Travel Behaviour and Society 33 (2023) 100643

Contents lists available at ScienceDirect

Travel Behaviour and Society

journal homepage: www.elsevier.com/locate/tbs

Stereotypes and the public acceptability of shared micromobility

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ARTICLE INFO

Keywords:
Shared micromobility
Acceptability
Stereotype
Stereotype content model
Shared e-scooter
Shared bike

ABSTRACT

Understanding the public's views and acceptability of shared micromobility (SMM) is crucial for uncovering barriers to incorporating SMM into sustainable urban mobility. This research studies stereotypes of SMM and their impacts on SMM's public acceptability. We focus on shared e-scooters and shared bikes/e-bikes in England, the Netherlands, and Sweden. We conceptualise stereotypes of SMM, developing a scale for their measurement. Factor analysis reveals that stereotypes of SMM are structured around two cognitive dimensions, namely, warmth and competence, which aligns with the stereotype content model. Warmth captures individuals' stereotyped SMM user images regarding how the users interact with other road users; competence reflects individuals' stereotyped SMM's capabilities to improve existing transport systems. Overall, stereotypes of SMM, characterised by low levels of warmth and high levels of competence, are ambivalent. Yet, they are also variable. Analysis of covariance unveils variations in SMM stereotypes across countries, sociodemographics, and travel patterns. Swedish residents, older adults, individuals from households without children, SMM users, and car-oriented individuals hold lower levels of warmth (for both types of SMM) and competence (for shared e-scooters) than their counterparts. Finally, the public acceptability of shared e-scooters is neutral, whilst that of shared bikes/e-bikes is mildly positive. Multivariate analyses show that stereotypes' warmth and competence are positively associated with individuals' acceptability of SMM, cumulatively accounting for over 50% of the variation in acceptability. Our findings help inform policies and planning on SMM. The developed scale holds the potential for evaluating stereotypes of SMM in particular and emerging transport services in general.

1. Introduction

Shared micromobility (SMM) is a relatively novel form of urban mobility. Micromobility refers to a range of human-/electric-powered lightweight vehicles operated at speeds generally below 25 km/h (Behrendt et al. 2022, Tice 2019). SMM offers a flexible and often relatively low-emission transport option for short-distance trips by allowing access to micromobility on an as-needed basis (Shaheen and Cohen 2021). These services may therefore have the potential to contribute to more efficient, sustainable, and cost-effective transport systems. The SMM market has seen a breakthrough and rapid development in the last 15 years, owing to the evolution of shared economy business models and (mobile) technologies (Guyader et al. 2021, Bylieva et al. 2022). This initially involved bike-sharing services and was then followed by the continuous emergence of novel SMM, such as shared e-scooters, which quickly became popular in the US, Australia, and some European countries in recent years (Button et al., 2020; Damien, 2020). In Europe alone, for example, shared bikes and shared e-scooters can be found in 420 cities and towns in 35 countries as of 2022 (Friedel 2021).

With SMM's fast expansion, individuals have formed various views of SMM images through experiences as a user, observations, and media publicity. For example, studies show that people in developed countries hold in general positive views of shared bikes (Duran-Rodas et al., 2020b; Rahim Taleqani et al., 2019): they are seen as an environmentally-friendly mode (Castillo-Manzano and Sánchez-Braza 2013) and a good supplement to the whole transport system (Bakogiannis et al. 2019). Nevertheless, negative views towards SMM are present as well. For example, a large proportion of people hold the belief that SMM services, including shared bikes and shared e-scooters, contribute to clutter and congestion, cause conflicts between road users,

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https://doi.org/10.1016/j.tbs.2023.100643
Received 17 January 2023; Received in revised form 15 July 2023; Accepted 20 July 2023
Available online 3 August 2023

and lead to more road hazards (Lipovsky 2021, Kale 2022, Duran-Rodas et al. 2020b, Duran-Rodas et al. 2020a, Kjærup et al. 2021). There are also individuals' views that these services, in contrast to what they are expected to accomplish, in reality may not support more cost-effective and sustainable daily travels (Duran-Rodas et al. 2020b, People's Daily 2020, Aman et al. 2021).

Understanding the public's views and acceptability of SMM is crucial if we are to assess the prospects of SMM facilitating modal shifts away from motor vehicles to improve sustainability. However, it remains largely unknown which main themes underlie the views of SMM and how these views may vary in different geographical locations and by subpopulations with different backgrounds. More importantly, we know hardly anything about how views of SMM may influence the general public's, especially the non-users', acceptability of SMM. The acceptability of SMM herein refers to the extent to which an individual accepts the introduction of new SMM services or the expansion of existing ones, independent of their intention to use SMM. This notion is, therefore, different from widely-studied SMM's consumer acceptance (Öztaş Karlı et al. 2022, Kopplin et al. 2021), which focuses on behavioural intentions. Given SMM's rapid expansion (Heineke et al. 2020), insights into these issues are timely and crucial for SMM developments and regulations and may support population- or attribute-specific improvements in SMM services.

In this paper, we draw on the concept of stereotypes to investigate the public's views and their impacts on the acceptability of SMM. In social psychology, stereotypes can be defined as an individual's (generalised) *views of people and objects of a particular category*. In recent years, this concept has been extensively applied in marketing studies as a psychological representation of consumers' views of products, brands, and corporates (Schwind et al. 2019, Diamantopoulos et al. 2017, Kolbl et al. 2020). It is therefore intuitive that stereotypes also fit conceptually and can increase our understanding of individuals' views of SMM. Existing studies also reveal that stereotypes of members of a category can be divided into two universal dimensions, namely warmth and competence (Fiske et al. 2002). Thus, the internal structure of stereotypes may help uncover the main themes underlying individuals' views of SMM. Moreover, marketing studies show that the integration of warmth and competence dimensions simplifies consumers' decision-making process by allowing consumers to evaluate a product primarily based on the knowledge attached to the category membership rather than specific attributes (Ivens et al. 2015). Stereotypes thus have significant implications for consumers' attitudinal reactions and behavioural intentions (Puddifoot 2019), which provides us with the theoretical basis for connecting the public's views and acceptability of SMM.

This research aims to better understand stereotypes of SMM and the extent to which these stereotypes may influence SMM's public acceptability. We focus on two types of SMM – shared bikes/e-bikes and shared e-scooters – in three European areas: Greater Manchester, England, Utrecht, the Netherlands, and Malmö, Sweden. We have three objectives. First, we investigate how SMM is stereotyped through two dimensions conceptualised in the stereotype content model, i.e., warmth and competence. Second, we study the discrepancies in stereotypes of SMM between subpopulations. Third, we scrutinise how these stereotypes may influence SMM's public acceptability. To fulfil these objectives, we develop a scale, informed by the stereotype content model, to measure various stereotypes of SMM. Employing exploratory factor analysis (EFA), we reveal the internal structure of these stereotypes, while detailing their characteristics via descriptive analyses. Subsequently, we explore variations in the stereotypes across locations, sociodemographic profiles, and travel patterns, using analysis of covariance (ANCOVA). Through multivariate analyses, we finally delve into the association between stereotypes and the public acceptability of SMM.

2. Background

2.1. Concept of stereotypes

In social sciences, the origin of the concept of stereotypes can date back to Lippmann's (1922) book *Public Opinion*, where stereotypes are described as 'pictures in our heads' about what a social group is like. While stereotypes have been extensively studied since then, there is no unanimously accepted definition for the concept (Kanahara 2006). In the APA Dictionary of Psychology, for example, VandenBos (2015, p. 1031) defines stereotypes as 'a set of cognitive generalisations (e.g., beliefs, expectations) about the qualities and characteristics of the members of a group or social category.' In contrast, some studies have taken more generalised definitions that stereotypes are views or mental representations (i.e., images) an individual associates with a certain category (Ivens et al. 2015, Stangor et al. 2014, Van Knippenberg and Dijksterhuis 2000). Despite the disparities, scholars have come to the agreement that a stereotype corresponds to an individual's self- or social-relevant categorical knowledge (Lee et al. 2013) and that stereotyping always includes evaluative components (Gilmour 2015).

Research reveals that stereotypes can be applied to not only groups of people but also categories of non-human entities and social objects, such as brands (Davvetas and Halkias 2019), products (Brouthers and Xu, 2002), emerging technologies (Schwind et al. 2019), and modes of transport (Daley and Rissel 2011).

Stereotypes are formed in various manners, such as through actual interactions with members of certain groups, societal influences (e.g., influences of media), and illusory correlations (Lilli and Rehm 1988). Against this backdrop, stereotypes can be relatively concrete (e.g., 'Asians are good at math') or abstract (e.g., 'Asians are cold') and may not necessarily be accurate (Madon et al. 2006).

Stereotypes play a crucial role in guiding individuals' reactions to new information, as they prepare individuals for encountering yet unknown objects. Stereotypes drive individuals to conduct evaluations of an object primarily based on established expectations of the category membership, rather than the characteristics and qualities of the object in question (Puddifoot 2019). Stereotypes thus allow an easier and more efficient decision-making process (Fiske and Neuberg 1990). This aligns well with the human cognitive mechanism in which people tend to simplify information for evaluations to reduce cognitive resource consumption (Nelson 2009, Stanovich 2009). Therefore, stereotypes, independent of their accuracy, have significant implications for an individual's information process and follow-up behaviours (Ryan et al. 1996).

2.2. Stereotype content model

The stereotype content model, as proposed by Fiske et al. (2002), is a framework aimed at explaining the cognitive structure of stereotype contents and the potential mechanism by which stereotypes may affect individuals' behavioural and emotional reactions. This model postulates that stereotypes are primarily underpinned by two cognitive dimensions: *warmth* and *competence*. For an individual's stereotypes of people or objects within a group, warmth refers to the individual's judgements in general on the group member's intention to provide help or inflict harm. Research shows that warmth is closely connected with the level of competition between the individual and members of the group (Kervyn et al. 2015; Russell and Fiske, 2008). The more intense the competition for the same pool of resources, the lower the level of warmth the individual may perceive. Competence denotes the individual's judgement of the group member's capability to achieve goals. Warmth and competence are theoretically independent of each other, although studies have observed moderate-to-high levels of correlations between these two dimensions (Niewiadomski et al. 2010, Imhoff et al. 2013).

The stereotype content model explains the acceptability of objects

through stereotypes on an individual level. In this model, the combination of warmth and competence constitutes a four-quadrant map (i.e., high warmth – high competence, high warmth – low competence, low warmth – high competence, and low warmth – low competence), which is also known as the Behaviours from Intergroup Affect and Stereotypes (BIAS) map (Cuddy et al. 2008). The BIAS map posits that warmth determines tendencies to enact active behaviours, whilst competence determines tendencies to enact passive behaviours. Cuddy et al. (2007) defined active behaviours as those enacted with explicit efforts to affect the target group, and passive behaviours as those enacted with more implicit efforts but still having implications for the target group. *Ceteris paribus*, a greater strength of warmth or competence contributes to a larger tendency of active (i.e., acting for) or passive (i.e., acting with) facilitation and, vice versa, a larger tendency of active (i.e., acting against) or passive (i.e., acting without) harm (Cuddy et al. 2007; Becker and Asbrock 2012; Froehlich et al., 2019). To elaborate, active facilitation explicitly seeks to benefit others through actions like providing aid, assistance, or protection. Passive facilitation, conversely, primarily caters to self-interests and, as a by-product, yields benefits for others, as seen when hiring the services of an outgroup member. Active harm entails actions taken with an explicit intent to cause harm, seen in behaviours like bullying and verbal harassment. Passive harm, however, subtly degrades other groups, diminishing their social worth through acts of exclusion, neglect, or disregard. Studies show that warmth and competence drive individuals' behaviour and attitudes towards not only other people but also inanimate entities, such as products (Schwind et al. 2019) and travel destinations (Shen et al. 2019). However, it remains inconclusive which dimension is more influential in determining behavioural and emotional tendencies. For example, a recent review shows that warmth is more influential than competence in predicting social perceptions of groups of people (Eisenbruch and Krasnow, 2019), while inconsistent findings suggesting a more influential role of competence can be found, for example, on topics concerning brand evaluations (Xue et al. 2020), intentions to visit destinations (Shen et al. 2019), and the social acceptability of mobile devices (Schwind et al. 2019).

2.3. Stereotypes and SMM

Marketing research reveals that consumers stereotype products (Maheswaran 1994). Similar to general products, people categorise transport services owing to the differences between services, such as those in the usage condition, performance, and user group images. On this basis, people stereotype transport services by forming their views of a certain category of transport service (e.g., developing views of bus services as a whole) based on the observed or illusory attributes of the service. The existing literature shows that stereotypes of a transport service are primarily reflected in two aspects, i.e., the image of user groups and the capacity of the service. For example, bus passengers are commonly described as low-status people (Fitt 2018), whilst cyclists are mentioned as risk-takers and regulation-breakers (Daley and Rissel 2011). Stereotypes concerning the capacity of transport services, such as 'buses are crowded and slow' (Scherer 2011), 'automated vehicles increase congestion' (Rahman et al., 2021), 'e-bikes cause serious risks on the road' (Su and Feng 2016), can also be found in the existing literature. Research by Burgess et al. (2013) and Rahman et al. (2021) suggests that an individual's stereotypes of a given type of transport service can be ambivalent. For example, Burgess et al. (2013) found that people held traditionally negative stereotypes of electric vehicles overall yet believed that electric vehicles have promising capacities.

Some transport studies may typologise stereotypes as attitudes, yet these two constructs are theoretically distinct from each other. Attitudes refer to the overall (un-)favourableness of an object or a group, whilst stereotypes are specific trait attributions (views) to a group (Kurdi et al. 2019). While stereotypes (views to categories) may be able to reflect attitudes to a group, there are no necessarily high-level consistencies between these two constructs (see, Fishbein and Ajzen (2011) and Kurdi et al. (2019) for reviews on this topic). The reasons are that warmth and competence may independently reflect attitudes (Cuddy et al. 2008), and that these two stereotypical dimensions can be ambivalent. For example, Caucasian Americans tend to have negative attitudes towards Asian Americans but positively stereotyped Asian Americans as intelligent (Lin et al. 2005).

Studies have looked into the individuals' views and perceptions of (given) SMM services. The identified views and perceptions are helpful indications for understanding stereotypes of SMM. For shared e-scooters, Feng et al. (2021) investigated the sentiment of tweets concerning shared e-scooters in the US, and found that most people held positive views. Nevertheless, studies on perceptions of shared e-scooter users highlighted people's concerns about safety and right-of-way conflicts when interacting with these users. For example, James et al. (2019a) found that 56% of individuals indicated that they felt unsafe when walking around shared e-scooter riders in Austin, US. Similarly, Buehler et al. (2021) observed that improper parking, illegal speeding, and unsafe riding of shared e-scooter users were the most common concerns of non-users.

These studies are in line with those on the media coverage of shared e-scooter users (Gössling 2020, Lipovsky 2021, Caspi and Smart 2022). While media coverage may not entirely capture how people view shared e-scooter users, it plays an important role in identifying issues meriting attention and picking up on public concerns (Gössling 2020). For example, Gössling (2020) analysed the coverage of shared e-scooter services in news reports in the US, Europe, and Australia/New Zealand. Gössling (2020) identified several keywords commonly used to describe shared e-scooter users and their riding behaviour, including 'irresponsible riding', 'conflicts over space', 'safety/injuries', 'cluttering', and 'vandalism'. In contrast to the negative user group images, a limited number of studies showed that people, especially shared e-scooter users, might hold positive views of the capacity of shared e-scooters. Such a service was commonly seen to be useful for addressing urban problems, such as mitigating traffic emissions and congestion (Kjærup et al. 2021) and promoting transport accessibility (Kopplin et al. 2021), as well as making travel more enjoyable (Buehler et al. 2021).

For shared bikes, large-scale text mining studies show that people in developed countries have, in general, positive views of shared bike services (Duran-Rodas et al., 2020b; Rahim Taleqani et al., 2019). Regarding the user group image, James et al. (2019a) found that, unlike shared e-scooter systems, pedestrians might not have substantial safety concerns when they were around shared bike users, although they felt more comfortable walking around private bikes. However, public opinions were reported that these users tended to incorrectly park the shared bikes, which might compromise other road users' right-of-way and safety (Kutela et al. 2021, Sun 2018, Duran-Rodas et al. 2020b). While shared bikes are predominately seen as a sustainable mode of transport (Duran-Rodas et al. 2020b, Cerutti et al. 2019, Hurtubia et al. 2021), there are mixed views on their capacity. For example, Duran-Rodas et al. (2020b) showed that one-third of tweets concerning shared bikes suggested that these services were good for mobility and could be efficiently combined with the existing transport system, but a similar proportion of tweets expressed their views that shared bike services did not help promote transport equity and was not cost-effective. Kutela et al. (2021) also showed that the negative views of shared bikes, such as improper distribution, high price, and limited service area of shared bikes, were scattered across the population in Seattle, US.

3. Research design

3.1. Case study areas

We investigated SMM in three European countries focusing on Greater Manchester (England), Utrecht (Netherlands), and Malmö (Sweden). There is substantial variation in the regulations and levels of

SMM in each area.

Greater Manchester is a city region in North West England, comprising ten cities and towns, most of which are contiguous. Cycling levels are low in Greater Manchester. Only 5% of total trips in this region are made by bikes, whilst car trips account for 52% (Deloitte 2020). As in other parts of the UK, SMM services are not widespread in the city region. At the time our data was collected, there was a publicly funded and managed, privately operated cycle hire scheme in parts of the city region. This scheme was undergoing expansion from just 30 docking stations to what is planned to be over 1500 stations in the cities of Manchester and Salford, as well as the town of Trafford (Manchester City Council 2022). In England, at the time of data collection, e-scooters could only legally be ridden on public roads and paths if they were part of one of the trials permitted in some areas by the national government and managed by local authorities (Kane 2022). In Greater Manchester trials existed in Salford and Rochdale. Our study focused on areas where SMM operated, covering Manchester City, Salford, and the adjacent Trafford.

Utrecht is the third-largest city in the Netherlands. It is located in the centre of the country and well connected with all other regions. Like most of the Netherlands, Utrecht is flat, and has a moderate climate. The city is known as a cycling city. 28% of all trips starting or ending in Utrecht are made by bikes; within the city, this increases to 48.5% (CBS 2020). SMM is not as widespread as in other countries. There were existing shared bike schemes, run by the Dutch Railways, and it is also possible to rent a bike long-term. More recently, shared e-bikes, shared (e-)cargo bikes, and shared mopeds have become available. E-scooters are not available in a shared form, and they are hardly present on the road.

Malmö is the third-biggest city in Sweden. The flat topography, oceanic climate, and medium size of the city provide an ideal environment for micromobility, such as bikes, e-bikes, and e-scooters. With efforts to promote sustainable mobility during the last decades, the city has built dedicated cycling infrastructures, which reputed the city as a bicycle-friendly city (Hamidi and Zhao 2020), with 26% of residents using bicycles as the main mode of transport (Region Skåne 2022). In terms of SMM, shared bikes, e-bikes, and e-scooters have been available in the entire city area for a few years, operated either by the municipality (shared bike) or private operators (shared bike, e-bikes and e-scooters). The early generation of shared bikes was introduced in 2016 with 50 stations, which was expanded to 100 stations in 2019 due to strong demand (Caggiani et al. 2021); shared e-scooter became available in 2019 along with other shared bikes and e-bikes operated by private operators. While the e-scooters are a relatively new mode of travel for the residents, they has been regulated as bikes, with a maximum speed that must not exceed 20 km/h, since 2013 (The Swedish Transport Agency 2020).

3.2. Data

Given the lack of existing data, we collected data through online questionnaire surveys. The surveys were conducted from July to September 2022. A sample of the general population, including both users and non-users of SMM, was needed to investigate the public's stereotypes and acceptability of SMM. To achieve this, we applied commercial survey panel services for recruitment. We restricted participation to residents aged over 18 in our study areas. Following these criteria, the panel service companies randomly recruited the respondents according to the panellists' information registered in their database. The panellists were vetted and managed over time to ensure the quality of responses. Each respondent who completed the questionnaire survey received a small incentive for participation.

The questionnaire contains four sections that cover a variety of questions on demographic and socioeconomic characteristics, usage patterns of SMM and other forms of transport, views of SMM, and social connections. The questionnaire was provided in the native language of each respective country (i.e., Dutch for the Netherlands and Swedish for Sweden) with an additional English version offered as an option. On average, it took a respondent 22 min to complete this survey. Only a part of the questionnaire survey data was used in our research.

We received 2921 responses. A response was recorded when a respondent answered at least one question. 2100 participants had a 100% completion rate. We excluded individuals who answered 'I don't know' when evaluating any statements regarding views of SMM (see **Section 3.3**) and those who did not provide the required personal information (see **Section 3.4**) from our final analyses. Our final sample size was 1394. Of the analysed sample, 22%, 28%, and 50% were from the Dutch, English, and Swedish respondents, respectively. 46% were male, and 53% were female. 44% had used at least one type of SMM in the last 12 months prior to our survey. 81% and 75% have regular access to cars and bikes, respectively. We asked respondents about their household income according to the officially reported household income quintile in their respective country; 12%, 15%, 21%, 21%, and 20% of the analysed individuals were from households with income falling into the first through fifth quintiles ('prefer not to say' accounted for 10%), respectively. Our data have an underrepresentation of individuals aged 65 and above (9%). We will reflect on the issue of data representativeness in the discussion section (**Section 5**).

3.3. Stereotype measurements

We measured respondents' stereotypes of two types of SMM services – shared e-scooters and shared bikes/e-bikes – following the conceptualisation of the stereotype content model. While the existing literature has developed various measurement scales for the stereotype content model, there are no unanimously accepted scales that suit all or most topics. More importantly, no studies in the field of transport have looked into the application of such a model, and thus, a new measurement scale needs to be designed to fit our research purposes.

For measuring the warmth dimension of stereotypes of SMM, the respondents were asked to evaluate eight statements concerning the user images of a given SMM service (e.g., shared e-scooter users) in general, using a five-point Likert scale that ranges from −2 'Strongly Disagree' to

Table 1
Statements for measuring stereotypes and acceptability of SMM.

Warmth	In general, shared [e-scooter or bike/e-bike] users …
S1	are trustworthy road users.
S2	are friendly road users.
S3	care about others' feelings on the road.
S4	value traffic safety.
S5	do not take risks on the road.
S6	obey traffic regulations.
S7	use [shared e-scooters or shared bikes/e-bikes] only where they are allowed.
S8	park [shared e-scooters or shared bikes/e-bikes] properly.
Competence	**In general, shared [e-scooter or bike/e-bike] services have the potential to …**
S1	make the overall transport system more efficient.
S2	make travelling more flexible.
S3	reduce travelling costs.
S4	allow better access to travel destinations.
S5	reduce traffic emissions.
S6	reduce traffic congestion.
S7	make travelling more pleasurable.
S8	make travelling more comfortable.
Acceptability	
S1	Overall, using [shared e-scooters or shared bikes/e-bikes] should be encouraged.
S2	Overall, [shared e-scooter services or shared bike/e-bike services] should be expanded.
S3	Overall, supporting policies should be implemented to encourage the use of [shared e-scooters or shared bikes/e-bikes]

+ 2 'Strongly Agree' (Table 1). The reason we focused on SMM user images to capture respondents' stereotypes' warmth of the corresponding SMM service was that these users largely determined whether other road users' travelling was influenced (e.g., being hindered or harmed), which corresponds to the definition of the warmth dimension. Kervyn et al. (2015) suggested that the warmth dimension can be further divided into two components, namely, sociability and morality. Sociability (e.g., friendliness and amiability) refers to collaborating with other individuals, whereas morality (e.g., trustworthiness and tolerance) corresponds to a sense of right or wrong. The eight statements we applied to measure stereotypes' warmth of SMM were proposed centring on these two components and existing studies on SMM user images (James et al. 2019b, Buehler et al. 2021, Gössling 2020, Duran-Rodas et al. 2020b). For example, the statement 'In general, shared e-scooter users care about others' feelings on the road' corresponds to the sociability component, whereas 'In general, shared e-scooter users value traffic safety' corresponds to both morality and sociability components. For a given type of SMM, there was a high level of internal consistency in the scores for the statements (Cronbach's alpha = 0.955 and 0.952 for shared e-scooters and shared bikes/e-bikes, respectively), suggesting that individuals' evaluations of these statements are suitable for measuring the same construct.

For stereotypes' competence of SMM, we considered eight general goals in the transport sector based on EU transport white papers (European Commission 2020, 2011) as well as studies on the public views of SMM's capacity (Duran-Rodas et al. 2020b, Cerutti et al. 2019, Hurtubia et al. 2021). Notably, these general goals are not confined to these sources but are also frequently observed in mass media outlets such as social media and newspapers in the three countries studied (Kirstie Brewer 2016, Bremmer 2022, Pettersson-Löfstedt et al. 2021). The respondents were asked to evaluate the statements regarding the potential of the typical SMM services (rather than only the SMM service in the city where they live) in question to improve the existing transport systems by achieving these goals (Table 1), using a five-point Likert scale. For a given type of SMM, the internal consistency for the statements' scores was high (Cronbach's alpha = 0.925 and 0.939 for shared e-scooters and shared bikes/e-bikes, respectively).

All the considered statements were presented in a randomised order to the respondents. To effectively capture respondents' stereotypes of SMM, we highlighted and asked the respondents to follow their first instinct and not overthink when evaluating the statements. We also set up an 'I don't know' option. Only 13% of the total statements were evaluated by 'I don't know', indicating that the majority of respondents did have (explicit) views of SMM. We excluded individuals who answered 'I don't know' (N = 698) for further stereotype measurements[1].

We used sum scores to measure the warmth and competence dimension of stereotypes of SMM, given the high internal consistency between respondents' evaluations of statements in each dimension. Therefore, both warmth and competence theoretically ranged from −16 to 16, with 0 marking the neutral point. We performed EFA to explore the underlying structure of stereotypes of SMM. For a given type of SMM, individuals' evaluations on all 16 statements were included in EFA. Independent of SMM types, two factors were extracted: stereotypes' warmth and competence (see **Appendix A**), which were consistent with our conceptualisation. The extracted factors explained more than 70% (71.5% for shared e-scooters; 73% for shared bikes/e-bikes) of the total variance of individuals' evaluations of stereotypical statements. Results of EFA suggest that our measurement scales are suitable for establishing the SMM-specific stereotype content model from both theoretical and data-driven standpoints. Since stereotypes of SMM are primarily reflected in two aspects in the existing literature, i.e., the image of SMM users and the capacity of SMM, as we considered in the stereotypical statements, our examinations corroborate that a two-dimensional structure concerning warmth and competence could underpin stereotypes of SMM.

3.4. Acceptability measurements

Respondents were also asked to evaluate their acceptability of SMM (Table 1). We provided three statements with a five-point Likert scale (from −2 'Strongly disagree' to + 2 'Strongly agree') for the evaluation: 'Overall, using [shared e-scooters or shared bikes/e-bikes] should be encouraged', 'Overall, [shared e-scooter services or shared bike/e-bike services] should be expanded', and 'Overall, supporting policies should be implemented to encourage the use of [shared e-scooters or shared bikes/e-bikes]' (Cronbach's alpha = 0.837 and 0.879 for scores for statements evaluating the acceptability of shared e-scooters and shared bikes/e-bikes, respectively). We used sum scores to measure individuals' overall acceptability of SMM. Therefore, the acceptability measurement operated within a designated range of −6 to 6, with neutrality represented by 0.

3.5. Analytical approaches

This research has three objectives: (1) to investigate the structure of stereotypes of SMM; (2) to explore differences in stereotypes of SMM between subpopulations; and (3) to examine the extent to which stereotypes of SMM influence SMM's public acceptability.

For our first objective, we performed descriptive analyses on the measured stereotypes' warmth and competence. This and the EFA previously conducted (**Subsection 3.3**) help uncover the internal structure of stereotypes of SMM.

For our second objective, we focused on eight sets of comparisons (Table 2). First, we compared individuals' stereotypes of SMM between the three investigated countries. Second, we conducted two comparisons in the stereotypes between users and non-users of SMM (i.e., shared e-scooters and shared bikes/e-bikes). A user herein refers to an individual who used the investigated SMM at least once in the 12 months prior to the questionnaire survey. These comparisons may provide us insights into the difference in stereotypes of SMM between in-groups and out-groups concerning SMM usership. Third, we conducted five sets of comparisons in SMM stereotypes, differentiating groups in the comparison based on an individual attribute: gender, age, household income, the presence or absence of children in the household, and travel patterns. Examining differences in stereotypes of SMM amongst these sociodemographic groups could enhance our understanding of social inequalities associated with SMM provision and regulation. Specifically, we examined the differences between two gender groups (female and male), four age brackets (20–35, 35–50, 50–65, and over 65), five income categories established based on quintiles (ranging from Q1 to Q5, representing ascending income levels) of household income of the countries investigated, and individuals from households with and without children.

To identify the respondents' travel patterns, we applied a k-modes clustering method based on the frequency of modal usage, including walking, cycling, as well as the use of cars, local public transport, and regional public transport. The number of clusters was determined based on the silhouette coefficient (Rousseeuw 1987). We identified three distinct travel patterns: (1) 'Car-oriented', which emphasises a higher usage of cars compared to the other patterns; (2) Mode-balanced, which signifies a more balanced usage of different modes compared to the other patterns; and (3) PT (i.e., public transport)-reliant, which highlights a higher reliance on regional and local public transport compared to the other patterns. We refer our readers to **Appendix B** for detailed information on modal usage for each pattern.

We conducted ANCOVA to compare the estimated marginal means (i.e., covariate-adjusted means) of warmth and competence, thereby

[1] Independent of SMM types, <3 statements were evaluated as 'I don't know' for 60% of respondents who ever chose this option.

Table 2
Considered comparisons in stereotypes.

Areas	Shared E-scooter Usership	Shared Bikes/E-bikes Usership	Gender	Age	Household Income	Presence of Children in the Household	Travel Patterns
1) Greater Manchester 2) Utrecht 3) Malmö	1) User 2) Non-user	1) User 2) Non-user	1) Female 2) Male	1) 18–34 2) 35–49 3) 50–64 4) >65	1) Q1 2) Q2 3) Q3 4) Q4 5) Q5	1) Yes 2) No	1) Car-oriented 2) Mode-balanced 3) PT-reliant

Table 3
Summary statistics of variables.

Variables	Greater Manchester	Utrecht	Malmö	Total
Gender				
Male	45.4%	45.5%	47.3%	46.4%
Female	53.6%	52.8%	52.4%	52.8%
Other	1.0%	1.7%	0.3%	0.8%
Age				
18–34	53.1%	39.2%	37.3%	42.2%
35–49	31.7%	31.1%	27.5%	29.5%
50–64	11.9%	18.5%	21.1%	17.9%
>65	3.1%	5.2%	13.6%	8.8%
Prefer not to say	0.3%	5.9%	0.4%	1.5%
Country of Origin				
The studied country	86.6%	86.7%	86.1%	86.4%
Other	13.4%	13.3%	13.9%	13.6%
Living Alone				
Yes	11.1%	25.5%	24.0%	20.6%
No	88.9%	74.5%	76.0%	79.4%
Presence of Children in the Household				
Yes	45.1%	31.8%	30.7%	35.1%
No	54.9%	68.2%	69.3%	64.9%
Employment Status				
Full-time	69.1%	66.1%	64.4%	66.1%
Part-time	7.2%	13.3%	2.5%	6.1%
Student	6.2%	3.5%	8.8%	6.9%
Retired	3.4%	4.9%	14.6%	9.4%
Unemployed	7.7%	7.3%	5.6%	6.6%
Homemaker	6.4%	4.9%	4.1%	4.9%
Household Income				
Q1 (Low)	18.8%	13.3%	6.7%	11.6%
Q2	19.8%	16.8%	11.4%	15.0%
Q3	19.3%	23.1%	21.2%	21.1%
Q4	18.0%	21.3%	22.5%	21.0%
Q5 (High)	15.7%	12.6%	25.6%	20.0%
Prefer not to say	8.2%	12.9%	12.4%	11.3%
Educational Attainment				
College and Above	52.6%	59.8%	50.8%	53.6%
Other	47.4%	40.2%	49.2%	46.4%
Regular Access to Cars				
Yes	77.6%	87.4%	80.2%	81.0%
No	22.4%	12.6%	19.8%	19.0%
Regular Access to Bikes				
Yes	52.8%	83.6%	84.6%	75.3%
No	47.2%	16.4%	15.4%	24.7%
Long-term Health Condition Yes				
Yes	7.5%	7.7%	3.7%	5.6%
No	92.5%	92.3%	96.3%	94.4%
Shared E-scooter User				
Yes	60.6%	100.0%	65.6%	71.4%
No	39.4%	0.0%	34.4%	28.6%
Shared Bike/E-bike User				
Yes	50.8%	57.7%	24.2%	38.8%
No	49.2%	42.3%	75.8%	61.2%
Travel Pattern				
Car-oriented	42.0%	33.9%	43.0%	40.8%
Mode-balanced	39.7%	45.5%	39.4%	40.8%
PT-reliant	18.3%	20.6%	17.6%	18.4%

controlling for confounding between observed individual characteristics (see, Table 3). We applied the Tukey-Kramer test for post-hoc pairwise comparisons following ANCOVA.

For our third objective, we used multi-stage (hierarchical) multivariate models with the acceptability of SMM as the dependent variable. In the first step, we estimated the model with only individual demographic and socioeconomic characteristics, travel patterns, and SMM usership (see, Table 3) as explanatory variables. This model focused on the relationship between individuals' observed characteristics and acceptability of SMM. In the second step, we added stereotypes' warmth and competence in the model. We employed an ordering-averaged variance decomposition approach (Lindeman 1980)[2] to calculate the variance explained by stereotypes' warmth and competence, and examined the changes in the R-squared between the first-step and second-step models using the F-test. These analyses allow us to quantify the importance of stereotypes in explaining the acceptability of SMM. In the third step, we replaced stereotypes' warmth and competence with individuals' evaluations of detailed stereotypical statements concerning SMM's user images and capacities. For each model, we tested potential multicollinearity using the variance inflation factor (VIF; best if < 3) and found no severe multicollinearity. We used (Huber-White HC0) robust standard errors for statistical inference to reduce potential heteroscedasticity.

4. Results

4.1. Descriptive analyses

This subsection provides the results of descriptive analyses on two aspects: the warmth and competence dimensions of SMM stereotypes, as well as the public acceptability of SMM. It is important to note that both warmth and competence were gauged within a designated range from −16 to 16, with 0 marking the neutral point, whilst the acceptability measurement operated within a designated range of −6 to 6, with neutrality represented by 0.

For stereotypes of shared e-scooter services, the warmth dimension was −5.9 (95% CI: −6.4 – −5.5), indicating that overall negative stereotypes prevail towards the users of shared e-scooters. All stereotypical statements used to measure the warmth dimension were on average scored below 0 (i.e., the neutral point) (Fig. 1-**A**). The respondents were most negative about three statements, i.e., shared e-scooter users 'park e-scooters properly', 'are trustworthy road users', and 'do not take risks'. The competence dimension had an average score of 3.7 (95% CI: 3.3 – 4.1), which suggests that individuals have positive stereotypes on the potential of shared e-scooters to make the existing transport system more desirable. Shared e-scooter services have the potential to 'reduce traffic congestion', 'reduce travelling costs', and 'allow better access to daily travel destinations' are the three highest-scored competence-

[2] In a multivariate model, the percentage of variance explained by a given variable depends on the order each considered variable enter the model. Therefore, we used the variance decomposition method proposed by Lindeman (1980), which calculated the variance contribution averaged over orderings amongst regressors.

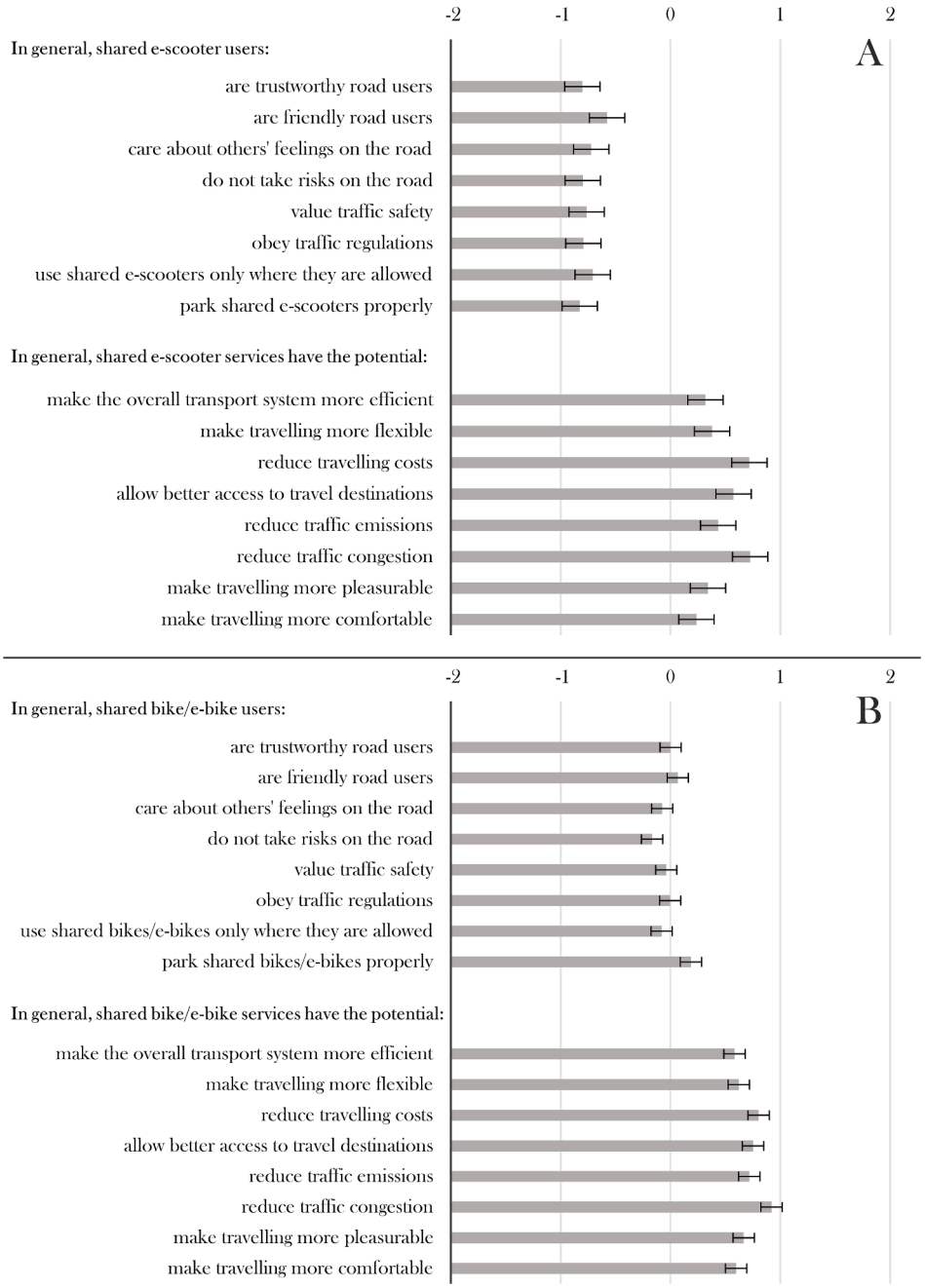

Fig. 1. Individuals' evaluations of SMM stereotype statements.

Table 4
The public acceptability of SMM.

Acceptability	Greater Manchester	Malmö	Utrecht	ANOVA	Overall
Shared E-scooter	2.05	−0.58	0.97	$p < 0.001$	0.50
Shared Bike/E-bike	2.56	1.73	1.84	$p < 0.001$	1.99

Note. We reported the mean value of the acceptability indicator (neutral point = 0).
ANOVA tested if there were significant differences in the level of acceptability of SMM across study areas.

specific statements. We also found that the large warmth-competence gap was present in all study areas (warmth-competence gap: −6.6 for Greater Manchester; −5.8 for Utrecht; −13.0 for Malmö).

Individuals' acceptability of shared e-scooters was 0.5 on average (95% CI: 0.3 – 0.7) (Table 4), suggesting that respondents are relatively neutral towards the introduction of shared e-scooters. The acceptability value differed significantly between the studied areas at the level of $p < 0.001$. Individuals in Malmö had the lowest level of acceptability of shared e-scooters (-0.6), which was followed by those in Utrecht (1.0) and Greater Manchester (2.0).

Stereotypes of shared bikes/e-bikes were significantly ($p < 0.001$) more positive than those of shared e-scooters. The warmth dimension

scored −0.1 (95% CI: −0.5 – 0.4), whilst the competence dimension scored 5.7 (95% CI: 5.3 – 6.0). The warmth-competence gap was observed in all study areas (warmth-competence gap: −4.7 for Greater Manchester; −4.2 for Utrecht; −6.9 for Malmö). Specifically, all stereotypical statements used to measure the warmth dimension were rated around 0 (Fig. 1-**B**). Three statements with the lowest scores were that shared bike/e-bike users 'do not take risks on the road', 'park shared bikes/e-bikes properly', and 'care about others' feelings on the road'. Individuals showed moderately positive stereotypes of shared bikes'/e-bikes' potentials, particularly the potential to 'reduce traffic congestions', 'reduce travelling costs', and 'allow better access to daily travel destinations'.

Overall, the acceptability of shared bikes/e-bikes scored 2.0 (95% CI: 1.8 – 2.2) (Table 4). Greater Manchester (2.6) showed significantly higher levels of acceptability than the other two areas (1.8 for Utrecht; 1.7 for Malmö).

4.2. Distribution of stereotypes

Table 5 shows the estimated marginal means of stereotypes across subpopulations. ANCOVA detected significant differences in stereotypes' warmth and competence for most considered comparisons at the significance level of 0.05.

Post-hoc comparisons revealed that Malmö residents, compared to residents living in the other two areas, held lower levels of stereotypes' warmth and competence of shared e-scooters. Malmö residents also stereotyped shared bikes/e-bikes with lower levels of warmth. In contrast, there were no statistical differences in stereotypes' competence of shared bike/e-bikes between the studied areas.

SMM users, including both shared e-scooter and bike/e-bike users, exhibited higher levels of stereotypes' warmth and competence of both shared e-scooters and shared bikes/e-bikes than the non-users, although SMM usership was still associated with negative stereotypes' warmth. This suggests that having experiences in using a specific type of SMM (e.g., shared bikes/e-bikes) may contribute to more positive stereotypes of not only the SMM in question, but also other types of SMM.

There were no statistical differences in stereotypes of SMM between females and males.

Older age groups, in general, showed significantly lower levels of stereotypes' warmth and competence of both shared e-scooters and shared bikes/e-bikes.

Individuals from households with children were found to have higher levels of warmth and competence towards both shared e-scooters and shared bikes/e-bikes.

We found no statistical differences in stereotypes of SMM between different household income groups.

The car-oriented travel pattern was associated with lower levels of stereotypes' warmth of shared e-scooters than the mode-balanced and PT-reliant patterns. In contrast, no significant differences were found regarding stereotypes' competence between travel patterns. For stereotypes of shared bikes/e-bikes, the PT-reliant pattern was associated with a higher level of stereotypes' warmth, but there were no statistical

Table 5
Stereotypes of SMM across (sub-)populations.

	Shared E-scooters		Shared Bikes/E-bikes	
Subpopulations	Warmth	Competence	Warmth	Competence
Areas				
Utrecht	−0.13 (-2.16, 1.89)	5.66 (3.58, 7.73)	3.61 (1.41, 5.82)	8.66 (6.68, 10.64)
Greater Manchester	−1.57 (-3.50, 0.35)	5.39 (3.42, 7.37)	2.50 (0.41, 4.60)	8.15 (6.26, 10.03)
Malmö	−9.23 (-11.14, −7.33)	2.86 (0.91, 4.82)	1.25 (-0.82, 3.32)	7.61 (5.75, 9.47)
ANCOVA	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p = 0.664$
Shared E-scooter Usership				
Non-user	−5.00 (-6.81, −3.20)	3.36 (1.51, 5.21)	1.80 (-0.17, 3.76)	7.56 (5.80, 9.33)
User	−2.29 (-4.27, −0.31)	5.92 (3.89, 7.95)	3.12 (0.97, 5.27)	8.72 (6.79, 10.65)
ANCOVA	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
Shared Bike/E-bike Usership				
Non-user	−5.00 (-6.88, −3.12)	4.14 (2.22, 6.07)	1.06 (-0.98, 3.10)	7.45 (5.62, 9.29)
User	−2.29 (-4.19, −0.40)	5.13 (3.19, 7.07)	3.86 (1.80, 5.91)	8.83 (6.98, 10.68)
ANCOVA	$p < 0.001$	$p = 0.055$	$p < 0.001$	$p < 0.01$
Gender				
Female	−3.01 (-4.12, −1.91)	4.50 (3.36, 5.63)	0.84 (-0.36, 2.04)	5.68 (4.60, 6.76)
Male	−3.42 (-4.49, −2.34)	4.37 (3.27, 5.47)	0.60 (-0.57, 1.76)	6.08 (5.03, 7.13)
ANCOVA	$p = 0.329$	$p = 0.819$	$p = 0.153$	$p = 0.319$
Age				
18 – 34	−2.14 (-4.06, −0.22)	6.31 (4.34, 8.27)	4.56 (2.48, 6.64)	9.36 (7.49, 11.24)
35 – 49	−2.87 (-4.78, −0.96)	5.50 (3.54, 7.46)	3.30 (1.22, 5.37)	8.62 (6.76, 10.49)
50 – 64	−4.63 (-6.64, −2.62)	4.96 (2.91, 7.02)	1.79 (-0.39, 3.97)	9.05 (7.09, 11.01)
>65	−4.95 (-7.68, −2.22)	1.78 (-1.01, 4.57)	0.18 (-2.78, 3.14)	5.53 (2.86, 8.19)
ANCOVA	$p < 0.001$	$p < 0.001$	$p < 0.001$	$p < 0.001$
Household Income				
Q1 (Low)	−3.00 (-5.02, −0.98)	4.54 (2.47, 6.60)	3.31 (1.12, 5.50)	7.75 (5.78, 9.72)
Q2	−3.95 (-5.95, −1.96)	4.81 (2.76, 6.85)	1.69 (-0.47, 3.86)	8.23 (6.28, 10.19)
Q3	−4.11 (-6.10, −2.12)	4.55 (2.51, 6.59)	2.60 (0.44, 4.76)	8.00 (6.06, 9.95)
Q4	−3.34 (-5.34, −1.33)	4.62 (2.57, 6.67)	2.10 (-0.07, 4.27)	8.27 (6.32, 10.23)
Q5 (High)	−3.84 (-5.87, −1.81)	4.68 (2.60, 6.75)	2.59 (0.38, 4.79)	8.44 (6.46, 10.42)
ANCOVA	$p = 0.444$	$p = 0.990$	$p = 0.344$	$p = 0.896$
Presence of Children in the Household				
Yes	−2.85 (-4.81, −0.89)	5.32 (3.31, 7.32)	3.30 (1.17, 5.42)	8.67 (6.76, 10.58)
No	−4.45 (-6.25, −2.64)	3.96 (2.11, 5.80)	1.62 (-0.34, 3.58)	7.61 (5.85, 9.37)
ANCOVA	$p < 0.001$	$p < 0.01$	$p < 0.001$	$p = 0.075$
Travel Pattern				
Car-oriented	−4.16 (-6.08, −2.24)	4.61 (2.65, 6.58)	1.68 (-0.41, 3.76)	8.09 (6.22, 9.97)
Mode-balanced	−3.77 (-5.65, −1.88)	5.00 (3.06, 6.93)	2.50 (0.46, 4.55)	8.40 (6.56, 10.24)
PT-reliant	−3.01 (-4.97, −1.05)	4.30 (2.29, 6.31)	3.19 (1.06, 5.32)	7.93 (6.02, 9.85)
ANCOVA	$p < 0.001$	$p = 0.294$	$p < 0.001$	$p = 0.388$

Note. We reported the estimated marginal mean and the corresponding 95% CI (in parentheses) of each indicator as well as the p value for ANCOVA.

Table 6
Multivariate analyses of SMM acceptability.

	Shared E-scooter Acceptability		Shared Bike/E-bike Acceptability	
Variables	Model A-1 without stereotypes Coef. (SE)	Model A-2 with stereotypes Coef. (SE)	Model B-1 without stereotypes Coef. (SE)	Model B-2 with stereotypes Coef. (SE)
Stereotypes				
Warmth		0.101 (0.009) ***		0.043 (0.008) ***
Competence		0.278 (0.009) ***		0.304 (0.008) ***
Gender				
Male (ref.)				
Female	−0.030 (0.173)	0.027 (0.116)	0.279 (0.162) †	0.049 (0.101)
Other	−0.137 (0.937)	−0.414 (0.627)	2.970 (0.877) ***	0.647 (0.550)
Age				
18–34 (ref.)				
35–49	−0.433 (0.218) *	−0.113 (0.146)	−0.395 (0.204) †	−0.150 (0.128)
50–64	−0.546 (0.269) *	−0.012 (0.181)	−0.395 (0.252)	−0.203 (0.158)
>65	−1.240 (0.533) *	−0.167 (0.357)	−1.189 (0.499) *	0.220 (0.313)
Prefer not to say	−0.394 (0.704)	0.094 (0.471)	−0.591 (0.658)	0.042 (0.411)
Area				
Utrecht (ref.)				
Greater Manchester	0.305 (0.273)	0.438 (0.183) *	0.416 (0.259)	0.791 (0.162) ***
Malmö	−1.787 (0.260) ***	−0.239 (0.190)	0.149 (0.247)	0.615 (0.155) ***
Country of Origin				
The studied country	−0.524 (0.246) *	−0.428 (0.165) **	−0.113 (0.230)	−0.135 (0.144)
Other (ref.)				
Living Alone				
Yes	−0.222 (0.235)	−0.064 (0.157)	−0.325 (0.220)	−0.205 (0.137)
No (ref.)				
Presence of Children in the Household				
Yes	0.584 (0.205) **	0.124 (0.138)	0.263 (0.192)	0.036 (0.120)
No (ref.)				
Employment Status				
Full-time (ref.)				
Part-time	−0.282 (0.365)	−0.138 (0.244)	−0.251 (0.341)	−0.176 (0.213)
Student	0.263 (0.364)	0.066 (0.244)	−0.057 (0.341)	−0.359 (0.213) †
Retired	−0.189 (0.505)	−0.056 (0.338)	−0.492 (0.473)	−0.783 (0.295) **
Unemployed	−0.501 (0.367)	−0.168 (0.246)	−0.459 (0.343)	−0.389 (0.214) †
Homemaker	−0.630 (0.400)	−0.053 (0.268)	−0.230 (0.374)	−0.143 (0.233)
Household Income				
Q1 (Low)				
Q2	−0.069 (0.339)	−0.037 (0.227)	−0.052 (0.317)	−0.084 (0.198)
Q3	0.056 (0.329)	0.140 (0.220)	−0.056 (0.308)	−0.076 (0.192)
Q4	−0.133 (0.339)	−0.160 (0.227)	−0.067 (0.317)	−0.203 (0.198)
Q5 (High)	−0.401 (0.344)	−0.362 (0.230)	−0.098 (0.322)	−0.320 (0.201)
Prefer not to say	−0.883 (0.364) *	−0.136 (0.244)	−1.452 (0.340) ***	−0.410 (0.214) †
Educational Attainment				
College and Above	−0.393 (0.178) *	−0.161 (0.120)	0.007 (0.173)	0.038 (0.108)
Other (ref.)				
Regular Access to Cars				
Yes (ref.)				
No	0.037 (0.234)	−0.144 (0.157)	0.682 (0.219) **	0.236 (0.137) †
Regular Access to Bikes				
Yes (ref.)				
No	0.059 (0.216)	0.272 (0.144) †	−0.234 (0.202)	0.113 (0.126)
Long-term Health Condition				
Yes (ref.)				
No	0.164 (0.373)	0.572 (0.250) *	−0.138 (0.349)	−0.403 (0.218) †
Travel Pattern				
Car-oriented (ref.)				
Mode-balanced	0.231 (0.198)	0.049 (0.132)	0.312 (0.185) †	0.096 (0.116)
PT-reliant	−0.124 (0.256)	−0.092 (0.172)	−0.032 (0.240)	−0.073 (0.150)
Shared E-scooter User				
Yes	1.332 (0.227) ***	0.288 (0.155) †	0.416 (0.213) †	−0.003 (0.133)
No (ref.)				
Shared Bike/E-bike User				
Yes	0.468 (0.213) *	0.000 (0.144)	0.922 (0.199) ***	0.411 (0.126) **
No (ref.)				
Intercept	1.653 (0.618) **	−0.024 (0.416)	1.782 (0.584) **	0.335 (0.366)
R-squared	0.221	0.652	0.144	0.667

Note. The standard errors reported are (Huber-White HC0) robust standard errors.
† $p < 0.10$; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

differences in stereotypes' competence of shared bikes/e-bikes between travel patterns. We refer our readers to Table 1 in **Supplementary Material** for detailed information on post-hoc comparisons.

4.3. Stereotypes and acceptability of SMM

We first looked into multivariate analyses of the acceptability of shared e-scooters (Table 6). For the observed personal characteristics-only model (**Model A-1**), lower levels of shared e- scooter acceptability were found amongst individuals who were aged 35 – 49, 50 – 64, and over 65 (compared to those aged 18 – 34), lived in Malmö (compared to those living in the Utrecht), was born in the studied country, and had a college degree or above. In contrast, shared e-scooter and shared bike/e-bike users and individuals who lived with children tended to have higher levels of acceptability of shared e-scooters.

When the stereotype variables were added to the model, both warmth and competence dimensions were positively associated with the acceptability of shared e-scooters at the significance level of 0.001 (**Model A-2**). One unit increase in warmth and competence was associated with 0.101 and 0.278 increases in the acceptability of shared e-scooters, respectively.

When we replaced stereotypes' warmth and competence with individuals' evaluations of stereotypical statements, we found that those who held stronger views that shared e-scooter users 'are friendly road users', 'do not take risks on the road', and 'only use shared e-scooters where they are allowed', and that shared e-scooter services have the potential to 'make the overall transport system more efficient', 'make travelling more pleasurable', 'reduce travelling costs', 'reduce traffic congestion', and 'reduce traffic emissions' had a higher level of acceptability of e-scooters (see, Table 2 in **Supplementary Material**).

Compared to **Model A-1**, the R-squared in **Model A-2** significantly ($p < 0.001$ for the F-test) increased from 0.221 to 0.652. The variance decomposition showed that warmth and competence dimensions explained 52.9% of the total variation in the acceptability of shared e-scooters; competence explained more variation than warmth (38.2% vs. 14.7%).

We then focused on multivariate analyses of the acceptability of shared bikes/e-bikes (Table 6; **Models B-1 & 2**). Lower levels of shared bike/e-bike acceptability were found amongst individuals who were aged 35 – 49 and over 65 (compared to those aged 18 – 34) and those who had no regular access to cars, whilst females, mode-balanced travellers (compared to car-oriented travellers), shared e-scooter and bike/e-bike users tended to have higher levels of acceptability. Warmth and competence dimensions positively correlated with the acceptability of shared bikes/e-bikes at the level of 0.001; these two dimensions explained 58.0% of the total variation in the acceptability (warmth: 11.7%, competence: 46.3%) (**Model B-2**). Finally, we found that holding stronger views that shared bike/e-bike users 'are trustworthy road users' and 'value road safety', and that shared bikes/e-bikes services had the potential to 'make travelling more flexible', 'allow better access to travel destinations', 'reduce traffic congestion', 'reduce traffic emissions', and 'reduce travelling costs' predicted a higher level of acceptability of shared bikes/e-bikes (Table 2 in **Supplementary Material**).

5. Discussions and conclusion

5.1. Discussions on principal findings

This research studied stereotypes of SMM and how these stereotypes may influence SMM's acceptability. Our findings reveal that stereotypes of SMM could be underpinned by two cognitive dimensions conceptualised in the stereotype content model, warmth and competence (Fiske et al. 2002). The warmth dimension captures how SMM users interact with other travellers. The competence dimension reflects views on how SMM can improve the existing transport systems. Confirming the two-dimensional structure of stereotypes of SMM is an important extension of the existing literature, as it offers theoretical underpinning to understand individuals' views of SMM. Our findings go beyond existing studies, such as text-mining studies, which have observed individuals' views of SMM's capacities and user images (Rahim Taleqani et al., 2019; Duran-Rodas et al., 2020b; Feng et al., 2021). We reveal that an individual tends to develop stereotypes of SMM in both warmth and competence dimensions simultaneously, and that these two dimensions are largely independent of each other.

Overall, individuals developed *ambivalent* stereotypes of SMM, which were characterised by low-to-medium levels of warmth and medium-to-high levels of competence. This suggests that individuals tend to appreciate the usability and impact of SMM, yet hold negative views of images of SMM users due to their irresponsible riding, rule-breaking behaviour, and poor safety awareness.

Ambivalent stereotypes of SMM were present in all three studied areas. The stereotypical ambivalence seems to be independent of the availability, developments, and usage of SMM in these locations to a certain extent. For example, we observed a large warmth-competence gap (negative warmth-positive competence) of stereotypes of shared e-scooters in Utrecht, despite the unavailability of these services in the area. This may be related to the mechanism by which stereotypes are developed. Studies show that stereotypes can arise from not only actual interactions but also societal influences and (illusory) correlations (Lilli and Rehm 1988). Therefore, the negative image of SMM users in media coverage (Gössling 2020) and associations based on private shared e-scooter users may contribute to the low level of stereotypes' warmth of shared e-scooters, even though Utrecht residents have no opportunities to use these services and interact with the users.

The public's acceptability of shared e-scooters was relatively neutral. This is similar to a study on social media reactions by Aman and Smith-Colin (2021) who investigated the social media reactions after the City Department of Transportation of Dallas banned the pilot shared e-scooter scheme two years after its introduction, and found that 39% of comments concerning this ban were neutral, 39% positive, and 22% against this ban. While there are distinct differences in shared e-scooter developments, transport conditions, and social-cultural backgrounds between countries, our and Aman and Smith-Colin's (2021) findings suggest that the medium levels of shared e-scooter acceptability may not entirely be location- or service-specific. Pervasive factors, such as low-level stereotypes' warmth, may act as dominant obstructors to the public's acceptability of shared e-scooters. In contrast, we found that the acceptability of shared bikes/e-bikes was positive. This seems to be in line with existing studies in Europe on the public acceptability of shared bikes/e-bikes (Nikitas et al., 2016; Nikitas, 2018) as well as in developed countries on views of these services (Duran-Rodas et al., 2020b; Rahim Taleqani et al., 2019).

Stereotypes' warmth and competence were significantly associated with the acceptability of SMM. These two stereotypical dimensions explained in total more than 50% of acceptability. This corroborated that warmth and competence dimensions independently predict emotional reactions (Cuddy et al. 2008, Fiske et al. 2002, Guo et al. 2022), and their importance in SMM's acceptability.

We also found that competence was more influential than warmth in explaining individuals' acceptability of SMM. This indicates that individuals' views on the capacities of SMM in improving transport systems may be more important than the image of SMM's users for the acceptability of SMM. Theoretically, warmth is seen as the primary dimension of stereotypes in the BIAS map built upon the stereotype content model (Becker and Asbrock 2012), since competition traits embedded in stereotypes' warmth help inform intentions and create an urgent need to react. Therefore, stereotypes' warmth elicits stronger and more direct reactions than competence (Laustsen and Bor 2017). However, empirical evidence shows that the relative importance of warmth and competence in explaining reactions seems to depend on the topic of investigation (Eisenbruch and Krasnow, 2019; Shen et al., 2019, Schwind et al., 2019), and has not been examined in the context of SMM.

Our finding thus fills this research gap and potentially provides helpful implications for policies aimed at encouraging SMM, as we will discuss in the final subsection (**Subsection 5.3**).

Finally, we detected significant differences in the warmth and competence dimensions of stereotypes of SMM across countries, individuals' demographic and socioeconomic characteristics, and travel patterns. This suggests that stereotypes of SMM differ between locations and people. However, in the multivariate models, stereotypes explained the variance of SMM's acceptability to a much greater extent than the locations or observed personal characteristics. This suggests that while stereotypes differ between groups, they offer an independent and substantial impact on the acceptability of SMM.

Going beyond our empirical findings, our research shows the potential application value of the stereotype content model in understanding individuals' stereotypes and acceptability of transport services. In general, the concept of stereotypes and its application are largely under-explored in the field of transport. We show that the developed measurement scale of stereotypes well suits the stereotype content model for SMM. Upon introducing context-specific modifications, notably, modifications to warmth-related statements, this scale could hold the potential to investigate individuals' stereotypes of other existing, emerging, and even non-existing transport services, such as public transport, ride-hailing, and fully automated vehicles. Employing this scale, the stereotype content model could be applied to better understand people's views of these transport services and measures that need to be implemented to improve the quality and (*a priori*) acceptability of such services.

5.2. Limitations and future research directions

We used multinational data and performed rigorous statistical examinations. This research has nevertheless several limitations. First, our study centred on three high-income European countries, where high levels of car usage and ownership prevail. Our findings may therefore lack generalisability to countries demonstrating different transport and economic characteristics. Further studies should extend to other contexts such as the Global South, where reliance on 'informal micromobility' modes, such as unregulated motorcycle taxis, is more pronounced (Evans et al. 2018). In such contexts, SMM might receive more positive stereotypes and a higher level of public acceptability.

Second, our data are not population-representative; for example, there is an underrepresentation of individuals aged 65 and above. The robustness of our findings concerning specific groups needs to be examined using more representative data with a larger sample size.

Third, the cross-sectional nature of our research limits the interpretations of our findings to correlations rather than causalities. To delineate potential causal relationships between individual attributes, SMM stereotypes, and public acceptability of SMM, future investigations should employ longitudinal designs and more sophisticated statistical methodologies.

Forth, we detected significant differences in stereotypes and the public acceptability of SMM across the studied areas, yet the underlying causes for these differences remain unclear. These differences persisted even after controlling for observable individual characteristics using ANCOVA and multivariate analyses. This suggests that additional location-specific factors, including SMM-related (e.g., the availability and duration of SMM) and unobserved (e.g., transport cultures and social norms) factors, may be important in explaining such differences. The availability and duration of SMM differed between our three study areas. Malmö introduced shared e-scooters the earliest of our three cities and still possesses the largest fleet by far amongst the three studied areas. As noted in news reports, the high-level availability and usage of shared e-scooters in Malmö, mirroring several other large Swedish cities, may have spurred discussions around safety concerns (amongst the non-users), induced urban space compression, and escalated conflicts with other road users, particularly cyclists and pedestrians (Löfgren 2019). These factors might contribute to the understanding of relatively negative stereotypes and the low level of public acceptability of shared e-scooters observed in Malmö. In contrast, such negative discussions are less common in Greater Manchester, where shared e-scooter services are available in restricted zones and their numbers are comparatively low. Yet, these interpretations remain speculative given the limited number of studied locations, and in the absence of systematic cross-location examinations. Future research endeavours could explore this through a multicity or multinational comparative analysis to delve deeper into the mechanisms underlying our observations.

5.3. Policy implications

While our research is theoretical, it has significant implications for policymaking. Our study demonstrates how investigating stereotypes provides a more nuanced understanding of public views than can be discovered from the assessment of acceptability alone. The approach of using stereotypes to help inform policymaking comprises two components. The first is that stereotypes contribute to the understanding of public opinion, and - irrespective of whether policymakers agree with that opinion - incorporating public opinion into account is a necessary aspect of democratic accountability in decision-making (see, for example, Harris, 1989). The second component is that efforts to improve the sustainability of urban mobility may be affected by acceptability and stereotypes related to SMM. As discussed in the introduction to the paper, there might be inconsistency between evidence about the practical implications of SMM and acceptability and stereotypes regarding SMM. If there is evidence that some SMM services contribute to accessibility, liveability, social sustainability or environmental sustainability, but acceptability and stereotypes are negative, then public opposition can impede or prevent the introduction of those services. There are examples of this occurring in relation to other transport measures such as low-traffic neighbourhoods (Dudley et al., 2022) and congestion charging (Hensher and Li, 2013). On the other hand, positive acceptability and stereotypes might increase pressure for SMM provision which could create problems for accessibility, liveability or sustainability if there is evidence that SMM services are detrimental to these aspects (cf. Kirschner and Lanzendorf (2020)). In either case, understanding stereotypes provides more nuanced insight into public opinion than is gained from understanding acceptability alone. That insight can be used to inform public information or campaigns so that they are able to effectively respond to the views and concerns of the public.

To illustrate how the understanding of stereotypes might be used to respond to public views and concerns, we can consider the findings from our study. The low warmth for SMM, and especially for e-scooters, and across locations indicates concern about riders' behaviour. This understanding can be used in conjunction with further empirical evidence about how riders actually behave, to decide policy measures. If the stereotypes are found to be consistent with evidence on behaviour, then there is a case for policy measures designed to encourage different behaviours, change allocations of public space to support better rider behaviour, or even reduce the provision of SMM. On the other hand, if the stereotypes are inconsistent with evidence on behaviour, then there is a case for challenging the views of poor rider behaviour.

Yet our study provides further insight into influences on acceptability. While policy and media discourses on SMM developments have extensively focused on the users' improper behaviour (Bieliński and Ważna 2020, Caspi and Smart 2022), our results indicate that despite these views being significant, they are not the only relevant ones. Our findings on the relative importance of warmth and competence suggest SMM' acceptability may be more strongly influenced by perceptions of SMM's competence in improving the transport system (e.g., in congestion reduction, cost reduction, and accessibility promotion). If, or where, there is empirical evidence that SMM does support sustainability in transport, then policy measures might focus on explaining this.

Our findings on variations in stereotypes between subpopulations

offer policy implications to support equitable and efficient developments in SMM. The findings can help understand whether some groups perceive that the presence of SMM is a disadvantage to them, and as indicated above, this understanding by itself can have relevance for democratic decision-making. It may also indicate where there are risks that perceptions of SMM could exacerbate social exclusion. For example, older adults developed negative stereotypes of SMM, reflected by low levels of both stereotypes' warmth and competence. This may raise concern that SMM hinders their use of roads, and this concern may need to be investigated to support social inclusion.

We also revealed that individuals living in households with children held more positive stereotypes of SMM. This finding seems counterintuitive at first, as SMM, particularly shared e-scooters, may not be suitable for activities involving children, and may raise safety concerns amongst parents. As such we would have expected a lower level of perceived competence and warmth associated with stereotypes of SMM. However, those living in households with children may opt for areas prioritising traffic safety, which potentially results in lower levels of safety concerns (Sanders et al. 2020). Moreover, families tend to live further away from the city centre, where issues with SMM often occur, and may thus not have developed as negative a stereotype as people who on average interact more (frequently) with SMM users. These circumstances may contribute to parents holding relatively more positive stereotypes of SMM. To ensure equitable developments in SMM, it is imperative for policymakers to assess the generalisability of our findings to parents lacking the means to reside in such areas. Should this not be the case, it becomes paramount to seek for solutions to prevent the presence of SMM from causing negative impacts, whether actual or perceived, on individuals living with their children.

CRediT authorship contribution statement

Zihao An: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. **Caroline Mullen:** Conceptualization, Writing – original draft, Writing – review & editing. **Chunli Zhao:** Conceptualization, Writing – original draft, Writing – review & editing. **Eva Heinen:** Conceptualization, Writing – original draft, Writing – review & editing.

Declaration of Competing Interest

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

Acknowledgement

This article forms part of work for the project COmpeting and COmplementary MObility solutions in urban contexts – CoCoMo funded by the Economic and Social Research Council (UK) (ES/W000547/1), and co-funded by JPI-Europe. We are grateful to the three anonymous reviewers, whose comments have greatly improved the quality of our paper.

Appendix A

EFA for shared e-scooter stereotypes.

	Factor 1	Factor 2
In general, shared e-scooter user …		
are trustworthy road users.	**0.887**	0.200
are friendly road users.	**0.789**	0.288
care about others' feelings on the road.	**0.828**	0.200
value traffic safety.	**0.765**	0.149
do not take risks on the road.	**0.873**	0.198
obey traffic regulations.	**0.872**	0.178
use shared e-scooters only where they are allowed.	**0.808**	0.201
park shared e-scooters properly.	**0.823**	0.160
In general, shared e-scooter services have the potential to …		
make travelling more pleasurable.	0.258	**0.746**
make travelling more comfortable.	0.195	**0.760**
make travelling more flexible.	0.098	**0.805**
allow better access to travel destinations.	0.111	**0.808**
reduce traffic congestion.	0.224	**0.779**
reduce traffic emissions.	0.093	**0.739**
make the overall transport system more efficient.	0.235	**0.798**
reduce travelling cost.	0.311	**0.621**

In bold denotes a factor loading greater than 0.6.

EFA for shared bike/e-bike stereotypes.

	Factor 1	Factor 2
In general, shared e-scooter user …		
are trustworthy road users	**0.858**	0.264
are friendly road users	**0.815**	0.290
care about others' feelings on the road.	**0.835**	0.237
value traffic safety.	**0.802**	0.168
do not take risks on the road.	**0.849**	0.257
obey traffic regulations.	**0.848**	0.234
use shared e-scooters only where they are allowed.	**0.802**	0.214
park shared e-scooters properly.	**0.694**	0.267

(*continued on next page*)

(*continued*)

	Factor 1	Factor 2
In general, shared e-scooter services have the potential to …		
make travelling more pleasurable.	0.313	**0.737**
make travelling more comfortable.	0.297	**0.751**
make travelling more flexible.	0.223	**0.820**
allow better access to travel destinations.	0.210	**0.815**
reduce traffic congestion.	0.235	**0.784**
reduce traffic emissions.	0.149	**0.790**
make the overall transport system more efficient.	0.234	**0.828**
reduce travelling cost.	0.214	**0.694**

In bold denotes s a factor loading greater than 0.6.

Appendix B

Clusters of travel patterns.

Modal usage	Car-oriented	Mode-balanced	PT-reliant
Car			
Daily	**30.9%**	20.1%	18.8%
4–6 times a week	**18.4%**	15.0%	8.8%
1–3 times a week	27.4%	**27.8%**	21.6%
1–3 times a month	8.8%	16.5%	**24.0%**
Less than once a month	14.4%	20.6%	**26.8%**
Walk			
Daily	59.7%	70.9%	**74.4%**
4–6 times a week	**13.2%**	11.6%	12.0%
1–3 times a week	**14.3%**	10.8%	5.6%
1–3 times a month	4.5%	3.8%	**6.0%**
Less than once a month	**8.3%**	2.9%	2.0%
Bike			
Daily	16.2%	**28.6%**	21.2%
4–6 times a week	10.1%	16.8%	**19.2%**
1–3 times a week	9.4%	**16.8%**	15.6%
1–3 times a month	7.4%	**16.5%**	9.6%
Less than once a month	**56.9%**	21.3%	34.4%
Regional Public Transport			
Daily	0.2%	2.7%	**20.4%**
4–6 times a week	0.4%	0.9%	**48.0%**
1–3 times a week	0.4%	**27.5%**	9.6%
1–3 times a month	3.4%	**51.9%**	10.4%
Less than once a month	**95.7%**	17.0%	11.6%
Local Public Transport			
Daily	2.7%	2.2%	**26.4%**
4–6 times a week	0.2%	0.0%	**58.8%**
1–3 times a week	4.3%	**38.7%**	11.6%
1–3 times a month	6.3%	**48.8%**	0.4%
Less than once a month	**86.5%**	10.3%	2.8%
Observations	554	553	250

Note. The figures reported are the percentages of individuals who use given modes of transport at specified frequencies. In bold denotes the largest figures across clusters.

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tbs.2023.100643.

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