Transport Policy 191 (2027) 104547



Contents lists available at ScienceDirect

Transport Policy

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



Engagement towards car-sharing use in Budapest: from fears to benefits

Dávid Földes [a,*], Ráchel Surányi [a], Bálint Csonka [b], Csaba Csiszár [b], Borbála Simonovits [a]

[a] Department of Transport Technology and Economics, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics, Műegyetem rkp. 3., H-1111, Budapest, Hungary
[b] Institute of Intercultural Psychology and Education, Faculty of Education and Psychology, ELTE Eötvös Loránd University, Budapest, Hungary

ARTICLE INFO

Keywords:
Car-sharing
Representative survey
Quantitative research
Usage intention

ABSTRACT

Car-sharing has the potential to alleviate urban transport problems, yet its modal share remains relatively low. Increasing usage requires a clear understanding of key motivations and barriers. In this study, we analysed a city-level online survey of licensed adult residents (N = 836) conducted in Budapest in October–November 2024, weighted to be representative by gender, age, and education. Our main research question was which factors are associated with different levels of car-sharing engagement, especially differences between potential, trial, and active users. These engagement groups were compared by using descriptive statistics and chi-square tests, and then a multivariate analysis was conducted. Looking at the socio-demographic factors, the engagement is higher among younger and higher-educated respondents, those with higher incomes, and especially those without regular access to a private car. However, when controlling for these variables, only gender and age correlate significantly. Furthermore, we examined different dimensions of perceptions about car-sharing, and we found that while fear and environmental benefits are negatively associated with active-user status, while perceived personal benefits are positively associated with it. These findings can inform operators and policymakers in designing measures that foster both adoption and frequent use.

1. Introduction

Shared mobility is expected to contribute to the shift toward more sustainable transport by promoting resource usage efficiency (Martinez et al., 2024). At the policy level, shared mobility is positioned as a key instrument of the EU's Sustainable and Smart Mobility agenda, contingent on effective regulation and data governance (Tánczos, 2025). Car-sharing offers individual travel without the disadvantages of owning a vehicle and improves vehicle utilisation. The services can lead to positive impacts, such as reduced car use and ownership, but the magnitude of these benefits depends on the fuel type and the lifetime of shared vehicles (Harris et al., 2021; Jung and Koo, 2018; Liao & and Correia, 2022; Poltimäe et al., 2022). One car-sharing vehicle could even replace up to 20 private cars (Jochem et al., 2020), resulting in a lower parking space requirement. Furthermore, fewer cars should be manufactured, which contributes to material saving and waste reduction (Harris et al., 2021). Another more indirect effect on sustainability is that car-sharing users in suburban areas tend to drive fewer kilometres than their counterparts in dense urban areas (Clewlow, 2016).

Car-sharing is expanding globally; in Europe, services operate in at least 72 cities (Fluctuo, 2024). Despite continued growth, its modal share remains low. In Berlin—one of the early adopter cities—the estimated modal share of car-sharing is only 0.24% (based on the number of rides provided by Fluctuo (2024) in 2023 and modal shift data). Turoń (2025) argues that many sustainable mobility approaches are normatively well justified, but their practical implementation is often weakened by fragmentation, insufficient sequencing, limited intermodality, and weak citizen participation. This perspective is relevant for car-sharing as well: although it is commonly presented as a sustainable mobility solution, its contribution to urban mobility transitions depends on whether it is embedded in predictable, user-centred and well-integrated mobility ecosystems.

Understanding the motivation for usage and the complex associations behind it is essential to increase its share, introduce motivation measures, and improve the service quality. Because successful car-sharing systems must reflect both general behavioural patterns and the specific needs of local urban and national contexts (Aguilera-García et al., 2022; Parente et al., 2018), empirical evidence from individual

* Corresponding author.
E-mail address: foldes.david@kjk.bme.hu (D. Földes).

https://doi.org/10.1016/j.tranpol.2026.104547
Received 13 January 2026; Received in revised form 2 October 2026; Accepted 6 November 2026
Available online 7 November 2026
0967-070X/© 2026 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

cities remains essential. However, the existing literature still leaves several gaps. Social pressure, electric vehicle options, premium cars, and hygiene or vehicle condition are rarely examined. Moreover, studies usually do not compare user types, which limits our understanding of how potential, trial, and active users differ in their socio-demographic profiles, perceptions and intentions. Accordingly, we aimed to reveal the association between travel habits, personal characteristics, and car-sharing usage. Our main research question was which barriers and motivational factors are associated with active car-sharing use rather than potential interest or trial use. An online quantitative survey was conducted, and responses from people with a driver's license were collected in Budapest, Hungary. The novelty of the research lies in the externally valid sample, as the sample size is large (N = 836) and representative of the gender, age group, and educational level of Budapest inhabitants over 18 years old. To the best of our knowledge, no representative survey has been conducted that focuses on car-sharing usage in a single large city, such as Budapest. Furthermore, socio-demographic aspects, expected impacts, and service characteristics were combined during the analysis to identify typologies.

The remainder of the paper is organised as follows. Section 2 provides a comprehensive review of questionnaire-based studies on expectations and usage intentions; furthermore, it summarises the travel behaviour change and urban mobility transitions related to car-sharing use. Section 3 describes the research design, including the study area, data collection, and analytical methods. Section 4 presents the results, and Section 5 discusses their implications and outlines corresponding policy recommendations.

2. Literature review

The literature review synthesised two complementary strands: (i) empirical, survey-based studies on car-sharing adoption, usage intentions, motivations and barriers, and (ii) broader conceptual research interpreting car-sharing within behavioural change and urban mobility

Table 1
Focus area and sample characteristics of the reviewed papers.

Paper	Focus area	Location	Year of sampling	Sample size	Representativeness	Note
Abouelela et al. (2024)	Acceptance modelling	Munich (Germany)	2022	1044	No	Students are overrepresented
Aguilera-García et al. (2022)	Acceptance modelling	Madrid (Spain), Munich (Germany)	2019	1865	No	
Akel and Bayır (2025)	Psychological factors	Turkey[a]	2025	395	No	
Ali Aden et al. (2022)	Market potential analyses	Djibouti City (Djibouti)	2022	600	No	
Becker et al. (2017)	Usage patterns	Basel (Switzerland)	2015	1480	Partially	Control group is weighted
Bojković et al. (2025)	Usage patterns	Belgrade (Serbia)	2017	907	No	University students
Bretter et al. (2024)	Psychological factors	United Kingdom[a]	2024	1294	Yes	Gender and age, but people of white ethnicity are overrepresented
Burghard and Dütschke (2019)	Socio-demo-graphic factors	Stuttgart (Germany)	2014	1548	No	
Burghard and Scherrer (2022)	Psychological factors	Germany[a]	2019	1531	Yes	Gender and age for urban citizens based on quotas
Curtale et al. (2021)	Acceptance modelling	The Netherlands	2020	656	Partially	Age and income, but women and high income are overrepresented
Fleury et al. (2017)	Socio-demo-graphic factors	Paris (France)	2017	228	Partially	Weighted for gender, age, and employment status
Guglielmetti Mugion et al. (2019)	Socio-demo-graphic factors	Rome and Milan (Italy)	2017	230	No	
Lempert et al. (2019)	Usage patterns	Vancouver (Canada)	2017	4010	Partially	For the two-way car-sharing users
G. Li et al. (2025)	Acceptance modelling	China[a]	2025	399	Yes	Gender, age, and income for private car owners
L. Li and Zhang (2023)	Acceptance modelling	3 big cities (China)	2021	1165	No	
Matowicki et al. (2021)	Market potential analysis	Czech Republic[a]	2019	366	No	Among car-sharing users
Mavlutova et al. (2021)	Sustainability dimensions	Riga (Latvia)	2013	2054	No	Household survey
Prieto et al. (2019)	Market potential analysis	London (UK), Paris (France), Madrid (Spain)	2019	2159	Yes	Gender, age, and employment status for licensed car drivers
Priya Uteng et al. (2019)	Socio-demo-graphic factors	Oslo (Norway)	2017	2841	No	
Safdar et al. (2022)	Acceptance modelling	Lahore (Pakistan)	2018	242	No	
van der Linden et al. (2025)	Usage patterns	The Netherlands[a]	2023	1281	Yes	Gender, age, education, income, location, and car ownership
Vătămănescu et al. (2025)	Sustainability dimensions	Romania[a]	2023	400	No	Only generation Z
Y. Wang et al. (2017)	Acceptance modelling	4 big cities (China)	2015	826	No	
D. Wang et al. (2025)	Acceptance modelling	China	2020	500	No	
S. Wang and Song (2024)	Acceptance modelling	China[a]	2021	1238	Yes	Gender, age
Wittwer and Hubrich (2018)	Usage patterns	7 big cities (Germany)	2012 and 2016	1973 and 2567	No	
Yu et al. (2023)	Acceptance modelling	Guangzhou (China)	2022	486	No	Only students
Zawieska et al. (2025)	Usage patterns	Warsaw (Poland)	2023	1157	No	

[a] Country level.

transitions.

2.1. Car-sharing adoption and usage intention

Connected to the methodology used in this study, we conducted a keyword-based search in Scopus, using the term "car-sharing" in combination with terms related to service use (usage, adoption, acceptance, intention, motivation, and barrier) and methodological approaches (survey, questionnaire, stated preference, and discrete choice) in titles and abstracts, including common spelling variants. 128 papers published in English and later than 2014 were retrieved. After screening the titles and abstracts, 29 papers were selected for further analysis.

Table 1 summarises the key characteristics of the selected studies. Based on their primary focus, the papers were grouped into six categories: market potential assessments (3), general sustainability analyses (2), acceptance modelling (11), psychological determinants (3), socio-demographic correlates (4), and general usage-pattern studies (6). Although the study locations vary, most evidence comes from Europe and China. Sample sizes range from a few hundred to several thousand respondents. However, only 10 of the 29 studies use samples that are at least partially representative for selected characteristics, and none provides a representative sample at the single-city level.

The papers were further analysed using a content-based coding scheme. The following thematic categories and related aspects were identified as relevant to the aim of this study:

- socio-demographic: gender, age, education, income, private car access;
- expected effects of car-sharing: economic benefit, sustainability, social pressure/opinion;
- service characteristics: electric cars, premium cars, price, hygiene/condition;
- user segmentation (considering users or non-users).

Table 2 shows whether the papers analysed the aspects. Overall, the literature primarily emphasises socio-demographic aspects and/or expected impacts, often in the context of technology acceptance modelling. In several cases, aspects are only mentioned descriptively without a detailed empirical assessment. Service characteristics are comparatively underexplored, typically limited to price.

Similarly, respondents with driving licenses were analysed by Prieto et al. (2019), S. Wang and Song (2024), or Zawieska et al. (2025); however, some aspects were not considered, such as social pressure, electric cars, and hygiene/condition. These aspects are the least analysed ones in the literature. Moreover, some studies cover multiple dimensions but do not compare user segments, e.g., G. Li et al. (2025), L. Li and Zhang (2023) and D. Wang et al. (2025). The studies are built on surveys analysing at least existing car-sharing users; however, Safdar et al. (2022) and Y. Wang et al. (2017) used a stated-preference survey of the general public as car-sharing is not available in their study context.

Across the literature, the most common car-sharing user profile is that of a younger male, typically with higher education and income (Abouelela et al., 2024; Aguilera-García et al., 2022; Becker et al., 2017; Wittwer and Hubrich, 2018). Socio-demographic effects are not uniform: gender is often non-significant as a direct predictor and instead operates indirectly or via moderation (Curtale et al., 2021; Fleury et al., 2017; L. Li and Zhang, 2023). This pattern may partly reflect the higher driving-licence ownership among men. Car access tends to hinder car-sharing adoption and usage intention (Abouelela et al., 2024; Becker et al., 2017; Curtale et al., 2021; S. Wang and Song, 2024), whereas car-sharing user groups exhibit a higher proportion of car-free households (Burghard and Dütschke, 2019). At the same time, several findings indicate that many users also own cars, and the relationship is strongly service- and context-dependent (e.g., one-way vs. two-way schemes; city-specific patterns) (Aguilera-García et al., 2022; Guglielmetti Mugion et al., 2019; Lempert et al., 2019).

Evidence on environmental consciousness is mixed. It can increase intention and use (Akel and Bayır, 2025; Prieto et al., 2019; Yu et al., 2023), yet sustainability is often weak or non-significant (Becker et al., 2017; Fleury et al., 2017; Mavlutova et al., 2021; Wittwer and Hubrich, 2018). Explanations include a normative "should" motive that does not translate into behaviour (Bretter et al., 2024) and debate over net emission reductions when car-sharing does not substitute private car use (Burghard and Scherrer, 2022; G. Li et al., 2025). Where economic benefits are measured explicitly, results are more consistent: perceived cost savings are typically among the strongest determinants of attitudes (Ali Aden et al., 2022; Bojković et al., 2025; Mavlutova et al., 2021; Yu et al., 2023). Social influence is less frequently examined, but it often shows a positive association with attitudes and intention (Curtale et al., 2021; L. Li and Zhang, 2023).

Service characteristics are most commonly captured through price and availability. Higher costs reduce choice probability (Bojković et al., 2025; Safdar et al., 2022; Zawieska et al., 2025), and per-minute tariffs are often perceived as cheaper and preferred (Abouelela et al., 2024). Longer access distance or higher "scarcity risk" suppresses usage, while better availability increases intention and usage (Abouelela et al., 2024; Bojković et al., 2025; Prieto et al., 2019; Yu et al., 2023; Zawieska et al., 2025). Vehicle type is less studied: electric vehicles are often treated as context or policy; where tested directly, they can have a positive effect (Zawieska et al., 2025) but are typically less decisive than other attributes (Aguilera-García et al., 2022). Premium vehicles may attract some users but usually rank below other attributes, although a higher vehicle class can increase willingness to pay (Y. Wang et al., 2017; Zawieska et al., 2025). Hygiene/cleanliness remains under-analysed, yet evidence suggests poor cleanliness can inhibit intention, whereas good hygiene reduces anxiety and increases acceptance (Curtale et al., 2021; Guglielmetti Mugion et al., 2019; Vătămănescu et al., 2025; D. Wang et al., 2025). Notably, Bojković et al. (2025) identify cleanliness as a top-ranked attribute—and for many respondents, the most important—suggesting it may function as a threshold condition for adoption and satisfaction in certain groups (e.g., university students).

2.2. Travel behaviour change and urban mobility transition

To broaden the review beyond survey-based adoption studies, an additional Scopus search was conducted using "car-sharing" with terms related to behavioural change, mobility transitions, multimodality, car ownership reduction, mobility governance, Mobility as a Service, and shared mobility ecosystems in titles and abstracts. The search retrieved the most recent 82 urban-context papers published after 2022. After screening the titles and abstracts, 24 papers were selected for further analysis.

Recent research increasingly interprets car-sharing not only as an individual adoption decision, but as part of broader behavioural change and urban mobility transitions. System-level studies show that its potential to reduce private car ownership depends strongly on service design, including walking distance to stations, vehicle availability, fleet size, pricing, dedicated parking, and service area (Czarnetzki, 2025; Czarnetzki et al., 2025; Nachtigall and Lienkamp, 2026). Review-based evidence highlights heterogeneous impacts across schemes, influencing whether car-sharing substitutes for private car ownership or functions as a complementary alternative (Gkavra et al., 2025; Nachtigall and Lienkamp, 2026).

Car-sharing is more likely to reduce car use when it supports selling or avoiding a private car, while existing car owners are less likely to reduce car use (Laviolette et al., 2024; Vega-Gonzalo et al., 2024; Vejchodská et al., 2024). Mobility trials and modelling studies indicate that car-sharing can reduce car-use intentions and ownership when municipal incentives are combined with policies increasing private car use costs (Cellina et al., 2025; Hou et al., 2025; Sarri et al., 2023). However, frequent users may also generate additional trips or replace

Table 2
Analysed aspects in the reviewed papers.

Papers (Author, Year)	Socio-demographic					Expected effects			Service characteristics					
	Gender	Age	Education	Income	Private car access	Economic benefit	Sustainability	Social pressure/ opinion	Availability	Electric cars	Premium cars	Price	Hygiene/ condition	User segmentation
Abouelela et al. (2024)	+		+	+	+	×			+	+		+		+
Aguilera-García et al. (2022)	+	+	+	+	+		+		×					+
Akel and Bayır (2025)	+	+	+	+		+	+	+	+			+		
Ali Aden et al. (2022)	+	×[2]		+		+						+		
Becker et al. (2017)	+	+	+	+	+	+	+		+					+
Bojković et al. (2025)	+					+			+			+	+	
Bretter et al. (2024)	×	×	×	×			+	+			+			
Burghard and Dütschke (2019)	+	+	+		+			+		+[1]				+
Burghard and Scherrer (2022)	×	×	×				+					×		
Curtale et al. (2021)	+	+	+	+	+	×	+	+		+			+	×
Fleury et al. (2017)	+	+					+	+	×					+
Guglielmetti Mugion et al. (2019)	+	+	+		+	+	+					+	+	+
Lempert et al. (2019)	+	+		+	+	+	+					+		
G. Li et al. (2025)	+	+	+	+	+	+	+	+	×	×		+		
L. Li and Zhang (2023)	+	+	+	+	+	×	+	+	×	+[1]				
Matowicki et al. (2021)	+	+	+	+	+	+	+	×	+	×		+	+	
Mavlutova et al. (2021)	+	×[2]	×		×	+	+		+		+	+		+
Prieto et al. (2019)	+	+			+		+		+		×			×
Priya Uteng et al. (2019)	+	+	+	+	+	+	+		+		+	+		
Safdar et al. (2022)	×	+	+	+	×	+	+							
van der Linden et al. (2025)		+	+		+	+	+	+	+			+		
Vătămănescu et al. (2025)	×	+				+	+		×			+	+	×
Y. Wang et al. (2017)	+	+	+	+	+		+			+	×	+		
D. Wang et al. (2025)	+	+	+	+	+	×		+	+			+	+	
S. Wang and Song (2024)	+	+	+	+	+	×	+	+	+			+	+	+
Wittwer and Hubrich (2018)	+	+	+	+	+	+	+		+					+
Yu et al. (2023)	+	×[2]	×			×	+	×	+	+[1]		+		
Zawieska et al. (2025)	+	+	×	×	+	×	×		+	+	+	+		+

+ analysed aspect, statistically relevant, used as a predictor; × only descriptive aspect without detailed analysis, statistically not relevant, the focus of the research was different; [1] electric car-sharing services were studied; [2] the respondents were young (Y or Z generation, university students).

journeys otherwise made by more sustainable modes (Widhalm et al., 2023).

Car-sharing should therefore be embedded in multimodal mobility systems. Its positive effect on private car use depends on its integration with public transport and MaaS (Narayanan et al., 2025). MaaS studies show that car-sharing can be part of subscription-based mobility packages (Kriswardhana and Esztergár-Kiss, 2023; Steffen et al., 2024); however, different user segments, such as households with or without private cars, must be considered (Narayanan and Antoniou, 2023).

Spatial and governance conditions are also central. Dedicated car-sharing parking spots on streets (Czarnetzki, 2023) or in mobility hubs (Czarnetzki and Siek, 2023; Reindl et al., 2024) can improve the perceived reliability and convenience. Nevertheless, market-driven provision may concentrate in prosperous urban areas, leaving peripheral, lower-income or car-dependent areas underserved (Groth et al., 2023; Paul et al., 2024). Therefore, inclusive shared mobility systems must be institutionalised by public authorities, operators and community actors (Pereira and Silva, 2023).

The sustainability impacts of car-sharing are conditional. Environmental assessments show that users who abandon private car ownership may substantially reduce their transport-related carbon footprint (Vélez, 2023), However, rebound effects and induced trips can offset part of these benefits (Widhalm et al., 2023).

Overall, the literature suggests that car-sharing contributes to sustainable mobility transitions only when it is reliable, spatially accessible, multimodally integrated and supported by coherent urban policy.

3. The research context

3.1. Study site: Budapest

Budapest, the capital of Hungary, has a population of 1.7 million and covers an area of 525.2 km^2. The Danube River divides the city into hilly, wealthier Buda and flat, sprawling Pest. Budapest is served by a dense public transport network and, as of November 2024, several shared mobility providers operate: the municipality-owned station-based bike-sharing system (Bubi), two free-floating scooter services (Dott, Lime), and three domestic free-floating car-sharing operators (Greengo, MOL Limo, and Wigo). According to the Centre for Budapest Transport (BKK, 2025), the modal split was 19% walking, 5% micro-mobility, 41% public transport, and 35% car use. The 2030 targets aim to raise these shares to 20%, 10%, and 50%, respectively.

However, high car dependency remains a challenge. Official statistics report a motorisation rate of 426 cars per 1000 inhabitants in Budapest and 486 in the metropolitan region—about 1.35 million registered cars in total, roughly half within the city (Hungarian Central Statistical Office, 2024, 2025). Suburbanisation and the growth of the car fleet contribute to severe congestion, as roughly half of suburban vehicles enter the city on a daily basis. The TomTom Traffic Index (2024) ranks Budapest as the 21st most congested large city in Europe out of 254 examined. Parking is regulated via zones, typically €0.5–1.5 per hour in central districts and around metro stations, while electric cars park free of charge.

Car-sharing has operated since 2016. The service areas overlap in central districts but differ at the periphery, covering an average of roughly 110 km^2, with fleets of approximately 500 vehicles per operator. Greengo mainly offers small electric cars, while Wigo and MOL Limo operate mixed fleets. Tariffs also differ: as of November 2024, Greengo (from €0.25/min) and Wigo (€0.25–0.35/min) use time-based pricing, whereas MOL Limo charges mainly by distance (€0.6–1/km). For context, a single public transport ticket costs €1, and petrol is about €1.5 per litre.

3.2. Data collection and analysis

Data collection was conducted by TÁRKI (Social Research Institute) between 20 October and 10 November 2024. The questionnaire comprised three main sections (see Annex 1): (1) general travel behaviour, (2) shared mobility use, and (3) socio-demographic characteristics. As this paper examines car-sharing and its usage patterns in detail, shared-mobility items not directly related to car-sharing were excluded from the present analysis; descriptive statistics on shared mobility use in Budapest are reported in Földes et al. (2025).

The survey included multiple-choice items and 7-point Likert-scale questions (1–7, ranging from ‘strongly disagree’ to ‘strongly agree’). Because one key rationale for car-sharing is to provide access to private cars without ownership—and thereby potentially reduce car ownership—only Budapest residents holding a driving licence were eligible to participate (consistent with Prieto et al. (2019). In total, 836 valid responses were collected, yielding a sample representative of licensed adult residents of Budapest by age, gender, and educational attainment. To reduce sampling bias and improve external validity, post-stratification weights based on Hungarian Central Statistical Office statistics were applied; all results reported here use weighted data. The weights ranged from 0.67 to 2.21 (mean: 1). Analytically, we combined descriptive statistics with cross-tabulation analysis relying on chi-square tests to assess associations between socio-demographic factors and car-sharing engagement. To understand the partial associations of the socio-demographic factors, we ran a multinomial logistic regression model. Accordingly, differences between engagement categories were analysed in a more complex way, including partial associations of socio-demographic factors and attitudinal variables as independent variables. Respondents who reported using at least one car-sharing service frequently or occasionally were classified as active users. Respondents who had already tried at least one service but did not report current frequent or occasional use were classified as trial users. Respondents who had not used car-sharing yet but planned to or could imagine trying it were classified as potential users. Finally, respondents who had not used car-sharing and did not plan to use it, or who had not heard of the services, were classified as not interested.

Although the engagement categories can be interpreted as successive stages of car-sharing involvement, the proportional odds assumption required for ordinal logistic regression was not satisfied ($\chi^2(6) = 13.35$; $p = 0.038$). Therefore, multinomial logistic regression was used to model the differences between potential, trial, and active users.

4. Results

4.1. Socio-demographic background

Considering engagement level towards car-sharing, one quarter of respondents are active users of at least one car-sharing service, 13 percent have tried at least one, 25 percent are potential users (i.e., “I haven't used it yet, but I plan/imagine trying it out”), and 37 percent report that they never used car-sharing and do not intend to or have never heard of it. We refer to this combined category as “not interested at all”. The two response categories were merged due to the very small size of the “never heard of it” group (14 of 369) and because those unfamiliar with car-sharing are unlikely to be interested in using it.

Considering socio-demographic profiles, the descriptive results show several significant associations (see Annex 2). Gender is the least distinctive factor, with only a slight overrepresentation of active users among men. Car-sharing use declines with age: older respondents are more likely to be uninterested or unaware of the services, while potential users and trial users are most common in the 40–49 and 30–39 age groups, respectively. Respondents with primary or basic vocational education and those in the lowest income group are more likely to be uninterested and less likely to be active or potential users. The strongest association is related to private car access: regular car access corresponds to lower active use and greater disinterest, whereas those with limited or no access are more engaged. Spatially, active users are concentrated in the city centre and inner city, while areas outside the

service zone show higher disinterest. However, the overrepresentation of potential users in outer Buda suggests latent demand that could be unlocked through service expansion.

To reveal what distinguishes potential users from active users, a multinomial logistic regression model was built. The dependent variable was user type, while the independent variables were gender, age, education, residence location, and the number of household cars. Income was excluded due to the high refusal rate and its strong correlation with education. The model was significant ($p = 0.000$) with a pseudo-R^2 of 0.18. This suggests that socio-demographic variables are associated with differences between engagement groups, although a substantial part of the variation remains unexplained. Table 3 summarises our findings, using the potential user as the reference category. The attitude variables and the extended model are discussed in Section 4.7.

Differences between potential and active users:

1. Men are significantly more likely to be in the active user group than women.
2. Age is significantly negatively associated with car usage: as age increases, the odds of active use decrease.
3. Compared with city-centre residents, those living outside the car-sharing service area are less likely to be active users.
4. The number of household cars also has a significant negative effect, meaning that car ownership reduces the likelihood of active use.
5. Other associations are not significant.

For differences between potential and trial use, gender and age show similar effects, while education has a significant positive association: higher education increases the likelihood of trying car-sharing. Other socio-demographic factors have no significant association. Overall, the associations are stronger for active users than trial users.

The regression results largely confirm the descriptive findings, with the main difference being that gender becomes significant in the multivariate model.

4.2. Attitudes towards car-sharing use

Statements (A1–A15) on car-sharing use were assessed by active users and trial users (N = 316). Fig. 1 summarises the agreement levels.

Overall satisfaction is high, although agreement varies substantially across characteristics. The highest agreement relates to basic usability: respondents report confidence in using the service and in driving (A9: 94%; A8: 88%), sufficient knowledge to use it (A7: 93%), and that the system is simple and booking is easy (A1: 91%; A4: 89%).

Starting and locking the car seems like an easy task (A5: 80% and A6: 75% agreed with it), and satisfaction with the customer service provided is also high (A10: 76%). The value for money of the services is generally agreed upon in a high proportion (A11: 77%). Statements regarding the tariffs are more divisive, but they still have the support of the majority: the calculation of the costs and their comparison across services are agreed upon by 61 percent (A3) and 60 percent (A2).

Lower agreement is observed for comparative and habitual-use statements. Only 46–47% agree that car-sharing is more convenient (A13) or cheaper (A12) than owning a private car. Routine use is limited: 32% report using car-sharing automatically (A14) and 26% state that it has become part of their daily routine (A15). Agreement with A15 is strongly associated with private car access; respondents without access to a car agree more often (43% versus 26%), consistent with more frequent reliance on car-sharing.

Active users also differ from trial users. Trial users report systematically lower agreement—and higher disagreement—across positive statements. For trial users, agreement falls to 84% for having the necessary knowledge (A7), 79% for booking being easy (A4), 78% for the service being simple to use (A1), 79% for confidently driving an unfamiliar car (A8), 86% for being able to use the service (A9), and 60% for being able to rely on customer service (A10). All of these differences

Table 3
Multinomial Logistic Regression model of car-sharing engagement level, (N = 513).

Engagement level	Variables	Model 1: Baseline socio-demographic model (odds ratio)	Model 2: Socio-demographic + attitudinal model (odds ratio)
Active user (ref. potential user)	**Control variables**		
	Gender: male (ref. female)	2.073** (0.219)	2.011** (0.243)
	Age	0.939*** (0.010)	0.933*** (0.011)
	Education	1.144 (0.093)	1.116 (0.104)
	Residence: other area (ref. city centre)	0.542* (0.324)	0.650 (0.350)
	Residence: service area (ref. city centre)	0.925 (0.302)	1.096 (0.331)
	Residence: inner city (ref. city centre)	1.550 (0.394)	1.946 (0.436)
	Number of owned cars	0.804* (0.118)	0.926 (0.133)
	Attitude variables		
	Concerns regarding vehicle use (standardized principal component), B1		0.491*** (0.164)
	Financial concerns (standardized principal component), B2		0.813 (0.128)
	Perceived benefit (standardized principal component), C		2.897*** (0.183)
	Perceived environmental impact (standardized principal component), D		0.624** (0.161)
Trialuser (ref. potential user)	**Control variables**		
	Gender: male (ref. female)	1.832** (0.252)	1.530 (0.263)
	Age	0.958*** (0.011)	0.956*** (0.012)
	Education	1.226*** (0.109)	1.154 (0.114)
	Residence: other area (ref. city centre)	1.181 (0.375)	1.378 (0.385)
	Residence: service area (ref. city centre)	1.001 (0.376)	1.195 (0.387)
	Residence: inner city (ref. city centre)	1.642 (0.476)	1.855 (0.494)
	Number of owned cars	1.140 (0.131)	1.067 (0.132)
	Attitude variables		
	Concerns regarding vehicle use (standardized principal component), B1		0.566*** (0.140)
	Financial concerns (standardized principal component), B2		1060 (0.135)
	Perceived benefit (standardized principal component, C)		1.204 (0.170)
	Perceived environmental impact (standardized principal component, D)		0.632** (0.169)
Nagelkerke pseudo-R^2		0.180	0.363
Model fit (Chi-Square sig.)		0.000	0.000

***p < 0.001, **p < 0.05, *p < 0.1, Note: standard errors in parentheses.

are statistically significant.

4.3. Fear about car-sharing use

Statements (B1-B7) assessing the fear of car-sharing use were

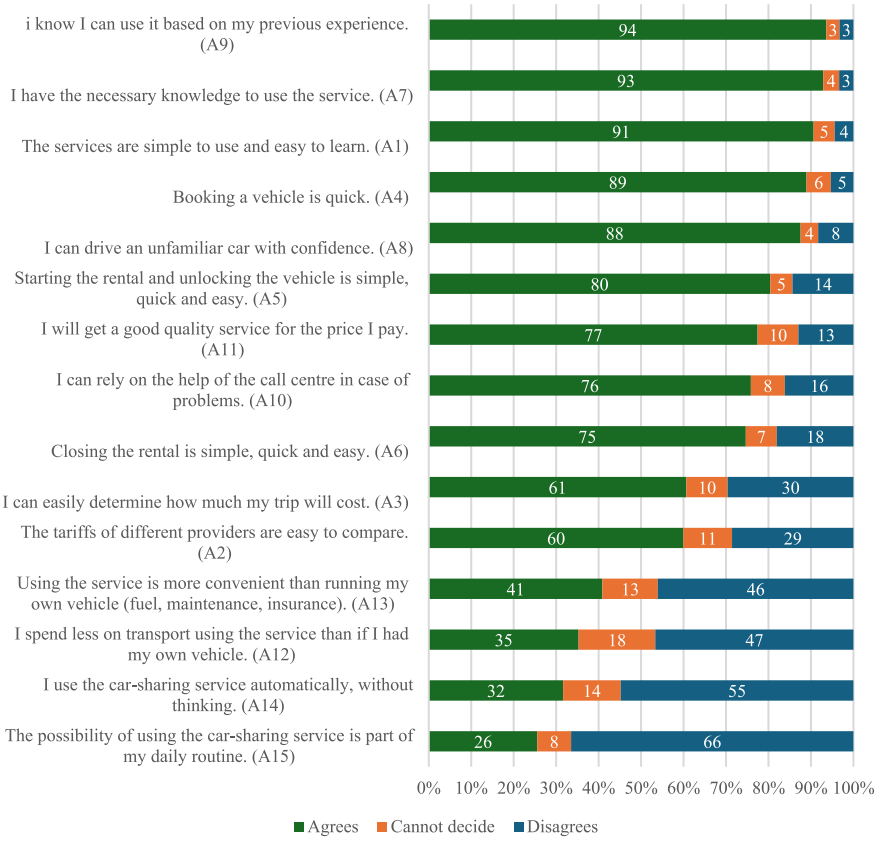


Fig. 1. Statements from Q13 on car-sharing use and their agreement level among experienced users [%], ordered by the share of agreement, N = 316. Item labels in brackets refer to the original Q13 item numbering reported in Annex 1.

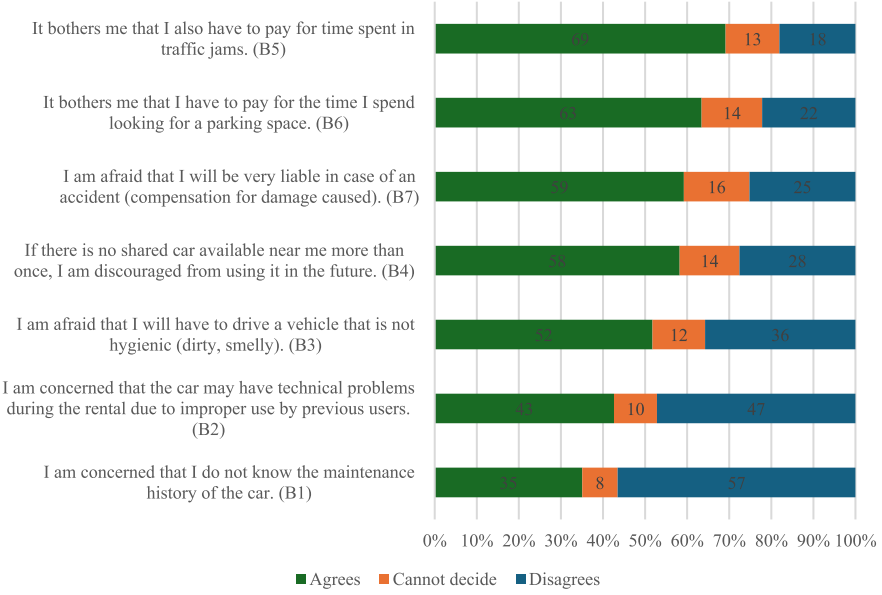


Fig. 2. Statements from Q14 on fears regarding car-sharing use and their agreement level [%], ordered by the share of agreement, N = 836. Item labels in brackets refer to the original Q14 item numbering reported in Annex 1.

completed by all respondents, regardless of their experience. Accordingly, aligned with the goal of the research project, the features people fear the most were detected. Fig. 2 shows that statements related to costs (B5, B6), liability (B7), and comfort (B4) have the most dissuasive effect, and technical issues (B2, B1) are less of a fear. Hygiene (B3) divides the sample more, but still slightly more than half agree.

A more detailed analysis suggests that some concerns are largely hypothetical rather than rooted in direct experience. In other words, some fears (regarding technical problems, not knowing the vehicle maintenance history, hygiene) are lower among active users than among potential or trial users (see Annex 3, a-d for more details).

4.4. Personal benefits of car-sharing use

Statements (C1–C9) on the perceived personal effects of car-sharing were assessed by respondents, and Fig. 3 summarises the agreement levels. Among active users, trial users, and potential users, the highest agreement relates to practicality: 74% agree that car-sharing helps them reach their destination and work efficiently (C2), 68% believe it increases their mobility (C1), and 61% report that it facilitates access to other transport modes (C3).

Perception about car-sharing is also viewed positively by the majority: 59 percent agree with the statement "People I know have a positive opinion about car-sharing (C4)". However, the respondents are reluctant to others' views about using car-sharing, which is visible in C5-C7 statements: "My friends' opinion about car-sharing is important (C5)" (59% disagreed), "It makes a good impression on others (C7)" (60% disagreed), and "I use it because it is becoming popular (C6)" (76% disagreed). Comfort is agreed by the majority: 55 percent agreed that "It makes my journey more comfortable (C9)", but the majority do not use it with joy (C8: 43%).

The results were disaggregated by engagement level (Annex 4, a-e); we report only statistically significant associations. Active users consistently perceive greater benefits from car-sharing than other groups. They are substantially more likely to agree that car-sharing increases their mobility, helps them reach their destination, and makes travel more comfortable, with agreement levels well above the sample average. The largest differences appear for enjoyment and comfort, where active users report much more positive experiences than trial or potential users. Active users are also less influenced by others' opinions, whereas potential users place greater importance on social approval.

4.5. Environmental benefits of car-sharing use

Statements capturing broader sustainability-related effects of car-sharing were also assessed (Fig. 4). In the main text, these statements are referred to as D1–D5. D1 corresponds to Q15 item 10 and captures whether respondents feel good about using innovative, sustainable solutions. D2–D5 correspond to Q15 items 11–14 and capture broader environmental and urban-transport effects of car-sharing. Because D1 refers to a personal experience, it was assessed among respondents with at least some car-sharing interest or experience, whereas D2–D5 were assessed among the total sample. A slim majority (51%) agrees that car-sharing reduces the number of cars and parking spaces (D4), whereas the remaining statements are more divisive. Only 42 percent agree that car-sharing helps to alleviate urban transport problems (D5). Agreement is even lower for environmental claims: 36 percent consider car-sharing environmentally friendly (D3), and 38 percent consider electric car-sharing environmentally-friendly (D2).

Active and potential users agree more that there will be fewer cars (D4: 63% and 62% versus 51%), while the other groups vary in this regard. The other statement where the difference was statistically significant was about helping urban transport. Active and potential users agree with this statement in higher ratios (D5: 55 and 52 versus 42%, respectively).

4.6. Usage intention

Future usage intentions were assessed across the full sample (Fig. 5); most respondents do not plan to use car-sharing either within the next month or within the next semester (E1–E2). This is consistent with our earlier results: although most active users (N = 202) report using car-sharing several times per month, trial users and potential users—who constitute a sizable share of the sample—do not anticipate frequent use. Regarding vehicle type, a majority (E5: N = 521; 55%) indicate they would use whichever car is available. Premium cars are not a key driver

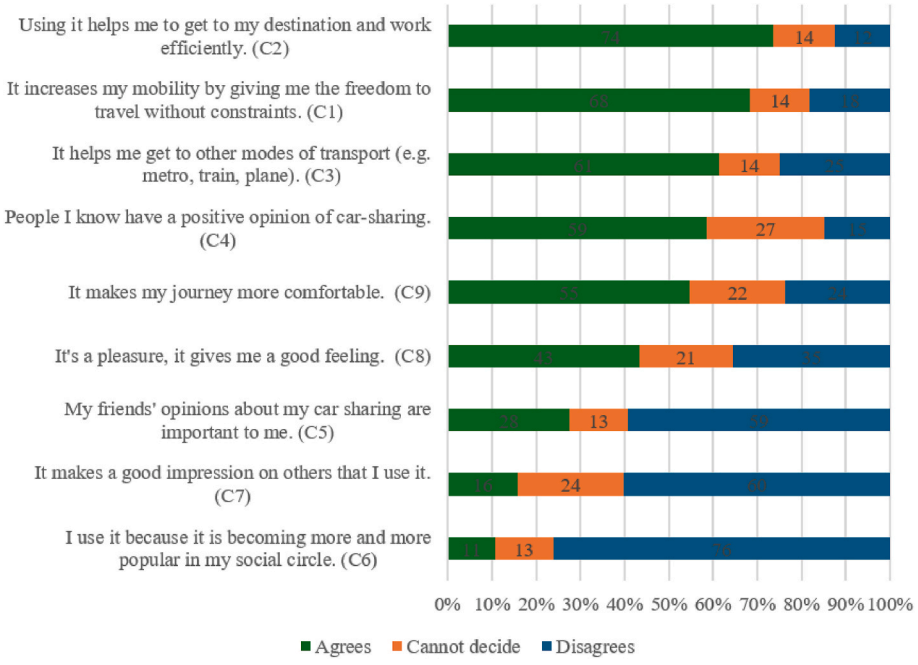


Fig. 3. Statements from Q15 on the personal effects of car-sharing use and their agreement level [%], ordered by the share of agreement, N = 521. Item labels in brackets refer to the original Q15 item numbering reported in Annex 1.

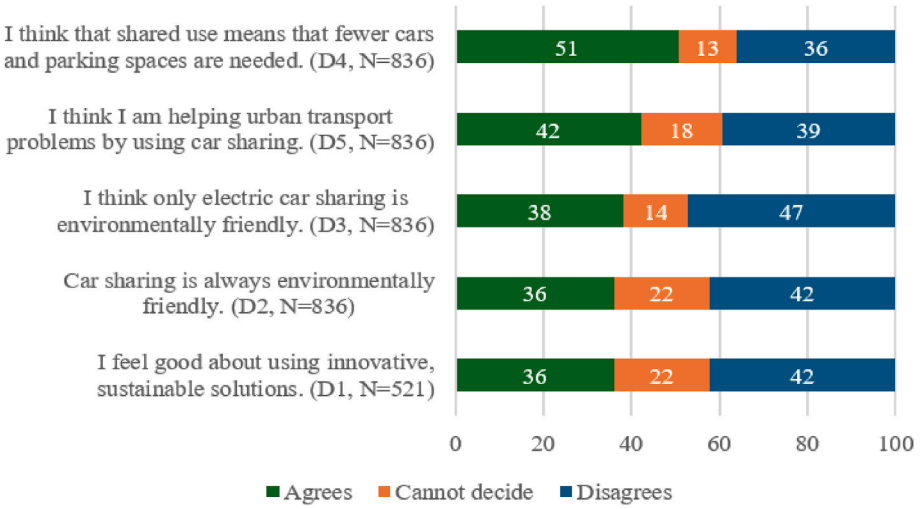


Fig. 4. Statements from Q15 on the environmental effects of car-sharing use and their agreement level [%], ordered by the share of agreement. Item labels in brackets refer to the D1–D5 labels defined in Annex 1, corresponding to Q15 items 10–14.

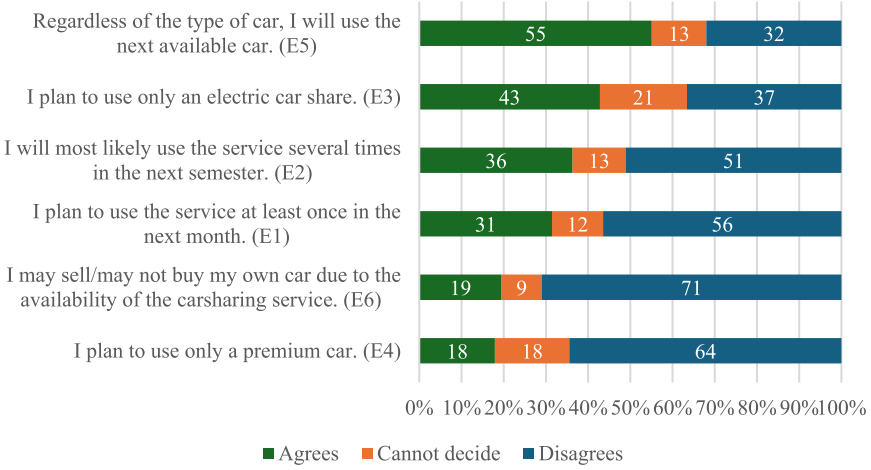


Fig. 5. Statements from Q16 on intended car-sharing use and their agreement level [%], ordered by the share of agreement, N = 521. Item labels in brackets refer to the original Q16 item numbering reported in Annex 1.

(E4: 64% disagree with planning to use), while interest in electric vehicles is more pronounced but still moderate (E3: 43% agree with planning to use). Finally, only 19 percent agree that the availability of car-sharing might lead them to postpone buying a car or to sell their current one (E6). This intention is substantially higher among respondents without access to a car (48% versus 19%), whereas those with regular car access disagree more often (78% versus 71%), indicating a stronger intention to retain or eventually buy a new private car.

The tendency with these statements is similar to that of the earlier ones: almost two-thirds of the active users plan to use the services in the next month or semester (62% and 66%), whereas those who have used it once or potential users agree in much lower ratios. Regarding the type of car, the agreement to use an electric or premium car is higher among active users, but the difference is not significant.

4.7. Attitudes that differ between potential and active users

To understand the differences between potential, trial and active users, we ran an extended multinomial logistic regression model. Unlike the benchmark model in Section 4.1, this model included both socio-demographic factors and attitudinal components, allowing a more comprehensive interpretation of how these factors are interrelated.

The main predictors were derived from the statement groups (A–E) using principal component analysis to reduce the number of variables. Principal component analysis was used as a dimension-reduction technique rather than to construct reflective latent scales. Therefore, the retained components are interpreted as empirical summaries of related questionnaire items. Component retention was based on eigenvalues above one, explained variance, communalities, component loadings and substantive interpretability; the detailed PCA diagnostics are reported in Annex 5. Components B, C and D were added to the baseline model first separately and then jointly. Group A was excluded because these statements were asked only from trial and active users, which would have reduced the model sample. Group E was excluded from the main explanatory model because it captures future usage intention, which is closely related to current active use and may therefore reflect current experience or reverse causality rather than an independent explanatory factor. Group B was divided into two different components based on the factor-retention criteria and substantive interpretability. The final model, including all variables, was significant and achieved better model fit, with a Nagelkerke pseudo-R^2 of 0.363. Compared with the baseline model, the last column of Table 3 shows the extended model

results for the differences between potential and active users.

Car ownership and residence location are significant in the baseline model, but their associations with active-user status become non-significant in the extended specification. This indicates that the results should be interpreted as conditional associations within the model rather than as evidence of indirect or mediated effects.

Regarding the differences between potential and trial users, education and gender lose their significant effects compared to the baseline model.

After controlling for socio-demographic factors, the attitudinal results show that.

- Concerns regarding vehicle use (of previous custormers) reduces the odds of being either a trial or an active user group compared to potential users.
- Financial concerns were not significantly associated with either occasional or active car-sharing use - with lower odds of being either a trial or an active user, compared with potential users.

Respondents classified as not interested were excluded from the regression analysis. Potential users were used as the reference category of the dependent variable. Gender was entered as a binary variable with female respondents as the reference category, and residence location was entered with city-centre residents as the reference category. The models report odds ratios (Exp(B)). Cases with missing values on any variable included in the respective model were excluded using listwise deletion. Income was not included in the regression models because of the high refusal rate and its strong association with education.

To sum it up, model fit improved substantially after adding the attitudinal variables; this suggests that attitudes provide substantial additional information for distinguishing between potential, trial, and active car-sharing users beyond socio-demographic characteristics alone.

5. Discussion

5.1. General habits and expectations

Our results from Budapest align with prior evidence: active users are younger in bigger ratios (Abouelela et al., 2024; Guglielmetti Mugion et al., 2019; Prieto et al., 2019), higher educated (Aguilera-García et al., 2022; Wittwer and Hubrich, 2018), have higher income (Ali Aden et al., 2022; S. Wang and Song, 2024), and adoption is higher among residents of centrally located and well-served residential areas (Aguilera-García et al., 2022). However, the fact that active users have higher incomes indicates that car-sharing services do not meet one of their goals, which is to reach less privileged social strata (Abouelela et al., 2024).

In our descriptive analysis, gender was not statistically significant, similar to Curtale et al. (2021), Fleury et al. (2017), and L. Li and Zhang (2023). However, in the multinomial logistic regression model, gender becomes significant: men are more likely to be in the active group than in the potential user group. This is consistent with studies that identified higher car-sharing adoption or use among men (Abouelela et al., 2024; Aguilera-García et al., 2022). Age remains a robust predictor; the odds of belonging to both active user or trial user groups decrease with age, confirming both the descriptive pattern and previous findings that car-sharing users are more often younger adults (Abouelela et al., 2024; Aguilera-García et al., 2022; Prieto et al., 2019). In our sample, the most engaged users and potential users are aged 18-39; retaining them is important to prevent future private car dependence. Potential users are also common in the 40–49 age group, policy-relevant because car ownership is highest there, so shifting them to car-sharing could reduce private car numbers.

Access to a private car reduces willingness to use car-sharing in the bivariate analysis; respondents with regular car access are less often active users and more often uninterested. That is consistent with previous studies showing that car ownership decreases the likelihood of adopting car-sharing (Abouelela et al., 2024; Priya Uteng et al., 2019; S. Wang and Song, 2024). In the baseline model, household car ownership had a significant negative association with active use, but this effect disappeared after including the principal components. After adjusting for attitudinal components, the associations of residence and car ownership with active-user status were no longer statistically significant. Therefore, the extended model indicates that socio-demographic and attitudinal variables should be interpreted jointly, without implying a formal mediation relationship. This interpretation is consistent with studies emphasizing travel attitudes, symbolic car attachment, perceived car dependence and residential context (Laviolette et al., 2024; Vejchodská et al., 2024).

Car-sharing use is most prevalent in the inner city, where private car storage is inconvenient and less cost-effective due to good public transport and short distances. Disinterest is higher outside the service zone, while outer Buda shows latent demand. In the baseline model, living outside the service area reduced active use, but this effect disappeared in the model where the principal components are included. Similarly, residence location was significant in the baseline model but not in the extended specification. This result should be interpreted cautiously as a change in statistical association after adding attitudinal components, rather than as evidence of mediation.

Fear regarding vehicle use (by a previous customer) reduce trial and active use, supporting the descriptive findings: concerns about poor vehicle condition are lower among active users and higher among potential and uninterested respondents. Concerns about the extra pay due to a traffic jam or finding a parking space have mixed results. Trial users are also less concerned about car availability in the neighbourhood, a barrier widely discussed in the literature (Safdar et al., 2022; van der Linden et al., 2025), but this was only true in the descriptive analysis. Hygiene and vehicle condition also appear as important barriers. Hygiene concerns are similar to Bojković et al. (2025), who found cleanliness to be a key attribute for young users. Vehicle condition is less commonly highlighted, as the literature usually emphasises uncertainty and responsibility issues (Curtale et al., 2021; Vătămănescu et al., 2025). Overall, fears regarding previous vehicle use are threshold conditions that may prevent trial or regular use.

Not only the fears, but positive service features, such as booking and closing, were evaluated less favourably by trial users than active users, suggesting that these features may discourage continued use. Booking as a barrier aligns with Turoń (2021), thus the role of familiarity is consistent with (Abouelela et al., 2024). Overall, non-users show slight negative preconceptions toward car-sharing.

The results can also be interpreted through the CalmMobility paradigm (Turoń, 2025). From this perspective, the identified barriers reflect not only operational shortcomings but also users' need for predictable, low-stress and understandable mobility. The strongest deterrents—cost uncertainty, availability concerns, liability, hygiene and vehicle condition—are all linked to a perceived lack of control. Thus, adoption depends not only on price or usability, but also on whether the service provides a calm and reliable mobility experience.

Perceived benefits are positively associated with belonging to the active-user group rather than the potential-user group, but they are not significantly associated with trial user. This suggests that benefits are more important for repeated use than for initial trial. A similar tendency emerges as in the case of fears: active users agree more strongly with positive statements, indicating that perceived advantages are higher among those with car-sharing experience - also reported by Zawieska et al. (2025). Therefore, stronger communication is needed during the persuasion phase, as also stated by Y. Wang et al. (2017), to highlight personal benefits and convince potential users who do not yet recognise them. Convenience has also been identified as a key motivation for car-sharing use (Abouelela et al., 2024; Maas and Attard, 2020; Vassi et al., 2023). In our sample, perceived comfort is higher among active

users, as also noted by D. Wang et al. (2025), than among rare users and non-users. This suggests that car-sharing is experienced as comfortable, but this advantage is not yet widely recognised among non-users. Trial may therefore help users recognise its benefits (Burghard and Scherrer, 2022).

Although economic benefits are often important in choosing car-sharing (Lempert et al., 2019; Mavlutova et al., 2021; van der Linden et al., 2025; Wittwer and Hubrich, 2018), even active users in our sample do not perceive car-sharing as cheaper than private car ownership. This suggests limited awareness of the full costs of owning a car.

The role of perceived environmental and societal benefits is more complex. In the descriptive analysis, active users more often believe that car-sharing helps urban transport problems and reduces the need for cars and parking spaces. However, only a minority considers (electric) car-sharing environmentally friendly. This reflects the contested literature on its sustainability impacts. According to G. Li et al. (2025), electric car-sharing does not automatically reduce emissions unless it decreases private car use; thus, Aguilera-García et al. (2022) noted that it may substitute for public transport trips. In the multivariate model, stronger perceived environmental benefits are associated with lower chances of being a user relative to remaining a potential user, suggesting an attitude–behaviour gap. This is consistent with Becker et al. (2017), who found no clear "green attitude profile" among car-sharing users. Therefore, the sustainability contribution of car-sharing is conditional rather than automatic, depending on whether it replaces car ownership or induces/substitutes trips (Aguilera-García et al., 2022; Vélez, 2023; Widhalm et al., 2023). Respondents with regular car access also agree less with sustainability-related statements, possibly because car attachment leads them to downplay the positive effects of car-sharing, which can be considered as a cognitive dissonance reduction. They try to alleviate the psychological discomfort arising from the perceived inconsistency between their behaviour and sustainability considerations.

Social influence appears moderate overall, although several studies identify social approval and subjective norms as significant drivers of car-sharing adoption (e.g., Akel and Bayır (2025); Bretter et al. (2024); Curtale et al. (2021); L. Li and Zhang (2023)). In our survey, only one item showed high agreement: "People I know have a positive opinion about car-sharing." This is consistent with studies finding neutral or non-significant effects of social norms on usage intention (Fleury et al., 2017; van der Linden et al., 2025; Yu et al., 2023). Thus, social influence may contribute to general legitimacy, but it does not appear to be a primary driver of active use in Budapest.

Regarding usage intentions, respondents appear to place particular importance on vehicle availability, while electric vehicle availability also receives some attention. In contrast, premium vehicles seem irrelevant, suggesting that service development should not prioritise a premium fleet strategy. Overall, the reported willingness to give up private car use is limited, implying that car-sharing will likely remain a complementary mode rather than a direct substitute for car ownership. However, those without car access are more likely to forgo buying one, which is beneficial. Regarding the differences between groups, our finding – namely that active users tend to report usage intention as opposed to trial users or potential users - is consistent with stage- and intention-based adoption models, where intention, perceived behavioural control, attitudes and stage-specific barriers shape the transition from consideration to adoption (S. Wang and Song, 2024; Yu et al., 2023; L. Li and Zhang, 2023). In our case, trial use may result from experimentation, whereas active use may require lower fears, stronger perceived benefits and a concrete intention to integrate car-sharing into everyday mobility.

5.2. Policy implications and practical use of the results

Our findings suggest that increasing car-sharing use in Budapest is a question of (i) moving non-users and potential users from awareness to trial and from trial to repeat use, while (ii) retaining the already-engaged 18–39 age group, and (iii) reducing specific, well-identified fears (perceived indirect costs, hygiene, vehicle condition and availability concerns).

The trial barrier can be reduced with a "starter" package. Concerns and negative preconceptions are markedly higher among potential users and non-users than among active users. Although the cross-sectional data do not establish whether experience reduces perceived risk, this pattern indicates that low-cost entry trial opportunities (e.g., valid for 3–5 trips), and clearer information (e.g., tutorial videos, in-app assistance). may help address perceived barriers.

The 18–39 group contains the most engaged users; retention instruments, such as loyalty-based pricing, light gamification, and recurring-user discounts, should be designed to maintain commitment over time and across life-course changes. As this group is likely to move to outer districts during family formation, retention also requires coverage expansion into these areas; otherwise, users may churn despite positive experiences. In parallel, the 40–49 group is particularly promising because potential users are prevalent, and car ownership in this group is generally high. Accordingly, targeted conversion measures for this group can generate substantial system-level benefits. Possible measures include entry discounts and public policies encouraging private car reduction within the household.

The usage intentions are primarily shaped by vehicle availability. Electric availability matters, while premium vehicles are not a meaningful driver. Accordingly, investment should prioritise operational reliability and geographic reach over premium fleet strategies. Outer, public transport-poor neighbourhoods are an important target: "not interested" shares are high there, likely reflecting low awareness; yet, the share of potential users according to their socio-demographic characteristics is also high, indicating latent demand that can be activated through combined service expansion and localised outreach.

Fear of indirect costs (e.g., congestion time, parking search) is a key deterrent. Beyond price reductions, the goal should be cost predictability through transparent in-app cost feedback, caps or safeguards around end-of-trip parking searches, and carefully designed tariff options that reduce perceived penalty risk without encouraging peak-period demand (current km-based tariff systems may encourage use during peaks). Public policy measures can also support the use of car-sharing, for instance, by providing dedicated parking spaces for car-sharing in dense areas. In addition, hygiene and vehicle condition concerns are significant; operators should treat cleanliness as a core service-quality dimension, with visible assurance mechanisms (such as rapid response to reports, regular cleaning routines, and clear accountability).

Communication should emphasise personal benefits and credible cost comparisons. Campaigns can acknowledge the convenience of private cars while presenting car-sharing as a way to retain flexibility without fixed ownership costs. Because perceived personal benefits are higher among experienced users, persuasion should foreground convenience and comfort. In addition, users should be offered customised comparisons between the full monthly cost of car ownership and the amount of car-sharing the same budget would cover. Such transparency is necessary, as even active users do not perceive car-sharing as cheaper than owning and maintaining a private car. Such campaigns should particularly target households considering buying a first or second car, where car-sharing can realistically help avoid or postpone ownership.

To support broader urban mobility goals, car-sharing should be integrated into multimodal transport planning rather than treated as a stand-alone service. It can provide occasional car access within a multimodal lifestyle: public transport and active modes can cover routine trips, while shared cars serve trips involving goods, family members or poorly connected destinations. Long-term car ownership reduction also requires coordinated policy measures, as service expansion alone is unlikely to be sufficient while private car ownership remains cheap and convenient. Therefore, car-sharing policy should be linked to parking management, residential mobility packages, dedicated

spaces in new housing developments, and incentives for households giving up a second car or avoiding a first car. In line with CalmMobility, users should first experience reliable alternatives, transparent costs and convenient access before car-sharing can support longer-term behavioural change.

6. Conclusion

This study investigates the factors that encourage or discourage the adoption of car-sharing services in Budapest. The study provides a rare single-city, externally valid assessment based on a representative sample of licensed adults in Budapest (N = 836). Respondents were classified into four engagement groups: non-users, potential users, trial users, and active users.

The results show that younger, higher-educated and higher-income individuals, especially those without regular access to a private car, are more likely to use car-sharing. Experienced users generally evaluate usability and booking positively, but many do not perceive car-sharing as cheaper or more convenient than private car ownership. The main barriers are cost uncertainty, liability concerns, vehicle availability, comfort and hygiene, while technical concerns are relatively minor. Perceived personal benefits are positively associated with being active-users, whereas fears are negatively associated with current car-sharing engagement. Potential users perceive greater environmental benefits than active users, suggesting that environmental attitudes alone do not necessarily translate into use. Active users are more likely to believe that car-sharing alleviates urban transport problems, but sustainability perceptions remain limited, especially among car owners. This may be explained by cognitive dissonance reduction.

The findings provide practical recommendations for policymakers and service providers to increase car-sharing adoption by improving service availability, reducing perceived risks, and communicating tangible personal benefits rather than relying on environmental arguments alone.

Future work will focus on developing a technology acceptance model that incorporates service-related fears, broader perceived effects, and both subjective and objective benefits associated with private car accessibility. Based on the results, service planning methods, such as service area expansion or the differentiated tariff system, are planned. Further research should extend the analysis to suburban and metropolitan commuting contexts, where car dependency is high and a full shift to public transport may not be realistic. In these areas, car-sharing could serve as a complementary alternative, depending on how residents perceive the service and under what conditions they would consider using it.

CRediT authorship contribution statement

Dávid Földes: Writing – original draft, Visualization, Investigation, Conceptualization. **Ráchel Surányi:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Bálint Csonka:** Writing – review & editing, Conceptualization. **Csaba Csiszár:** Supervision, Project administration, Conceptualization. **Borbála Simonovits:** Writing – review & editing, Supervision, Project administration, Methodology, Conceptualization.

Acknowledgment

Project numbers K-146966 and K-147169 have been implemented with the support provided by the Ministry of Science and Technology of Hungary from the National Research, Development and Innovation Fund, financed under the K_23 “OTKA” thematic research projects funding scheme.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tranpol.2026.104547.

Data availability

Data will be made available on request.

References

Abouelela, M., Al Haddad, C., Antoniou, C., 2024. Psychological factors impacts on carsharing use. Transportation. https://doi.org/10.1007/s11116-024-10514-4.
Aguilera-García, Á., Gomez, J., Antoniou, C., Vassallo, J.M., 2022. Behavioral factors impacting adoption and frequency of use of carsharing: a tale of two European cities. Transp. Policy 123, 55–72. https://doi.org/10.1016/j.tranpol.2022.04.007.
Akel, G., Bayır, T., 2025. The role of perceived consumer value dimensions in predicting behavioral intention toward car-sharing: an empirical study based on the extended technology acceptance model. Entertainment Computing 54, 100967. https://doi.org/10.1016/j.entcom.2025.100967.
Ali Aden, W., Zheng, J., Ullah, I., Safdar, M., 2022. Public preferences towards car sharing service: the case of Djibouti. Front. Environ. Sci. 10. https://doi.org/10.3389/fenvs.2022.889453.
Becker, H., Loder, A., Schmid, B., Axhausen, K.W., 2017. Modeling car-sharing membership as a mobility tool: a multivariate probit approach with latent variables. Travel Behaviour and Society 8, 26–36. https://doi.org/10.1016/j.tbs.2017.04.006.
BKK, 2025. Budapesti mobilitási riport. Centre for Budapest Transport. https://bkk.hu/rolunk/strategiank/budapesti-mobilitasi-terv/monitoring-es-ertekelesi-rendszer/.
Bojković, N., Jeremić, V., Petrović, M., Tica, S., 2025. Preferences for car sharing service attributes among university students: evidence from an emerging market. J. East Eur. Manag. Stud. 24 (4), 636. https://doi.org/10.5771/0949-6181-2019-4-636.
Bretter, C., Sharma, H., Pangbourne, K., 2024. Understanding car-sharing by integrating long-, medium- and short-term cognitions. Transport. Res. F Traffic Psychol. Behav. 107, 985–996. https://doi.org/10.1016/j.trf.2024.10.020.
Burghard, U., Dütschke, E., 2019. Who wants shared mobility? Lessons from early adopters and mainstream drivers on electric carsharing in Germany. Transp. Res. Part D: Transport and Environment, The Roles of Users in Low-Carbon Transport Innovations: Electrified, Automated, and Shared Mobility 71, 96–109. https://doi.org/10.1016/j.trd.2018.11.011.
Burghard, U., Scherrer, A., 2022. Sharing vehicles or sharing rides—Psychological factors influencing the acceptance of carsharing and ridepooling in Germany. Energy Policy 164, 112874. https://doi.org/10.1016/j.enpol.2022.112874.
Cellina, F., Gerosa, T., Ventimiglia, L., Hoerler, R., Del Duce, A., Klopfenstein Frei, N., Grundisch, J., 2025. Can we become car-free in just one month? Evidence from Switzerland. Transport. Res. Transport Environ. 148, 104991. https://doi.org/10.1016/j.trd.2025.104991.
Clewlow, R.R., 2016. Carsharing and sustainable travel behavior: results from the San Francisco Bay area. Transp. Policy 51, 158–164. https://doi.org/10.1016/j.tranpol.2016.01.013. Transit Investment and Land Development. Edited by Xinyu (Jason) Cao and Qisheng Pan &Shared Use Mobility Innovations. Edited by Susan Shaheen.
Curtale, R., Liao, F., van der Waerden, P., 2021. User acceptance of electric car-sharing services: the case of the Netherlands. Transport. Res. Pol. Pract. 149, 266–282. https://doi.org/10.1016/j.tra.2021.05.006.
Czarnetzki, F., 2023. The effects of exclusive on-street carsharing parking on carsharing perception and car ownership: a structural equation modeling approach. Journal of Transport and Land Use 16 (1), 319–334. https://doi.org/10.5198/jtlu.2023.2256.
Czarnetzki, F., 2025. Car dependence and car ownership among carsharing users and the mitigating effect of having multiple carsharing memberships: a moderated mediation analysis. Transport. Res. F Traffic Psychol. Behav. 114, 1207–1222. https://doi.org/10.1016/j.trf.2025.07.026.
Czarnetzki, F., Freude, M.P., Gertz, C., 2025. Do mobility hubs boost the adoption and impact of carsharing in the urban periphery? Insights from a mixed-methods case study. Transp. Res. Interdiscip. Perspect. 34, 101682. https://doi.org/10.1016/j.trip.2025.101682.
Czarnetzki, F., Siek, F., 2023. Decentralized mobility hubs in urban residential neighborhoods improve the contribution of carsharing to sustainable mobility: findings from a quasi-experimental study. Transportation 50 (6), 2193–2225. https://doi.org/10.1007/s11116-022-10305-9.
Fleury, S., Tom, A., Jamet, E., Colas-Maheux, E., 2017. What drives corporate carsharing acceptance? A French case study. Transport. Res. F Traffic Psychol. Behav. 45, 218–227. https://doi.org/10.1016/j.trf.2016.12.004.
Fluctuo, 2024. European shared mobility. Annual Review 2023. https://european-index.fluctuo.com/.
Földes, D., SurányI, R., Csonka, B., Simonovits, B., Csiszár, C., 2025. Shared mobility service usage patterns—results of a representative survey in Budapest. Transactions on Transport Sciences 16 (SI SCSP conference), 37–43. https://doi.org/10.5507/tots.2025.009.
Gkavra, R., Rossolov, O., Susilo, Y.O., 2025. Can the co-existence of bike, e-scooter, and car-sharing promote sustainable mode choices? Sustain. Futures 10, 101220. https://doi.org/10.1016/j.sftr.2025.101220.

Groth, S., Klinger, T., Otsuka, N., 2023. Geographies of new mobility services: the emergence of a premium mobility network space. Geoforum 144, 103765. https://doi.org/10.1016/j.geoforum.2023.103765.

Guglielmetti Mugion, R., Toni, M., Di Pietro, L., Pasca, M.G., Renzi, M.F., 2019. Understanding the antecedents of car sharing usage: an empirical study in Italy. Int. J. Qual. Serv. Sci. 11 (4), 523–541. https://doi.org/10.1108/IJQSS-02-2019-0029.

Harris, S., Mata, É., Plepys, A., Katzeff, C., 2021. Sharing is daring, but is it sustainable? An assessment of sharing cars, electric tools and offices in Sweden. Resour. Conserv. Recycl. 170, 105583. https://doi.org/10.1016/j.resconrec.2021.105583.

Hou, N., Dahlin, J.-E., Shollock, B., 2025. Assessing the key drivers for carsharing adoption: a system dynamics approach in London. Sustain. Sci. Pract. Pol. 21 (1), 2554003. https://doi.org/10.1080/15487733.2025.2554003.

Hungarian Central Statistical Office, 2024. *Population by Sex (1870–)* (No. Nep0034). Hungarian Central Statistical Office. https://www.ksh.hu/stadat_files/nep/hu/nep0034.html.

Hungarian Central Statistical Office, 2025. *Passenger Cars per 1,000 Inhabitants (1990–)* (No. Sza0040). Hungarian Central Statistical Office. https://www.ksh.hu/stadat_files/sza/hu/sza0040.html.

Jochem, P., Frankenhauser, D., Ewald, L., Ensslen, A., Fromm, H., 2020. Does free-floating carsharing reduce private vehicle ownership? The case of SHARE NOW in European cities. Transport. Res. Pol. Pract. 141, 373–395. https://doi.org/10.1016/j.tra.2020.09.016.

Jung, J., Koo, Y., 2018. Analyzing the effects of car sharing services on the reduction of greenhouse gas (GHG) emissions. Sustainability 10 (2), 539. https://doi.org/10.3390/su10020539.

Kriswardhana, W., Esztergár-Kiss, D., 2023. A systematic literature review of mobility as a service: examining the socio-technical factors in MaaS adoption and bundling packages. Travel Behaviour and Society 31, 232–243. https://doi.org/10.1016/j.tbs.2022.12.007.

Laviolette, J., Morency, C., Waygood, E.O.D., 2024. Car ownership, carsharing, neighbourhood types and travel attitudes: a latent-cluster analysis. Case Stud. Transp. Policy 18, 101292. https://doi.org/10.1016/j.cstp.2024.101292.

Lempert, R., Zhao, J., Dowlatabadi, H., 2019. Convenience, savings, or lifestyle? Distinct motivations and travel patterns of one-way and two-way carsharing members in Vancouver, Canada. Transp. Res. Part D: Transport and Environment, The Roles of Users in Low-Carbon Transport Innovations: Electrified, Automated, and Shared Mobility 71, 141–152. https://doi.org/10.1016/j.trd.2018.12.010.

Li, G., Sun, Q., Dong, Z., 2025. Factors influencing car owners' intentions of using shared cars: an extension of the theory of planned behavior in China. Transport. Res. F Traffic Psychol. Behav. 110, 230–246. https://doi.org/10.1016/j.trf.2025.02.021.

Li, L., Zhang, Y., 2023. An extended theory of planned behavior to explain the intention to use carsharing: a multi-group analysis of different sociodemographic characteristics. Transportation 50 (1), 143–181. https://doi.org/10.1007/s11116-021-10240-1.

Liao, F., Correia, G., 2022. Electric carsharing and micromobility: a literature review on their usage pattern, demand, and potential impacts. Int. J. Sustain. Transp. 16 (3), 269–286. https://doi.org/10.1080/15568318.2020.1861394.

Maas, S., Attard, M., 2020. Attitudes and perceptions towards shared mobility services: repeated cross-sectional results from a survey among the Maltese population. Transportation Research Procedia, Transport Infrastructure and Systems in a Changing World. Towards a More Sustainable, Reliable and Smarter Mobility.TIS Roma 2019 Conference Proceedings 45, 955–962. https://doi.org/10.1016/j.trpro.2020.02.071.

Martinez, L.M., Pritchard, J.P., Crist, P., 2024. Shared mobility's role in sustainable mobility: past, present, and future. Annu. Rev. Environ. Resour. 49, 191–222. https://doi.org/10.1146/annurev-environ-121522-041916. Volume 49, 2024.

Matowicki, M., Pribyl, O., Pecherkova, P., 2021. Carsharing in the Czech Republic: understanding why users chose this mode of travel for different purposes. Case Stud. Transp. Policy 9 (2), 842–850. https://doi.org/10.1016/j.cstp.2021.04.003.

Mavlutova, I., Kuzmina, J., Uvarova, I., Atstaja, D., Lesinskis, K., Mikelsone, E., Brizga, J., 2021. Does car sharing contribute to urban sustainability from user-motivation perspectives? Sustainability 13 (19), 10588. https://doi.org/10.3390/su131910588.

Nachtigall, N., Lienkamp, M., 2026. Cost-effective planning of station-based car-sharing systems: increasing efficiency while emphasizing user comfort. Smart Cities 9 (4), 60. https://doi.org/10.3390/smartcities9040060.

Narayanan, S., Antoniou, C., 2023. Shared mobility services towards mobility as a service (MaaS): what, who and when? Transport. Res. Pol. Pract. 168, 103581. https://doi.org/10.1016/j.tra.2023.103581.

Narayanan, S., Arango, J.P.R., Tympakianaki, A., Frederix, R., Antoniou, C., 2025. Can emerging mobility solutions complement public transport and lead to a sustainable future?: a case study on regensburg, Germany. Case Stud. Transp. Policy 19, 101338. https://doi.org/10.1016/j.cstp.2024.101338.

Parente, R.C., Geleilate, J.-M.G., Rong, K., 2018. The sharing economy globalization phenomenon: a research agenda. J. Int. Manag. 24 (1), 52–64. https://doi.org/10.1016/j.intman.2017.10.001.

Paul, J., Pinski, M., Brozen, M., Blumenberg, E., 2024. Can subsidized carshare programs enhance access for low-income travelers?: a case study of BlueLA in Los Angeles. J. Am. Plann. Assoc. 90 (3), 537–550. https://doi.org/10.1080/01944363.2023.2268064.

Pereira, C.H.T., Silva, M.E., 2023. Fostering a transition to inclusive sustainability through shared urban mobility. Research in Transportation Business & Management 51, 101045. https://doi.org/10.1016/j.rtbm.2023.101045.

Poltimäe, H., Rehema, M., Raun, J., Poom, A., 2022. In search of sustainable and inclusive mobility solutions for rural areas. European Transport Research Review 14 (1), 13. https://doi.org/10.1186/s12544-022-00536-3.

Prieto, M., Stan, V., Baltas, G., Lawson, S., 2019. Shifting consumers into gear: car sharing services in urban areas. Int. J. Retail Distrib. Manag. 47 (5), 552–570. https://doi.org/10.1108/IJRDM-08-2018-0184.

Priya Uteng, T., Julsrud, T.E., George, C., 2019. The role of life events and context in type of car share uptake: comparing users of peer-to-peer and cooperative programs in Oslo, Norway. Transp. Res. Part D: Transport and Environment, The Roles of Users in Low-Carbon Transport Innovations: Electrified, Automated, and Shared Mobility 71, 186–206. https://doi.org/10.1016/j.trd.2019.01.009.

Reindl, A., Graf, P., Knapp, D., Schildorfer, W., 2024. How carsharing services in residential housing impacts modal split and car usage – a multi-method investigation including legal challenges. Human Factors in Architecture, Sustainable Urban Planning and Infrastructure. https://doi.org/10.54941/ahfe1005340.

Safdar, M., Jamal, A., Al-Ahmadi, H.M., Rahman, M.T., Almoshaogeh, M., 2022. Analysis of the influential factors towards adoption of car-sharing: a case study of a megacity in a developing country. Sustainability 14 (5), 2778. https://doi.org/10.3390/su14052778.

Sarri, P., Kaparias, I., Preston, J., 2023. Effects of shared vehicle schemes and mobility as a service on car ownership: a cost-based analysis. 2023 8th International Conference on Models and Technologies for Intelligent Transportation Systems (MT-ITS), pp. 1–6. https://doi.org/10.1109/MT-ITS56129.2023.10241594.

Steffen, J., Hook, H., Witlox, F., 2024. Improving interest in public, active, and shared travel modes through nudging interventions. Transport. Res. F Traffic Psychol. Behav. 103, 353–367. https://doi.org/10.1016/j.trf.2024.04.020.

Tánczos, K., 2025. Adapting the itf's transport policy with a focus on the EU's strategy of sustainable mobility. Period. Polytech. Transp. Eng. 53 (2), 222–225. https://doi.org/10.3311/PPtr.39780.

Turoń, K., 2021. Social barriers and transportation social exclusion issues in creating sustainable car-sharing systems. Entrepreneurship and Sustainability Issues 9 (1), 10–22. https://doi.org/10.9770/jesi.2021.9.1(1.

Turoń, K., 2025. Sustainable urban mobility transitions—from policy uncertainty to the CalmMobility paradigm. Smart Cities 8 (5), 164. https://doi.org/10.3390/smartcities8050164.

van der Linden, H., Correia, G., van Oort, N., Koster, S., Legêne, M., Kroesen, M., 2025. Driving factors behind station-based car sharing adoption: discovering distinct user profiles through a latent class cluster analysis. Transp. Policy 162, 232–241. https://doi.org/10.1016/j.tranpol.2024.12.001.

Vassi, A., Karolemeas, C., Tsigdinos, S., Bakogiannis, E., Vassi, A., Karolemeas, C., Tsigdinos, S., Bakogiannis, E., 2023. Motivational patterns and personal characteristics of potential carsharing users: a qualitative analysis. Future Transportation 3 (3), 1068–1084. https://doi.org/10.3390/futuretransp3030059.

Vătămănescu, E.-M., Dincă, V.-M., Cegarra-Navarro, J.-G., Gazzola, P., Amelio, S., 2025. Individuals' behavioral intention to use car sharing (CS): from environmental consciousness to socio-psychological drivers. EuroMed J. Bus. 20 (5), 234–257. https://doi.org/10.1108/EMJB-11-2024-0297.

Vega-Gonzalo, M., Gomez, J., Christidis, P., Manuel Vassallo, J., 2024. The role of shared mobility in reducing perceived private car dependency. Transport. Res. Transport Environ. 126, 104023. https://doi.org/10.1016/j.trd.2023.104023.

Vejchodská, E., Brůhová Foltýnová, H., Rybičková, A., 2024. Carsharing users' behaviour and attitudes. The role of car availability in households. Transportation 51 (5), 1785–1807. https://doi.org/10.1007/s11116-023-10386-0.

Vélez, A.M.A., 2023. Economic impacts, carbon footprint and rebound effects of car sharing: scenario analysis assessing business-to-consumer and peer-to-peer car sharing. Sustain. Prod. Consum. 35, 238–249. https://doi.org/10.1016/j.spc.2022.11.004.

Wang, D., Ye, J., Jia, Y., Jing, P., 2025. Modelling carsharing choice behaviour considering extended utility function and individual attitudes: a hybrid choice modelling approach. Transportation. https://doi.org/10.1007/s11116-025-10668-9.

Wang, S., Song, Z., 2024. Exploring the behavioral stage transition of traveler's adoption of carsharing: an integrated choice and latent variable model. Journal of Choice Modelling 51, 100477. https://doi.org/10.1016/j.jocm.2024.100477.

Wang, Y., Yan, X., Zhou, Y., Xue, Q., Sun, L., 2017. Individuals' acceptance to free-floating electric carsharing mode: a web-based survey in China. Int. J. Environ. Res. Publ. Health 14 (5), 476. https://doi.org/10.3390/ijerph14050476.

Widhalm, P., Ponweiser, W., Markvica, K., Dragaschnig, M., 2023. GPS-based analysis of shared e-mobility services. Transportation Research Procedia, TRA Lisbon 2022 Conference Proceedings Transport Research Arena (TRA Lisbon 2022),14th-17th November 2022, Lisboa, Portugal 72, 3489–3496. https://doi.org/10.1016/j.trpro.2023.11.764.

Wittwer, R., Hubrich, S., 2018. Free-floating carsharing experiences in German metropolitan areas. Transportation Research Procedia, XIII Conference on Transport Engineering, CIT2018 33, 323–330. https://doi.org/10.1016/j.trpro.2018.10.109.

Yu, T., Zhang, Y., Teoh, A.P., Wang, A., Wang, C., 2023. Factors influencing university students' behavioral intention to use electric car-sharing services in guangzhou, China. Sage Open 13 (4), 21582440231210551. https://doi.org/10.1177/21582440231210551.

Zawieska, J., Jakubczyk, M., Zagórska, K., Jaczewska, J., Zawojska, E., Skedsmo, P.W., Wolański, M., 2025. Why not share it? — understanding preferences for car sharing services in warsaw, Poland. Case Stud. Transp. Policy 19, 101346. https://doi.org/10.1016/j.cstp.2024.101346.