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Understanding the key criteria for shared mobility providers in their evaluation of potential markets

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ABSTRACT

Previous literature on shared mobility has primarily focused on the factors impacting user adoption rates to explain the diffusion of these services across urban areas. However, there is no research incorporating the providers' perspective and exploring the determinants of their expansion strategies. This study addresses this gap by identifying and prioritising the contextual factors that shared mobility providers deem (un)important in selecting the appropriate markets to become active in.

It regards international business, economic geography and shared mobility adoption literature to establish a theoretical framework that steers the search for potential contextual factors influencing these decisions. These criteria are evaluated using pairwise judgements and calculating the principal eigenvector values, as featured in the analytic hierarchy process (AHP) analysis framework, in order to determine their relative importance. The distribution of the utility values indicates the level of agreement regarding the perceived (un)importance of a certain criterion.

The results indicate that shared mobility providers are mainly considering the local institutional context, such as the type of permitting procedure to enter a market and the required key performance indicators with regard to fleet redistribution, fleet availability and parking compliance; the transportation infrastructure, where dedicated infrastructure for active mobility and parking infrastructure for shared mobility is valued; socio-demographics, in particular population density and income; and the coopetition environment, where public transport is considered a complementary service. In contrast, they are less valuing a potential integration within a MaaS application, the conditions specific to an area, such as weather conditions, topography and the land use mix, and the national regulations possibly impacting their services.

The results for different categories of shared mobility services, including free-floating scooters, station-based bicycles and cars, highlight different focal points. Car sharing operators prioritise factors impacting the utility of private vehicles, such as parking regulations and infrastructure, and attach significant importance to the existing uptake of sustainable travel modes by citizens. Micromobility providers, on the other hand, tend to target densely populated and touristic areas and, scooter sharing operators specifically, locations with less strict service level requirements, particularly regarding parking compliance and fleet availability. Furthermore, station-based bike sharing companies focus on the available infrastructure for micromobility vehicles and the assigned role of shared mobility in local policy objectives. There is also a contrast in how providers consider competition and collaboration opportunities with public transport or public sharing schemes, with scooter companies mainly regarding the extent of competitiveness, while bike and car sharing providers primarily consider collaboration possibilities.

As cities struggle to establish effective regulatory and governance frameworks, this research suggests that creating the right local institutional context is essential to attract providers while minimizing the externalities and enhancing the potential benefits of shared mobility. However, there are varying priorities between and within different categories of shared mobility operators, which makes it challenging for local policymakers to establish a policy environment that accommodates the diverse needs of the operators.

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1. Introduction

The current transportation system puts pressure on the livability and sustainability of urban environments. The dependence on the private car for the majority of trips puts challenges on the capacity of the road network, the parking capacity and the public space. Public transport and active mobility are at the core of a transportation system that is less reliant on private car trips. In order to reinforce and complement such network, shared mobility schemes can be introduced. These services can provide new use cases for which the private car was previously necessary (Asensio et al., 2022), extend the reach of the public transport network (Guidon et al., 2019) or increase the accessibility of certain areas (Desjardins et al., 2022). This market for shared mobility services is in full development; major acquisitions happened, new segments are introduced (e.g. shared cargo bike schemes are being launched in German, Dutch, Belgian and Swiss cities) and operators are required to carefully consider the markets they operate in due to the unfavorable economic environment. Additionally, public authorities are either restricting their regulatory environment to reduce the potential externalities of these services (Figg, 2022), looking for new governance forms (Vonk Noordegraaf et al., 2020) or investing in new infrastructural developments as mobility hubs (Coenegrachts et al., 2021) so that a beneficial cooperation can be established.

This leads to a scattered diffusion of shared mobility schemes across European cities (Coenegrachts et al., 2024), which raises the matter why certain cities cannot benefit from emerging mobility alternatives and thus keep partly relying on a private car-oriented transportation system. Previous research has already studied the impact of various urban factors on the diffusion of shared mobility systems, focusing on the consequences for user acceptance and adoption, while mainly having a unimodal focus (e.g. Celsor and Millard-Ball (2007); Kortum et al. (2016), Meelen et al. (2019), Münzel et al. (2019) and Vanheusden et al. (2022) considered car sharing schemes; Médard De Chardon et al. (2017), Galatoulas et al. (2020), Todd et al. (2021) and Anaya-Boig et al. (2021) regarded bike sharing schemes; Aguilera-García et al. (2020) studied moped sharing schemes; and Huo et al. (2021) considered scooter sharing). These studies contribute to our understanding of why certain urban environments could be interesting for shared mobility schemes, as they analyse the extent to which contextual variables, such as socio-demographics, climate, topography, and built environment, favor the probability that certain sharing schemes will be adopted.

However, it is still unclear which factors the actual providers take into consideration when evaluating potential markets (i.e. cities/municipalities), and, to the authors' knowledge, there are no existing studies that are explicitly integrating this operators' perspective. Therefore, this paper focuses on the private shared mobility operator and its assessment of the relative importance of a variety of contextual factors. Furthermore, as the shared mobility market consists of several segments, this paper takes a multimodal perspective, including operators from various shared mobility modes (i.e. shared cars, bicycles and scooters). The main research question this paper will provide an answer to is: *'What are the contextual factors that shared mobility providers take into account when evaluating potential markets they want to expand to and what is the relative importance of these criteria?'*.

This study determines the relative importance of potentially relevant decision elements on the basis of pairwise comparison matrices and the principal eigenvector as featured in the first steps from the Analytic Hierarchy Process (AHP) (Saaty, 1990). To construct a preliminary list of factors, a literature study was conducted on which variables impact user adoption and acceptance of various shared mobility services. As guidance for this review, we used aspects organisations could take into account when deciding on their expansion markets, as described in the international business and economic geography. The resulting list was discussed in 5 expert interviews to assess its comprehensiveness and whether there are other factors that could significantly impact on the operations of the providers. Next, 26 shared mobility operators participated in the survey, leading to 16 valid responses, representing shared mobility services in approximately 170 European cities. The outcomes indicate the importance of different (categories of) decision factors, from the perspective of the shared mobility provider. Therefore, this study contributes to the existing literature on shared mobility diffusion by taking another angle (i.e. the supplier's perspective) and including several segments of the shared mobility market. The outcomes will help us better understand the influencing factors steering shared mobility providers' decision which markets to expand to, and provide insights for local authorities on whether certain contextual factors impact the attractiveness of their city/municipality towards operators, providing them background to (re)consider certain governance elements if they look for opportunities to make shared mobility available.

The remainder of this paper is organized as follows. Section 2 provides the theoretical background as a basis to determine the fundamental elements that are relevant in identifying potential attractive expansion markets. Using this background as basis, this section is complemented with the actual design of the hierarchy of specific attributes that shared mobility providers in particular could take into account. Section 3 elaborates on the methodology that was applied to determine the utility values of the various hierarchy levels and criteria. Section 4 describes the results of this utility analysis, while Section 5 discusses these results and explains how they can be related to contextual characteristics, policies or strategic choices of the operators. The final section concludes the research, together with the limitations of this study and suggestions for further research.

2. Theoretical background

Research on international business and economic geography has considered the topic of location decision factors of firms. The main body of this research analyses which elements of the national and sub-national context impact on the firm-level decision of where to expand their activities (Hutzschenreuter et al., 2020; Jain et al., 2016). A review by Nielsen et al. (2017) argues that the foreign investment decision depends partly on the characteristics of the destination location, which are defined by variables under the umbrella of 'pure economic factors', 'institutions' and 'agglomeration'. The economic factors include attributes of the destination that affect the components of the firms' economic performance, such as market size, affluence, potential growth, presence of competitors, availability, quality and price of resources and physical infrastructure (Dunning, 2000). 'Institutions' refer to the formal institutional context, or the perceived quality of the political and legal national and sub-national institutions, that determine the credibility of the formal institutions and affect the level of uncertainty firms have to deal with when servicing the destination location. While institutions are mainly regarded from the national perspective, the variance in local (or sub-national) institutions, such as local tax incentives, could impact on the economic attractiveness of the location (Nielsen et al., 2017). Intra-industry agglomeration effects indicate the externalities that a geographic cluster of firms from the same industry deliver to an organization. This could occur in the form of increased knowledge transfer through the informal networking of employees from different firms located in proximity to each other or improved access to public infrastructure due to the increased bargaining power of the network (Krugman, 1991). In the next paragraphs, these three broader umbrella terms are used as basis to identify the specific criteria that shared mobility firms could consider relevant.

First, we identify the economic decision factors, or which contextual variables affect the economic potential of a market for shared mobility providers. In this regard, the focus is upon factors that impact the usage and adoption rate of shared mobility services, thus affecting the users' utility and demand for shared mobility services. These will have an impact on the market size and market potential of a municipality. This primarily concerns the socio-demographics of the considered market. User characteristics are assumed to be an important variable in this

regard, i.e. who is using/has a higher intention to adopt shared mobility services. Studies have suggested that age, education level, occupation and income affect the user adoption and usage rate of shared mobility services, i.e. car, (cargo) bike, scooter and moped sharing (e.g. Aguilera-García et al., 2022, 2020; Christoforou et al., 2021; Hess & Schubert, 2019; Mouratidis, 2022). Additionally, the choice for a particular municipality can also be influenced by the presence of a certain market segment, i.e. if certain user groups, who are inclined to use these services more often, are well-established. Examples of market segments are families, tourists or students. Families face more situations where typically a private car would be needed. They could be attracted to alternatives which can fulfil these use cases. Therefore, they could be an interesting target group for car or cargo bike sharing (Coll et al., 2014; Hess & Schubert, 2019). Additionally, tourists could value the temporal access to a range of mobility services (Esztergár-Kiss & Lopez Lizarraga, 2021) and students could be inclined to use shared services as they have less resources to own a private vehicle (Aguilera-García et al., 2020; Reck & Axhausen, 2021). Further considering the socio-demographics, it is argued that the population density is a driving factor for usage, as there is a larger user pool who can access the services within the system's boundaries. It is therefore considered one of the key elements for establishing an economically viable service (Hjorteset & Böcker, 2020; Prieto et al., 2017). Subsequently, there are attributes of the urban environment which have an impact on the utility and convenience of shared mobility services for the different user groups. A distinction is made between contextual factors which cannot be easily adapted, therefore called static, and infrastructural elements. These static elements include land use mix, weather conditions and topography. The precipitation level and temperature affect the temporal usage patterns of shared cars (Schmöller et al., 2015) and micromobility (Bean et al., 2021), while topography can have an impact on the intention to use particular electric shared vehicles (Julio & Monzon, 2022). Furthermore, the land use mix is mentioned in several studies to play a significant role in the success of shared mobility services: the density of trip-generating activities, such as workplaces, schools, restaurants, museums, airports and theatres, affects the potential demand for shared mobility services (Schmöller et al., 2015; Wagner et al., 2016; Zacharias & Meng, 2021). Next to these attributes of the environment, the physical infrastructure, which is considered an important economic appealing factor impacting on a firm's decision (Dunning, 2000), has been regarded in relation to shared mobility. Transportation infrastructure can increase the attractiveness of shared mobility services or decrease the utility of a competing transportation mode, which both increase the economic potential of the market. Examples such as dedicated bicycling infrastructure (Félix et al., 2020; Karpinski, 2021), density of shared stations (Faghih-Imani & Eluru, 2016) and flexible parking availability (Aguilera-García et al., 2020) are seen as advantageous towards shared micromobility, while a dense network of dedicated parking spots (Costain et al., 2012) provides convenience for car sharing users. However, parking infrastructure could also increase the utility of a private car, making it easier to park in the city centre and thereby decreasing the need for shared micromobility (Gonzalez et al., 2022).

Second, we study the institutional setting, the second aspect of a destination's attractiveness (Nielsen et al., 2017), for the shared mobility market. The shared mobility industry has rapidly expanded across urban areas, whose local institutional context has not been adapted to cope with the externalities and potential disturbances these services bring. As pointed out by Punt et al. (2021), location-bound services, such as shared mobility services, disrupt the status quo of local transportation services, while being subject to context-specific regulations. The formal institutions that are found in literature to affect the success of shared mobility systems are parking regulations (Akyelken et al., 2018; Balac et al., 2017), urban vehicle access regulations, such as low-emission zones (Gonzalez et al., 2022), the public support and aid packages (Punt et al., 2021; Vanheusden et al., 2022), the regulation of competition (Punt et al., 2021), the requested service levels (Asensio et al., 2022) and taxation policies (Schwieterman & Bieszczat, 2017). The informal institutions, or the reputation, trust and familiarity that is related to an organization and its activities in the host environment, also play a role. It is suggested that the legitimacy and adoption rate of sharing schemes are affected by the affiliation that customers have with previous sharing services (Punt et al., 2021). Furthermore, research suggests that shared mobility services are attracted to an informal institutional context where the level of environmental awareness is high, indicating that citizens value a sustainable way of travel (Münzel et al., 2019).

Lastly, we consider the agglomeration, being the third characteristic of the framework from Nielsen et al. (2017), with regard to shared mobility. The agglomeration variables represent if there is synergy with competitors, suppliers or other clusters of organizations that can stimulate the use of the different sharing systems and enable knowledge transfer and networking opportunities. Previous research has acknowledged that spillover effects are present between different sharing schemes, indicating that the diffusion and user adoption of one sharing scheme is affected by the presence of the other sharing scheme (Ceccato & Diana, 2018; Münzel et al., 2019). Furthermore, there are other transport services, such as public transport and MaaS operators, which can be regarded as a competitive or complementary actor. Their (perceived) performance and level of integration have an effect on the success of other sharing systems (Krauss et al., 2022; Lee et al., 2021; Stillwater et al., 2009).

By using these three umbrella terms from the framework from Nielsen et al. (2017) as guidance to review the literature on shared mobility in search of criteria that could impact shared mobility providers in their choice for expansion markets, we come up with a first categorization of criteria relevant to shared mobility operators. First, the characteristics of user(s) (groups), which indicate whether there is a large pool of potential users, are categorized under the term 'socio--demographics'. When explicating the criteria belonging to this category, the following attributes from the urban environment are included: the population density, the age structure, the per capita income and the presence of certain potential user groups that seem to be more inclined to use shared mobility, defined as target groups. This last attribute can be further specified as the presence of tourists, families, highly educated persons and students. The second category is named 'local institutional context', which includes the regulations introduced on a local level that significantly impact on the utility of shared mobility services and competing transportation modes. This category includes the regulations for private vehicles (such as parking and urban vehicle access regulations), the service levels required from shared mobility providers, defined as performance indicators, the local support for shared mobility, defined as the role of shared mobility in local policy objectives, and the taxation policies, defined as regulatory fees, posed by the municipality. Thirdly, the attributes from the urban environment that are not easily adaptable but could also have an impact on the adoption and usage rate of shared mobility services are classified as 'static urban environmental factors'. This category consists of the land use mix, the topography and the climate from the considered location. In contrast, attributes from the environment that can be adapted are specified as transportation infrastructural elements. However, in order to also capture the familiarity that current users of the transportation network could have with shared mobility services, the transportation infrastructure category is broadened, including factors such as spillover effects from existing shared mobility services and sustainable modes of transport, thus the fourth category being defined as 'transportation system characteristics'. This consists of contextual attributes such as the modal split, the congestion level, the transportation infrastructure and the spillover from current shared mobility services. The transportation infrastructure is further divided into transportation infrastructure for active mobility, such as dedicated bicycle paths; dedicated parking infrastructure for shared mobility, such as bike sharing stations or parking lots for shared cars; and parking infrastructure for private vehicles. The last, fifth category is

named 'mobility coopetition environment', which reflects the agglomeration effects, or the synergies and competition that shared mobility providers could face with existing actors of the transportation system. This is defined by two main components, namely the current competition in the market and the potential collaborative environment. The former is further defined as the presence of other private sharing schemes and the presence of a qualitative public transport system, while the latter is defined as an integration possibility with a MaaS operator and a collaboration possibility with a public transport operator.

These five categories of criteria include the components that are identified in various studies on shared mobility that could affect the attractiveness of a certain market for shared mobility providers. However, it is important to validate if this list is conclusive and to assess which variables are considered more or less important. The next section elaborates on the methodology that was used to (i) assess the comprehensiveness of the list of criteria and (ii) determine the relative importance of factors that are taken into account by shared mobility providers when considering markets to expand to.

3. Methodology

Literature on multicriteria decision-making processes was reviewed in order to select a method appropriate for the research objective. This research applies pairwise comparisons as featured in the analytical hierarchy process to measure the relative importance of the different decision criteria. As shared mobility providers go through a complex decision process when assessing potential expansion markets, AHP is useful to better understand the prioritization process of the various market's attributes by dividing it into pairwise comparison judgements constructed in hierarchy (Harker & Vargas, 1987). The AHP method was developed by Saaty (1977) and introduced as a decision support tool to evaluate different alternatives or objectives based on a weighting of tangible and intangible criteria or variables. The method has been applied to a wide range of decision-making processes in the field of transportation, in order to be able to prioritize and rank the transportation policy alternatives (e.g. determining the most suitable locations for electric vehicle charging stations (Karolemeas et al., 2021) or mobility hubs (Blad et al., 2022), based on the weights assigned to the attributes of those locations). However, this paper does not conduct an AHP analysis, as no decision-making process for determining the best alternative has been performed, but it does include the pairwise judgements constructed in hierarchy, so that decision-makers can better handle the process of weighing different criteria against each other. Other studies have applied these pairwise comparisons featured in AHP to determine the relative importance between different criteria (e.g. Boselli et al. (2015) studied which features of a smart mobility service are considered important by different types of stakeholders, Jain et al. (2014) analysed which public transport characteristics are considered most important by urban commuters to make a modal shift and Fabianek and Madlener (2023) determined which criteria for charging stations are perceived crucial for different types of drivers). The aim of this research is to better understand which attributes of expansion markets shared mobility providers prioritise and understand the relative importance of criteria against each other. In this regard, this study will apply pairwise judgements between criteria, as featured in the first steps from the AHP analysis, to determine the utility values of these criteria and establish a ranking for them organized in various hierarchy levels. The method consists of three steps. First, a decision hierarchy has to be established. Subsequently, a set of pairwise comparisons has to be created, and lastly, the weights of the different individual variables have to be calculated so that a prioritisation list can be constructed. These steps are illustrated in Fig. 1.

The decision hierarchy is already partly constructed in the previous section, based on a review of the literature. Interviews with key shared mobility stakeholders were held to assess the completeness and relevance of this decision criteria list. Five shared mobility experts provided their feedback, including a scooter, cargo bike, bike and car sharing operator, and a network organisation for shared mobility. In particular, they suggested adding an additional category related to the formal institutional context but reflecting the higher national, not local, level regulations that could impact shared mobility services' operations and utility. This has been defined as the 'national regulatory environment'. Regarding this sixth category, the following attributes have been made explicit: the national regulations for private cars, the presence of a national framework for shared mobility and the role of sustainable mobility services in national policy objectives. Next, the experts provided feedback on how the further hierarchy levels were defined and if the concretization of the lower-level criteria made sense. They suggested to further specify the performance indicators that are posed by the local authority, defined as performance indicators with regard to parking

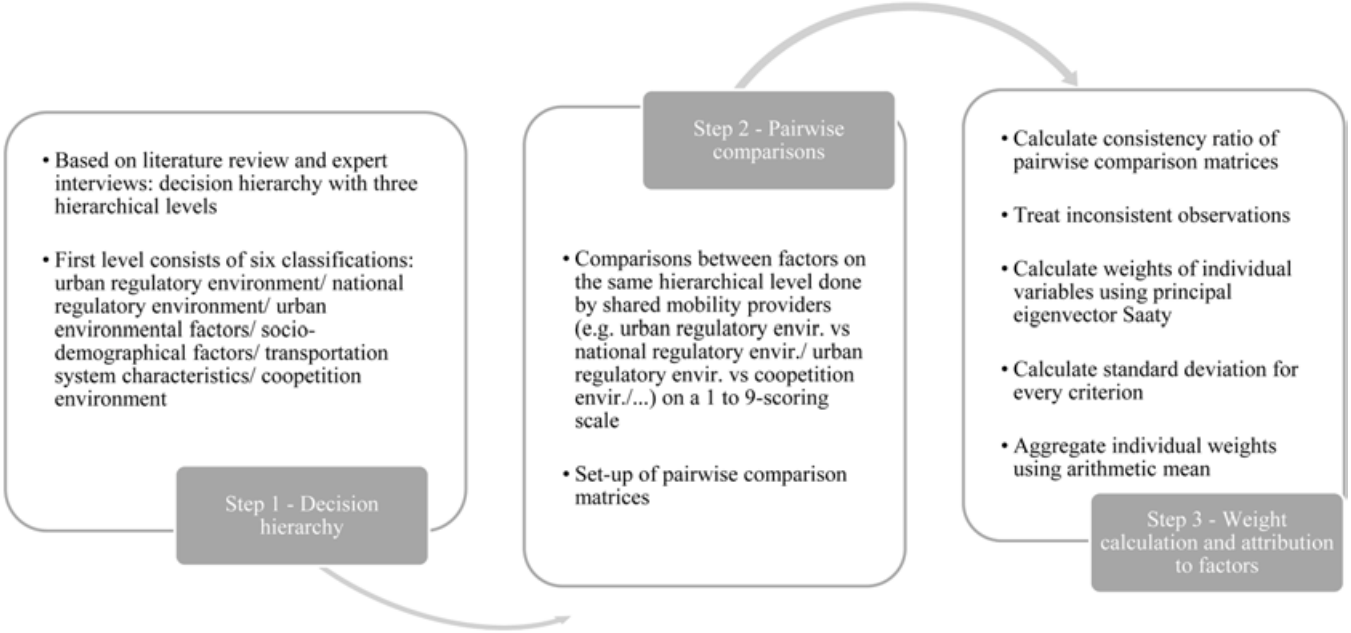

Fig. 1. Step-by-step analysis.

compliance, data sharing requirements, usage level requirements and minimum availability and distribution requirements. Furthermore, the attribute land use mix seemed to be too general, so it has been further defined as the density of point-of-interests, workplaces and residential housing. Lastly, the competition and collaboration factors lacked the integration of a public sharing scheme. The experts indicated that a public sharing scheme can be a significant competitor, as their pricing schemes are relatively inexpensive due to public support, while it can also offer an integration possibility. The final resulting decision hierarchy is depicted in the results section.

Next, a set of pairwise comparison matrices has to be constructed. Therefore, comparative judgments between the criteria on the same hierarchical level are performed by the decision-makers. The panel of respondents only included people involved in the actual decision-making process regarding the choice of markets to which the shared mobility provider would expand. This included CEOs, COOs, business development managers and market expansion managers from bike sharing, scooter sharing, car sharing and cargo bike sharing operators. In total, 26 respondents filled in the surveys, which, after excluding the surveys with missing and inconsistent pairwise comparisons, resulted in 16 usable surveys. This reflects seven responses from scooter providers (all free-floating), four from bicycle providers (all station-based) and five from car providers (two free-floating, three station-based). As these numbers are relatively low, the 16 providers still represent a relevant panel as they operate sharing services in approximately 170 European cities. They had to consider the question*, 'Which of the two factors is more important when deciding on the market (*i.e. *city/municipality) you want to provide shared services to?'*. Before scoring the pairs of criteria, they received information regarding the definition of the criteria to make sure they understood what the factor entails. To make the pairwise

Table 1
Decision hierarchy of market selection factors.

First level attributes	Second Level Attributes	Third level attributes
1. Urban Governance Environment	Permitting Procedure	
	Strict (parking) regulations for private vehicles	
	Less strict performance indicators	Less strict KPIs wrt parking compliance Less strict KPIs wrt data sharing Less strict KPIs wrt usage Less strict KPIs wrt availability and distribution
	Role of SM in local authority's objectives	
	Size of regulatory fee for non-compliance	
2. National Governance Environment	Less car-friendly regulations	
	Presence of a national framework for shared and micromobility regulation	
	Role of sustainable mobility services in national authority's objectives	
3. Urban environmental factors (static)	Land Use Mix	POI density Residential density Workplace density
	Topography	
	Climate	
4. Socio-demographics	Presence of target group	Share of students Share of families Share of highly educated citizens Number of tourists
	Population density	
	Age Structure	Share of young people (18-24y) Share of middle young people (25-44y) Share of middle aged people (45-64y) Share of aged people (65+y)
	Per capita income	
5. Transportation system characteristics	Sustainable modal split	
	Spillover shared mobility	
	Transportation infr. enabling shared and micromobility	Transportation infr. for active mobility Less available parking infr. for private vehicles Parking infr. for shared mobility
	Congestion level	
6. Mobility Coopetition Environment	Competition in the market	Presence of other private sharing scheme Presence of qualitative public transport network Presence of other public sharing scheme
	Potential collaborative environment	Public transport operator's willingness to cooperate Integration possibility with MaaS-operator Integration possibility with public sharing scheme

- Based on literature review
- Based on expert interviews

comparison, they had to provide a score using a scale from 1 to 9, where 1 indicates that both factors are equally important and 9 indicates that this factor is absolutely more important than the other factor. Afterwards, a matrix containing all pairwise comparison scores and their reciprocals is constructed. These matrices are used to perform the third step. This last step consists of calculating the individual weights for every criterion, using the principal eigenvector Saaty (2003) and synthesizing all individual weights to receive an overall priority ranking of the criteria. The aggregation of the individual weights has been done using the arithmetic mean.

First, the overall ranking was created based on the input from all respondents, after which separate rankings were constructed reflecting the different business perspectives, so that a comparison between the factors' prioritization of free-floating scooter sharing, station-based bike sharing and car sharing (i.e. station-based and free-floating) can be made. Further, in order to assess the extent of agreement on the importance of a factor, the standard deviation has been calculated for every criterion, differentiated by the three different operator perspectives and the overall perspective. The R-package ahp survey (Cho, 2019) was used to perform the analysis and treat inconsistent observations so that the consistency ratio is below 0.1, the value considered the limit for obtaining reliable results (Saaty, 1990).

4. Results – the construction, weighting and prioritization of decision factors

As mentioned in the previous section, the preliminary list of decision criteria, based on the literature review, has been assessed on its comprehensiveness by conducting five expert interviews. This resulted in a final decision hierarchy, containing six first-level categories, as depicted in Table 1. The shaded areas indicate the criteria added based on the input from the shared mobility professionals.

The aggregated results of the analysis represent the relative importance of the factors on different hierarchical levels for the panel of all respondents. As they have different business perspectives and operate varying services, there is no consensus on the absolute importance of the criteria. There are certain factors however, that seem to be regarded significantly more important than others, while there are also factors where there seems to be a consensus on its (un)importance. In order to also account for the different business perspectives, the results have further been disaggregated into three categories, namely free-floating scooter sharing, station-based bicycle sharing and car sharing. The following section shows the results of the analysis including the overall sample's perspective, while also reflecting upon (dis)similarities between the results from the different operators' perspectives. The detailed weights, standard deviations and rankings for these three business perspectives are shown in annex A.

When considering the criteria belonging to the first hierarchical level, the factor 'Urban Governance Environment (UGE)' is ranked highest, followed by 'Transportation System Characteristics (TSC)', 'Socio-Demographics (SD)', and 'Mobility Coopetition Environment (MCE)'. The 'National Governance Environment (NGE)' and 'Urban Environmental Factors (UEF)' are considered less important; when considering the spread between utility values, there seems to be most congruence on the low value for UEF, which has the lowest standard deviation (see Table 2, where the standard deviations are displayed between brackets).

Comparing the importance of these factors for the various types of operators, the *urban governance environment* is also ranked first for scooter operators, while bike – and car sharing operators attach more importance to the *characteristics of the transportation system*. However, the *urban governance environment* is still seriously regarded as it is ranked second and third respectively. The least important factor differs only for bike sharing operators, as they score the socio-demographics criterion the lowest. In this regard, scooter and car sharing operators indicate similar results as the overall ranking. One factor that differs between

Table 2
Weights and *standard deviations* of first-level decision factors.

First Level Attributes	Global weight	Scooter sharing	Bicycle sharing	Car sharing
Urban Governance Environment	27.4 % *(0.16)*	31.4 % *(0.14)*	20.7 % *(0.26)*	21.9 % *(0.16)*
Transportation System Characteristics	19.4 % *(0.15)*	11.4 % *(0.08)*	33.3 % *(0.28)*	29.6 % *(0.08)*
Socio-demographics	17.2 % *(0.12)*	16.8 % *(0.12)*	8.5 % *(0.05)*	27.3 % *(0.13)*
Mobility Coopetition Environment	15.7 % *(0.13)*	19.2 % *(0.16)*	11.5 % *(0.08)*	9.6 % *(0.09)*
National Governance Environment	11.1 % *(0.10)*	11.4 % *(0.12)*	12.3 % *(0.15)*	9.0 % *(0.04)*
Urban Environmental Factors (Static)	9.1 % *(0.07)*	9.7 % *(0.04)*	13.7 % *(0.16)*	2.7 % *(0.00)*

scooter versus bike and car sharing operators is the *mobility coopetition* factor, which is highly ranked by scooter operators while being indicated less important by the other two types of operators. Comparing the spread of individual weights between the criteria and types of operators, the standard deviation is low for the *'urban environmental factors'* for both car and scooter sharing operators, while bike sharing operators did not value *'Socio-demographics'* very differently amongst each other. There is however a high standard deviation for *'Urban governance environment'* and *'Transportation system characteristics'* for bike sharing, which indicates a high spread amongst individual values, while having a high aggregated value. In this regard, it is interesting to see the low spread for the '*Transportation system characteristics'* factor for car sharing (highly valued) and scooter sharing (middle-valued) operators.

Considering the ranking of second-and third-level factors, there are certain criteria being regarded as important within their classification class. Related to the UGE criterion, the *permitting procedure* is ranked high, which is also particularly the case for scooter and bike sharing operators, the latter indicating a low spread across their individual weights. Car sharing providers primarily evaluate *the regulations for private vehicles* and the *role of shared mobility in local policy objectives*, the latter being also highly relevant from a bike sharing perspective but not for scooter sharing operators, which do have similar individual weights. The *performance indicators* operators have to comply with are overall an important criterion, but primarily for scooter sharing providers. In this regard, it is interesting to see *distribution and fleet availability requirements* are of concern to all operators, but there is still considerable spread across individual weights. This is due to the fact that they regard another performance indicator, being *parking compliance, level of usage* and *data sharing requirements,* as main consideration, for scooter, bike and car sharing providers, respectively.

Considering the TSC criterion, it is clear that high importance is attached to the *transportation infrastructure*. The kind of transportation infrastructure considered important by all three kinds of providers is *parking infrastructure for shared mobility,* whereas micromobility operators put more emphasis on the *transportation infrastructure for active mobility* compared to *less available parking infrastructure for private vehicles*, which car sharing providers do consider more important. In this regard, there is a very low spread regarding the magnitude of bike and car sharing operators' weights for *transportation infra. for active mobility,* respectively regarded as a major and minor consideration. Furthermore, all operators seem to attach a lower valuation to the factor *sustainable modal split*.

Next, underlying the SD criterion, *population density* and *per capita income* are ranked high by all types of operators, where the *presence of a certain target group* is mainly considered by scooter and car sharing providers. A specific target group is clearly *tourists* for scooter and, to a lesser extent, bike sharing companies, where the latter indicated differing valuations and the former attached similar high valuations to this target group. However, valued as the primary criterion underlying the target group by bike and car sharing providers is the extent to which

the local population have a higher education level. To this regard, it is interesting to see that some bike sharing operators clearly value *tourists*, while others mainly target *citizens having a higher education level*, whereas car sharing operators tend to agree with the high valuation for *citizens having a higher education level*. Regarding the *age structure* factor, which is considered least important across all respondents, there is a clear focus on *young* (bike and scooter sharing) and *middle-young* (all three types of operators) *people.*

Considering the MCE factor, there is a contrast between scooter operators on the one side and bike and car sharing operators on the other. Scooter operators deem the current competition in the market, regarded as both public transport and public or private shared mobility schemes, as very important. This is also reflected in the low spread across scooter sharing operators' valuations of this factor. In this regard, they do not necessarily consider one as a more serious competitor compared to the others. Bike and car sharing operators reflect more upon the collaboration opportunities existing in the market, in which the public transport operator has been indicated an important actor, especially for bike sharing. Scooter sharing operators, although not particularly considering collaboration opportunities, also regard integration with public transport as most interesting cooperation compared to the other two integration possibilities, but there is some spread across the valuations of the different collaboration possibilities. Interestingly, while not significantly considering the competitive environment, almost all bike and car sharing companies also assign public transport the highest value as a potential competitor compared to the other two actors. Furthermore, all three types of operators rank the *integration possibility with a Maas-operator* as the least interesting opportunity for collaboration, but there are variations in car and scooter sharing's weights for this factor.

Underlying the NGE, there is not a clear criterion standing out. There is a clear difference in the value assigned to *less car-friendly regulations implemented at national level*, where car sharing operators rank this factor clearly first and bike sharing operators consistently assign low values to this factor. Scooter sharing operators have distributed weights across the three NGE factors, while car sharing operators converge low weights towards the *presence of a national framework for shared and micromobility regulation*.

Lastly, the more static UE factors, which are valued the least, bring forward the *topography* as least considered criterion, while *land use mix*, is highly ranked by both bike and car sharing operators and *climate* is ranked first by scooter sharing operators. There seems to be uniformity regarding the importance of the land use mix for bike sharing operators, while scooter and car sharing operators show a more dispersed distribution across the three UE factors. Considering the *land use mix*, residential areas are more focused on by some car sharing operators, while bike and scooter sharing providers consistently assign higher values to areas with higher *POI* and *workplace density*. The final weights from the overall analysis covering the whole sample are shown in Table 3, together with the standard deviations. The values displayed indicate the aggregated weight of an individual (sub-)criterion without taking into account the weight from the above hierarchical factor, while the values displayed in brackets indicate the final aggregated weights for the sub-criteria when multiplied by the weight of their upper hierarchical factor. The last column displays the standard deviation of the decision factor, indicating the variation in the valuation of this criteria by all respondents. Annex A presents the final weights and standard deviations, differentiated by the three types of operators.

5. Discussion

The results of the utility analysis, conducted from the overall shared mobility perspective and the perspective of three different types of shared mobility providers, allow to better understand which criteria shared mobility providers take into consideration for the markets they evaluate in their expansion strategies. While the overall results incorporate a group consensus view, conducting this analysis also separately for the different types of shared mobility providers offers the opportunity to see whether there are interesting similarities or dissimilarities between their evaluation of criteria. Furthermore, considering the variation in the values assigned to the criteria, indicated by the standard deviations, for the three operator types, partially allows to understand the extent of agreement regarding the perceived importance of each criterion.

The differences in the valuation of criteria can mainly be attributed to the different impacts these criteria have on the operation or demand for a certain type of shared mobility service. Local regulations are evidently considered, as city officials and planners define the set of rules and legislation for urban mobility. However, it is interesting to see that scooter sharing operators are not agreeing on the importance of one local governance criteria, but weigh between three criteria that directly impact their operations, being the permitting procedure, the imposed performance indicators and the regulatory fees. The type of permitting procedure concerns both micromobility operator types, thus also consistently being highly valued by bike sharing providers, as more and more cities are imposing strict entry regulations for micromobility so that they can set the number of operators and vehicles and define required service levels (Sokolowski, 2020). Certain permitting procedures require many resources for micromobility operators to apply, while some procedures are much less stringent or non-existent, which allows micromobility operators to become active without the need for investing resources in the application process. It could partly explain the large presence of scooter sharing operators in smaller cities that do not use strict procedures (Coenegrachts et al., 2024). Car sharing operators currently do not face that fierce competition to enter markets through competitive tender processes, and it is reasonable that the utility of their services is mainly impacted by local and national (parking) regulations for private vehicles, which they both consider important to a varying degree.

Next, the variation and range of the values assigned to the different performance indicators provide an indication of the extent of the effort required to adhere to these requirements. Parking compliance, which does not seem to pose a problem for car sharing and station-based bike sharing services as these operators agree on its relative unimportance, is particularly difficult for free-floating devices such as scooters. City governments are cautious when it comes to parking and shared mobility, as they do not want an uncontrolled cluttering of vehicles in the public domain (Sokolowski, 2020). Furthermore, bike sharing operators are mainly having difficulties with two performance indicators, being distribution and availability of their fleet and usage levels, while car sharing operators balance between distribution and fleet availability and data sharing requirements.

The extent of the envisaged role that public authorities assign to shared mobility in local, and to a lesser extent national, policies can influence the decision of shared mobility providers to become active in a certain region or municipality, as it is probably linked to potential public funding and development of infrastructure for shared mobility. Considering that station-based bike and car sharing services are regularly being supported or co-operated by a local public partner while scooter sharing services are exclusively provided by private operators (Coenegrachts et al., 2024), it is reasonable that these two former types of operators consistently attach a high value to the envisaged role of shared mobility in local public policy objectives.

The high consideration for the characteristics of the transportation system can be mainly explained by the importance of infrastructure for

Table 3
(Variation of) Overall weights of decision factors.

First Level Attributes	Second Level Attributes	Third Level Attributes	Global Weights	Standard deviation (SD)
Urban Governance Environment			27.4%	*0.16*
	Permitting Procedure		**30.4% (8.3%)**	*0.21*
	Performance indicators for Shared Mobility Providers		22.3% (6.1%)	*0.19*
		Performance indicators wrt distribution and availability of fleet	**34.0% (2.1%)**	*0.24*
		Performance indicators wrt parking compliance	**31.3% (1.9%)**	*0.21*
		Performance indicators wrt usage levels	**17.6% (1.1%)**	*0.18*
		Performance indicators wrt data sharing	**17.1% (1.0%)**	*0.20*
	Role of Shared Mobility in Local Authority's objectives		**19.2% (5.2%)**	*0.18*
	Regulatory Fees		**14.4% (4.0%)**	*0.12*
	Parking Regulations for Private Vehicles		**13.7% (3.7%)**	*0.13*
Transportation System Characteristics			19.4%	*0.15*
	Transportation Infrastructure enabling shared and micromobility		44.7% (8.7%)	*0.19*
		Parking infrastructure for shared mobility	**39.4% (3.4%)**	*0.23*
		Transportation infra. for active mobility	**34.3% (3.0%)**	*0.18*
		Less available parking infrastructure for private vehicles	**26.3% (2.3%)**	*0.23*
	Congestion Level		**20.7% (4.0%)**	*0.17*
	Spillover		**20.7% (4.0%)**	*0.17*
	Sustainable Modal Split		**13.9% (2.7%)**	*0.09*
Socio-demographics			17.2%	*0.12*
	Population Density		**36.6% (6.3%)**	*0.16*
	Per Capita Income		**29.3% (5.1%)**	*0.22*
	Presence of Target Group		20.0% (3.5%)	*0.16*
		Number of tourists	**42.7% (1.5%)**	*0.21*
		Share of highly educated citizens	**26.7% (0.9%)**	*0.19*
		Share of students	**20.3% (0.7%)**	*0.13*
		Share of families	**10.3% (0.4%)**	*0.09*
	Age Structure		14.0% (2.4%)	*0.12*
		Share of middle young people	**46.3% (1.1%)**	*0.16*
		Share of young people	**40.6% (1.0%)**	*0.17*
		Share of middle aged people	**7.7% (0.2%)**	*0.02*
		Share of aged people	**5.4% (0.1%)**	*0.01*
Mobility Coopetition Environment			15.7%	*0.13*

(*continued on next page*)

Table 3 (*continued*)

	Competition in the market		52.6% (8.3%)	*0.35*
		Presence of qualitative public transport network	**48.6% (4.0%)**	*0.30*
		Presence of other public sharing scheme	**27.9% (2.3%)**	*0.24*
		Presence of other private sharing scheme	**23.5% (1.9%)**	*0.24*
	Potential collaborative environment		47.4% (7.5%)	*0.35*
		Public transport operator's willingness to cooperate	**55.3% (4.1%)**	*0.25*
		Integration possibility with other public sharing scheme	**25.2% (1.9%)**	*0.18*
		Integration possibility with MaaS-Operator	**19.5% (1.5%)**	*0.13*
National Governance Environment			11.1%	*0.10*
	Role of sustainable mobility services in national authority's objectives		**40.0% (4.4%)**	*0.23*
	Presence of national framework for shared and micromobility regulation		**31.8% (3.5%)**	*0.21*
	Less Car-Friendly Regulations		**28.2% (3.1%)**	*0.31*
Urban Environmental Factors (Static)			9.1%	*0.07*
	Climate		**41.5% (3.8%)**	*0.30*
	Land Use Mix		33.5% (3.0%)	*0.26*
		POI Density	**40.4% (1.2%)**	*0.13*
		Workplace Density	**33.7% (1.0%)**	*0.11*
		Residential Density	**25.8% (0.8%)**	*0.19*
	Topography		**25.0% (2.3%)**	*0.18*

shared mobility services. Bike sharing operators show dispersion in their valuation of this criteria, but on average, they indicate it as the most important criterion, while all car sharing providers do agree on the importance of this criterion. However, this is not the case for scooter sharing operators, as they agree on the relatively lesser importance of this criterion for them. It is difficult to extract information on which of the underlying criteria the operator types collectively perceive as important, as the different respondents have dispersed valuations. However, there are certain criteria on which consensus is reached, such as the modal split (low importance for scooters and bicycles, relatively high importance of car sharing), spillover effects (low importance for bike sharing) and the current congestion levels (relatively high importance for car sharing). Underlying the transportation infrastructure, which the operator types value to varying extent, there is agreement on the importance of transportation infrastructure for micromobility operators, whereas it is logical that carsharing operators agree on its unimportance. This type of dedicated infrastructure (such as bicycle lanes) increases the safety perception of potential micromobility users and makes it more convenient to use these vehicles. Cities having extensive infrastructure for active mobility, also seem to attract relatively more micromobility operators, as indicated by Coenegrachts et al. (2024). The other two transportation infrastructure factors are more traded-off by the three operators types, but on average parking infrastructure is more valued by scooter and car sharing operators. This dedicated parking infrastructure for shared mobility services is valuable for scooter sharing operators on the one side, as it creates the capacity to comply with parking requirements so that the public resistance against these modes (Gössling, 2020) will lower. On the other side, such infrastructure is also valuable for car sharing operators, as parking pressure for cars, both shared as private, can be extremely high in cities, which could cause frustration for customers trying to find an available parking spot for a shared car when there are no dedicated spots.

The values of the socio-demographic category, which are relatively similar within the type of operator, indicate that car sharing operators are significantly considering the socio-demographics in order to estimate potential demand, while scooter and especially bike sharing operators are less focused upon the socio-demographical characteristics of the potential municipality. In this regard, car sharing companies are

balancing between the level of wealth and the presence of a certain target group within a market, while they converge on the relative importance of densely populated areas. Their services are more complex and expensive to use than micromobility services, but they also offer other types of use cases. Car sharing trips are more frequently planned, longer trips (Ferrero et al., 2018), whereas micromobility trips tend to be more spontaneous, short trips (Badia & Jenelius, 2023). This is partly reflected in the importance that scooter operators consistently assign to densely populated and touristic areas. The age structure is of minor importance for all operator types, but when asked to evaluate the importance of different age groups, there is a clear tendency towards young and middle-young customers.

As stated above, the consideration of competition to enter a market is reflected by the importance of the permitting procedure for micromobility operators. Additionally, all scooter sharing respondents indicated that they consider existing competition to be more decisive than potential collaboration opportunities when assessing possible markets. In contrast, all bike and car sharing operators place much greater importance on collaboration possibilities. Regarding possible competitive actors, scooter-sharing operators have differing views on which competitor poses the greatest threat, whether it is public transport, a public sharing scheme, or a private sharing scheme. If a public transport or bike sharing service is available in a certain location and regarded as qualitative, there is less tendency from current users to switch to a scooter sharing service, which could diminish the attractivity of such locations for scooter operators planning expansions. Furthermore, the pricing schemes for public services are typically less expensive compared to private shared mobility services, adding to the competitive disadvantage for scooter sharing operators. However, we see that large cities having a public bike sharing system also attract numerous private free floating mobility services, as the pool of potential users is still sufficiently large (Coenegrachts et al., 2024). Regarding collaborative opportunities, all operators identify integration with public transport to a certain extent as the most promising option among the three collaboration possibilities. However, bike-sharing operators consistently prioritize this type of cooperation. This could be attributed to the fact that many station-based bike-sharing schemes are co-operated with or supported by a public entity, reflecting an intention to integrate station-based bike sharing into existing public transport services. In contrast, integration within a MaaS-platform is consistently considered overall as the least important among the three collaboration opportunities. This is remarkable, given that many public authorities are implementing MaaS solutions. In such cases, integrating private shared mobility services could become an issue as their operators are not really finding this integration opportune. Nonetheless, to a certain extent, shared mobility operators are thus looking for collaboration opportunities with existing mobility services, which can support local authorities to move towards a less car-centric local transportation system.

Further, there is uniformity regarding the lesser importance of the national institutional context as decision criterion. A possible explanation could be that national legislation is mainly considering all transportation modes, so not bringing a (dis)advantage to shared mobility modes compared to privately owned vehicles. As already stated above, local authorities, rather than national authorities, have more policy interventions at hand that can either enhance or reduce the utility that shared mobility services can bring to the public urban environment.

Finally, it seems reasonable that all three operator types overlook factors, and to the greatest extent car sharing operators, specific to a certain geographical area, such as weather conditions, topography and spatial planning considerations such as land use mix. However, these factors still impact the utility of shared micromobility services, but not really for car sharing services, which is in line with their valuation. It is difficult to draw conclusions on the alignment of the underlying criteria's importance. However, bike sharing operators do consistently prioritise the mix of land use. In this regard, there is a clear preference from both micromobility provider types towards areas having a high density of workplaces and point-of-interests.

The results indicate that the priorities differ to a certain extent across, but also within, different business perspectives. These differences provide valuable insights into which contextual factors seem to impact the economic potential of a market for a specific type of shared mobility service. There are some common denominators that seem to be considered important by all providers, where the distribution of individual weights is concentrated around higher values, such as the way local authorities govern and manage shared mobility services, the available infrastructure for shared mobility and densely populated and wealthy areas. Additionally, there are certain factors that seem to be considered less important to all providers, such as the age structure of a considered area, the integration possibility within a MaaS-application and the specific climate, topological and spatial conditions from an area, grouped under the urban environmental factors category.

When considering the dissimilarities between the providers, it is interesting to see that scooter operators are mainly considering factors related to their competitiveness, as they are operating in a highly competitive environment. They have to compete in order to enter markets (i.e. the type of permitting procedure plays an important role here), they have to be allowed to keep operating in a market (i.e. local authorities are requiring compliance with stricter service levels, which has an impact on scooter operators' daily operations) and they are partly competing as an alternative for other public mobility services (such as public transport or public bike sharing). Station-based bike sharing operators differ from scooter sharing operators as they are mainly public supported entities which do not face this competition in terms of being allowed to stay in the market. As they are relying on public funding, they significantly value the ambition that local authorities have for shared mobility. Additionally, they are significantly valuing opportunities to collaborate with public transport. It is suggested that, since this is also a public service, integrating their services with public transport can leverage their network and better showcase the added value of their service towards policymakers. Contrasting the micromobility services, car sharing providers mainly value factors that negatively affect the utility of the private car, for which they provide a direct alternative for. They also seem to rely on local authorities to provide the necessary support and infrastructure so that there are enough dedicated parking spots. Furthermore, they seem to highly consider the number of people already using a sustainable mode of transportation, such as bicycles or public transport, as their shared vehicles are typically used in cases where bicycles or public transport are not feasible to use.

6. Conclusion

This paper took a multimodal perspective and regarded the shared mobility market in various segments. The diffusion of shared mobility services across European cities is dispersed and the suppliers' dynamics behind this diffusion are unclear. Therefore, this paper considered the perspective of shared mobility service providers, in order to better understand which factors they prioritise or overlook when evaluating potential expansion markets. To the authors' knowledge, their input has not been regarded before in this field of research.

International business and economic geography literature was used as a theoretical basis to identify key components that organisations, in general, could consider in their expansion decisions. These components

guided the next step in the literature review, namely to search for potential criteria in a shared mobility context. This, together with input from five expert interviews, led to the decision hierarchy framework that contains the factors that shared mobility providers could take into account. In order to determine the relative importance of these criteria for shared mobility providers in general and identify specific (dis)similarities in the relative ranking between different types of shared mobility providers, a pairwise judgements analysis was conducted. A panel of decision makers which represent a broad share of the shared mobility market in European cities, including major scooter, station-based bike and car sharing companies, scored the pairwise comparisons between different criteria. This led to individual utility values for every criterion, which were aggregated according to the specific operator type. The distribution of these values indicates the degree of consensus within each operator category regarding the (un)importance of a certain criterion. The results suggest that local authorities have a considerable impact on the attractiveness of their municipality towards shared mobility operators. First, they are determining the local regulations and governance of (shared) urban mobility, which are criteria considered highly important for all shared mobility organisations. Additionally, local authorities are (partly) responsible for developing the infrastructure that allows shared mobility services to be convenient and utile to use, such as dedicated bicycle paths and dedicated parking infrastructure, which are additional significant regarded factors. Lastly, they frequently are a stakeholder in public transport or public shared mobility companies, whose presence, performance and collaborative willingness are prominent factors considered by both scooter sharing (mainly regarded in terms of competition) and bike and car sharing companies (mainly regarded in terms of cooperation potential).

These findings add to a better understanding of the specific criteria that different shared mobility companies value, which allows local authorities to determine if and which factors they could adapt if they want to attract or influence certain types of shared mobility companies. They could explore possible opportunities for collaboration and integration, or they could discuss changes to the regulatory and governance framework in order to make certain types of service level requirements less stringent or apply a different type of permitting procedure. However, it is important to keep in mind that regulation is necessary to reduce the externalities that shared mobility could bring (such as uncontrolled cluttering and preventing right-of-way). In this regard, parking compliance can be improved by incentivising the operators to keep further developing solutions that can assess proper parking behaviour, while cities can provide more (virtual) drop-off zones that accommodate parked vehicles. Furthermore, local authorities could discuss with shared mobility providers to broaden their focus, also including older and lower-income citizens, and discuss how an advantageous relation with public transport can be established, as it is now regarded as both a competitive and complementary service.

In addition, the findings help us understand the differences in focal points from the different types of companies so that we can better identify their target groups, the regulations that heavily impact their operations or the urban form factors that influence the preferred areas they want to be active in. From the literature, certain of these factors also seem to have an impact on the diffusion, adoption and usage rate when considering the user perspective, such as the presence of other urban mobility services or the availability and quality of the transportation infrastructure. These influence the utility that shared mobility services could offer for citizens, thereby increasing the market potential and business opportunity for shared mobility organizations.

A limitation of this study is that the weighting of the decision criteria is done on an aggregated basis, which implies that there is no consensus on the absolute importance of the criteria and that information on the individual's scores is partly lost. This has been partly addressed by calculating the standard deviation for every criterion, differentiated by operator type. However, this spread varies according to the number of pairwise comparisons the individuals had to perform within a hierarchy and also the number of respondents that are within an operator category. As the number of bike sharing and car sharing respondents is more limited, they tend to have less varying values and more distinct weights compared to the group of scooter sharing respondents. A larger pool of respondents could lead to less biased results for estimating the extent of consensus.

Furthermore, the actual (aggregated) weights from the analysis are not used in a model to assess the attractiveness of actual markets (municipalities) for the different types of shared mobility operators included in this study. However, it was not the aim of this paper to determine valid, actual weights for the criteria, but to determine the relative importance or ranking of the criteria, and the extent of (dis)agreement, from the perspective of shared mobility providers in general and from the perspective of different shared mobility businesses in specific. Given that our respondent pool comprises a representative sample, including key decision-makers and covering a significant part of the market, their evaluation of the relative importance of criteria still remains insightful. Building and using an actual assessment model to estimate the potential attractiveness of municipalities for different types of shared mobility providers can be a path that future research could explore. Lastly, in order to cope with the inconsistency and loss of information that is coherent with the process, future research could focus more on the actual investment behavior that service providers show in their destination locations and see if it is consistent with the results of this study.

CRediT authorship contribution statement

Elnert Coenegrachts: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Thierry Vanelslander:** Writing – review & editing, Supervision. **Ann Verhetsel:** Writing – review & editing, Supervision. **Joris Beckers:** Writing – review & editing, Supervision, Funding acquisition.

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.

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Annex A – (Spread of) Weights of decision criteria across different operator types

Appendix

Criteria	Overall -Weights (SD)	Scooter sharing – Weights (SD)	Bicycle sharing – Weights (SD)	Car sharing – Weights (SD)
Urban governance environment	**27.4% (0.16)**	**31.5% (0.14)**	**20.7% (0.26)**	**21.9% (0.16)**
Permitting procedure	30.4% (0.21)	35.7% (0.23)	32.5% (0.13)	12.5% (0.11)
Performance indicators for shared mobility providers	22.3% (0.19)	26.9% (0.22)	16.3% (0.18)	14.8% (0.07)
Performance ind. distribution and availability of fleet	*34.0% (0.24)*	*34.1% (0.21)*	*35.2% (0.42)*	*35.4% (0.35)*
Performance ind. parking compliance	*31.3% (0.21)*	*42.1% (0.19)*	*17.1% (0.00)*	*8.5% (0.03)*
Performance ind. usage levels	*17.6% (0.18)*	*9.2% (0.04)*	*41.3% (0.38)*	*20.8% (0.03)*
Performance ind. data sharing	*17.1% (0.20)*	*14.6% (0.16)*	*6.3% (0.04)*	*35.4% (0.36)*
Role of shared mobility in local authority's objectives	19.2% (0.18)	8.0% (0.01)	40.8% (0.29)	30.9% (0.15)
Regulatory fees	14.4% (0.12)	18.5% (0.14)	4.9% (0.02)	11.8% (0.12)
Parking regulations for private vehicles	13.7% (0.13)	10.9% (0.11)	5.4% (0.05)	30.0% (0.15)
Transportation system characteristics	**19.4% (0.15)**	**11.4% (0.08)**	**33.3% (0.28)**	**29.6% (0.08)**
Transportation infrastructure enabling shared and micromobility	44.7% (0.19)	42.5% (0.21)	57.5% (0.18)	38.3% (0.19)
Parking infrastructure for shared mobility	*39.4% (0.23)*	*39.9% (0.20)*	*26.2% (0.30)*	*60.7% (0.37)*
Transportation infrastructure for active mobility	*34.3% (0.18)*	*38.5% (0.16)*	*47.2% (0.00)*	*10.9% (0.03)*
Less available parking infrastructure for private vehicles	*26.3% (0.23)*	*21.6% (0.19)*	*26.6% (0.29)*	*28.4% (0.39)*
Congestion level	20.7% (0.17)	19.3% (0.19)	24.3% (0.27)	21.6% (0.05)
Spillover	20.7% (0.17)	27.6% (0.18)	6.8% (0.01)	14.0% (0.16)
Sustainable modal split	13.9% (0.09)	10.6% (0.07)	11.4% (0.10)	26.0% (0.01)
Socio-demographics	**17.2% (0.12)**	**16.8% (0.12)**	**8.5% (0.05)**	**27.3% (0.13)**
Population density	36.6% (0.16)	37.8% (0.13)	42.7% (0.32)	23.0% (0.03)
Per capita income	29.3% (0.22)	21.1% (0.11)	43.0% (0.38)	41.5% (0.40)
Presence of target group	20.0% (0.16)	21.9% (0.13)	11.0% (0.05)	26.9% (0.31)
Number of tourists	*42.7% (0.21)*	*50.5% (0.13)*	*38.2% (0.35)*	*23.8% (0.26)*
Share of citizens having higher education level	*26.7% (0.19)*	*18.3% (0.11)*	*43.2% (0.38)*	*35.5% (0.06)*
Share of students	*20.3% (0.13)*	*22.2% (0.16)*	*15.3% (0.03)*	*19.7% (0.17)*
Share of families	*10.3% (0.09)*	*9.1% (0.06)*	*3.3% (0.00)*	*20.9% (0.15)*
Age structure	14.0% (0.12)	19.2% (0.13)	3.3% (0.00)	8.5% (0.05)
Share of middle-young people	*46.3% (0.16)*	*41.0% (0.07)*	*43.5% (0.35)*	*65.4% (0.03)*
Share of young people	*40.6% (0.17)*	*46.8% (0.06)*	*43.9% (0.33)*	*20.0% (0.00)*
Share of middle-aged people	*7.7% (0.02)*	*6.5% (0.01)*	*7.7% (0.03)*	*9.8% (0.04)*
Share of aged people	*5.4% (0.01)*	*5.8% (0.01)*	*4.9% (0.00)*	*4.9% (0.01)*
Mobility coopetition environment	**15.7% (0.13)**	**19.2% (0.16)**	**11.5% (0.08)**	**9.6% (0.09)**
Competition in the market	52.6% (0.35)	78.6% (0.15)	11.8% (0.01)	15.5% (0.02)
Presence of qualitative public transport network	*48.6% (0.30)*	*36.5% (0.32)*	*79.5% (0.02)*	*54.1% (0.29)*
Presence of other public sharing scheme	*27.9% (0.24)*	*32.9% (0.22)*	*14.3% (0.04)*	*26.6% (0.10)*
Presence of other private sharing scheme	*23.5% (0.24)*	*30.6% (0.22)*	*6.2% (0.03)*	*19.3% (0.20)*
Potential collaborative environment	47.4% (0.35)	21.4% (0.15)	88.2% (0.01)	84.5% (0.02)
Public transport operator's willingness to cooperate	*55.3% (0.25)*	*45.6% (0.23)*	*80.7% (0.01)*	*57.0% (0.33)*
Integration possibility with other public sharing scheme	*25.2% (0.18)*	*32.7% (0.12)*	*10.7% (0.01)*	*22.3% (0.16)*
Integration possibility with MaaS-Operator	*19.5% (0.13)*	*21.6% (0.14)*	*8.6% (0.02)*	*20.7% (0.18)*
National governance environment	**11.1% (0.10)**	**11.4% (0.12)**	**12.3% (0.15)**	**9.0% (0.04)**
Role of sustainable mobility services in national authority's objectives	40.0% (0.23)	37.7% (0.26)	38.1% (0.17)	28.2% (0.27)
Presence of national framework for shared and micromobility regulation	31.8% (0.21)	39.0% (0.16)	56.3% (0.18)	7.2% (0.03)
Less car-friendly regulations	28.2% (0.31)	23.2% (0.23)	5.6% (0.01)	64.6% (0.23)
Urban environmental factors	**9.1% (0.07)**	**9.7% (0.04)**	**13.7% (0.16)**	**2.7% (0.00)**
Climate	41.5% (0.30)	48.0% (0.29)	19.3% (0.13)	21.2% (0.17)
Land use mix	33.5% (0.26)	16.8% (0.11)	72.1% (0.11)	57.6% (0.34)
POI density	*40.4% (0.13)*	*43.3% (0.12)*	*47.2% (0.00)*	*25.0% (0.12)*
Workplace density	*33.1% (0.11)*	*32.1% (0.08)*	*47.2% (0.00)*	*25.0% (0.12)*
Residential density	*25.8% (0.19)*	*24.5% (0.10)*	*5.6% (0.00)*	*50.0% (0.24)*
Topography	25.0% (0.18)	35.2% (0.25)	8.6% (0.02)	21.2% (0.17)

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