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Exploring the role of service quality attributes and user perceptions on customer satisfaction and loyalty for continued shared mobility use in Europe

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ABSTRACT

The growing adoption of shared mobility services provides a sustainable alternative to private vehicle use and offers a potential solution to urban challenges such as traffic congestion, environmental degradation, and inefficient land use. This study examines how service quality attributes, perceived usefulness, and environmental benefits influence user satisfaction and loyalty across multiple shared mobility modes, including shared electric cars, bicycles, and scooters. Drawing on survey data collected from 331 shared mobility users across Inverness (Scotland), Greater Manchester (England), and Dublin (Ireland), we apply Partial Least Squares Structural Equation Modelling (PLS-SEM) to identify the key determinants of satisfaction and loyalty. An Importance–Performance Map (IPM) analysis is used to prioritise areas for service improvement, while multigroup analysis highlights differences in user preferences across transport modes and geographic contexts. The results show that service quality attributes, specifically accessibility, affordability, safety, ease of use, and convenience, play a central role in shaping user satisfaction, which in turn directly increases loyalty. Perceived environmental benefits also display a significant positive influence on satisfaction, underscoring the importance of sustainability considerations in user decision-making. By analysing satisfaction and loyalty across diverse shared mobility modes and three European cities, this study makes a significant step forward in advancing the existing knowledge in shared mobility literature. The findings offer operators and policymakers actionable guidance to optimise service delivery, strengthen user retention, and promote the uptake of sustainable transport solutions.

Introduction

Urban transport systems face persistent challenges related to congestion, environmental externalities, and the inefficient use of limited urban space. Private vehicle ownership and use remain dominant across many European regions, contributing to traffic congestion, air pollution, and the excessive allocation of public space to roads and parking (Bhagat et al., 2024; Shoup, 2021). These pressures are compounded by ongoing urbanisation, which is expected to further strain transport infrastructure and intensify environmental impacts if mobility systems remain car-oriented (United Nations, 2018). Addressing these challenges requires transport solutions that are not only sustainable but also capable of competing effectively within increasingly complex urban mobility markets.

Shared mobility has emerged as a key component of contemporary transport strategies aimed at reducing reliance on private vehicle ownership. Originating from the broader concept of collaborative consumption (Felson & Spaeth, 1978), shared mobility refers to services that provide short-term access to shared vehicles, such as cars, bicycles, and scooters, without the need for ownership (Shaheen et al., 2015). By enabling a shift from ownership-based to access-based mobility, shared systems have the potential to increase vehicle utilisation rates and reduce the need for vehicle production, thereby lowering embedded carbon emissions (Morfeldt & Johansson, 2022). In urban contexts, shared mobility is frequently positioned as a complement to public transport, supporting multimodal travel and first- and last-mile

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connectivity (Shaheen & Chan, 2016).

However, the contribution of shared mobility to broader sustainability objectives is not guaranteed. Evidence regarding its effectiveness in reducing private car use remains mixed, and outcomes depend strongly on local context, service design, and user behaviour (Bösehans et al., 2024a). In cities with dense public transport networks and multiple competing mobility options, including private cars, taxis, ride-hailing services, and micromobility, the long-term role of shared mobility hinges less on initial adoption and more on sustained, repeated use. In such competitive environments, user satisfaction and loyalty become critical determinants of whether shared mobility services are integrated into everyday travel practices or remain marginal or occasional choices (Qiao and Gar-On Yeh, 2023).

A growing body of research has examined user satisfaction, preferences, and behavioural responses to shared mobility services. Much of this literature, however, focuses on individual modes, specific user groups, or single-city case studies (see also Table 1). In recent years, European shared mobility research has expanded substantially, with studies addressing market development, adoption intentions, user preferences, spatial equity, and mobility hub design (Burghardt et al., 2025; López et al., 2024; Singh et al., 2025). Nevertheless, the specific evidence base on post-adoption satisfaction and loyalty remains comparatively less developed, particularly in studies that use primary survey data to compare multiple shared mobility modes operating within similar urban contexts. As a result, evidence remains limited on how users evaluate and prioritise shared mobility services once adopted, and how these evaluations differ across modes.

This study addresses these gaps by examining user satisfaction and loyalty across multiple shared mobility modes, including shared electric cars, bike-sharing, and e-scooter sharing, available at integrated mobility hubs (eHUBS) within the same locations (Bösehans et al., 2023, 2024b; Kavta et al., 2024). Empirically, the analysis focuses on Inverness (Scotland), Greater Manchester (England), and Dublin (Ireland), which differ in size, urban structure, and mobility contexts, allowing for cross-city and cross-mode comparison. By analysing shared mobility services operating under comparable urban conditions, the study extends the service quality–satisfaction–loyalty framework to a comparative, multi-mode European context. Rather than treating shared mobility as a single service category, it examines whether the determinants of satisfaction and loyalty vary across modes and places, thereby providing a contextual extension of established service quality and mobility behaviour perspectives.

Specifically, the study aims to:

- Examine how service quality attributes and user perceptions influence satisfaction and loyalty across different shared mobility modes.
- Assess whether the relative importance of these factors varies across European urban contexts.
- Derive actionable insights for shared mobility operators and policymakers seeking to enhance long-term service viability and integration within urban transport systems.

The remainder of the paper is structured as follows. Section 2 reviews the relevant literature and identifies the research gaps this study addresses. Section 3 presents the conceptual framework and develops the research hypotheses. Section 4 outlines the methodological approach, followed by an assessment of the measurement model in Section 5. Section 6 reports the structural model results and additional analyses. Section 7 discusses the findings in relation to existing research and highlights their practical and theoretical implications. Finally, Section 8 concludes the paper and outlines directions for future research.

Literature review

Table 1 summarises prior research focusing on user satisfaction and loyalty within the transportation domain, providing key insights into

Table 1
Overview of shared mobility research with a focus on user satisfaction and loyalty.

Study	Mode	City, Country (Sample size)	Variables and Analysis	Main findings
Liang et al. (2022)	Bike sharing	Taipei, China,	Four-phase loyalty theory, Structural Equations Modelling (SEM)	Green perceived value and trust of users positively relate to use intention and loyalty
Liu et al. (2020)	Bike-sharing	Chengdu, China (374)	Service quality, perceived green value/ pleasure, customer satisfaction and loyalty, Partial Least Squares Structural Equation Modelling (PLS-SEM)	Customer loyalty was the final construct produced by perceived green value, customer satisfaction, and perceived pleasure
Lou et al. (2021)	Bike-sharing	Generic, China (438)	Altruism, Reward, Perceived ease of use, user knowledge /satisfaction/ commitment, in-role/extra-role participation, PLS-SEM	Altruism, rewards, and user knowledge enhance both in- and extra-role participations, whereas perceived ease of use promotes only user in-role participation,
Xue et al. (2022)	Bike-sharing	Changsha, China (569)	Value identity, convenience, economy, comfort, perceived safety, travel characteristics, Choice Behaviour Model	Loyalty to bike sharing was predicted by all the studied constructs except for gender
(Bruzzone et al., 2025)	Car-sharing	Multiple cities in Central Europe (1000)	Fuzzy-Hybrid TOPSIS approach, individual socioeconomic effects	Satisfaction and loyalty in car-based commuting are influenced by several socio-economic factors, including travel distance, travel time, occupation, and income. Males and older individuals exhibit a higher inclination to drive.
(Lee and Yoon Cheong, 2021)	Car-sharing	Sejong, Korea (899)	Model of utility, intention, satisfaction, and loyalty, using factor and regression analysis, ANOVA	The model of utility positively predicts attitude toward the B2C service. Attitude, in turn, is a significant predictor of satisfaction, which is a significant predictor of loyalty.

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Table 1 (*continued*)

Study	Mode	City, Country (Sample size)	Variables and Analysis	Main findings
(Ma et al., 2020)	Car-sharing	Generic, China (755)	Continuous improvement, Passenger perceived value, passenger trust, transaction costs, passenger loyalty, SEM	The relationship between continuous improvement and passenger loyalty is mediated by passenger perceived value, passenger trust, and transaction costs.
Jia et al. (2020)	Bike-sharing	Generic, China (30 interviews)	Cross-case analysis on how sharing platforms achieve platform loyalty through various operation management strategies	Platform asset characteristics and mergers and acquisitions affect supply network readiness and operational capacity, respectively, and this effect consequently contributes to achieving platform loyalty through user satisfaction
Nguyen-Phuoc et al. (2020)	Ride-sharing	Ho Chi Minh, Vietnam (545)	Perceived risk, trust, ride-sourcing user behavioural intention, satisfaction and loyalty, PLS-SEM	Perceived vehicle and driver-related risk directly affected satisfaction and loyalty; trust mediated relationship between perceived booking app-related risk and loyalty
Shamsudin et al. (2023)	Ride-sharing	Kuala Lumpur, Malaysia (200)	Brand image, price, customer satisfaction, customer loyalty	Both brand image and price significantly influence customer satisfaction. However, in terms of customer loyalty, only brand image is statistically significant.
(Jamšek and Culiberg, 2020)	Bike-sharing	Genric, Slovenia (185)	Perceived bike quality/ ease-of-use/usefulness of the system, extra-version, subjective norms, loyalty, SEM	Bike quality positively influences perceived sustainable usefulness, but not ease-of-use; however, ease-of-use, subjective norms, and extraversion positively influence loyalty among users, while usefulness does not
Mattia et al. (2019)	Car-sharing	Generic, Italy (300)	Attitude, subjective norm, and perceived behavioural control (PBC), re-use intention, SEM	Social, economic, and environmental, benefits indicate the attitude toward free-floating car sharing and that attitude, PBC, and subjective norm have a significant influence on the re-use intention
Popov & Ravi (2020)	E-scooter sharing	Linkoping, Sweden (249)	Customer satisfaction, affective commitment, ownership advantage, relative advantage, service image, PLS-SEM	Customer satisfaction, service image, affective commitment and relative advantage are drivers of service loyalty. Service image, affective commitment and relative advantage mediate the customer satisfaction – service loyalty relationship.
Askari et al. (2024)	E-Scooter sharing	Chicago, USA (569)	Service quality and values impact on satisfaction; SEM	Cost, availability, and payment convenience are top three important factors for satisfaction.
Aman et al. (2021)	E-Scooter sharing	Generic, USA (Review data)	Ease of use, payment, cost, refund, safety, map, etc. Logistic regression	The factors contributing to satisfaction vary between men and women.
Cheng et al. (2024)	Micro-mobility	Generic, China (Review data)	Expectation, product quality, subjective consciousness, Interaction; SEM	Expectation, interactive experience, and product quality impact perceived value while indirectly user satisfaction.
Guan et al. (2024)	Micro-mobility	Utrecht (NL), Malmö (SE), Manchester (UK) (1596)	Multivariate analyses (binary logistic regression models)	A high satisfaction with shared micro-mobility trips encourages people's future use of these services.
(Pasca, 2025)	Micro-mobility	Italy	Mixed-method approach (Interviews and SEM)	Gamification promotes consumers loyalty and service quality in shared mobility services.
An & Noh (2009)	Airlines	Generic, South Korea (494)	Responsive, reliability, food quality, beverage; SEM	Responsiveness and empathy, reliability, beverage and food quality affect loyalty. Two classes:

(*continued on next page*)

Table 1 (*continued*)

Study	Mode	City, Country (Sample size)	Variables and Analysis	Main findings
				Prestige and Economy
Imam (2014)	Public Transport	Amman, Jordan (450)	Ease of payment, no. of routes, cost, time; Descriptive analysis	Users of buses are the most satisfied, followed by users of jitneys and minibuses, respectively

global trends, methodological approaches, and influential factors. The literature search is expanded beyond the realm of shared mobility to encompass a wider body of work, recognising that concepts of satisfaction and loyalty from other domains are also applicable to shared mobility. The key insights emerging from the literature review are explained in the following themes.

Theoretical insights

There have been various approaches used to study shared mobility user satisfaction and loyalty. While some approaches are grounded in theory, such as Liang et al.'s (2022) application of four-phase loyalty theory (Liang et al., 2022), most approaches are less theory-focused and more data-driven in their study of loyalty (e.g (Xue et al., 2022)). A commonality across the different approaches is the assumption that perceived service quality attributes (e.g., ease of use, reliability, pricing) drive shared mobility user satisfaction, which in turn fosters loyalty towards the shared mobility service. As demonstrated by Guan et al. (2024) and others, satisfaction with shared mobility trips increases the likelihood of future use. However, in a European context, evidence of the relationship between perceived service quality attributes and shared mobility user satisfaction and loyalty has been scarce, especially as regards micro mobility. Additionally, in shared mobility contexts, this relationship may not operate uniformly across services. Shared cars, bicycles, and e-scooters differ in cost structures, trip purposes, access conditions, safety requirements, and levels of digital interaction. Therefore, the current study extends the framework by examining whether the same broad satisfaction–loyalty pathway operates differently across shared mobility modes and European urban contexts.

Methodological insights

Structural Equation Modelling (SEM) emerges as the dominant analytical approach in these studies, as it effectively handles complex interrelationships between latent constructs like satisfaction and loyalty as well as observable variables such as demographics, behavioural factors, and service quality (Amin et al., 2014; Yuan et al., 2021). SEM allows for the simultaneous modelling of direct and indirect effects, offering a comprehensive view of factors influencing user behaviour. This methodological strength has informed our decision to adopt Partial Least Squares Structural Equation Modelling (PLS-SEM) in our analysis, which is particularly suited for smaller sample sizes and exploratory studies (Kwong & Wong, 2013). In terms of data sources, the majority of previous studies on satisfaction and loyalty rely on primary data collected through surveys. However, a few notable exceptions, such as those by Aman et al. (2021) and Cheng et al. (2024), have used data extraction techniques on online user reviews to investigate the factors influencing user experience.

Factors influencing satisfaction and loyalty

The literature highlights a range of social, economic, and environmental factors influencing satisfaction and loyalty. Service quality attributes, such as accessibility, affordability, safety, security, ease of rental, and convenience, are consistently identified as critical determinants (Ahmed et al., 2021; Nguyen-Phuoc et al., 2020; Wu et al., 2018). In addition to service quality, perceived environmental contribution and usefulness have gained prominence in recent research. Kwon et al. (2020) and Okada et al. (2019) demonstrated that users are more likely to be satisfied with services that align with their environmental values, particularly as global awareness of climate change and sustainability grows. Similarly, Lee and Wong (2021) and Pick and Schreiner (2020) found that perceived usefulness, defined as the practicality and efficiency of the service in daily life, plays a significant role in fostering user satisfaction. These attributes shape the overall user experience and contribute to sustained service adoption, particularly when aligned with users' expectations and needs. Finally, gamification approaches have been shown to increase consumer loyalty and perceived service quality (Pasca, 2025).

Gaps in the literature and contribution of the current study

Existing research on shared mobility has generated substantial insights into user behaviour, service adoption, market development, and operational performance. The European literature has also expanded considerably in recent years, reflecting the rapid growth and diversification of shared mobility systems across the continent. However, important gaps remain in relation to post-adoption evaluations of shared mobility services, particularly studies that explicitly examine satisfaction and loyalty using primary data and compare multiple shared mobility modes within European urban contexts.

Within the European literature, only a limited number of studies explicitly address satisfaction or loyalty outcomes. For example, Jamšek & Culiberg, (2020), investigate loyalty among bike-sharing users in Slovenia and identify key influencing factors, while highlighting the need for validation across different European contexts and larger samples. Akhmedova et al. (2025) provide further insights by analysing online user reviews of car-sharing services across Europe; however, their reliance on secondary data limits the ability to examine structured relationships between service attributes, satisfaction, and loyalty using established behavioural models. Overall, primary data-driven analyses of shared mobility satisfaction and loyalty in European settings remain relatively scarce (see Guan et al., 2024; Pasca et al., 2025; for exceptions).

In addition, most studies focus on examining individual shared mobility services in isolation, most commonly bike-sharing (Jamšek & Culiberg, 2020; Xia et al., 2022). Other modes, such as car-sharing and e-scooter sharing, have received comparatively less attention, and studies that empirically compare user experiences across multiple shared mobility modes (e.g., Guan et al., 2024) remain rare. While some research has examined determinants of satisfaction within specific services, such as car-sharing (Ma et al., 2020) or e-scooter sharing Popov & Ravi, 2020), there is limited evidence on how satisfaction and loyalty drivers differ across modes operating within the same urban environments. This constrains the understanding of how users prioritise service quality attributes and how these priorities vary by mode and context.

Addressing these gaps, the present study adopts a comparative, post-adoption perspective on shared mobility use in Europe. Using primary survey data, it examines user satisfaction and loyalty across multiple shared mobility modes, shared electric cars, bike-sharing, and e-scooter sharing, available at integrated mobility hubs (eHUBS). The empirical analysis focuses on three European cities, Inverness (Scotland), Greater Manchester (England), and Dublin (Ireland), which differ in size, urban structure, and mobility contexts. By jointly considering regional and modal variation, this study advances existing research and provides policy-relevant insights for shared mobility operators and decision-makers seeking to enhance long-term service performance and integration within urban transport systems.

Conceptual model and hypothesis development

The conceptual model proposed in this study (see Fig. 1) builds on prior research by defining user satisfaction as an outcome of the perceived performance of shared mobility services influenced by various service quality attributes. The rationale for selecting these attributes, along with relevant references and hypothesised direction of relation with user satisfaction, is detailed in Table 2.

The conceptual model (see Fig. 1) integrates a series of hypothesised relationships grounded in prior research on shared mobility and related fields. Hypotheses H1 to H8 examine the relationship between service quality attributes and user satisfaction, drawing on findings from previous studies (Ahmed et al., 2021; Amin et al., 2014; Lee and Wong, 2021; Quy Nguyen-Phuoc et al., 2021; Yuan et al., 2021). It is expected that improvements in these service attributes will positively influence user satisfaction. For instance, accessibility, achieved by strategically locating shared mobility services in easily walkable areas, has been shown to enhance user satisfaction (Chen et al., 2020).

Hypothesis H9 posits that users who perceive shared mobility as contributing to environmental sustainability are more likely to report higher levels of satisfaction. With growing concerns about climate change and urban sustainability, environmental factors have become a significant consideration in shaping user attitudes toward transportation modes. Shared mobility services are often promoted as an environmentally friendly alternative to private car ownership, helping reduce traffic congestion and lower carbon emissions (Shaheen et al., 2015). While the impact of service quality attributes on user satisfaction has been well studied, the impact of perceived environmental contribution on user satisfaction needs further evaluation.

Hypothesis *H*10 posits a positive relationship between perceived usefulness and user satisfaction, suggesting that individuals who find shared mobility services valuable for meeting their daily travel needs will exhibit higher satisfaction. Perceived usefulness encompasses the service's ability to offer flexible, efficient, and seamless transportation options that complement or replace traditional mobility choices (Amin et al., 2014).

Hypothesis *H*11 posits a positive relationship between user satisfaction and loyalty, suggesting that higher satisfaction levels will lead to greater user retention and long-term engagement with shared mobility services. Customer satisfaction has long been established as a key driver of user loyalty across a range of service industries, including transportation. In the context of shared mobility, loyalty refers to a user's likelihood of continued usage and preference for the service over competing mobility options (Ahmed et al., 2021b; Amin et al., 2014; Nguyen-Phuoc et al., 2020; Nguyen-Phuoc et al., 2021a; Wu et al., 2018; Yuan et al., 2021).

The hypotheses were tested using the PLS-SEM approach, detailed in Section 4.1. This study seeks to answer the following research questions:

RQ1: What are the key attributes influencing user satisfaction with shared mobility services in a European context?

RQ2: How do users across different countries and shared mobility modes prioritise service quality attributes?

RQ3: What actionable insights can guide service providers and policymakers in enhancing the adoption and use of shared mobility

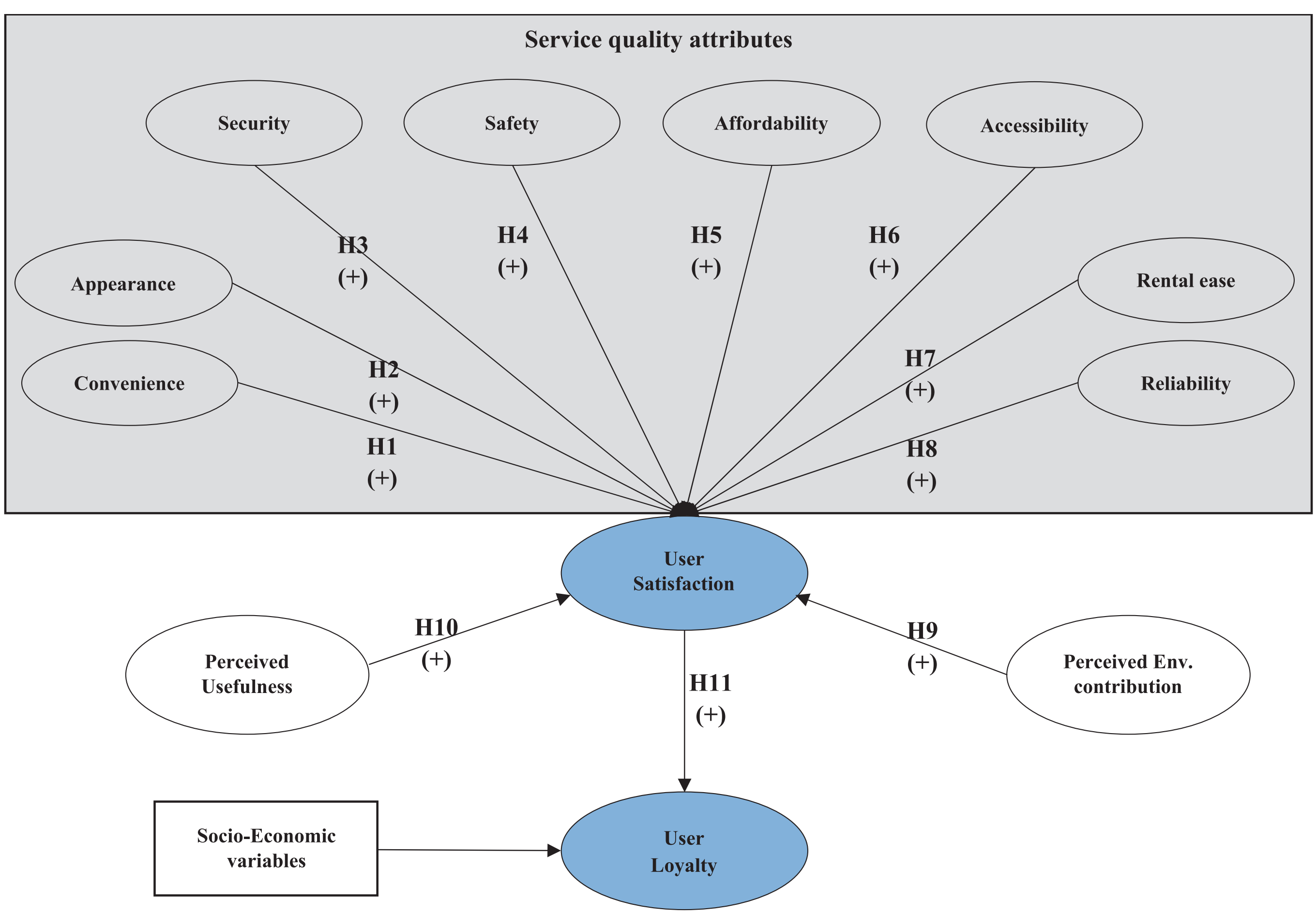

Fig. 1. Conceptual model predicting shared mobility user loyalty.

Table 2
Attributes considered in the study and their rationale.

Attributes	Rationale for hypothesis and relevant references	Hypothesis (Direction)
Convenience	Seamless, hassle-free door-to-door travel with readily available free-floating vehicles and an easy payment process improves user satisfaction (Bösehans & Walker, 2020; Chen et al., 2020).	H1 (+ve)
Appearance	Distinctive design or branding of shared vehicles and rental stations enhances visibility and improves satisfaction (Xia et al., 2022).	H2 (+ve)
Security	Service providers must keep their data secure and private. Anonymization of data in mobile apps enhances user confidence and satisfaction (Turoń et al., 2019).	H3 (+ve)
Safety	Ensuring physical safety through proper maintenance of vehicles and the provision of protective equipment (e.g. helmets) is critical for user trust and satisfaction (Turoń et al., 2019).	H4 (+ve)
Affordability	Pricing should enable individuals with lower incomes to access shared vehicles. Equal access to new technologies and services is crucial for satisfaction (Fleming, 2018; Shaheen & Chan, 2016).	H5 (+ve)
Accessibility	Shared vehicles should be conveniently located within walking distance and easy to find to ensure higher user satisfaction towards shared mobility (Abduljabbar et al., 2021; Krauss et al., 2022).	H6 (+ve)
Ease of rental	A straightforward rental process, including locking/unlocking vehicles and payments digitally, is important for enhancing the user experience and satisfaction (Narsaria et al., 2020).	H7 (+ve)
Reliability	Shared mobility services must ensure fleet availability, along with transparent information such as status for user satisfaction (Herrmann et al., 2014).	H8 (+ve)
Perceived environmental contribution	Awareness of shared mobility's role in reducing traffic and pollution increases user satisfaction and loyalty (Liang et al., 2022; Pick & Schreiner, 2020; Si et al., 2022; Singh, et al., 2025)	H9 (+ve)
Perceived usefulness	The utility derived from shared vehicles impacts satisfaction and adoption. Service providers should cater to diverse needs across trip types, timings, and costs (Si et al., 2022; Wu et al., 2018)	H10 (+ve)
Satisfaction (IV + DV)	Improvement in user satisfaction, improves the loyalty towards the service (El-Adly, 2019)	H11 (+ve)
Loyalty (DV)	Continued use of shared mobility services, likelihood to recommend	–
Socio-economic variables	Demographics such as age, gender, income, and education influence shared mobility adoption and loyalty, acting as control variables in user behaviour studies (Jie et al., 2021; Bösehans et al., 2023b; Singh, et al., 2025).	–

services?

Methodology

Partial least squares- structural equation modelling (PLS-SEM)

Partial Least Squares Structural Equation Modelling (PLS-SEM) is a variance-based SEM technique that simultaneously estimates relationships between latent constructs and their observed indicators, as well as causal relationships among the latent constructs themselves (Hair et al., 2019). PLS-SEM focuses on maximising the explained variance of endogenous constructs and is particularly suited for predictive and exploratory research objectives.

The PLS-SEM framework consists of two interrelated components: the measurement (outer) model and the structural (inner) model. The measurement model specifies the relationships between latent variables and their observed indicators, while the structural model captures the hypothesised relationships among exogenous and endogenous latent variables.

The measurement model can be expressed as:

$$x_{ij} = \lambda_{ij}\eta_j + \varepsilon_{ij}$$

where x_{ij} is denotes indicator i for jth latent variable measuring latent variable j (1- strongly Disagree to 7- strongly agree), λ_{ij} is the loading, η_j is the latent variable and ε_{ij} is the residual term. All indicators were measured using seven-point Likert scales ranging from 1 (strongly disagree) to 7 (strongly agree). The structural model can be expressed mathematically as follows:

$$\eta_{\text{endo}} = \beta_0 + \sum_{j=1}^{J} \beta_j \eta_{\text{exo},j} + \zeta$$

where η_{endo} denotes the endogenous latent variable, $\eta_{\text{exo},j}$ represents the j-th exogenous latent variable, β_j is the corresponding path coefficient, β_0 is the intercept, and ζ is the structural error term.

The choice of PLS-SEM over covariance-based SEM (CB-SEM) is based on the objectives and characteristics of the present study. CB-SEM and PLS-SEM serve related but distinct analytical purposes. CB-SEM is generally preferred when the primary aim is to test a well-established theory, evaluate global model fit, and confirm a mature measurement structure. Its strength lies in theory confirmation and the assessment of whether an observed covariance matrix is consistent with a hypothesised theoretical model. However, CB-SEM typically requires stronger distributional assumptions, including approximate multivariate normality, and its estimates may be more sensitive to sample size, model complexity, and departures from these assumptions.

In contrast, PLS-SEM is generally preferred for exploratory and prediction-oriented studies, particularly when the research objective is to identify key determinants of endogenous constructs, maximise explained variance, and examine complex models involving several latent variables and indicators. PLS-SEM is also less restrictive with respect to distributional assumptions and can be appropriate for survey-based studies using Likert-scale indicators, especially when sample sizes are moderate and when subgroup comparisons are required (Hair et al., 2017; Hair et al., 2019). Its limitation is that it does not provide the same type of global goodness-of-fit assessment as CB-SEM and is therefore less suitable when the main objective is strict confirmation of a fully established theory.

In this study, the objective is not to validate a single established theory of shared mobility satisfaction and loyalty. Rather, the study develops and tests exploratory hypotheses regarding how multiple service quality attributes and user perceptions influence satisfaction and loyalty across different shared mobility modes and European urban contexts. The analysis is also intended to identify practically relevant determinants of satisfaction and loyalty and to compare these relationships across modes and regions. For this reason, a prediction-oriented approach is more closely aligned with the purpose of the study than a strictly confirmatory CB-SEM approach.

A further consideration is the structure of the data. The final sample consists of 331 respondents distributed across three study areas and several shared mobility modes. Although the total sample size exceeds the minimum requirement based on the power analysis reported below, the moderate sample size, subgroup structure, and exploratory nature of the model make PLS-SEM suitable for obtaining stable estimates without relying on strict assumptions of multivariate normality. In addition, PLS-SEM facilitates complementary analyses such as multigroup analysis and Importance–Performance Map Analysis (IPMA), which are central to the practical and policy-oriented objectives of this study.

The sample sizes for the SEM analysis vary substantially (see Table 1), ranging from 185 to 755 participants, placing our study in the middle of the range (331 participants). Following the approach proposed by Soper, (2025), the minimum required sample size for a model with 12 latent variables and 36 observed indicators is 243 observations to detect medium-sized effects (0.30) at a 0.05 significance level with 90% statistical power. The final sample size of 331 respondents exceeds this threshold, supporting the suitability of the data for PLS-SEM estimation.

Statistical analysis workflow

The statistical analysis was conducted in several sequential stages as depicted below in Fig. 2.

First, the survey data were screened for missing values and inconsistencies. Missing values for categorical and Likert-scale variables were replaced using the modal response, while missing values for continuous variables were replaced using the mean. Second, descriptive statistics were calculated to summarise the demographic characteristics of respondents and the distribution of responses to the attitudinal indicators. Third, because the measurement indicators were developed for this study, an exploratory factor analysis was conducted to assess whether the observed indicators aligned with the theoretically proposed latent constructs. The suitability of the data for factor analysis was examined using the Kaiser–Meyer–Olkin measure of sampling adequacy and Bartlett's test of sphericity. Fourth, the measurement model was assessed following established PLS-SEM criteria. Indicator reliability was evaluated using standardised outer loadings; internal consistency reliability was assessed using Cronbach's alpha and composite reliability; convergent validity was examined using average variance extracted; and discriminant validity was assessed using the Fornell–Larcker criterion. Fifth, after establishing the adequacy of the measurement model, the structural model was estimated using SmartPLS 4. Bootstrapping with 5,000 resamples was used to assess the statistical significance of the path coefficients, including direct and indirect effects. The explanatory power of the model was evaluated using the coefficient of determination for the endogenous constructs. Finally, two complementary analyses were conducted to support interpretation of the structural model results. Multigroup analysis was used to examine whether the estimated relationships differed across country groups and shared mobility modes. Importance–Performance Map Analysis was then used to identify service attributes that were important for user satisfaction but showed comparatively lower performance. Together, these steps provided a comprehensive assessment of the measurement model, structural relationships, group differences, and practical priorities for service improvement.

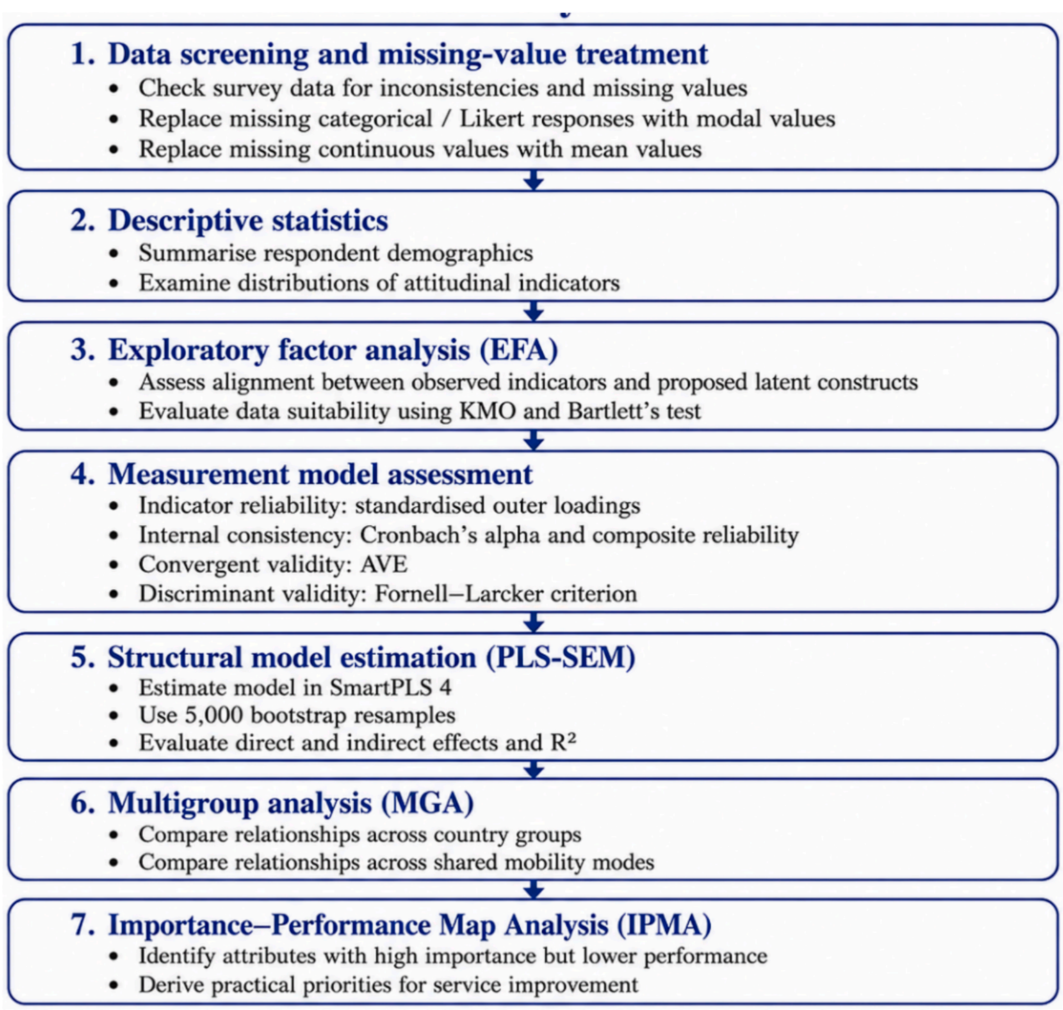

Fig. 2. Statistical analysis workflow.

Data collection and descriptive statistics

The survey targeted users of shared mobility services in three study areas: Dublin (Ireland), Inverness (Scotland), and Greater Manchester (England), shown in Fig. 3.

These cities were selected primarily to allow comparison across multiple shared modes, as they have implemented a concept called eHUBS (Interreg, 2022). These eHUBS integrate various shared mobility options, such as e-cars, e-scooters, and e-bikes, at a single location, offering a unique opportunity to examine user preferences across different modes. Furthermore, the cities vary significantly in size and are located in different countries, providing a broader perspective on user behaviour and preferences across diverse geographical and demographic contexts. Manchester, a key industrial city in the UK with a population of approximately 570,000, has experienced rapid industrial growth since the early 20th century and represents an important nexus in the Northwest of England. In contrast, Dublin, with a population of roughly 600,000, is the capital of Ireland, bustling with administrative activities, modern information technology industries, and tourist attractions. Inverness, though smaller (population of about 50,000), is the capital city of the Highlands region of Scotland and exemplifies how shared mobility use can be achieved in a smaller city context. All three cities offer various shared mobility services, including car sharing, e-bike sharing, and e-cargo bike sharing.

The sampling frame for this study consisted of current users of shared mobility services in the three case study areas: Greater Manchester, Inverness, and Dublin. Since the objective of the study was to examine post-adoption satisfaction and loyalty, respondents were eligible to participate only if they had experience using at least one of the shared mobility services considered in the study, including shared electric cars, shared bicycles, e-bikes, e-cargo bikes, or e-scooters. The survey therefore targeted actual users rather than the general population of each city. Respondents were recruited using a non-probability, user-based sampling approach. The survey was distributed online through channels associated with the shared mobility schemes and local eHUBS project partners, including communication with registered or known service users where available, online survey links, and local project dissemination channels. The same survey instrument and eligibility criteria were applied across all three study areas to ensure consistency in measurement.

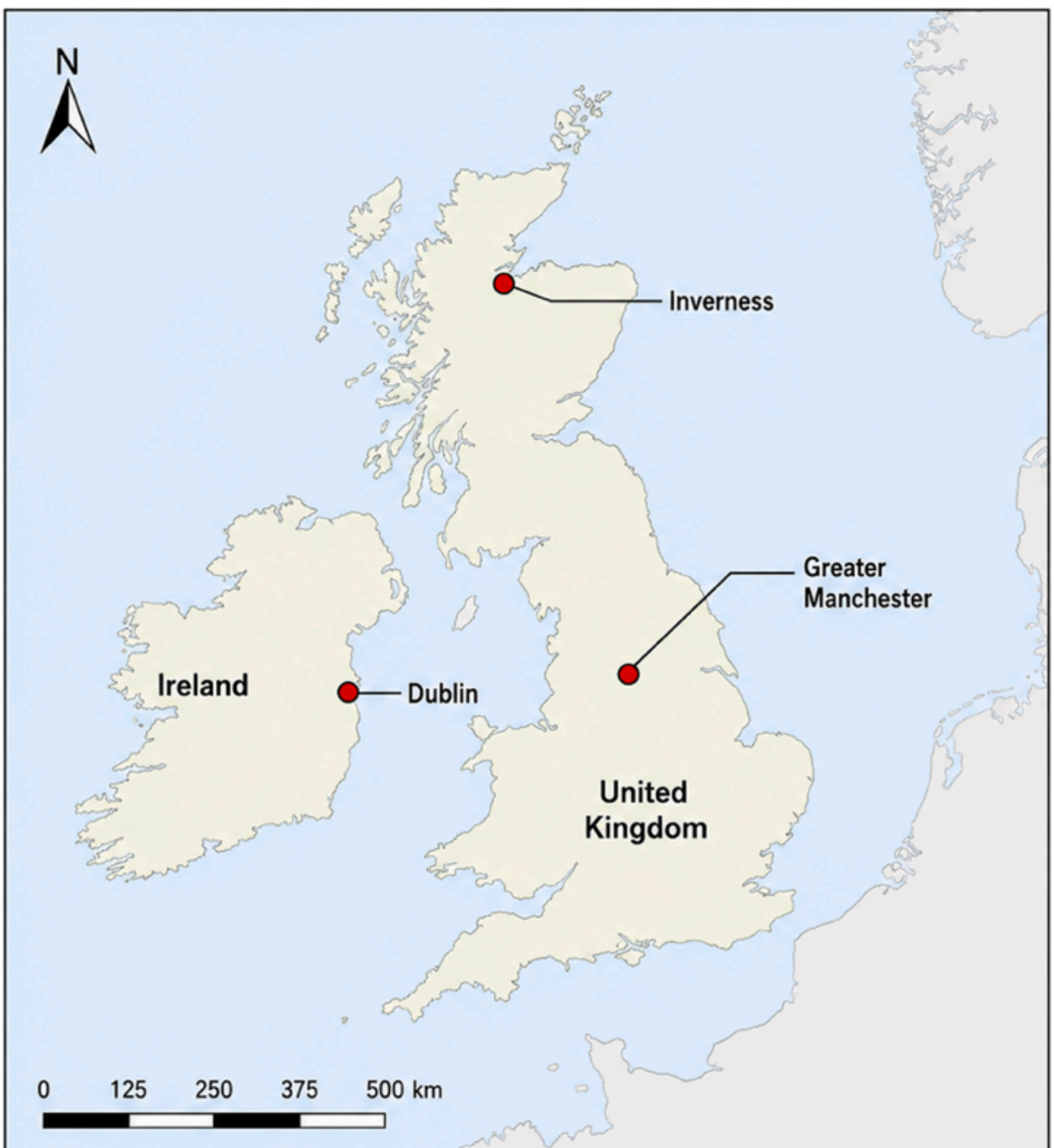

Fig. 3. Study area map.

As explained in the previous sections, the survey consisted of four parts covering questions related to dependent variables (satisfaction and loyalty), service quality attributes, user perceptions, and demographic characteristics of the users. Except for demographics, all the variables were modelled as latent variables, and for each latent variable, three indicator questions were asked to the respondents. The responses to the indicator questions were recorded on a 7-point Likert scale (1 – strongly disagree to 7 – strongly agree).

In total, 331 samples were collected through self-reporting by shared mobility users. The data were screened and cleaned for missing values before analysis. Missing values for questions measured on a categorical scale (1 – strongly disagree to 7 – strongly agree) were replaced with mode values, while missing values for variables measured on continuous scales were replaced with mean values. The demographics of the sample of shared mobility users are shown in Table 3, whereas Table 10 in the appendix presents the means and standard deviations of the attitudinal statements.

As presented in Table 3, the sample varied across demographic groups and study areas. Respondents were mainly from England, followed by Scotland and Ireland. The sample included a higher proportion of male respondents, was concentrated largely among those aged 25–44, and was highly educated, with university-educated respondents forming the largest group. Most respondents were employed, while students, retired respondents, and unemployed or family-care respondents represented smaller shares. The table also includes indicative population distributions to contextualise the survey sample. These benchmarks were compiled from official national statistics, including the Office for National Statistics for England, Scotland's Census / National Records of Scotland for Scotland, and the Central Statistics Office for Ireland. The comparison is intended only to show how the surveyed shared mobility users differ from the broader population. Some groups, particularly employed, university-educated, and younger-to-middle-aged adults, are over-represented, while older and retired individuals are under-represented. This is expected because the study focuses on current shared mobility users and uses online data collection, both of which may attract more digitally active and mobility-engaged respondents. For the PLS-SEM analysis, the key requirement is sufficient variation and adequate numbers across relevant categories to estimate reliable relationships, rather than full demographic representativeness of the national population.

Measurement model assessments

Before examining the structural relationships between latent constructs, the quality of the measurement model was assessed to ensure the reliability and validity of the constructs included in the analysis. Following established PLS-SEM guidelines, this assessment evaluated indicator reliability, internal consistency, convergent validity, and discriminant validity. As the measurement indicators were developed specifically for this study, an exploratory factor analysis (EFA) was first conducted to examine whether the theoretically proposed relationships between indicators and latent constructs were empirically supported..

The EFA results, reported in Appendix Table 11, aligned with the theoretical structure and justified the subsequent confirmatory factor analysis (CFA) using PLS-SEM. Additionally, the complete results from PLS-SEM are reported in Appendix Table 9.

Reliability

Indicator reliability was assessed using standardised outer loadings. Previous studies suggest minimum acceptable thresholds ranging from 0.40 to 0.70 depending on research context (Hair, 2009; Henseler et al., 2009). In this study, a conservative threshold of 0.60 was adopted to ensure adequate indicator reliability. Indicators with loadings below this threshold were excluded from further analysis. As a result, the constructs Appearance, Convenience, Reliability, and Perceived Usefulness were removed from the final model. Although these constructs were removed to maintain measurement reliability, their exclusion means that the final model does not capture all factors that may influence satisfaction and loyalty. Therefore, the effects of the retained constructs should be interpreted as conditional on the final model specification, rather than as evidence that the excluded constructs are unimportant. Future research should refine these measures, use additional indicators, and consider validated service-quality scales to better distinguish overlapping constructs such as accessibility, convenience, and usefulness. The complete list of initially specified constructs and

Table 3
Descriptive statistics (N = 331).

Variable	Category	Manchester (%)	England population (%)	Inverness (%)	Scotland population (%)	Dublin (%)	Ireland population (%)
Gender	Male	67	49	55	48	70	49
	Female	33	51	45	52	30	51
Age	18 to 24	8	11	11	10	13	11
	25 to 34	45	17	26	16	27	18
	35 to 44	22	16	28	15	30	18
	45 to 54	18	16	25	16	14	16
	55 or older	7	40	11	43	16	37
Education	School education	15	–	20	–	2	–
	Professional education	14	–	14	–	5	–
	University	71	–	66	–	91	–
Occupation	Student	7	6	5	5	8	11
	Employed	84	57	82	58	86	56
	Unemployed / Family	5	8	5	6	2	11
	Retired	2	22	7	23	2	8
	Other	4	–	1	–	3	–
Income	< £20,000 / 24,000€	10	–	12	–	13	–
	£20,000–£39,999 / 24,000–47,999€	30	–	38	–	11	–
	£40,000–£59,999 / 48,000–71,999€	26	–	18	–	16	–
	£60,000–£79,999 / 72,000–95,999€	15	–	11	–	13	–
	£80,000–£99,999 / 96,000–120,000€	9	–	9	–	16	–
	> £100,000 / > 120,000€	7	–	4	–	21	–
	Prefer not to say	4	–	8	–	11	–

indicators is provided in Appendix Table 10. Table 4 presents the standardised factor loadings, standard deviations, and t-values for the retained indicators, all of which exceed the adopted threshold and are statistically significant.

Internal consistency and convergent validity

Internal consistency reliability was evaluated using Cronbach's alpha and composite reliability (CR), while convergent validity was assessed using the Average Variance Extracted (AVE). Although Cronbach's alpha values for Accessibility (0.63) and Safety (0.58) were slightly below the conventional threshold of 0.70, values above 0.60 are considered acceptable for exploratory research in the social sciences (Fornell & Larcker, 1981; Kwon et al., 2020). Moreover, both constructs exhibited composite reliability values exceeding 0.70 and AVE values above the recommended threshold of 0.50, indicating satisfactory internal consistency and convergent validity. As composite reliability accounts for individual indicator loadings, it is considered a more appropriate reliability measure in PLS-SEM than Cronbach's alpha (Raza et al., 2020). Table 5 summarises the reliability and convergent validity statistics for all constructs retained in the model.

Table 4
Final latent variables and factor loadings after confirmatory factor analysis.

	Item	Loading	SD	t-value
Accessibility	Access1: The shared vehicle pickup spot is located conveniently for me.	0.97	0.02	53.73
	Access2: The shared vehicle location is within walking distance from my home.	0.64	0.11	5.81
Affordability	Afford1: The fares of using shared vehicles are reasonable.	0.88	0.02	46.58
	Afford2: I think shared vehicles provide a cheap travel alternative.	0.89	0.02	55.47
	Afford3: The fare of using shared vehicles costs me less than using my own vehicle.	0.67	0.06	11.39
User Loyalty	Loyal_1: I intend to keep travelling by this shared mobility service in the future.	0.89	0.02	50.17
	Loyal_2: I would recommend other people to travel by using this shared mobility service.	0.86	0.02	36.29
	Loyal_3: I intend to travel by this shared mobility service more often.	0.81	0.03	33.03
Perceived Env. Contribution	Environ1: Shared vehicles contribute to reduce the level of pollution in my city.	0.91	0.02	60.16
	Environ2: Shared vehicles contribute to reduce the level of traffic in my city.	0.90	0.02	47.73
	Environ3: Shared vehicles make me feel like a responsible traveller from an environmental viewpoint.	0.88	0.02	47.09
Rental ease	Rental1: It is easy to pay for shared vehicles	0.90	0.02	47.69
	Rental2: Picking up / Unlocking shared vehicles is straightforward.	0.85	0.03	27.22
Safety	Safety1: I feel safe at the shared vehicle pickup and drop-off locations.	0.85	0.03	26.95
	Safety2: I feel safe when riding shared vehicles amongst other road users.	0.84	0.03	24.40
Satisfaction	Sat_1: I feel happy with my decision to travel by using this shared mobility service.	0.87	0.02	42.69
	Sat_2: I am satisfied with this shared mobility service.	0.88	0.02	35.92
	Sat_3: The shared mobility service meets all my expectations.	0.80	0.04	20.68
Security	Secure1: I trust that the shared vehicle service provider does not share my personal information with third parties.	0.84	0.03	25.44
	Secure2: I am confident that my trip information is kept anonymous.	0.85	0.03	30.49
	Secure3: The service provider's mobile app is trustworthy.	0.81	0.03	25.07

Discriminant validity

Discriminant validity was assessed using the Fornell–Larcker criterion (Fornell & Larcker, 1981). Table 6 reports the square roots of the AVE values along the diagonal and the inter-construct correlations in the lower triangle. For all constructs, the square root of the AVE exceeds the corresponding inter-construct correlations, indicating satisfactory discriminant validity. Although a relatively strong correlation is observed between Satisfaction and User Loyalty (0.73), this relationship is theoretically expected and does not compromise discriminant validity.

Results

After establishing the reliability and validity of the measurement model, the structural model was evaluated to test the hypothesised relationships between latent constructs. This section presents the estimated path coefficients, their statistical significance, and the model's explanatory power. In addition, the direct effects of sociodemographic variables on user loyalty are examined.

Path/structural model

Table 7 displays the path/structural model estimated using SmartPLS 4 software, employing 5000 bootstrap samples. Bootstrap analysis, a non-parametric resampling technique, was utilised to assess the variability of statistics by iteratively resampling the data, thereby providing robust estimates without assuming parametric distributions (Efron & Tibshirani, 1994; Streukens & Leroi-Werelds, 2016). This model investigates the relationships between latent variables and examines the hypotheses posited in the conceptual model, encompassing both direct (H1 to H11) and indirect effects. The R-square values show that the model collectively accounts for 56.9% of the variance in user loyalty and 39.6% of the variance in user satisfaction.

Among the service quality latent variables (LVs), 'security' exhibits the strongest association with user satisfaction, followed by rental ease, accessibility, affordability, and safety, in descending order. However, beyond these service quality factors, the perceived environmental contribution of shared vehicles shows a stronger correlation with satisfaction. This underscores the importance of emphasising the environmental benefits of shared vehicle use to enhance user satisfaction and

Table 5
Construct reliability and convergent validity.

Latent variable	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
Accessibility	0.63	0.81	0.68
Affordability	0.76	0.86	0.67
User Loyalty	0.82	0.89	0.73
Perceived Env. Contribution	0.87	0.92	0.80
Rental ease	0.71	0.87	0.77
Safety	0.58	0.83	0.71
Satisfaction	0.81	0.89	0.72
Security	0.79	0.87	0.70

Table 6
Correlations between latent variables and the square roots of AVE.

	Accessibility	Affordability	User Loyalty	Perceived Env. Contribution	Rental ease	Safety	Satisfaction	Security
Accessibility	0.83							
Affordability	0.24	0.82						
User Loyalty	0.22	0.46	0.85					
Perceived Env. Contribution	0.11	0.51	0.57	0.89				
Rental ease	0.30	0.40	0.36	0.30	0.88			
Safety	0.39	0.39	0.41	0.35	0.55	0.84		
Satisfaction	0.30	0.45	0.73	0.48	0.43	0.43	0.85	
Security	0.18	0.38	0.35	0.47	0.40	0.43	0.46	0.84

Table 7
Direct and indirect effects of the structural model.

	Mean	SD	t value	p value
Direct effects				
Accessibility → Satisfaction	0.14	0.05	3.07	0.00
Affordability → Satisfaction	0.13	0.06	2.25	0.01
Perceived Env. Contribution → Satisfaction	0.24	0.06	4.25	0.00
Rental ease → Satisfaction	0.15	0.07	2.16	0.02
Safety → Satisfaction	0.08	0.05	1.40	0.08
Satisfaction → User Loyalty	0.74	0.03	24.30	0.00
Security → Satisfaction	0.18	0.05	3.39	0.00
Young age → User Loyalty	−0.25	0.15	1.71	0.04
High education → User Loyalty	0.26	0.09	2.99	0.00
High income → User Loyalty	0.12	0.08	1.42	0.08
Indirect effects				
Accessibility → User Loyalty	0.11	0.03	3.07	0.00
Affordability → User Loyalty	0.10	0.05	2.20	0.01
Perceived Env. Contribution → User Loyalty	0.18	0.04	3.99	0.00
Rental ease → User Loyalty	0.11	0.05	2.15	0.02
Safety → User Loyalty	0.06	0.04	1.41	0.08
Security → User Loyalty	0.14	0.04	3.38	0.00

Table 8
Multigroup analysis based on country of residence and shared mode used.

	Difference (Country)	**p value** (Country)	**Difference** (Mode)	**p value** (Mode)
Accessibility → Satisfaction	−0.08	0.19	**−0.22**	**0.01**
Affordability → Satisfaction	**0.19**	**0.05**	**0.15**	**0.09**
Env. Contribution → Satisfaction	**−0.14**	**0.10**	0.06	0.29
Rental ease → Satisfaction	0.11	0.22	**−0.21**	**0.05**
Safety → Satisfaction	−0.05	0.33	0.01	0.48
Satisfaction → User Loyalty	−0.02	0.34	0.07	0.12
Security → Satisfaction	**−0.20**	**0.04**	0.12	0.14
Young age → User Loyalty	−0.18	0.28	0.12	0.34
High education → User Loyalty	−0.07	0.36	**−0.34**	**0.03**
High income → User Loyalty	−0.17	0.15	0.13	0.21

thereby foster service reuse (loyalty). Furthermore, the influence of control variables pertaining to age, education level, and income on user loyalty was examined. The findings indicate that individuals in the younger age group (under 25) are less inclined to exhibit loyalty towards shared vehicle services compared to other age cohorts. This aligns with similar observations in previous studies, where older demographics exhibited greater loyalty to ride-sourcing services (Nguyen-Phuoc et al., 2021b). Conversely, individuals with higher levels of education (undergraduate and above) and higher incomes (£60,000/€72,000 per year or more) tend to display greater loyalty towards shared mobility services. The results presented in Table 7 below confirm all hypothesis relationships with a minimum confidence level of 90%, thereby affirming the positive influence of service quality latent variables on satisfaction, consequently bolstering overall user loyalty.

Multi-group analysis

The multigroup analysis aims to identify differences in relationships across group segments (Cheah et al., 2020). Two distinct analyses were conducted to examine how group characteristics influence the structural model. The first analysis focused on country segmentation, comparing data from England with combined data from Scotland and Ireland. Efforts to further separate Scotland and Ireland were limited by sample size constraints. The second analysis examined the impact of shared mode types, comparing shared car users to a group combining shared bike and scooter users.

Results in Table 8 show a few statistically significant differences across most relationships. For the country-based analysis, significant differences at the 90% confidence level were observed in the relationships among 'affordability to satisfaction,' 'perceived environmental contribution to satisfaction,' and 'security to satisfaction.' In England, affordability has a stronger influence on satisfaction, while in Ireland and Scotland, security and environmental benefits are more critical. For the mode-based analysis, significant differences at a 90% confidence level were found in the relationships between 'affordability to satisfaction' and 'rental ease to satisfaction.' Shared car users are more influenced by affordability, while rental ease is more important for shared bike and scooter users. Additionally, accessibility and higher education levels have a stronger impact on satisfaction and loyalty, respectively, among shared bike and scooter users compared to shared car users.

Importance performance Map analysis (IPMA)

Importance Performance Map Analysis (IPMA) extends the capabilities of Partial Least Squares Structural Equation Modelling (PLS-SEM) by offering graphical insights to aid in policy formulation. In IPMA, a Cartesian coordinate plot depicts the relative importance and performance of latent variables. The x-axis represents the total effect of latent variables (Importance), while the y-axis indicates the average latent scores (Performance), rescaled from 0 to 100 (Slack, 1994), where 0 signifies the lowest performance and 100 denotes the highest. The rescaling process involves straightforward arithmetic calculations utilising standardised outer weights of indicators and responses to indicators on the Likert scale as inputs (Slack, 1994). The aim of IPMA is to identify predecessor or antecedent latent variables that exhibit high importance but comparatively lower performance toward the target latent variable.

In this study, IPMA was conducted for the target latent variable (user satisfaction) and all 'service quality' and 'perceived environmental contribution' latent variables, which served as predecessors in the analysis. The results, depicted in Fig. 4, reveal that the 'security' latent variable lies in the lower right quadrant, indicating high importance but relatively lower performance. Quadrant formation was based on mean

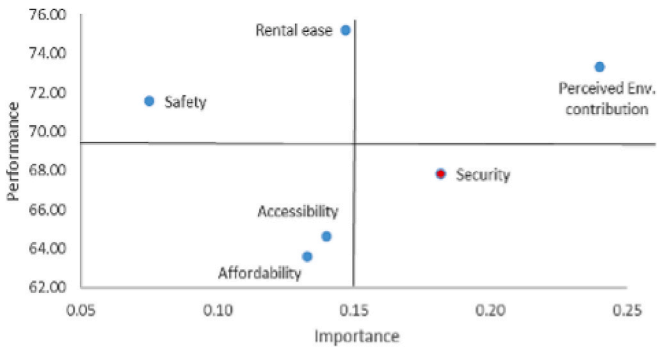

Fig. 4. Importance (x-axis)-Performance (y-axis) Map for satisfaction.

values of performance and the importance of all latent variables. This suggests that users prioritise 'security' aspects in shared mobility, deeming them highly important. Consequently, service providers should prioritise enhancing security measures to elevate user satisfaction levels and foster loyalty toward their service. The 'security' latent variable primarily pertains to the collection, storage, processing, and utilisation of user data (such as names, tracking information, credit card details, etc.) by service providers through their mobile applications. Accessibility and Affordability were also found to be underperforming, yet were deemed less important by users. To attract more users, however, improving the accessibility and affordability of shared vehicles is recommended.

Discussions

The results of this study provide valuable insights into user satisfaction and loyalty towards shared mobility services and highlight key differences in user perceptions across countries and shared mobility modes. This section discusses the implications of these findings for shared mobility operators, explores the reasons behind observed variations, and outlines limitations and future research directions.

Context-specific determinants of satisfaction and loyalty

The results underscore the importance of context-specific insights in understanding shared mobility use in Europe (see Guan et al., 2024, for another example). Across the three cities examined, Inverness, Greater Manchester, and Dublin, user evaluations of shared mobility services differed in both the relative importance of service attributes and the pathways through which satisfaction and loyalty are formed. For example, affordability emerged as a particularly salient driver of satisfaction and loyalty in Greater Manchester, whereas safety and perceived environmental contribution played a more prominent role in Inverness and Dublin. These findings highlight the sensitivity of shared mobility evaluations to local transport conditions, pricing structures, and broader policy and cultural contexts.

Compared with the predominantly Asian-focused literature (see also Hu & Creutzig, 2022, or Zhu et al., 2023, for a systematic review of shared mobility in China), which often emphasises convenience, reliability, and ease of use as primary drivers of satisfaction (Zhou et al., 2019), the present findings suggest a distinct European pattern. In particular, the Importance–Performance Map Analysis indicates that perceived environmental contribution is consistently prioritised by European users. This reinforces the argument that insights derived from non-European contexts may not be directly transferable, and that European shared mobility research requires greater attention to environmental motivations and sustainability-oriented user perceptions.

The study further contributes to the literature by revealing mode-specific differences in satisfaction drivers. The multigroup analysis shows that car-sharing users are more sensitive to affordability, while bike-sharing and e-scooter users place greater emphasis on ease of rental. This differentiation reflects the distinct cost structures, usage patterns, and functional roles of each mode. Importantly, these findings challenge the tendency to treat shared mobility as a homogeneous category and instead support a more nuanced, mode-sensitive analytical approach.

While the observed differences are likely shaped by a combination of economic, cultural, and infrastructural factors, the results suggest that user priorities are closely linked to the role shared mobility plays within local transport systems. In contexts where shared mobility complements well-developed public transport networks, environmental contribution and safety may be more salient, whereas in settings where cost pressures are more pronounced, affordability becomes a dominant concern. These patterns warrant further investigation but already demonstrate the value of comparative, place-based analysis.

Practical implications for shared mobility operators and policymakers

The findings offer several implications for shared mobility operators and policymakers seeking to enhance long-term service viability.

For micromobility service providers, two critical factors to consider are investments in rental affordability and vehicle accessibility, which are likely to yield greater gains in user satisfaction and thus loyalty. This is particularly the case for shared electric cars, where affordability plays a greater role than for shared bike and scooter users. Trust-related attributes such as security and data protection and environmental contribution also emerged as critical factors, with findings suggesting a greater impact on user satisfaction in Ireland and Scotland compared to England. Whether these findings reflect actual differences in national level environmental and security concerns is subject to future investigation. In conclusion, for providers, the results suggest that service improvements should be tailored to both local context and mobility mode.

From a policy perspective, the prominence of perceived environmental contribution highlights the importance of embedding shared mobility within broader sustainability strategies. Public communication campaigns and policy frameworks that explicitly link shared mobility to emissions reduction, congestion mitigation, and responsible travel may reinforce positive user perceptions and support sustained use. In addition, policies aimed at improving accessibility and affordability, such as targeted subsidies, integration with public transport, or incentives for service provision in underserved areas, can further enhance user satisfaction and loyalty. Importantly, the integration of shared mobility into cities' transportation networks should be gradual, adaptive, and futureproof, while reducing rather than exacerbating existing inequalities in mobility (Dill & McNeil, 2021). Sustainable mobility frameworks, such as the CalmMobility Paradigm (Turoń, 2025), provide further guidance on how cities can prepare for a seamless integration of sustainable mobility into daily travel patterns. A key consideration is that citizens' needs and expectations should be taken into account during planning, requiring consultation and feedback mechanisms.

Limitations and future research

Several limitations should be acknowledged. First, although the study provides comparative evidence from three European urban contexts, the findings should be interpreted in light of the specific governance arrangements, infrastructure maturity, service availability, and cultural mobility norms of the selected study areas. The study areas differ in size and mobility context, but they are all located in highly developed European countries and therefore share some similarities in institutional setting, infrastructure maturity, and broader mobility culture. As a result, some insights may be transferable to comparable European urban contexts. However, the results may not be directly transferable to regions that differ substantially from Europe in geographical, cultural, governance, regulatory, or infrastructural terms, such as many Asian contexts where shared mobility systems, user behaviour, and policy environments may differ considerably. Future research should therefore test the model across a wider range of global urban contexts to examine how local governance, infrastructure, and mobility cultures shape satisfaction and loyalty.

Second, the study relied on a non-probability, convenience-based sampling approach, as no complete sampling frame of shared mobility users exists for the three study areas and participation was restricted to actual users. The achieved samples may therefore not be fully representative of each city's shared mobility user population, and no operator- or scheme-level data on the characteristics of the total user base were available to benchmark the samples beyond the national comparisons in Table 3. Some caution is warranted when generalising the findings, particularly the country and mode-specific comparisons.

Third, several constructs commonly discussed in the service quality literature, such as appearance, reliability, convenience, and perceived usefulness, were excluded due to insufficient reliability. These constructs were removed because their indicators did not meet the required reliability criteria, which helped preserve the validity of the final measurement model. Future research should refine these measures by using additional indicators, larger samples, and validated service-quality scales, while also examining potential conceptual overlap between related constructs such as accessibility, convenience, usefulness, and rental ease. As the indicators were developed specifically for this study, further refinement and validation of measurement instruments are warranted.

Fourth, the analysis focuses exclusively on current users of shared mobility services. Incorporating non-users or occasional users in future research could provide additional insights into barriers to adoption and differences in attribute prioritisation between adopters and non-adopters (e.g., Guan et al., 2024). Finally, while the study identifies key determinants of satisfaction and loyalty, it does not explicitly model underlying psychological mechanisms, such as habit formation or trust development, and does not consider factors that may bolster the latter, such as gamification elements (Pasca et al., 2025). Longitudinal or mixed-methods research could offer a deeper understanding of these processes and further strengthen evidence on the long-term integration of shared mobility into everyday travel behaviour.

Conclusions

This study examined the determinants of user satisfaction and loyalty towards shared mobility services in European urban contexts. By analysing shared electric cars, bike-sharing, and e-scooter sharing across Inverness, Greater Manchester, and Dublin, the study provides comparative insights into how users evaluate shared mobility after adoption. The findings show that satisfaction and loyalty are shaped by service quality attributes and user perceptions, with accessibility, affordability, safety, rental ease, security, and perceived environmental contribution playing important roles. Satisfaction was also found to be a strong predictor of loyalty, highlighting the importance of positive user experience for continued use.

The results show that shared mobility users should not be treated as a homogeneous group. Satisfaction drivers varied across study areas and modes. For example, affordability was more important for shared car users, while ease of rental and accessibility were more relevant for micromobility users. This suggests that policy and service interventions should be tailored to local transport conditions and mode-specific user needs rather than applying uniform strategies across all shared mobility services.

The findings also provide several policy implications. Shared mobility should be integrated more explicitly into wider urban mobility and sustainability strategies, as users appear to respond positively when services are associated with reduced emissions, congestion mitigation, and sustainable travel. Policies should also support affordability, accessibility, safety, and trust through measures such as targeted subsidies, public transport integration, service provision in underserved areas, well-located mobility hubs, safe infrastructure, reliable vehicles and digital platforms, and transparent data protection practices.

Theoretically, the study extends the service quality–satisfaction–loyalty framework by showing that the determinants of satisfaction and loyalty in shared mobility are mode- and context-dependent rather than uniform across services and cities. Despite limitations related to non-probability sampling and the exclusion of some constructs due to measurement reliability issues, the study provides useful evidence for improving shared mobility services and strengthening their long-term role in sustainable urban transport systems. Future research could extend this work using longitudinal data and broader cross-city comparisons to examine how satisfaction, loyalty, and actual usage evolve over time.

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CRediT authorship contribution statement

Kuldeep Kavta: Writing – original draft, Software, Investigation, Formal analysis, Data curation, Conceptualization. **Gustav Bösehans:** Writing – original draft, Software, Investigation, Formal analysis, Data curation. **Margaret Bell:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Dilum Dissanayake:** Writing – review & editing, Supervision, Project administration, Funding acquisition, Conceptualization.

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.

Appendix

Table 9
Detailed PLS-SEM results.

SEM component	Construct / relationship	Indicator / path	Loading / coefficient	SD	t-value	p-value	C-alpha	Composite reliability	AVE	Interpretation
Measurement model	Accessibility	Access1	0.97	0.02	53.73	—	0.63	0.81	0.68	Retained

(continued on next page)

Table 9 (*continued*)

SEM component	Construct / relationship	Indicator / path	Loading / coefficient	SD	t-value	p-value	C-alpha	Composite reliability	AVE	Interpretation
Measurement model	Accessibility	Access2	0.64	0.11	5.81	—	0.63	0.81	0.68	Retained
Measurement model	Affordability	Afford1	0.88	0.02	46.58	—	0.76	0.86	0.67	Retained
Measurement model	Affordability	Afford2	0.89	0.02	55.47	—	0.76	0.86	0.67	Retained
Measurement model	Affordability	Afford3	0.67	0.06	11.39	—	0.76	0.86	0.67	Retained
Measurement model	User Loyalty	Loyal1	0.89	0.02	50.17	—	0.82	0.89	0.73	Retained
Measurement model	User Loyalty	Loyal2	0.86	0.02	36.29	—	0.82	0.89	0.73	Retained
Measurement model	User Loyalty	Loyal3	0.81	0.03	33.03	—	0.82	0.89	0.73	Retained
Measurement model	Per. environmental contribution	Environ1	0.91	0.02	60.16	—	0.87	0.92	0.80	Retained
Measurement model	Per. environmental contribution	Environ2	0.90	0.02	47.73	—	0.87	0.92	0.80	Retained
Measurement model	Per. environmental contribution	Environ3	0.88	0.02	47.09	—	0.87	0.92	0.80	Retained
Measurement model	Rental ease	Rental1	0.90	0.02	47.69	—	0.71	0.87	0.77	Retained
Measurement model	Rental ease	Rental2	0.85	0.03	27.22	—	0.71	0.87	0.77	Retained
Measurement model	Safety	Safety1	0.85	0.03	26.95	—	0.58	0.83	0.71	Retained
Measurement model	Safety	Safety2	0.84	0.03	24.40	—	0.58	0.83	0.71	Retained
Measurement model	Satisfaction	Sat1	0.87	0.02	42.69	—	0.81	0.89	0.72	Retained
Measurement model	Satisfaction	Sat2	0.88	0.02	35.92	—	0.81	0.89	0.72	Retained
Measurement model	Satisfaction	Sat3	0.80	0.04	20.68	—	0.81	0.89	0.72	Retained
Measurement model	Security	Secure1	0.84	0.03	25.44	—	0.79	0.87	0.70	Retained
Measurement model	Security	Secure2	0.85	0.03	30.49	—	0.79	0.87	0.70	Retained
Measurement model	Security	Secure3	0.81	0.03	25.07	—	0.79	0.87	0.70	Retained
Structural model: direct effect	Accessibility → Satisfaction	H6	0.14	0.05	3.07	0.00	—	—	—	Supported
Structural model: direct effect	Affordability → Satisfaction	H5	0.13	0.06	2.25	0.01	—	—	—	Supported
Structural model: direct effect	Per. environmental contribution → Satisfaction	H9	0.24	0.06	4.25	0.00	—	—	—	Supported
Structural model: direct effect	Rental ease → Satisfaction	H7	0.15	0.07	2.16	0.02	—	—	—	Supported
Structural model: direct effect	Safety → Satisfaction	H4	0.08	0.05	1.40	0.08	—	—	—	Supported at 90% CI
Structural model: direct effect	Satisfaction → User Loyalty	*H*11	0.74	0.03	24.30	0.00	—	—	—	Supported
Structural model: direct effect	Security → Satisfaction	H3	0.18	0.05	3.39	0.00	—	—	—	Supported
Structural model: direct effect	Young age → User Loyalty	Control variable	−0.25	0.15	1.71	0.04	—	—	—	Significant negative effect
Structural model: direct effect	High education → User Loyalty	Control variable	0.26	0.09	2.99	0.00	—	—	—	Significant positive effect
Structural model: direct effect	High income → User Loyalty	Control variable	0.12	0.08	1.42	0.08	—	—	—	Supported at 90% CI
Structural model: indirect effect	Accessibility → Satisfaction → User Loyalty	Indirect effect	0.11	0.03	3.07	0.00	—	—	—	Significant indirect effect
Structural model: indirect effect	Affordability → Satisfaction → User Loyalty	Indirect effect	0.10	0.05	2.20	0.01	—	—	—	Significant indirect effect
Structural model: indirect effect	Per. environmental contribution → Satisfaction → User Loyalty	Indirect effect	0.18	0.04	3.99	0.00	—	—	—	Significant indirect effect
Structural model: indirect effect	Rental ease → Satisfaction → User Loyalty	Indirect effect	0.11	0.05	2.15	0.02	—	—	—	Significant indirect effect
Structural model: indirect effect	Safety → Satisfaction → User Loyalty	Indirect effect	0.06	0.04	1.41	0.08	—	—	—	Supported at 90% CI
Structural model: indirect effect	Security → Satisfaction → User Loyalty	Indirect effect	0.14	0.04	3.38	0.00	—	—	—	Significant indirect effect
Model explanatory power	Satisfaction	R^2	0.396	—	—	—	—	—	—	39.6% of variance explained

(*continued on next page*)

Table 9 (*continued*)

SEM component	Construct / relationship	Indicator / path	Loading / coefficient	SD	t-value	p-value	C-alpha	Composite reliability	AVE	Interpretation
Model explanatory power	User Loyalty	R^2	0.569	—	—	—	—	—	—	56.9% of variance explained

Table 10
Latent variable constructs, indicators, descriptives, and their acceptance to, or rejection from, the final structural equation model.

Statement	Variable	N	Mean	SD	Accepted/Rejected (Reason)
The shared vehicle pickup spot is located conveniently for me	Accessibility	326	4.98	1.53	Accepted
The shared vehicle location is within walking distance from my home/work		325	4.33	2.07	Accepted
Shared vehicles are accessible at any time of the day.		325	4.98	1.43	Rejected (not significantly reliable)
I think the shared vehicles provide a cheap travel alternative	Affordability	326	4.94	1.49	Accepted
The fares of using shared vehicles are reasonable		326	4.8	1.4	Accepted
The fare of using shared vehicles costs me less than using my own vehicle		326	4.44	1.75	Accepted
The design of shared vehicles is recognisable	Appearance	325	5.59	1.22	Rejected (not significantly reliable)
The shared vehicles are generally kept clean		325	5.19	1.3	
The shared vehicles do not have a modern look		326	3.1	1.5	
I prefer a service that allows me to leave the shared vehicles anywhere I want	Convenience	325	5.44	1.41	Rejected (not significantly reliable)
Shared vehicles save time spent on searching for parking		325	5.19	1.49	
It is convenient to transfer to other transport modes		326	5.06	1.31	
I would recommend other people to travel by using this shared mobility service	Customer loyalty	331	5.7	1.21	Accepted
I intend to keep travelling by this shared mobility service in the future		331	5.46	1.37	Accepted
I intend to travel by this shared mobility service more often		331	4.75	1.42	Accepted
I feel happy with my decision to travel by using this shared mobility service	Customer satisfaction	331	5.73	1.18	Accepted
I am satisfied with this shared mobility service		331	5.38	1.16	Accepted
The shared mobility service meets all my expectations		331	5.18	1.29	Accepted
Shared vehicles contribute to reduce the level of pollution in my city	Perceived environmental contribution	326	5.63	1.24	Accepted
Shared vehicles contribute to reduce the level of traffic in my city		325	5.42	1.3	Accepted
Shared vehicles make me feel like a responsible traveller from an env. viewpoint		325	5.35	1.3	Accepted
Shared vehicles provide me with more flexibility in the way I travel	Perceived usefulness	325	5.39	1.27	Rejected (not significantly reliable)
Using a shared vehicle service is a good alternative to owning a vehicle		326	5.1	1.52	
Shared mobility cannot fulfil my mobility needs		324	3.91	1.64	
It is important to me that the shared vehicles function properly (no breakdowns, empty battery)	Reliability	325	6.35	1.01	Rejected (not significantly reliable)
It is important to me that there is always a shared vehicle available when I need one		326	5.39	1.36	
The service provider information on shared vehicles is accurate (e.g., charging, location, etc.)		326	5.33	1.21	
It is easy to pay for shared vehicles	Rental ease	325	5.6	1.19	Accepted
Picking up / Unlocking shared vehicles is straightforward		323	5.36	1.27	Accepted
It is difficult to reserve shared vehicles		323	3.6	1.54	Rejected (not significantly reliable)
I feel safe at the shared vehicle pickup and drop-off locations	Safety	325	5.51	1.11	Accepted
I feel safe when riding shared vehicles amongst other road users		326	5	1.4	Accepted
I feel unsafe as the shared vehicles are badly maintained (lights, brakes, tyres, etc)		326	2.94	1.58	Rejected (not significantly reliable)
The service provider's mobile app is trustworthy	Security	326	5.33	1.21	Accepted
I trust that the mobility provider does not share my data with third parties		325	4.96	1.35	Accepted
I am confident that my trip information is kept anonymous		324	4.83	1.36	Accepted

Exploratory factor analysis.
Rotated Component Matrix – Varimax rotation.

Table 11
Exploratory Factor Analysis.

	Components (threshold – 0.5)									
	1	2	3	4	5	6	7	8	9	10
Sat_1	0.747									
Sat_2	0.716									
Sat_3	0.583									
Loyal_1		0.766								
Loyal_2		0.752								
Loyal_3		0.713								
Access1						0.739				
Access2						0.798				

(*continued on next page*)

Table 11 (*continued*)

	Components (threshold – 0.5)									
	1	2	3	4	5	6	7	8	9	10
Access3										
Afford1							0.672			
Afford2							0.66			
Afford3							0.744			
Appear1										
Appear2										
Appear3										0.719
Rental1				0.69						
Rental2				0.502						
Rental3										
Safety1										0.519
Safety2										0.741
Safety3										
Secure1					0.819					
Secure2					0.789					
Secure3					0.512					
Conven1										
Conven2										
Conven3								0.611		
Reliab1										
Reliab2				0.652						
Reliab3										
Environ1			0.72							
Environ2			0.69							
Environ3			0.608							
Useful1									0.686	
Useful2										
Useful3										

KMO sampling adequacy		0.904
Bartlett's test of sphericity	Approx Chi-square	5063.791
	df	630
	Sig.	0<.001

Data availability

The authors do not have permission to share data.

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