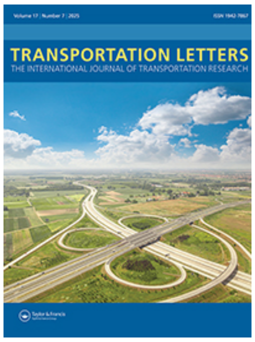

Taylor & Francis
Taylor & Francis Group

Transportation Letters
The International Journal of Transportation Research

ISSN: 1942-7867 (Print) 1942-7875 (Online) Journal homepage: www.tandfonline.com/journals/ytrl20

Differences in MaaS adoption among university students

Willy Kriswardhana, Balázs Sárvári & Domokos Esztergár-Kiss

To cite this article: Willy Kriswardhana, Balázs Sárvári & Domokos Esztergár-Kiss (25 Aug 2025): Differences in MaaS adoption among university students, Transportation Letters, DOI: 10.1080/19427867.2025.2550485

To link to this article: https://doi.org/10.1080/19427867.2025.2550485

Published online: 25 Aug 2025.

TRANSPORTATION LETTERS
https://doi.org/10.1080/19427867.2025.2550485

Differences in MaaS adoption among university students

Willy Kriswardhana[a,b], Balázs Sárvári[c,d,e] and Domokos Esztergár-Kiss[a]

[a]Department of Transport Technology and Economics, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics, Budapest, Hungary; [b]Department of Civil Engineering, Faculty of Engineering, Universitas Jember, Jember, Indonesia; [c]Institute of Economics, Corvinus University of Budapest, Budapest, Hungary; [d]Green Transition Institute, Budapest Metropolitan University, Budapest, Hungary; [e]Department of Sustainable Finance, Central Bank of Hungary, Budapest, Hungary

ABSTRACT

There is growing interest in identifying potential adopters of Mobility as a Service (MaaS). Although socio-demographic and travel-related factors influencing adoption have been studied, the impact of attitudinal factors within specific traveler groups has been partly neglected. This study explores how attitudinal factors affect university students' intention to use MaaS through structural equation modeling. Latent class cluster analysis reveals two groups: high-income students who frequently use cars (Cluster 1) and low-income students relying on public transport (Cluster 2). The results show that ease of learning the MaaS system and media influence significantly affect adoption. Perceived benefits play a crucial role in shaping willingness among Cluster 1, while environmental awareness influences adoption in Cluster 2. To enhance uptake, strategies such as social media promotion and gamification are recommended, offering insights for transportation planners and policy-makers.

ARTICLE HISTORY
Received 31 December 2024
Accepted 16 August 2025

KEYWORDS
MaaS; mobility as a service; acceptance; attitude; heterogeneity

Introduction

The advent of emerging mobilities (e.g. car-sharing and bike-sharing) in cities caused by the development of mobile technology and collaborative consumption may complement public transport (PT) services (Mounce and Nelson 2019). While shared mobility services promise such advantages as reduced carbon emissions (J. Chen et al. 2020), decreased traffic congestion (Fan and Harper 2022), and lower fuel consumption (Brunner et al. 2018), travelers may find it difficult to utilize the variety of transport modes, particularly when using various mobile applications (apps) with different user interfaces (Kamargianni et al. 2016). Mobility as a Service (MaaS) is currently a focal point in the vision of future connected and collaborative transportation (Ho, Hensher, and Reck 2021). MaaS is designed to unite multiple mobility services into one app (Esztergár-Kiss et al. 2020), where the inconvenience of installing several mobile apps and managing different payment methods is solved, which is highlighted as an advantage of the service (Arias-Molinares, Juan Carlos, and Javier 2023; Smith, Sochor, and Karlsson 2017).

Given the promising benefits of MaaS, several studies have examined which groups of travelers are more inclined to use MaaS. Previous works (Alonso-González et al. 2020; van't Veer et al. 2023) find that the individuals with higher educational levels are most likely to be potential MaaS adopters and have a greater tendency to adopt MaaS packages (Matyas and Kamargianni 2021). Furthermore, it is widely known that young people are potential early adopters of the service (Farahmand, Gkiotsalitis, and Geurs 2021) since they can quickly adapt to the development of information technology (Lee et al. 2020). Additionally, young individuals tend to favor living in urban areas (Xu 2020), where various transport modes (Delbosc et al. 2019), such as shared mobility services, supporting multimodal behavior (van der Waard, Jorritsma, and Immers 2013) are available.

As part of the young generation, college students frequently demonstrate flexibility in their choice of transport modes (Limanond, Butsingkorn, and Chermkhunthod 2011), and they tend to have positive viewpoints on alternative mobility solutions (Whalen, Páez, and Carrasco 2013), such as MaaS (Zijlstra et al. 2020). University students travel regularly between their campus, accommodation, social activities, and even their part-time jobs (Allen and Farber 2018). Moreover, students are more willing to try new services

CONTACT Willy Kriswardhana willy.kriswardhana@edu.bme.hu Department of Transport Technology and Economics, Faculty of Transportation Engineering and Vehicle Engineering, Budapest University of Technology and Economics, Műegyetem rkp. 3, Budapest 1111, Hungary

and technologies, which makes them potential MaaS customers (Kriswardhana and Esztergár-Kiss 2023b). Additionally, universities often collaborate with companies on pilot programs, and students can participate in the co-creation, thereby contributing to service improvement. Furthermore, capturing university students as early users can build long-term loyalty. Although their transportation needs can change in the future, they may continue using MaaS since they trust the service. Moreover, university students are likely to influence future urban transportation demand; thus, it is important for policy-makers to take their preferences into account (Nguyen-Phuoc et al. 2018). Therefore, capturing university students' preferences for MaaS is crucial for supporting its development and wider adoption.

Offering discounted fares for university students is a common practice. Studies focusing on travel behavior of university students often recommend giving students discounted fares for PT (Ribeiro and Fonseca 2022) and its integration with emerging mobility services (Irawan et al. 2021). Some MaaS initiatives and shared mobility services include several promotions aimed at attracting university students. Helsinki Region Transport (HSL) offers a student transport card with a 40% discount on season tickets, which can be accessed through a MaaS application (Helsinki Regional Transport Authority n.d.). Similarly, a MaaS application called Jelbi, developed by the main public transport provider in Berlin (Hauslbauer et al. 2024), allows university students to use their semester tickets within the platform, granting access to multiple mobility services such as bike-sharing and car-sharing. In the case of shared transport modes, some operators provide student discounts for bike-sharing (X. Chen et al. 2022) and car-sharing (Zhou 2014), both of which are frequently included in MaaS schemes. Given this potential, several studies have examined university students' preferences for MaaS bundles (Coppola, Silvestri, and Pastorelli 2025; Silvestri, Silvestri, and Coppola 2025).

While the preferences for MaaS have already been revealed, the attitudinal factors behind the adoption have not been widely examined, especially of those who are considered potential customers of the service. Studies adopting the unified theory of acceptance and use of technology (UTAUT) reveal the attitudinal factors influencing the intention to adopt MaaS (van't Veer et al. 2023; Ye, Zheng, and Yi 2020). Other attitudinal variables, such as environmental consciousness (EC) (Matowicki et al. 2022) and technology readiness (TR) (Alonso-González et al. 2020), are applied to investigate travelers' motivation to use MaaS. Several methods, such as structural equation modeling (SEM) (Schikofsky, Dannewald, and Kowald 2020; Ye, Zheng, and Yi 2020) and latent class cluster analysis (LCCA) (van't Veer et al. 2023), are used to investigate the attitudinal factors behind MaaS uptake. Earlier research works use various methods to investigate the intention to adopt MaaS, but mostly, one method is applied, which limits the understanding of the factors behind various groups of travelers' motivation to use MaaS.

Based on the above arguments, this study aims to address the research gaps by exploring college students' heterogeneous attitudes toward MaaS, where the potential disparities in the preferences are investigated through the combination of clustering solutions and SEM. The current study has two contributions to the literature. First, the existing UTAUT model is extended by incorporating added constructs pertaining to the acceptance of new mobility services. Second, LCCA and SEM are used simultaneously to understand the attitudinal factors behind the acceptance of the mobility solution at a group level. The variation in causal path coefficients across the identified clusters can guide the development of more targeted strategies and policy interventions to promote MaaS adoption, thereby avoiding the one-size-fits-all approaches and aggregation bias. For example, the influence of EC on MaaS adoption may differ between varied user groups. While EC may significantly explain the intention to use MaaS in one cluster, it may have little or no effect in another. Consequently, the strategies aiming at increasing the willingness to adopt MaaS should be tailored to the specific factors of each group. The applicability of the proposed method to reveal the acceptance of MaaS is examined, as well. This study uses data drawn from a survey among students at a university in Budapest. In the survey, the respondents are introduced to MaaS through a textual explanation and a link that provides a comprehensive description of the concept. A detailed explanation of the survey can be found in the Method section.

The paper begins with an introduction, followed by a review of literature on young generations' travel behavior and their preferences for MaaS. It then describes the data collection and analysis, presents the results, and discusses the findings. The paper concludes by highlighting the main outcomes.

Literature review

It is argued that young individuals exhibit distinct travel behavior compared to the preceding generations. Youngsters are considered tech-savvy individuals who have more open attitudes toward collaborative consumption (Hwang and Griffiths 2017) and consequently are more interested in using such emerging mobilities as e-scooter-sharing and bike-sharing (Alemi et al. 2018). Young individuals often behave more environmentally friendly (Brown et al. 2016). As a result, the intention to adopt more environmentally friendly transport modes among college students could be increased by providing information on the environmental impacts of various transport modes (Cattaneo et al. 2018). As part of the young generations, university students are expected to influence the future transportation demand significantly (Nguyen-Phuoc et al. 2018). A study (Lee et al. 2020) mentions that university students tend to be multimodal travelers rather than monomodal travelers. However, it is worth mentioning that college students are particularly sensitive to the travel time (Oubahman, Duleba, and Esztergár-Kiss 2024) and cost when conducting a journey with transfers, especially when using e-scooter-sharing (Nikiforiadis et al. 2023). Moreover, university students are more concerned about safety when selecting transport modes (Khalid et al. 2024). The previously mentioned studies emphasize the importance of investigating young generations' travel behavior, but most of them incorporate such classic transport modes as PT, car, and bikes, while discussions about shared mobility services are infrequent. As a new mobility solution, MaaS is more interesting for young generations (Feneri, Rasouli, and Timmermans 2022) including university students (Zijlstra et al. 2020). Earlier works on the preferences for MaaS confirm that college students who use PT and shared mobility services are more inclined to adopt MaaS early (Kriswardhana and Esztergár-Kiss 2024a). University students perceive that using the service will not be demanding thanks to their familiarity with journey planning apps (Kriswardhana and Esztergár-Kiss 2024b). The current research extends previous works on college students' preferences for MaaS by combining the LCCA and SEM methods, which results in a more detailed understanding of the motivational drivers for adopting the MaaS service at a group level.

Socio-demographic and travel-related factors are frequently considered in travel behavior research; however, the impacts of socio-demographic variables on the preferences for MaaS can vary (Kriswardhana and Esztergár-Kiss 2023a). While some research works (Hasselwander et al. 2022; Liu et al. 2024; van't Veer et al. 2023) claim that females are more inclined to adopt the mobility solution, other studies (La Gamba et al. 2024; Liljamo et al. 2020) suggest that males tend to have more favorable views on MaaS. Furthermore, a previous work (Hasselwander et al. 2022) claims that travelers' income levels are not related to MaaS preferences, yet other findings reveal a relationship between income levels and the willingness to use MaaS. On the one hand, MaaS is argued to be more appealing to low earners (Ko et al. 2022; La Gamba et al. 2024) as they might expect the new mobility solution could potentially reduce their transportation costs (Liu et al. 2024). On the other hand, other findings suggest that individuals with high incomes exhibit greater interest in adopting the service (Kim et al. 2021; Zijlstra et al. 2020), especially high-income PT users who appreciate the ease of using MaaS in comparison to traditional transport modes (Matowicki et al. 2024). Meanwhile, other socio-demographic factors, such as age, educational level, and employment status, show more stable effects on the MaaS preferences. Young (Farahmand, Gkiotsalitis, and Geurs 2021), educated individuals (Hoerler et al. 2020; La Gamba et al. 2024; Liu et al. 2024) mostly find MaaS an attractive offer. Students and employed people are more inclined to embrace the new mobility solution (Lopez-Carreiro, Monzon, and Lopez-Lambas 2021) than those people who work from home (Zijlstra et al. 2020). Given the diverse effects of demographic characteristics on the preferences toward MaaS, the current research includes the factors as indicators in the model to reveal the participants' heterogeneity. Thus, the preferences toward MaaS are investigated not merely among general participants but at group level, which provides more specific implications for the escalating service uptake.

Previous works (Back, Shon, and Hwang 2025; van't Veer et al. 2023; Ye, Zheng, and Yi 2020) use the UTAUT method to analyze travelers' attitudes toward MaaS, where it is mostly confirmed that the framework can explain the motivations to use the service. Proposed by Venkatesh et al. (2003), the UTAUT model identifies the following four key factors that influence behavioral intention (BI): performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FC). The current study builds on previous research by integrating additional variables, such as perceived risk (PR), TR, EC, and variety-seeking lifestyle (VS), into the UTAUT framework. These factors have been shown to impact the adoption of emerging transportation technologies significantly. For instance, Kapser and Abdelrahman (2020) examine PR in the context of autonomous delivery vehicle acceptance. TR and EC have been explored in relation to ride-hailing adoption by Lavieri and Bhat (2019) and Gomez et al. (2021). Ye, Zheng, and Yi (2020) investigate the role of VS in the willingness to adopt MaaS.

The differences in the effects of attitudinal factors on MaaS based on socio-demographic and travel characteristics have not been widely explored. Ye, Zheng, and Yi (2020) examine the willingness to use MaaS and find that EE plays a significantly larger role in influencing BI among women, while it is not significant and has a smaller effect in the case of men. Furthermore, age-related differences are found, as well. PE has a greater influence on the willingness to use MaaS among young individuals than among old travelers. Back, Shon, and Hwang (2025) evaluate commuters' acceptance of MaaS and argue that EC and SI have the strongest impact on MaaS usage among those commuting by PT. Additionally, PE and VS positively influence the intention of the users with prior smart mobility experience. Therefore, the current research examines how various socio-demographic and travel factors may influence the relationship between varied attitudes and the intention to use MaaS.

Method

Data collection and analysis

Primary data are collected by using an online survey distributed through a university mailing list from April 2022 to May 2022 among the students at Budapest University of Technology and Economics (BME). 712 responses are collected, of which 687 are considered valid (i.e. having no missing values). The survey consists of three parts. The first part presents the aim of the survey and a description of MaaS (https://maas-alliance.eu/homepage/what-is-maas/).
The second section includes questions about socio-demographic and travel characteristics. The participants' attitudes are captured in the third part, where the answers are assessed by using a five-point Likert scale. Table 1 demonstrates the latent variables along with their corresponding indicators.

The modeling framework of the current study is depicted in Figure 1. The latent attitudinal variables are derived from the UTAUT (Venkatesh, Thong, and Xu 2012) and other related studies (Alemi et al. 2018; Ali et al. 2018; Lavieri and Bhat 2019; Ye, Zheng, and Yi 2020). This research work uses LCCA and SEM to reveal the participants' intention to use MaaS. This approach allows the identification of heterogeneous causal relationships underlying MaaS adoption among the different clusters. The socio-demographic and travel characteristics are applied as indicators in LCCA to identify the user clusters. The LCCA method can reveal varied subgroups of a sample sharing observable characteristics, where the optimal number of classes and mixed types of variables can be assessed (Vermunt and Magidson 2002). The likelihood of obtaining a complete response can be expressed as follows:

$$P(y_i|k) = \sum_{k=1}^{K} P(k) \prod_{t=1}^{T} f(y_{it}|k) \tag{1}$$

Let y_{it} represent the response of person i on indicator t. k is the unobserved variable. $P(k)$ denotes the likelihood of being assigned to a particular class following the multinomial logit model, while $f(y_{it}|k)$ represents the probability density of y_{it} given k.

Meanwhile, SEM is applied to evaluate the participants' intention to use MaaS. SEM consists of two parts. Initially, a confirmatory factor analysis (CFA) is conducted to assess the measurement component. The primary goal of CFA is to examine how well a set of observed variables represent one or more underlying latent constructs. This relationship is expressed through the following measurement model:

$$x = \Lambda_x \xi + \delta \tag{2}$$

Where x is a vector of the observed variables, ξrepresents the latent variables, Λ_x is a matrix of factor loadings indicating the strength of the association between each observed variable and its corresponding latent factor, and δ denotes the measurement errors.

Afterward, path analysis is used to examine the proposed hypotheses. In SEM, path analysis represents the hypothesized causal relationships among the latent variables.

$$\eta = \beta_\eta + \Gamma\xi + \zeta \tag{3}$$

Table 1. Descriptive statistics of the sample used in this study.

Category	%	Category	%
Gender		**Household income**	
Male	68	≤700 euro	31
Female	32	>700 euro	69
Educational level		**Occupational status**	
Undergraduate	65	Unemployed	54
Postgraduate	35	Employed	46
Primary transport mode		**Shared mobility usage**	
PT	62	User	49
Micro-mobility	7	Non-user	51
Private car	5		
Walking	20		
Coach/train	6		

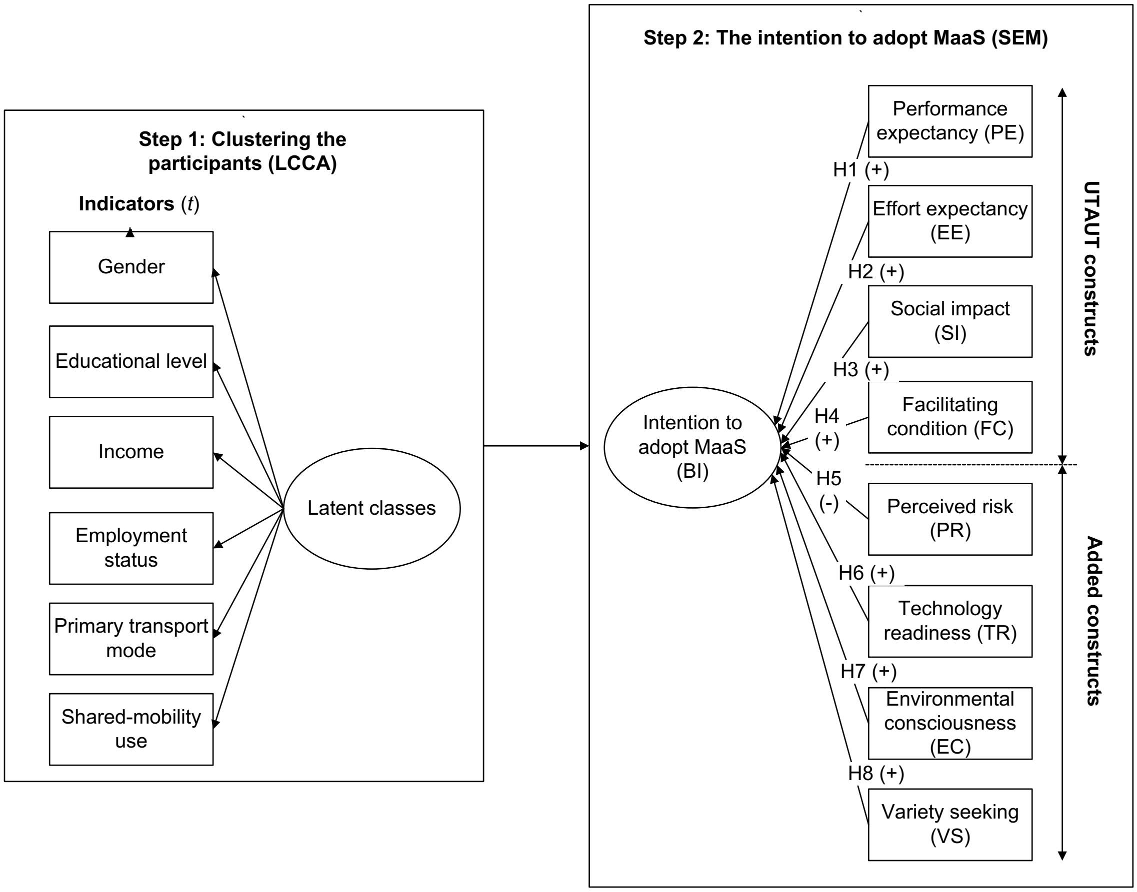

Figure 1. Modeling framework of the LCCA and SEM.

Where η is a vector of the endogenous latent variables, $\xi$is a vector of the latent variables, $\beta$is a matrix of the coefficients that describe the relationships among the endogenous latent variables, and Γ is a matrix of the coefficients representing the effects of the exogenous on the endogenous latent variables. The term ζ stands for residual errors.

The clustering solutions from the LCCA method are treated as a factor determining the multi-group analysis, which allows the understanding of the varied attitudes toward MaaS. Validity and reliability are evaluated to establish the measurement part. The reliability of the indicator is assessed through standardized loadings, which should exceed 0.7 (J. Hair et al. 2017). Additionally, the measurement reliability is assessed through Cronbach α. The internal consistency of the latent constructs is sufficient when the Cronbach α values exceed 0.6 (J. Hair et al. 2017). The average variance extracted (AVE) values should be above 0.5 thus confirming convergent validity (J. F. Hair et al. 2010). Maximum likelihood estimation is used to develop SEM. Several fit measures are applied: the comparative fit index (CFI), the goodness-of-fit index (GFI), and the Tucker-Lewis index (TLI), which should surpass 0.8. Moreover, the root mean square error (RMSEA) should be below 0.05 (Byrne 2013; Kline 2015).

Hypothesis development

Table 4 shows the attitudinal statements related to the respective latent variables. Several hypotheses associated with the intention to use MaaS are proposed in this study. The latent variables in the UTAUT model are proven to be effective in revealing the travelers' attitude toward using emerging mobility solutions. Such latent variables as FC (Kapser and Abdelrahman 2020), PE, and EE (Madigan et al. 2017) have significant impacts on the willingness to adopt autonomous vehicles (Ferencz and Zöldy 2024). Furthermore, the close relatives' opinions substantially influence college students' intention to adopt MaaS (Kriswardhana and Esztergár-Kiss 2024b). Therefore, the following hypotheses are proposed:

H1: PE positively affects the intention to use MaaS.

H2: EE positively affects the intention to use MaaS.

H3: SI positively affects the intention to use MaaS.

H4: FC positively affects the intention to use MaaS.

Those travelers who expect drawbacks in using MaaS are less likely to be interested in adopting the service (Ye, Zheng, and Yi 2020). The familiarity with using travel apps is proven to be significant in predicting the keenness to use MaaS (Hasselwander et al. 2022; Lopez-Carreiro, Monzon, and Lopez 2024). Meanwhile, the travelers with high environmental sensibility find the shared transport modes interesting (Mouratidis 2022). Finally, variety-seekers tend to embrace the new service (Lopez-Carreiro et al. 2021). Based on these descriptions, the following hypotheses are proposed:

H5: PR negatively affects the intention to use MaaS.

H6: TR positively affects the intention to use MaaS.

H7: EC positively affects the intention to use MaaS.

H8: VS positively affects the intention to use MaaS.

Results and discussion

The descriptive results of the survey are presented in Table 1. The sample primarily comprises male participants (68%) with the majority being undergraduate students (65%) aged 23 or younger (73%). The sample is in accordance with the BME Facts and Figures document (BME 2021), which reports that approximately 69% of the students are male and 61% are undergraduate. Most students do not work (54%) and come from households earning more than €700 per month (69%). The participants' primary transport mode is PT (62%), while slightly more than half of them (51%) are not shared mobility users.

Clustering the respondents

The LCCA method is conducted to identify the respondents' differences and variability. Figure 2 shows the model fit, where five models are evaluated to determine the most suitable number of clusters. Both the Bayesian information criterion (BIC) and Akaike information criterion (AIC) suggest that the 2-class model is the best clustering solution.

Table 2 presents the parameters of the final model. Except for the p-values of gender and educational level, the p-values of the other indicators are less than or equal to 0.05, which demonstrates that these indicators play

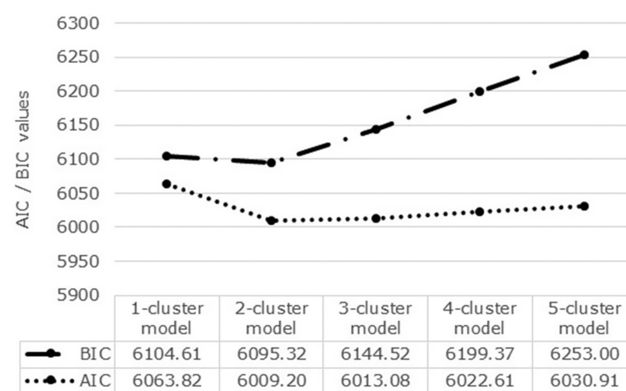

Figure 2. Model fit statistics for 1- to 5-cluster solutions based on the LCCA.

Table 2. Parameter estimates for the 2-cluster solution from the LCCA.

	Cluster-1	Cluster-2	Wald	*p*-value
Gender				
Male	−0.033	0.033	0.303	0.580
Female	0.033	−0.033		
Educational level				
Bachelor's degree	0.071	−0.071	1.538	0.210
Postgraduate	−0.071	0.071		
Income				
≤700 euro	−0.281	0.281	17.1942	0.001
>700 euro	0.281	−0.281		
Occupational status				
Unemployed	−0.776	0.776	12.803	0.001
Employed	0.776	−0.776		
Primary transport mode				
PT	−0.268	0.268	9.074	0.050
Micro-mobility	0.347	−0.347		
Private car	0.794	−0.794		
Walking	−0.545	0.545		
Coach/train	−0.327	0.327		
Shared mobility use				
User	−0.359	0.359	18.843	0.001
Non−user	0.359	−0.359		

a significant role in differentiating the clusters. Those college students who work and come from high-income households mostly fall into Cluster-1. The university students in Cluster-1 are more probably private car users. Meanwhile, Cluster-2 includes PT and shared mobility service users.

Figure 3 provides the descriptive statistics for the socio-demographic and travel characteristics of the two clusters. Cluster-1 represents 54% of the overall sample size. This group primarily comprises university students where 74% are employed, 79% are from high-income households, 8% use private cars, and 64% do not use shared mobility services. The students in Cluster-2 are primarily unemployed (88%), low earners (44%), PT, walking, or micro–mobility (99%), and shared mobility users (70%).

Estimation results

Table 3 demonstrates the factors and their loadings from the exploratory factor analysis (EFA). Most statements align with the expected indicators with the exception of the TR statements. TR2 and TR3 are removed from the analysis since the factor loadings are below 0.3.

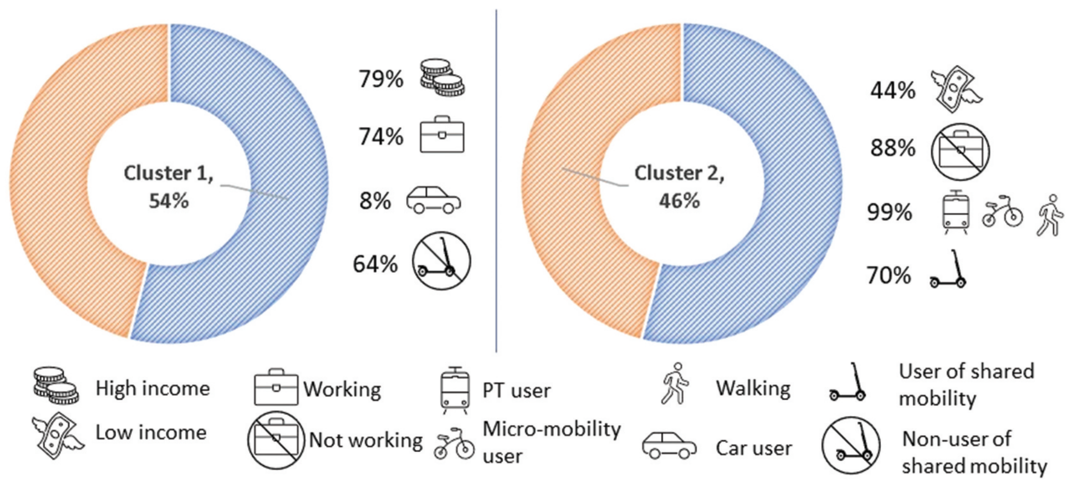

Figure 3. The characteristics of the clusters from the LCCA.

Table 3. Final EFA results for the factors.

	Factor 1 (FC)	Factor 2 (PE)	Factor 3 (EE)	Factor 4 (SI)	Factor 5 (PR)	Factor 6 (EC)	Factor 7 (VS)	Factor 8 (BI)
FC1	0.652							
FC2	0.500							
TR1	0.370							
PE1		0.813						
PE2		0.814						
PE3		0.818						
PE4		0.702						
EE1			0.675					
EE2			0.644					
EE3			0.918					
EE4			0.779					
SI1				0.925				
SI2				0.935				
SI3				0.713				
PR1					0.922			
PR2					0.971			
PR3					0.462			
EC1						0.800		
EC2						0.809		
EC3						0.402		
VS1							0.484	
VS2							0.915	
VS3							0.814	
BI1								0.621
BI2								0.314
BI3								0.697
SS loading	1.01	2.80	2.64	2.45	2.10	1.69	1.92	1.42
KMO	0.851							
RMSEA	0.042							

On the other hand, TR1 aligns with the FC indicator likely due to their similarities in the questionnaire items as both are related to the technical resources needed to use MaaS. Therefore, TR1 is combined with other FC statements. The EFA results indicate a Kaiser – Meyer – Olkin (KMO) value of 0.851 and a significant Bartlett's test of sphericity, which confirms that the sample is adequate, and the variables have sufficient correlations.

Table 4 shows the descriptive analysis of the indicators. The number of indicators is reduced by removing those with factor loadings less than 0.5 thus increasing the internal construct reliability. For FC, the variable is eliminated since it has unsatisfactory Cronbach α and AVE values. The remaining Cronbach α values are between 0.72 and 0.90, which confirms adequate reliability. Convergent validity is confirmed by the AVE values ranging from 0.60 to 0.82.

The comparison of the mean values of the indicators between the total sample and the identified clusters is shown in Figure 4. Generally, the students in Cluster-1 show more positive attitudes toward MaaS as evidenced by the highest mean values for PE, EE, and BI. Most college students in the first group work and come from high-income households. While the majority of the students in this group are PT users, a larger proportion of private car users are found in the cluster, and they are mostly not shared mobility users. Surprisingly, based on the results of the descriptive analysis, more positive attitudes toward MaaS are found among the participants in this cluster. Previous research works primarily suggest that early adopters of MaaS are PT users (Coppola, Silvestri, and Pastorelli 2025; B. Wang et al. 2024) and those who have tried shared mobility services (Hoerler et al. 2020; Kriswardhana and Esztergár-Kiss 2024b). However, it is worth noting that the participants of the current research are university students with more open attitudes toward emerging mobility solutions. Moreover, the students in the first group show high interest in having new experience indicated by the

Table 4. Latent variables and their corresponding indicators, including item means, SDs, and factor loadings from the measurement model.

Indicator	Mean	SD	Factor loading
Performance expectancy (PE)	(α= 0.88; AVE= 0.73)		
The individual anticipates that utilizing MaaS will be time-efficient (PE1) (Kriswardhana and Esztergár-Kiss 2025).	4.04	1.00	0.81
The individual anticipates that utilizing MaaS will reduce costs (PE2) (Kriswardhana and Esztergár-Kiss 2025).	4.00	1.06	0.80
The individual anticipates that MaaS will ensure convenience during trips (PE3) (Ye, Zheng, and Yi 2020).	4.02	1.02	0.87
The individual anticipates that MaaS will provide access to transportation services anytime and anywhere (PE4) (Ye, Zheng, and Yi 2020).	4.13	0.98	0.78
Effort expectancy (EE)	(α= 0.86; AVE= 0.69)		
The individual finds the MaaS framework easy to understand (EE1) (Kriswardhana and Esztergár-Kiss 2025).	3.04	1.11	0.74
The individual is able to accept the MaaS system (EE2) (Ye, Zheng, and Yi 2020).	3.73	0.95	0.75
The individual thinks the MaaS framework is simple to learn (EE3) (Ye, Zheng, and Yi 2020).	3.41	0.92	0.79
The individual believes that MaaS offers a quick purchasing process (EE4) (Venkatesh et al. 2003).	3.56	0.98	0.82
Social impact (SI)	(α= 0.90; AVE= 0.82)		
The individual is inclined to use MaaS if it becomes widely used (SI1) (Ye, Zheng, and Yi 2020).	3.07	1.21	1.12
The individual is inclined to use MaaS if it gains approval from those around them (SI2) (Madigan et al. 2017).	3.27	1.19	1.11
The individual is inclined to use MaaS if it gets media recognition (SI3) (Ye, Zheng, and Yi 2020).	2.87	1.19	0.90
Facilitating condition (FC)*			
The mobile network in the area is reliable (FC1) (Ye, Zheng, and Yi 2020).	4.27	0.87	
PT availability around the individual's home is sufficient (FC2).	4.02	1.13	
Technology readiness (TR)*	4.48	0.94	
The individual uses mobile apps to obtain travel updates (TR1) (Alemi et al. 2018).			
The individual frequently utilizes in-vehicle GPS (TR2).*	3.27	1.30	
The individual frequently accesses social media (TR3).*	3.64	1.19	
Perceived risk (PR)	(α= 0.83; AVE= 0.76)		
The individual is concerned about the difficulty of learning how to use MaaS (PR1) (Ye, Zheng, and Yi 2020).	2.05	1.07	1.00
The individual finds MaaS potentially complicated (PR2) (Ye, Zheng, and Yi 2020).	2.07	1.08	1.02
The individual is worried about their decreased privacy (PR3) (Ye, Zheng, and Yi 2020).	2.27	1.13	0.61
Environmental consciousness (EC)	(α= 0.72; AVE= 0.60)		
The individual takes environmental factors into account when selecting transport modes (EC1) (Lavieri and Bhat 2019).	2.97	1.22	0.96
The individual is willing to spend more on environmentally friendly products (EC2).	2.95	1.22	1.01
The individual believes in climate change (EC3) (Ali et al. 2018).	4.46	0.93	0.41
Variety-seeking lifestyle (VS)	(α= 0.80; AVE= 0.68)		
The individual values new experience (VS1) (Rieser-Schüssler and Axhausen 2012).	4.06	1.06	0.59
The individual enjoys trying new things and tools (VS2) (Alemi et al. 2018).	3.49	1.09	1.02
The individual likes testing new products before others (VS3) (Lavieri and Bhat 2019).	3.40	1.18	0.94
Behavioral intention (BI)	(α= 0.76; AVE 0.65)		
The individual perceives adopting MaaS as highly beneficial (BI1).	3.37	0.99	0.84
The individual plans to reduce car usage with MaaS (BI2).	2.78	1.16	0.58
The individual intends to use MaaS once it is implemented (BI3).	3.38	1.02	0.89

*Eliminated in the EFA.

Figure 4. The mean values of the indicators for the total sample and each cluster.

highest mean values of the VS indicator. The students in this group present more environmentally friendly behavior, too. These findings might be associated with the fact that they mostly come from high-income households and can afford to adopt recent technologies and pay for more environmentally friendly products. Thus, although most car users are present in this group, they could be considered potential adopters of the MaaS service.

Meanwhile, the students in Cluster-2 are primarily PT users who come from low-income households. Generally, their interest in adopting MaaS is less compared to Cluster-1 and all the sample. Moreover, the students in Cluster-2 have a high perception of risk when using MaaS. However, it is worth mentioning that the disparities in the mean values between the clusters are mostly insignificant except for BI2 ($\chi^2 = 16.444$, $p < 0.001$).

The Lavaan package in R is used to evaluate the structural model (Rosseel 2012). The path coefficient illustrates the relationships among the constructs (Table 5). It is important to note that *H4* and *H6* are excluded from the analysis due to unsatisfactory results in the EFA and CFA. The results reveal that the extended UTAUT framework can be used to increase the understanding of students' intentions to use MaaS. In particular, the results confirm that the intention to use MaaS is significantly influenced by PE, EE, SI, EC, and VS, while PR is not statistically significant.

In the total sample, EE is the most substantial predictor of BI, which is followed by SI, VS, EC, and PE. This means that those students who consider MaaS easy-to-learn are more likely to be MaaS adopters. Similarly, their relatives' opinions and the media affect the students' intentions to adopt MaaS. Thus, it can be confirmed that *H1-H5* are supported. In Cluster-1, a more positive effect of SI on BI is present. Conversely, the effect of SI on BI is lesser in Cluster-2. PE positively influences the intention to adopt MaaS in Cluster-1, while the effect is not significant in the other cluster. This could be interpreted as the important role of perceived beneficial aspects of using MaaS in influencing the willingness to adopt the mobility solution among the students of Cluster-1. Students will appreciate MaaS if the service could provide lower travel time, costs, and the ability to travel anywhere and anytime

Table 5. Results of the path coefficients for the total sample and each cluster.

		Path coefficient		
Hypothesis	Path	All	Cluster–1	Cluster–2
H1	BI ← PE	0.126*	0.218*	0.027
H2	BI ← EE	0.607*	0.489*	0.690*
H3	BI ← SI	0.281*	0.329*	0.261*
H5	BI ← PR	−0.026	−0.062	−0.018
H7	BI ← EC	0.135*	0.078	0.204*
H8	BI ← VS	0.183*	0.093	0.244*
Fit statistics		Total sample	Multigroup analysis	
GFI		0.994	0.993	
CFI		0.994	0.995	
TLI		0.993	0.994	
RMSEA		0.068	0.067	

*Statistically significant at a 95% confidence level.

conveniently. This is understandable since most car users are present in Cluster-1, and they are familiar with the convenience of using private cars with no transfers needed.

Meanwhile, the positive impacts of EC and VS on the intention to adopt MaaS are present in Cluster-2. The students who frequently use PT and shared transport modes as well as have a high awareness of environmental issues are more interested in adopting MaaS. Conversely, while the students of Cluster-1 exhibit a high level of EC, this variable does not have a statistically significant impact on the intention to use the mobility solution. Thus, the attitudes related to saving the environment are not necessarily associated with the intention to adopt MaaS in the case of those students who are frequent car users and come from high-income households. This finding implies that the value placed on environmental benefits may vary across different traveler groups. A similar trend is observed with the VS variable, where the students of Cluster-2 who recognize the value of gaining new experience are more inclined to adopt MaaS. Referring to the characteristics, most shared mobility users are present in Cluster-2. This finding aligns with a study (Song, Hess, and Dekker 2022) mentioning that novelty seekers are more likely to switch from existing modes to new shared mobility services. However, the effect is absent among the students in Cluster-1, which indicates that VS is not a main factor for frequent car users in adopting MaaS.

The policy implications for escalating the uptake of MaaS among college students differ based on the identified clusters. Since for all clusters, PE and SI are essential in affecting the willingness to use MaaS among university students, travel experience and the positive perception of the media and people toward MaaS should be increased. Attracting private car users to use MaaS is challenging since they are mostly not interested in adopting this new mobility solution. The integration of the modes supporting the use of PT should be improved, and the gap in last-mile trips should be covered. Furthermore, social media promotion could be essential to attract university students to use MaaS. As for Cluster-2, the MaaS system should be simple. Mentioning the environmental benefits of MaaS is essential for the students of this cluster. Thus, the information regarding comparing the environmental effects of using MaaS and private cars should be demonstrated. To increase the intention to adopt MaaS among variety-seekers and maintain the engagement, MaaS could provide gamification practices, such as reward, recognition, and a sense of progress. Gamification is a popular persuasive way to promote sustainable travel behavior (W. Wang et al. 2022). For example, those travelers who use MaaS bundles containing more environmentally friendly modes could be rewarded with badges or points to climb the leaderboard. This way, MaaS will not be considered a boring app for travelers.

Conclusion

This study analyzes university students' acceptance of MaaS by categorizing their preferences into two groups identified through LCCA. SEM is conducted to uncover the relationship between the latent attitudinal variables and the intention to use MaaS. Current research work extends the UTAUT framework by adding four latent variables associated with the adoption of new mobility services. Two groups of the examined students are revealed. The first group is comprised of high-income college students who use PT and private cars while showing a willingness to adopt MaaS if the service aligns with their positive expectations and receives favorable feedback from other travelers and the media. Cluster-2 includes low-income university students who use PT. They are likely to be interested in MaaS if the service is user-friendly and environmentally friendly. Relevant stakeholders could leverage these findings to implement more effective promotional strategies, such as utilizing social media platforms to promote MaaS among university students and incorporating gamification elements to attract more users.

The first limitation of this study pertains to its generalizability. The participants in this study are drawn from a university; thus, the findings should be interpreted with caution and may not be applicable to other population groups. Future research could broaden the sample to include students from various institutions and geographic regions to improve the validity of the study. Secondly, bias might exist since MaaS is yet to be introduced at the time when this study is conducted. Furthermore, the income category might oversimplify the income range and potentially introduce bias. The income grouping might overlook important differences in the income categories and could affect the results, especially if several respondents have incomes close to the cutoff of 700€ or if the income distribution is unbalanced. Several hypotheses do not meet the statistical significance criteria, especially at the group level. Therefore, upcoming research could redefine the group classifications by performing other classification methods. Lastly, the FC indicators do not completely account for the associated latent variable. Future studies could investigate additional indicators that may clarify the supporting conditions for using MaaS.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The research was supported by [OTKA FK23 145899] project funded by the National Research, Development and Innovation Office. The linguistic revision of this study is prepared by Eszter Tóth.

ORCID

Willy Kriswardhana http://orcid.org/0000-0003-2351-3573

References

Alemi, F., G. Circella, S. Handy, and P. Mokhtarian. 2018. "What Influences Travelers to Use Uber? Exploring the Factors Affecting the Adoption of On-Demand Ride Services in California." *Travel Behaviour and Society* 13:88–104. https://doi.org/10.1016/j.tbs.2018.06.002.

Ali, F., D. Dissanayake, M. Bell, and M. Farrow. 2018. "Investigating Car Users' Attitudes to Climate Change Using Multiple Correspondence Analysis." *Journal of Transport Geography* 72 (August): 237–247. https://doi.org/10.1016/j.jtrangeo.2018.09.007.

Allen, J., and S. Farber. 2018. "How Time-Use and Transportation Barriers Limit On-Campus Participation of University Students." *Travel Behaviour and Society* 13:174–182. https://doi.org/10.1016/j.tbs.2018.08.003.

Alonso-González, M. J., S. Hoogendoorn-Lanser, N. van Oort, O. Cats, and S. Hoogendoorn. 2020. "Drivers and Barriers in Adopting Mobility as a Service (MaaS) – A Latent Class Cluster Analysis of Attitudes." *Transportation Research Part A: Policy and Practice* 132:378–401. https://doi.org/10.1016/j.tra.2019.11.022.

Arias-Molinares, D., G.-P. Juan Carlos, and G. Javier. 2023. "On the Path to Mobility as a Service: A maas-Checklist for Assessing Existing maas-Like Schemes." *Transportation Letters* 15 (2): 142–151. https://doi.org/10.1080/19427867.2022.2038987.

Back, S., M. Shon, and J. Hwang. 2025. "Evaluating Korean Commuters' Acceptance of MaaS Through the UTAUT Framework." *Case Studies on Transport Policy* 20:101464. https://doi.org/10.1016/j.cstp.2025.101464.

BME. 2021. "*Tények és Adatok a Műegyetemről; Facts and Figures on BME.*" https://www.bme.hu/facts-and-figures?language=en .

Brown, A. E., E. Blumenberg, B. D. Taylor, K. Ralph, and C. T. Voulgaris. 2016. "A Taste for Transit? Analyzing Public Transit Use Trends Among Youth." *Journal of Public Transportation* 19 (1). https://doi.org/10.5038/2375-0901.19.1.4.

Brunner, H., M. Hirz, W. Hirschberg, and K. Fallast. 2018. "Evaluation of Various Means of Transport for Urban Areas." *Energy, Sustainability and Society* 8 (1). https://doi.org/10.1186/s13705-018-0149-0.

Byrne, B. M. 2013. "Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming, Second Edition." In *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming*, edited by B. M. Byrne, 416. 2nd ed. New York: Routledge. https://doi.org/10.4324/9780203805534.

Cattaneo, M., P. Malighetti, C. Morlotti, and S. Paleari. 2018. "Students' Mobility Attitudes and Sustainable Transport Mode Choice." *International Journal of Sustainability in Higher Education* 19 (5): 942–962. https://doi.org/10.1108/IJSHE-08-2017-0134.

Chen, J., D. Zhou, Y. Zhao, B. Wu, and T. Wu. 2020. "Life Cycle Carbon Dioxide Emissions of Bike Sharing in China: Production, Operation, and Recycling." *Resources, Conservation & Recycling* 162:105011. https://doi.org/10.1016/j.resconrec.2020.105011.

Chen, X., Z. Ma, G. Ye, and Z. Li. 2022. "Usage Behavior and Satisfaction Analysis of Free-Floating Bicycle Sharing System Service: Evidence from a Chinese University Campus." *Research in Transportation Business & Management* 43:100703. https://doi.org/10.1016/j.rtbm.2021.100703.

Coppola, P., F. Silvestri, and L. Pastorelli. 2025. "Mobility as a Service (MaaS) for University Communities: Modeling Preferences for Integrated Public Transport Bundles." *Travel Behaviour and Society* 38:100890. https://doi.org/10.1016/j.tbs.2024.100890.

Delbosc, A., N. McDonald, G. Stokes, K. Lucas, G. Circella, and Y. Lee. 2019. "Millennials in Cities: Comparing Travel Behaviour Trends Across Six Case Study Regions." *Cities* 90:1–14. https://doi.org/10.1016/j.cities.2019.01.023.

Esztergár-Kiss, D., T. Kerényi, T. Mátrai, and A. Aba. 2020. "Exploring the MAAS Market with Systematic Analysis." *European Transport Research Review* 12 (1). https://doi.org/10.1186/s12544-020-00465-z.

Fan, Z., and C. D. Harper. 2022. "Congestion and Environmental Impacts of Short Car Trip Replacement with Micromobility Modes." *Transportation Research Part D: Transport & Environment* 103:103173. https://doi.org/10.1016/j.trd.2022.103173.

Farahmand, Z. H., K. Gkiotsalitis, and K. T. Geurs. 2021. "Mobility-as-a-Service as a Transport Demand Management Tool: A Case Study Among Employees in the Netherlands." *Case Studies on Transport Policy* 9 (4): 1615–1629. https://doi.org/10.1016/J.CSTP.2021.09.001.

Feneri, A. M., S. Rasouli, and H. J. P. Timmermans. 2022. "Modeling the Effect of Mobility-as-a-Service on Mode Choice Decisions." *Transportation Letters* 14 (4): 324–331. https://doi.org/10.1080/19427867.2020.1730025.

Ferencz, C., and M. Zöldy. 2024. "Exhaustive Investigation of the Promises and Perils of Autonomous Mobility Technology." *Periodica Polytechnica Transportation Engineering* 52 (1): 86–95. https://doi.org/10.3311/PPtr.22573.

Gomez, J., Á. Aguilera-García, F. F. Dias, C. R. Bhat, and J. M. Vassallo. 2021. "Adoption and Frequency of Use of Ride-Hailing Services in a European City: The Case of Madrid." *Transportation Research Part C: Emerging Technologies* 131:103359. https://doi.org/10.1016/J.TRC.2021.103359.

Hair, J. F., W. C. Black, B. J. Babin, and R. E. Anderson. 2010. *Multivariate Data Analysis*, 816. New Jersey, USA: Pearson

Prentice Hall. https://doi.org/10.1016/j.ijpharm.2011.02.019.
Hair, J., C. L. Hollingsworth, A. B. Randolph, and A. Y. L. Chong. 2017. "An Updated and Expanded Assessment of PLS-SEM in Information Systems Research." *Industrial Management and Data Systems* 117 (3): 442–458. https://doi.org/10.1108/IMDS-04-2016-0130.
Hasselwander, M., J. F. Bigotte, A. P. Antunes, and R. G. Sigua. 2022. "Towards Sustainable Transport in Developing Countries: Preliminary Findings on the Demand for Mobility-as-a-Service (MaaS) in Metro Manila." *Transportation Research Part A: Policy and Practice* 155:501–518. https://doi.org/10.1016/j.tra.2021.11.024.
Hauslbauer, A. L., B. Verse, E. Guenther, and T. Petzoldt. 2024. "Access Over Ownership: Barriers and Psychological Motives for Adopting Mobility as a Service (MaaS) from the Perspective of Users and Non-Users." *Transportation Research Interdisciplinary Perspectives* 23:101005. https://doi.org/10.1016/j.trip.2023.101005.
Helsinki Regional Transport Authority. n.d.. "*Student Discount*." Accessed July 14, 2025, from https://www.hsl.fi/en/tickets-and-fares/discounted-travel/student-discount .
Ho, C. Q., D. A. Hensher, and D. J. Reck. 2021. "Drivers of Participant's Choices of Monthly Mobility Bundles: Key Behavioural Findings from the Sydney Mobility as a Service (MaaS) Trial." *Transportation Research Part C: Emerging Technologies* 124:102932. https://doi.org/10.1016/j.trc.2020.102932.
Hoerler, R., A. Stünzi, A. Patt, and A. Del Duce. 2020. "What Are the Factors and Needs Promoting Mobility-as-a-Service? Findings from the Swiss Household Energy Demand Survey (SHEDS)." *European Transport Research Review* 12 (1). https://doi.org/10.1186/s12544-020-00412-y.
Hwang, J., and M. A. Griffiths. 2017. "Share More, Drive Less: Millennials Value Perception and Behavioral Intent in Using Collaborative Consumption Services." *Journal of Consumer Marketing* 34 (2): 132–146. https://doi.org/10.1108/JCM-10-2015-1560.
Irawan, M. Z., F. F. Bastarianto S. Sugiarto, and M. Rizka Fahmi Amrozi. 2021. "Measuring the Perceived Need for Motorcycle-Based Ride-Hailing Services on Trip Characteristics Among University Students in Yogyakarta, Indonesia." *Travel Behaviour and Society* 24:303–312. https://doi.org/10.1016/j.tbs.2021.05.005.
Kamargianni, M., W. Li, M. Matyas, and A. Schäfer. 2016. "A Critical Review of New Mobility Services for Urban Transport." *Transportation Research Procedia* 14:3294–3303. https://doi.org/10.1016/j.trpro.2016.05.277.
Kapser, S., and M. Abdelrahman. 2020. "Acceptance of Autonomous Delivery Vehicles for Last-Mile Delivery in Germany – Extending UTAUT2 with Risk Perceptions." *Transportation Research Part C: Emerging Technologies* 111:210–225. https://doi.org/10.1016/j.trc.2019.12.016.
Khalid, B., Z. U. Rehman, F. Haider, A. Hassan Khan, Q. Naheed Hashmi, A. Raza, and M. Sohail Jameel. 2024. "Regression Approach to Analyze the Travel Characteristics of University Students." *Transportation Letters* 17 (3): 1–16. https://doi.org/10.1080/19427867.2024.2366327.
Kim, S., S. Choo, S. Choi, and H. Lee. 2021. "What Factors Affect Commuters' Utility of Choosing Mobility as a Service? An Empirical Evidence from Seoul." *Sustainability (Switzerland)* 13 (16): 9324. https://doi.org/10.3390/su13169324.
Kline, R. B. 2015. *Principles and Practice of Structural Equation Modeling*. New York, NY, USA: Guilford publications.
Ko, E., Y. Kwon, W. Son, J. Kim, and H. Kim. 2022. "Factors Influencing Intention to Use Mobility as a Service: Case Study of Gyeonggi Province, Korea." *Sustainability (Switzerland)* 14 (1): 218. https://doi.org/10.3390/su14010218.
Kriswardhana, W., and D. Esztergár-Kiss. 2023a. "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.
Kriswardhana, W., and D. Esztergár-Kiss. 2023b. "Exploring the Aspects of MAAS Adoption Based on College Students' Preferences." *Transport Policy* 136:113–125. https://doi.org/10.1016/j.tranpol.2023.03.018.
Kriswardhana, W., and D. Esztergár-Kiss. 2024a. "Heterogeneity in Transport Mode Choice of College Students at a University Based on the MaaS Concept." *Travel Behaviour and Society* 36:100801. https://doi.org/10.1016/j.tbs.2024.100801.
Kriswardhana, W., and D. Esztergár-Kiss. 2024b. "University Students' Adoption of Mobility as a Service with Respect to User Preferences and Group Differences." *Journal of Public Transportation* 26:100079. https://doi.org/10.1016/j.jpubtr.2023.100079.
Kriswardhana, W., and D. Esztergár-Kiss. 2025. "Stakeholders' Viewpoints Analysis on Mobility as a Service Using the MAMCA and the Fuzzy AHP Method." *Journal of Urban Mobility* 7:100121. https://doi.org/10.1016/j.urbmob.2025.100121.
La Gamba, D., C. Botta, M. Rataj, and M. Arnone. 2024. "A Discrete Choice Experiment to Evaluate the Interest of Piedmont Region Citizens on MaaS." *Multimodal Transportation* 3 (1): 100117. https://doi.org/10.1016/j.multra.2023.100117.
Lavieri, P. S., and C. R. Bhat. 2019. "Investigating Objective and Subjective Factors Influencing the Adoption, Frequency, and Characteristics of Ride-Hailing Trips." *Transportation Research Part C: Emerging Technologies* 105:100–125. https://doi.org/10.1016/j.trc.2019.05.037.
Lee, Y., G. Circella, P. L. Mokhtarian, and S. Guhathakurta. 2020. "Are Millennials More Multimodal? A Latent-Class Cluster Analysis with Attitudes and Preferences Among Millennial and Generation X Commuters in California." *Transportation* 47 (5): 2505–2528. https://doi.org/10.1007/s11116-019-10026-6.
Liljamo, T., H. Liimatainen, M. Pöllänen, and R. Utriainen. 2020. "People's Current Mobility Costs and Willingness to Pay for Mobility as a Service Offerings." *Transportation Research Part A: Policy and Practice* 136:99–119. https://doi.org/10.1016/j.tra.2020.03.034.
Limanond, T., T. Butsingkorn, and C. Chermkhunthod. 2011. "Travel Behavior of University Students Who Live on Campus: A Case Study of a Rural University in Asia."

Transport Policy 18 (1): 163–171. https://doi.org/10.1016/j.tranpol.2010.07.006.

Liu, J., S. Jian, C. Wu, and V. Dixit. 2024. "Risky Choice and Diminishing Sensitivity in MAAS Context: A Nonlinear Logit Analysis of Traveler Behavior." *Transportation Research Part C: Emerging Technologies* 162:104603. https://doi.org/10.1016/j.trc.2024.104603.

Lopez-Carreiro, I., A. Monzon, D. Lois, and M. E. Lopez-Lambas. 2021. "Are Travellers Willing to Adopt MaaS? Exploring Attitudinal and Personality Factors in the Case of Madrid, Spain." *Travel Behaviour and Society* 25:246–261. https://doi.org/10.1016/j.tbs.2021.07.011.

Lopez-Carreiro, I., A. Monzon, and E. Lopez. 2024. "Assessing the Intention to Uptake MaaS: The Case of Randstad." *European Transport Research Review* 16 (1). https://doi.org/10.1186/s12544-023-00625-x.

Lopez-Carreiro, I., A. Monzon, and M. E. Lopez-Lambas. 2021. "Comparison of the Willingness to Adopt MaaS in Madrid (Spain) and Randstad (the Netherlands) Metropolitan Areas." *Transportation Research Part A: Policy and Practice* 152:275–294. https://doi.org/10.1016/j.tra.2021.08.015.

Madigan, R., T. Louw, M. Wilbrink, A. Schieben, and N. Merat. 2017. "What Influences the Decision to Use Automated Public Transport? Using UTAUT to Understand Public Acceptance of Automated Road Transport Systems." *Transportation Research Part F, Traffic Psychology and Behaviour* 50:55–64. https://doi.org/10.1016/j.trf.2017.07.007.

Matowicki, M., M. Amorim, M. Kern, P. Pecherkova, N. Motzer, and O. Pribyl. 2022. "Understanding the Potential of MAAS – an European Survey on Attitudes." *Travel Behaviour and Society* 27:204–215. https://doi.org/10.1016/J.TBS.2022.01.009.

Matowicki, M., P. Pecherkova, M. Amorim, M. Kern, N. Motzer, and O. Pribyl. 2024. "Complementing or Competing with Public Transit? Evaluating the Parameter Sensitivity of Potential Mobility-as-a-Service (MaaS) Urban Users in Germany, the Czech Republic, Poland, and the United Kingdom with a Mixed Choice Model." *Transportation.* https://doi.org/10.1007/s11116-024-10501-9.

Matyas, M., and M. Kamargianni. 2021. "Investigating Heterogeneity in Preferences for Mobility-as-a-Service Plans Through a Latent Class Choice Model." *Travel Behaviour and Society* 23:143–156. https://doi.org/10.1016/j.tbs.2020.12.002.

Mounce, R., and J. D. Nelson. 2019. "On the Potential for One-Way Electric Vehicle Car-Sharing in Future Mobility Systems." *Transportation Research Part A: Policy and Practice* 120:17–30. https://doi.org/10.1016/j.tra.2018.12.003.

Mouratidis, K. 2022. "Bike-Sharing, Car-Sharing, E-Scooters, and Uber: Who Are the Shared Mobility Users and Where Do They Live?" *Sustainable Cities and Society* 86:104161. https://doi.org/10.1016/j.scs.2022.104161.

Nguyen-Phuoc, D. Q., R. Amoh-Gyimah, A. T. P. Tran, and C. T. Phan. 2018. "Mode Choice Among University Students to School in Danang, Vietnam." *Travel Behaviour and Society* 13:1–10. https://doi.org/10.1016/j.tbs.2018.05.003.

Nikiforiadis, A., E. Paschalidis, N. Stamatiadis, N. Paloka, E. Tsekoura, and S. Basbas. 2023. "E-Scooters and Other Mode Trip Chaining: Preferences and Attitudes of University Students." *Transportation Research Part A: Policy and Practice* 170:103636. https://doi.org/10.1016/j.tra.2023.103636.

Oubahman, L., S. Duleba, and D. Esztergár-Kiss. 2024. "Analyzing University Students' Mode Choice Preferences by Using a Hybrid AHP Group-PROMETHEE Model: Evidence from Budapest City." *European Transport Research Review* 16 (1): 8. https://doi.org/10.1186/s12544-023-00626-w.

Ribeiro, P. J. G., and F. Fonseca. 2022. "Students' Home-University Commuting Patterns: A Shift Towards More Sustainable Modes of Transport." *Case Studies on Transport Policy* 10 (2): 954–964. https://doi.org/10.1016/j.cstp.2022.03.009.

Rieser-Schüssler, N., and K. W. Axhausen. 2012. "Investigating the Influence of Environmentalism and Variety Seeking on Mode Choice." *Transportation Research Record: Journal of the Transportation Research Board* 2322 (1): 31–41. https://doi.org/10.3141/2322-04.

Rosseel, Y. 2012. "Lavaan: An R Package for Structural Equation Modeling." *Journal of Statistical Software* 48 (2). https://doi.org/10.18637/jss.v048.i02.

Schikofsky, J., T. Dannewald, and M. Kowald. 2020. "Exploring Motivational Mechanisms Behind the Intention to Adopt Mobility as a Service (MaaS): Insights from Germany." *Transportation Research Part A: Policy and Practice* 131:296–312. https://doi.org/10.1016/j.tra.2019.09.022.

Silvestri, F., F. Silvestri, and P. Coppola. 2025. "Mobility as a Service (MaaS) Bundle Uptake: A Case Study in Milan, Italy." *European Transport Research Review* 17 (1): 3. https://doi.org/10.1186/s12544-024-00698-2.

Smith, G., J. Sochor, and I. C. M. Karlsson. 2017. "Mobility as a Service: Development scenarios and implications for public transport." *Research in Transportation Economics* 69:592–599. https://doi.org/10.1016/j.retrec.2018.04.001.

Song, F., S. Hess, and T. Dekker. 2022. "Uncovering the Link Between Intra-Individual Heterogeneity and Variety Seeking: The Case of New Shared Mobility." *Transportation* 51 (2): 1–36. https://doi.org/10.1007/s11116-022-10334-4.

van der Waard, J., P. Jorritsma, and B. Immers. 2013. "New Drivers in Mobility; What Moves the Dutch in 2012?" *Transport Reviews* 33 (3): 343–359. https://doi.org/10.1080/01441647.2013.801046.

van't Veer, R., J. A. Annema, Y. Araghi, G. H. D. A. Correia, and B. van Wee. 2023. "Mobility-As-A-Service (MaaS): A Latent Class Cluster Analysis to Identify Dutch Vehicle Owners' Use Intention." *Transportation Research Part A: Policy and Practice* 169:103608. https://doi.org/10.1016/j.tra.2023.103608.

Venkatesh, V., M. G. Morris, G. B. Davis, and F. D. Davis. 2003. "User Acceptance of Information Technology: Toward a Unified View." *MIS Quarterly: Management Information Systems* 27 (3): 425–478. https://doi.org/10.2307/30036540.

Venkatesh, V., J. Y. L. Thong, and X. Xu. 2012. "Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology."

MIS Quarterly: Management Information Systems 36 (1): 157–178. https://doi.org/10.2307/41410412.

Vermunt, J. K., and J. Magidson. 2002. "Latent Class Cluster Analysis." *Applied Latent Class Analysis* 11 (89–106): 60.

Wang, B., M. Yang, T. Feng, Y. Yang, and Y. Yuan. 2024. "Heterogeneous Choice of Personalized Mobility-as-a-Service Bundles and Its Impact on Sustainable Transportation." *Transportation Research Part D: Transport & Environment* 131:104224. https://doi.org/10.1016/j.trd.2024.104224.

Wang, W., H. Gan, X. Wang, H. Lu, and Y. Huang. 2022. "Initiatives and Challenges in Using Gamification in Transportation: A Systematic Mapping." *European Transport Research Review* 14 (1). https://doi.org/10.1186/s12544-022-00567-w.

Whalen, K. E., A. Páez, and J. A. Carrasco. 2013. "Mode Choice of University Students Commuting to School and the Role of Active Travel." *Journal of Transport Geography* 31:132–142. https://doi.org/10.1016/j.jtrangeo.2013.06.008.

Xu, J. L. 2020. "Generational Trends of Gendered Mobility: How Do They Interact with Geographical Contexts?" *Journal of Transport Geography* 82:102623. https://doi.org/10.1016/j.jtrangeo.2019.102623.

Ye, J., J. Zheng, and F. Yi. 2020. "A Study on Users' Willingness to Accept Mobility as a Service Based on UTAUT Model." *Technological Forecasting & Social Change* 157:120066. https://doi.org/10.1016/j.techfore.2020.120066.

Zhou, J. 2014. "Carsharing on University Campus: Subsidies, Commuter Benefits, and Their Impacts on Carsharing." *Transportation Research Part D: Transport & Environment* 32:316–319. https://doi.org/10.1016/j.trd.2014.08.015.

Zijlstra, T., A. Durand, S. Hoogendoorn-Lanser, and L. Harms. 2020. "Early Adopters of Mobility-as-a-Service in the Netherlands." *Transport Policy* 97:197–209. https://doi.org/10.1016/j.tranpol.2020.07.019.