • A legal requirement for training would improve safety and user behaviour. This should extend beyond the current requirement for a provisional driving license which does not require any road safety knowledge. **Urban Structures** • Legislation is required that enforces the requirements for e-micromobility to be included in the design of roadways, to ensure they safely interact with other road user groups e.g. pedestrians and vehicles. • Enforcement of the laws surrounding the use of e-micromobility on public space and pavements should be tightened to ensure the correct use of e-scooters and e-bikes.
Equipment	**Family and Community Roles** • Consider the use of families and those travelling with dependants within the design stage of e-micromobility development. **Safety and Perceived Safety** • The lights on e-scooters needs to be improved to improve their visibility at night and the safety of the users. The use of high-vis and helmets would improve the safety of the user, in line with cyclists. • Consideration should be given to the types of journeys e-micromobility is used for and the availability of safety equipment e.g. when travelling without own helmet **Ergonomic Standards** • Gender disaggregated data should be used to inform the design of e-micromobility with the option for female and male designs, where needed.

	Mobility Needs • The different types of encumbered travel and the different user types and demographics need to be considered at the design phase. This should enable the provision of effective storage solutions. • The facilitates at storage locations needs to also be considered, the size and strength of female and male user's needs to be included to ensure that storage areas are usable to both genders. • Facilities at places of work should consider the differing needs of females and males in the use of hygiene facilities and storage facilities to encourage more females to cycle and scoot into work. **User Behaviour** • The design of the phone interface for e-scooter hire needs to enable accessibility. Other options for non-smart phone users should also be available for more inclusivity. **Urban Structures** • Increasing the cycling infrastructure will motivate more people to use e-micromobility. This will also link to improved safety perceptions of the travel mode.
Procedures	**Family and Community Roles** • Enable more hire-schemes to allow people to 'try before they buy' to see if they can use e-bikes, cargo bikes and e-scooters with their children, before making a large financial outlay. **Safety and Perceived Safety** • Placement of the e-scooter hubs should consider the lighting available and safety of the locations e.g. cctv, activity at night. **Ergonomic Standards** • More research and gender disaggregated data is required to understand the ergonomic constraints of e-micromobility relative to male and female body shapes. **Mobility Needs** • Consideration of the integration of e-micromobility with other transport modes is needed for female travellers who have more varied trip characteristics. **User Behaviour** • The benefits of e-micromobility to mental health should be more widely publicised. This can help encourage more female users.
Training	**Family and Community Roles** • Training for those travelling with children should be offered to understand how to best utilise emicromobility and improve confidence. **Safety and Perceived Safety** • Training on the safe use of e-scooters on the road is required to ensure the safety of users as well as other road users (especially pedestrians). This should also cover the safety equipment required and how to use the roadways. **Mobility Needs** • E-bikes and cargo bikes offer more storage solutions which are beneficial to females. More hire opportunities and training should target females. **User behaviour** • More training on how to access and use e-scooters is required. This includes the initial technological barrier of using the application and the road safety aspect of using the e-scooters. • Training and information about what occurs when the battery runs out should also be clearly accessible. • Training should also target the safe interactions with other road users, especially pedestrians. **Urban Structures** • Training on how to use e-micromobility on the roads and the different road intersections and road types should be enforced.

Combining the sociotechnical systems analysis with the recommendations from the user insights from the focus groups and interviews will enable them to be targeted systemically. Our next steps will be to map the actors from Figure 2 on to the recommendations in Table 2, to identify who is responsible for enacting the required changes. Furthermore, understanding the values and purposes of the e-micromobility domain can help to ensure that it develops in a way that is effective and desirable to the user.

4. Conclusion

This work has provided an insight in how the gender factors that are evident within traditional transport modes (including road, rail, air and sea), relate to the relatively new modes of e-micromobility. An equal gender sample size enabled disaggregation by gender within the analysis and the similarities and differences within the perspectives of males and females were used to inform the recommendations. Females are more concerned with the impact that e-micromobility has on conducting their family and community role. Males tend to be heavily incentivised by characteristics of the type of trip that they are taking when choosing to use e-micromobility. While males and females are concerned with the safety of using e-bikes, and especially e-scooters, females are much more likely to equate this to feelings of fear which prevent them from using e-micromobility. Supporting other research within the field we recommend the implementation of improved road infrastructure to increase the uptake of e-micromobility, for both male and females. For more detail on the findings from this work see [8,10].

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