Transportation Research Interdisciplinary Perspectives 38 (2026) 102125

Contents lists available at ScienceDirect

Transportation Research Interdisciplinary Perspectives

journal homepage: www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives

MaaS bundle uptake among university students: A cross-European survey

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ARTICLE INFO

Keywords:
MaaS
Mobility as a Service
Bundle
University student
Preference

ABSTRACT

Considering current trends in innovative mobility solutions and the shifts in young generations' travel behavior, this study investigates university students' Mobility as a Service (MaaS) bundle uptake. Travel behavior of the younger generation has been widely explored in the literature, but their uptake of MaaS bundles has received limited attention. The data are derived from stated preference surveys conducted among the students of four European universities, where a mixed logit model is performed to calculate the parameters. The descriptive statistics confirm that people using public transport (PT) are potential adopters of MaaS bundles, whereas car users exhibit less interest. The results indicate differences in travel characteristics among specific locations in Europe. Students in Budapest are mostly PT users, and they show the highest interest in adopting MaaS bundles. Furthermore, students in Delft cycle more often and show disinclination toward bundles containing bike-sharing services. Cars are popular among students in Catania and Katowice, and they have interest in purchasing bundles including car-sharing services. The current research finds that providing incentives in MaaS bundles could potentially support their uptake. The interaction analysis indicates that high-income students are more inclined to have e-scooter-sharing and car-sharing within MaaS bundles. The findings shed light on the preferences toward MaaS among university students with different travel characteristics, which are relevant in addressing policies to promote more sustainable mobility options for residents. The results can potentially counterbalance skepticism that MaaS is not a sustainable mobility tool by demonstrating how context-specific bundle customization can bridge the wider adoption.

1. Introduction

Young individuals' travel behavior is different from older generations (Zhou & Wang, 2019). They tend to live in urban areas where more transportation services are available (Delbosc et al., 2019) and are reported to possess fewer cars (Sigall, 2016). As part of the young generation, university students are argued to have distinct travel behavior. They tend to be more adaptable in choosing transport modes and to more frequently use alternative mobility solutions, such as on-demand modes and car-sharing (Limanond et al., 2011; Whalen et al., 2013). Furthermore, unlike old generations, university students are more familiar with information and communication technologies (Kriswardhana & Esztergár-Kiss, 2025). Finally, their fast adoption of new technologies may influence their mobility behavior (Lee et al., 2020), thus it is relevant to assess their preferences for new mobility solutions.

Shared transport modes are becoming increasingly popular in urban areas (Acheampong et al., 2020) due to the integration of information

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https://doi.org/10.1016/j.trip.2026.102125
Received 8 July 2025; Received in revised form 23 June 2026; Accepted 24 June 2026
Available online 27 June 2026
2590-1982/

technologies with transportation (Yan et al., 2019) and the development of collaborative consumption. Positioned as supporting modes for public transport (PT) (Montes et al., 2023; Zuniga-Garcia et al., 2022), shared mobility services can support first- and last-mile trips (van Mil et al., 2021). Yet, the coexistence of various transportation opportunities might lead to extra complexity for travelers (Kamargianni et al., 2016) as they need to install and use several mobile applications. To support seamless and integrated mobility, Mobility as a Service (MaaS), which combines various transportation options within a mobile application, is introduced (Ho et al., 2020). MaaS is expected to simplify trip planning by combining multiple trip legs across various transport modes (Smith et al., 2017) and support a multimodal lifestyle (Matyas & Kamargianni, 2019b).

MaaS represents an integrated and collaborative mobility solution by offering MaaS bundles that allows travelers to purchase packages consisting of multiple transport mode options (Mulley et al., 2018). The integration of underutilized but environmentally friendly transport modes with more established services, such as public transport (PT) (Matyas & Kamargianni, 2019b), into bundled offerings is expected to lead to greater acceptance (Stopka, 2020). Although travelers find MaaS bundles more appealing than individual offerings (Guidon et al., 2020), their willingness to subscribe is low (Caiati et al., 2020). Designing MaaS bundles is central to the potential to alter travel behavior (Reck et al., 2020). Meanwhile, it is important to note that although some regional platforms like Jelbi in Germany (Hauslbauer et al., 2024) have successfully established, numerous other MaaS initiatives never transitioned beyond the pilot phase to achieve full deployment, such as Breeze in the UK (Sagmanli et al., 2026). Furthermore, the complexities of sustaining a unified, single-app mobility service were highlighted by the bankruptcy of the MaaS Global, the company behind the pioneering Whim platform (Orozco-Fontalvo et al., 2026) and the market exit of providers like Kyyti Group. It becomes clear that attracting sufficient users is necessary to make MaaS remain viable. Given the essential role of MaaS bundles in the overall MaaS acceptance, further analysis of their construction and impacts on travel behavior are needed.

The majority of academic studies on MaaS bundle development (Caiati et al., 2020; Chen & He, 2023; Coppola et al., 2025; Guidon et al., 2020; Ho et al., 2018; Krauss et al., 2023; Matyas & Kamargianni, 2019b; Tsouros et al., 2021) use stated preference (SP) data, as real-world implementations are not widely available. In general, it is essential to identify how specific parameters, such as transport modes, prices, and additional features influence readiness to buy MaaS packages. However, regarding the fares of the bundles, most studies (Caiati et al., 2020; Chen & He, 2023; Kim & Rasouli, 2022; Krauss et al., 2023) offer fixed fares, which are treated as attributes in stated choice experiments. While the approach may appear practical, it is not very realistic in practice. Therefore, in this study, the actual fares of the transportation services are assigned to create more realistic bundles for the participants. Furthermore, this study includes incentives (i.e., shopping vouchers and gym membership) that have not yet been offered in previous works. In this case, these can be regarded as incentives, since they provide supplementary value specifically designed to motivate users to adopt the MaaS bundle.

Research on preferences for MaaS agrees that young individuals are more inclined to be early adopters (Lopez-Carreiro et al., 2021; Vij et al., 2020; Zijlstra et al., 2020). This can be attributed to their greater familiarity with recent technological advancements and their openness to embracing new solutions (Smyth et al., 2021). While it is well known that young people show more interest in adopting MaaS, little is known about university students' uptake of MaaS bundles. University students account for a significant share of the total trips in every city (Zhou et al., 2018) and potentially shape future transportation, which makes their travel behavior worth investigating (Nguyen-Phuoc et al., 2018). Thus, our work examines the adoption of MaaS packages among college students, using data collected from four European universities.

The objective of this study is to address some identified gaps by investigating university students' adoption of MaaS bundles as they are regarded as supporters of emerging mobility solutions. Our work realizes multiple contributions to the existing MaaS literature: (1) the formation of MaaS packages takes the real prices of transportation services into account, making the packages more realistic; (2) the bundles include incentives that previous studies have not analyzed; (3) data are gathered from four European universities, which is uncommon in previous research where one case study is provided in one location, such as in Milan (Coppola et al., 2025), Bari (Giuffrida et al., 2025), and Brisbane (Chen et al., 2026).

The paper is organized as follows. After introducing the topic, Section 2 reviews existing studies on the travel behavior of university students and MaaS bundle characteristics. Section 3 describes the data collection steps and the applied research methods. The elaborated results are explained in Section 4, while Section 5 discusses the implications and findings. Section 6 provides the conclusion of the paper.

2. Literature review

2.1. University students' travel behavior

Investigating students' travel behavior is essential since they might shape the future of urban mobility (Nguyen-Phuoc et al., 2018). This group is considered "digital natives" and demonstrates familiarity with information and communication technologies (Devaney, 2015). Previous studies have identified factors affecting university students' transport mode choice. Students with higher annual income (Zhou et al., 2018) and more cars in their households (Danaf et al., 2014) are not so much inclined to walk and use PT to reach their campus. Those university students who are employed are more likely to be frequent car users as they have greater purchasing power (Shafi et al., 2020). Furthermore, the travel time to the university affects students' mode choice, where cars (Moniruzzaman & Farber, 2018) and bicycles are preferred when travel times are longer (Whalen et al., 2013). Students who live in dormitories have a higher probability of using active transport modes (i.e., walking and cycling) (Moniruzzaman & Farber, 2018). Moreover, it is argued that university students are among the potential users of environmentally friendly transport modes (Cattaneo et al., 2018). Concerns about air quality are positively related to college students' active traveling (Nash & Mitra, 2019). Meanwhile, university students consider safety factors and the lack of cycling infrastructure as barriers to using bicycles to go to the campus (Limanond et al., 2011). Drawing the data from a university, Zhou (2012) found that providing a discounted transit pass could motivate students to use alternative modes (e.g., PT, carpool, biking, and walking), while possessing a parking permit decreases the willingness to use these modes.

Policy interventions, such as restricting parking spaces, lead university students to use PT (Rotaris & Danielis, 2014). Focusing on the PT service quality factors, the time between the first and last vehicles of a day is considered the most important factor for university students when choosing PT, which is followed by the frequency of lines (Oubahman et al., 2024). Meanwhile, a study (Mehdizadeh et al., 2019) in Norway considering the season factor confirms that students are more likely to be multimodal during winter since the bike lanes are often covered with ice and snow. Giving university students unlimited access to PT can be very effective to change mobility habits and improve modal share, as evidenced by Inturri et al (2020).

In terms of emerging mobility, such as e-scooters, Nikiforiadis et al. (2023) conduct an SP survey to investigate university students' preferences for trip chaining. The study confirms that shared e-scooters are preferred for intermodal trips when the travel time is less than 20–30 min. Pricing schemes and cleanliness are the key factors influencing university students' interest in car-sharing (Bojković et al., 2019). From the technology acceptance perspective, university students perceive reliability, security, and privacy as essential factors for their intention to adopt car-sharing (Mensah et al., 2019). A study (Kriswardhana & Esztergár-Kiss, 2024b) examining the college students' adoption of MaaS finds that the service should be easy to learn and provide a quick purchasing process. Focusing on university students' bike-sharing adoption, a study (Manca et al., 2019) in the UK confirms that avoiding congestion is the primary motivation for usage, outweighing factors such as environmental friendliness and cost savings. Meanwhile, some Italian studies (Fazio et al., 2021; Torrisi et al., 2021) highlight that cycling and e-scooter infrastructures are relevant for influencing college students' willingness to use micromobility services. Furthermore, weather factors significantly influence students' willingness to use bike-sharing, where severe weather conditions are closely related to a decrease in ridership (Kutela & Teng, 2019). Learning from the unsuccessful implementation of bike-sharing in China, a study by Sun and Duan (2021) argues that deposit is a leading barrier for using bike-sharing, while regular maintenance and better customer service should be facilitated.

2.2. MaaS bundle characteristics and preferences

Generally, MaaS bundles comprise various items including transport modes, prices, and incentives, such as park-and-ride (Guidon et al., 2020) and food delivery services (Matyas & Kamargianni, 2019a). Previous studies have investigated how the attributes of MaaS bundles influence their adoption. Most studies on MaaS bundle uptake (Ho et al., 2018; Matyas & Kamargianni, 2019b; Tsouros et al., 2021) include PT and car-sharing in the options, but the perceived effects vary among the research works. While it is generally agreed that travelers prefer bundles with PT (Coppola et al., 2025), the inclusion of car-sharing can either negatively (Matyas & Kamargianni, 2019b) or positively (Guidon et al., 2020) affect the inclination to adopt MaaS bundles. Bike-sharing services are found to positively affect the adoption of MaaS bundles (Jang et al., 2020), especially when offered at a discounted rate (Caiati et al., 2020). Meanwhile, high bundle prices are closely related to a decreased willingness to purchase MaaS bundles (Krauss et al., 2023; Matyas & Kamargianni, 2019b). Nevertheless, bundle prices are often offered as fixed fares and treated as the levels of the attributes. Therefore, in this study, it is argued that the reasonableness of such fares may be questioned as they do not fully reflect the actual prices of the offered services.

A potential increase in the uptake of MaaS can be achieved through the provision of incentives in the bundles. It is important to carefully include incentives in the bundles due to the differences in local conditions and individual characteristics (Kriswardhana & Esztergár-Kiss, 2023a). Providing park-and-ride services is believed to positively affect the adoption of MaaS bundles (Guidon et al., 2020), while food delivery and culinary vouchers have insignificant effects on the adoption (Matyas & Kamargianni, 2019b). Other services associated with MaaS bundles, such as rollover (i.e., carrying over unused credits to the next subscription period) (Ho et al., 2020), free trial as well as cancellation options (Caiati et al., 2020), might be included. This study introduces incentives that are not previously offered in MaaS packages, such as online shopping vouchers and discounts on gym membership. After the COVID-19 pandemic, online shopping became increasingly popular (Zhang et al., 2021). Furthermore, Gilboa (2009) confirms that shopping mall visitors are primarily young individuals, with gym attendance being one of the key motivating factors. Consequently, the growth of fitness centers increases the number of people going to the gym (Ong et al., 2022).

Besides the alternatives provided in MaaS bundles, there are various patterns in the construction of packages. In the first approach, researchers define the choice sets by determining various parameters such as transport modes, additional services, and the levels (Guidon et al., 2020; Ho et al., 2018; Krauss et al., 2023). While this technique can obtain essential data for analyzing user segments, it is often criticized for being time-consuming and susceptible to hypothetical bias (Ho et al., 2021). In the second technique, researchers allow participants to create their MaaS bundles assuming that the respondents have a complete understanding of mobility needs (Caiati et al., 2020). This approach has several benefits and is associated with the implementation part, where no prior investments are required because no surveys or models are needed to create bundles (Ho et al., 2021). However, previous studies suggest, such as the UbiGo trial, that travelers often overestimate their travel needs, for example by buying more hours of car-sharing than they actually use in the pilot phase (Sochor et al., 2016). Therefore, in this study the first technique is adopted, where predefined attributes and levels are created.

Previous research has already revealed impacts of socio-demographic characteristics on the adoption of MaaS. Regarding age, younger people show more positive attitudes toward MaaS, while retired and older people show less interest in using the service (Ali et al., 2025; Coppola et al., 2025; Farahmand et al., 2021). Higher-educated people (Alonso-González et al., 2020; Hoerler et al., 2020; Kim et al., 2021), full-time workers (Tsouros et al., 2021), and students are more likely to use mobility solutions. (Lopez-Carreiro et al., 2021), while other socio-demographic variables show mixed results. Some studies (Coppola et al., 2025; Ko et al., 2022; Liljamo et al., 2020) suggest that male are more enthusiastic of embracing MaaS and are willing to pay more for the packages, while other works (Hasselwander et al., 2022; Lopez-Carreiro et al., 2021) confirm that female are anticipated to adopt the mobility solution. Additionally, men prefer purchasing the pay-as-you-go (PAYG) alternative to MaaS bundles (Hensher et al., 2021a). In case of income, lower-earning individuals are argued to have less interest in MaaS compared to higher income individuals (Kim et al., 2021; Zijlstra et al., 2020). However, Ko et al. (2022) confirm that lower-income households are more inclined to adopt MaaS, while another study (Hasselwander et al., 2022) states that MaaS adoption is unrelated to income. The varied results open the avenue for further studies in the field.

Meanwhile, travel characteristics and attitudes have been proven to have important effects on MaaS uptake. Most research works agree that car ownership has negative effects on MaaS preferences. A study in the UK (Polydoropoulou et al., 2020) discovers that car users are not inclined to use mobility solutions. Comparable findings are found in several works (Fioreze et al., 2019; Ho et al., 2020), where "car lovers" are unwilling to abandon cars in favor of using MaaS. On the contrary, Zijlstra et al. (2020) suggests that in the MaaS context, the preferences are not influenced by the ownership of private transport modes. PT users (Coppola et al., 2025; Hoerler et al., 2020), shared mobility service users (Hasselwander et al., 2022; Hoerler et al., 2020), and citizens residing at areas with sufficient PT services (Kim et al., 2021) are more inclined to adopt MaaS, while other research (Matowicki et al., 2022) claims that PT users show a lack of interest in adopting MaaS since they feel PT services can adequately meet their travel needs. Although the influence of travel characteristics on MaaS adoption is somewhat similar, little is known about their impact on the willingness to adopt MaaS bundles.

3. Methodology

3.1. Overview of case studies

This research was conducted at four European universities with various urban settings and cultural contexts, i.e., Budapest University of Technology and Economics (BME), University of Catania (UCT), Delft University of Technology (TUD), and Silesian University of Technology (SUT). The four cities included in this study are selected to capture a wide range of mobility contexts. One of the most notable differences is that they vary in terms of shared micromobility maturity, availability, and pricing structures. This is relevant since MaaS bundle preferences are expected to be context-dependent rather than universal. Methodologically, heterogeneity is addressed through city-specific bundle designs, and the analysis avoids direct pooling of non-comparable bundle attributes across cities.

BME, Hungary's biggest technical university, is located along the

Danube river, close to the city center. The university is accessible by various transport modes; there are several bus and tram stops as well as a metro station nearby. Collections/drop-off points for e-scooter-sharing and bike-sharing can be found around the university. Bicycle racks are provided by the university, and parking spaces for cars are available within the surrounding area of the university.

UCT is one of the oldest universities in Italy, with buildings scattered across the city of Catania (and some of them also in other cities) and organized around two main campuses. The northern campus has adequate accessibility by PT (metro and bus) and private vehicles, since the campus is accessible by car and there is a big park-and-ride facility in the surrounding area. However, it lacks sufficient infrastructure for micromobility and active mobility even though it is reachable by shared e-scooters and there are collections/drop-off points for bike-sharing inside the campus. The buildings in the city center are well-connected by PT and are more accessible via micromobility and active mobility, yet there are fewer parking spaces.

TUD is situated in the city of Delft, in the west of the Netherlands. The campus is located in the southeastern part of the city, approximately 2 km from the main train station of Delft and 1.5 km from the station Delft Campus. Delft station has four bus lines running between the station and the university campus, while Delft Campus has no local PT connection. High quality cycling paths connect the campus to both stations, while shared bicycles can be rented from the Dutch railways, as well as shared e-mopeds are available in the city. Car parking locations are provided around the campus and are free for the time being, however, the university plans to introduce a payable scheme.

SUT is the one of the largest and oldest technical universities in Poland. The Faculty of Transport and Aviation Engineering is located in Katowice in a highly industrialized area in Europe. The buildings are within walking distance of the city center. Students can reach the location by using different transport modes, including tram and bus. The university area is characterized by high accessibility by car. On-street parking is available in front of the building, but there is no bigger parking lot close to the faculty. A bike-sharing station is in front of the faculty building, and in Katowice e-scooter-sharing is provided by multiple operators.

Table 1 describes the general demographics and transportation characteristics of each location, such as the modal share of private cars, PT, and active modes. Budapest has a well-integrated PT network (metro, tram, bus, trolleybus), with 37% of trips using PT, 36% active modes, and 27% cars (Hamadneh & Esztergar-Kiss, 2019). Shared mobility (bike-sharing, car-sharing, e-scooter-sharing) is accessible but mainly concentrated around city center, and no single app integrates all transport modes. In 2019, a MaaS pilot was realized in the city but solely for a few months (Aba & Esztergár-Kiss, 2024). Catania relies heavily on private cars (80 vehicles per 100 inhabitants) (PUMS Città metropolitana di Catania, 2022). PT has been improved with new metro and bus rapid transit lines, but the insufficiency of infrastructure for active transportation limits the adoption of sustainable transport modes. Shared mobility operators have emerged in the last years. Moreover, experimentation has been conducted using a MaaS-like application implemented by the university. Similar to Catania, Katowice relies primarily on cars (43%) followed by active mobility (32%) and PT (25%). The city has commuter rail, trams, and buses, but congestion and a lack of bus lanes make buses less attractive. The city oversees the bike-sharing system, which has recently been reorganized and integrated with PT. In the urban area, car-sharing and e-scooter-sharing services are accessible and managed by private companies, which operate through separate applications and are not integrated into a coherent system. Meanwhile, Delft exhibits high cycling and walking rates (75% of trips) due to excellent cycling infrastructure (Gemeente Delft, 2021). PT mainly serves connections to nearby cities, with two train stations and tram/bus lines. Due to the less frequent nature and indirect routing of several lines, they are not used regularly for trips within the town.

Table 1
The description of the case studies.

Indicator	Subgroup	Budapest	Catania	Delft	Katowice
General information	Population (million)	1.7	0.3	0.1	0.3
	Area (km^2)	525.2	183	24.1	164.7
	Density (person/km^2)	3,250	1,630	4.573	1,695
	GDP (EUR per person)	35,200	19,500	60,000	19,844
Modal share (%)	PT	37	10	2	25
	Car	27	70	20	43
	Active modes	36	20	75	32
	Other	–	–	3	–

3.2. Data collection and survey instruments

An online questionnaire is considered appropriate for the data collection of this study, as MaaS primarily targets travelers with access to the internet. The questions and survey items remain consistent across all cities (with the exception of income, monthly allowance, transport modes, and bundle prices, which are adjusted for the reality of each city). The uniform data input enables a complex comparison during the analysis. The data collection began in January 2024 and concluded in March 2024. Invitations to participate in the survey were distributed to students via mailing lists to which they are subscribed, and the participation is voluntary.

Eq. (1) determines the number of choice sets for SP studies (Rose & Bliemer, 2013):

$$N^*c = 500^*\left(\frac{l^{\max}}{a}\right) \tag{1}$$

where N denotes the sample size, c refers to number of choice tasks, l^{max} indicates the largest number of levels, while a stands for number of alternatives. Thus, the estimated minimum number of choice sets is 375. After excluding incomplete answers, a total of 124, 113, 263, and 122 valid responses are kept for BME, TUD, UCT, and SUT, respectively. The total number of collected responses are multiplied by six (i.e., the number of choice tasks), which results in more than the minimum number of choice sets for all case studies. Before starting the questionnaire, an introduction is presented aiming to provide the participants with a prior knowledge of MaaS. The MaaS principle is presented to the participants by using a textual explanation, a pictorial illustration (Fig. 1), and a link to a video. Regarding the content of the survey, the participants are asked about three main aspects:

- Socio-demographics: gender, educational qualification, and household income.
- Travel characteristics: transport options, driving licenses, and usage levels.
- MaaS bundles (see more details below).

For the transport options, besides PT, several private and shared transport modes are included, such as car, motorcycle, bike, e-scooter, car-sharing, bike-sharing, and e-scooter-sharing. But it should be noted that only transport modes that are commonly available in certain study locations are provided. For example, motorcycle is only provided in the survey among UCT students.

The main focus of this research is a SP experiment created for investigating preferences for MaaS bundles since MaaS as a package is not yet available in the locations of the case study. The attributes and corresponding levels are presented in Table 2. The choice experiment is

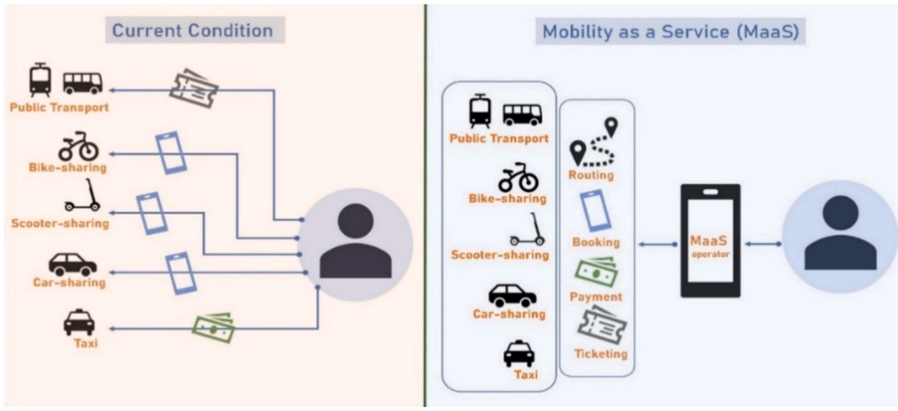

Fig. 1. The representation of MaaS.

Table 2
The attributes and levels in the choice tasks (per month).

Service	Attribute	Level
PT	Unlimited days of use	30
Bike-sharing	Unlimited days of use	0/ 30
Car-sharing	Hours of car-sharing use	0/ 1/ 2
E-scooter-sharing	Hours of e-scooter-sharing use	0/ 1/ 2
Taxi	Per-ride fare reduction	0%/ 10%/ 20%
Incentives:		
E-shopping voucher	Price reduction	0%/ 5%/ 10%
Gym subscription	Price reduction	0%/ 5%/ 10%
Package fare	Following the attribute levels	

created by using the "support.CEs" package in R, where 3 alternatives and 3 blocks have been constructed, resulting in 6 questions per block. Every participant is randomly assigned one of these blocks. For model estimation, the 2nd level of bike-sharing (30 days) is coded as 1, and remaining attributes are included with the values specified in Table 2.

In the bundle design process, a range of considerations is taken into account regarding the attributes to be included in the MaaS bundles and their measurements (i.e., attribute levels). The attributes should be perceived as realistic choices by participants, while keeping in mind that providing too many attributes to the respondents might lead to inappropriate tradeoffs (Hensher, 2006). It is important to note that there is flexibility in choosing the attributes. While including all shared transport mode options would be great, this might cause a cognitive burden for the participants, especially in the case of such a relatively new concept as MaaS. After collecting the data related to the transport modes (e.g., pricing structures, subscription options, and their coverage), five modes are included in the packages. At the outset, solely existing transport modes available in all case study locations are included in the plans. Since PT is considered as the backbone of MaaS, the mode is always included in the bundles.

The prices shown to participants represent the total cost of a bundle pivoted around the fares of each transport mode. This approach shows how the MaaS bundles would look in real settings. Aggregated hourly fares are formulated for car-sharing and e-scooter-sharing. In case of Delft, a monthly fare of bike rental is applied since the predominant bike-sharing service in the Netherlands is a monthly bike-leasing program. Shared bicycles are also available at the station but are rented for a 24-hour period and are primarily used for occasional trips. Meanwhile, taxis are offered with a discount, as suggested by Ho et al. (2018), who confirm that MaaS bundles are more attractive when offered with discounts. Thus, a nudging strategy is employed by displaying the prices of the bundles both with and without MaaS. In the MaaS scheme, the fares of the shared mobility services are reduced by 10%, which makes the total fares of the MaaS bundles lower than the actual rates. Fig. 2 illustrates the example of the stated choice experiment. Four options (i.e., three packages and a PAYG option) are provided to the respondents. The predefined bundles represent a subscription-based model in which the services are combined and offered in a MaaS package thus providing a set volume for accessing transport modes and incentives. Meanwhile, the PAYG represents the currently available options, which is treated as a zero alternative in the SP experiment.

3.3. Data analysis

The preferences for MaaS bundles are first analyzed by using a multinomial logit model (MNL). Afterward, mixed logit model (MXL) has been applied while considering random heterogeneity in the preferences. The MXL is an advanced and flexible model grounded in the random utility theory (Train, 2009), which can address the limitations of the MNL by accommodating random variations in preferences across individuals and accounting for the correlation effects over time and space (Bliemer & Rose, 2010).

It is assumed that individual n evaluates the alternatives I in each choice task $t \in T$ and picks an alternative having the highest utility. The utility expression is shown in Eq. (2).

$$U_{nit} = V_{nit} + \varepsilon_{nit} = ASC_{nit} + \sum_{k=1}^{K} \beta_{ik} X_{nitk} + \varepsilon_{nit} \tag{2}$$

where the deterministic part of the utility V has been expressed as linear function of an observable factor X_{nitk} and β_{ik}, which is a vector of parameters for K attributes to be estimated. ASC represents the alternative specific constant. The error term ε is assumed to follow a Gumbel distribution.

In the MNL, the parameter vector β is assumed to be equal for all participants. The probability of an individual n selecting alternative i in MNL is calculated by using Equation (3).

$$P_{nit} = \frac{e^{V_{nit}}}{\sum_{j=1}^{J} e^{V_{nit}}} \tag{3}$$

The probability of individual n selecting alternative i in the MXL is represented as the integral of the MNL probabilities across the distribution of the taste parameter β (Eq. (4)).

$$P_{nit} = \int \frac{e^{V_{nit}(\beta)}}{\sum_{j=1}^{J} e^{V_{nit}(\beta)}} f(\beta|\phi) d\beta \tag{4}$$

where $f(\beta|\varphi)$ denotes the density distribution. The choice probability is a weighted average of logit formula estimated at various values of β, where the weights are determined by the density $f(\beta|\varphi)$. Meanwhile, a simulation method is utilized to capture the inter-individual heterogeneity and panel effects, where the quasi-random maximum simulated likelihood using Halton draws is applied (Bhat, 2001). A thorough explanation of discrete choice models can be found in Train (2009) and

*	Bundle A	Bundle B	Bundle C	Pay-as-you-go
Public transport	Unlimited	Unlimited	Unlimited	Pay per ride
Bike-sharing	–	Unlimited	–	EUR 0.5/ 30 min
Car-sharing	1 hour	–	2 hours	EUR 2.4/ hour + 0.54/ km
E-scooter sharing	2 hours	1 hour	2 hours	EUR 14/ hour
Taxi	10% discount	–	20% discount	–
Gym membership	–	10% discount	10% discount	–
Online shopping voucher	10% discount	5% discount	10% discount	–
Price with MaaS	**EUR 66.90**	**EUR 46.20**	**EUR 78.60**	**EUR 0.00**
Price without MaaS	**EUR 71.00**	**EUR 48.00**	**EUR 84.00**	**EUR 0.00**

Which bundle would you prefer most?

Bundle A

Bundle B

Bundle C

Pay-as-you-go

Fig. 2. The example of a SP experiment.

Ben-Akiva and Lerman (1985). The models are realized by using maximum likelihood with 10,000 modified MLHS draws (Hess et al., 2006) in the R APOLLO package (Hess & Palma, 2019).

4. Results

4.1. Descriptive results

Table 3 shows the profiles of participants for each case study. It is evident from the sampled respondents that males are more present at technical universities, while a more balanced gender ratio is found in the sample drawn from UCT. The profiles mostly follow the patterns of technical universities, where around 70% of students' population are males (BME, 2021; Silesian University of Technology, 2021; TU Delft, 2024). Nevertheless, gender-related results should be interpreted with caution, especially when comparing cities with different institutional profiles. More than half of the participants come from low-income households, except for BME. Most participants, especially at UCT and SUT, possess a driving license. It is worth mentioning that respondents from BME, UCT, and SUT show less interest in owning a license in the future compared to TUD. Heterogeneous distributions are found in transport mode opportunities. Most participants from BME and UCT are PT subscribers, while bikes are more popular among TUD respondents. Meanwhile, cars are more accessible for the participants from SUT. The usage levels of transport modes generally reflect transport opportunities, except for TUD. Dutch students in the Netherlands get free PT passes during their studies; thus, they do not need a subscription. However, this does not apply to most international students, who need to pay for their trips. Thus, most participants from TUD are not PT subscribers, still

Table 3
Sample composition (%).

Category	BME	UCT	TUD	SUT
Gender				
Male	66	53	63	72
Female	34	47	37	28
Education				
Undergraduate student	68	74	51	34
Postgraduate student	32	26	49	66
Household income*				
Low income	24	65	56	58
High income	76	35	44	42
Driving license possession				
No	23	1	3	3
Yes	73	94	74	90
No, but planning to have one	4	5	23	7
Transport mode opportunity				
PT subscription	94	61	8***	30
Car	35	60	20	78
Bike	57	9	91	53
Motorcycle	N/A	9	N/A	N/A
Transport mode usage**				
Frequent PT user	90	60	72	48
Frequent car user	32	64	20	78
Frequent cyclist	16	1	83	15
Frequent motorcyclist	N/A	9	N/A	N/A

*The income classification is based on the average annual income released by Eurostat (https://ec.europa.eu/eurostat/en/); **frequent: the usage level is several times per week or more; ***PT services are free for Dutch students.

nearly three-quarters of them use PT at least several times a week.

Fig. 3 illustrates the comparison of the current primary transport mode shares. At BME, nearly 60% of the students use PT, while one-fifth walk to the university. The modal share of TUD students exhibits a distinct pattern with around 40% and 50% riding bicycles and using PT to access the university, respectively. In contrast, cars are popular among UCT and SUT students with 36% and 44% using cars to commute to the university, respectively. It is worth noting that motorcycles are used by around 5% of the students from UCT.

Table 4 shows the percentages of the MaaS plans chosen by the participants, where the majority of BME students choose bundles over the PAYG option. Overall, 45% of the bundles chosen by BME students include bike-sharing services, while around 60% have e-scooter-sharing and car-sharing services. The percentages of mobility bundle uptake among TUD and UCT students are similar, where 77% choose MaaS bundles. From the chosen bundles, nearly 40% contain bike-sharing services, and half of them include car-sharing and e-scooter-sharing hours. Finally, SUT students show the least interest in subscribing to MaaS bundles.

Fig. 4 illustrates the distribution of the MaaS packages compared to the PAYG option categorized by the travel characteristics. The chi-square (χ^2) tests aim to determine whether the differences between the plan and PAYG distributions are significant. Generally, the participants who are frequent PT users choose plans more often; however, this difference is not significant in the case of SUT. Conversely, the more often the respondents use cars, the less likely they are to purchase MaaS bundles. Interestingly, a contradictory result is found for SUT, where frequent car users show more interest in purchasing the plans, yet the difference is not significant. At the same time, frequent bike users choose mobility offerings more often, and a significant difference is found in case of BME. Finally, frequent motorcyclists at UCT more often pick mobility plans.

4.2. Estimation results

Table 5 presents the results for choice models where solely the primary attributes provided in the stated choice experiments are estimated (Model-1). Unobserved heterogeneity is introduced in the alternative specific constant (ASC) and the attributes across respondents. The ASC is estimated for all MaaS bundles with PAYG as the reference category. The random parameters follow normal distribution. The ASC estimated for the MaaS plans are varied. The ASC values are significantly positive for the case of BME, UCT, and TUD. This implies that the students at these universities find the MaaS packages attractive.

The results show that in most cases the bundles are less attractive when shared transport modes (car-sharing and e-scooter-sharing) are offered. Respondents from TUD show a stronger aversion to bike-sharing services. Meanwhile, the provision of car-sharing services in the bundle significantly reduces participants' willingness to choose bundles. Likewise, there appear to be negative effects on purchasing bundles when e-scooter-sharing is provided, especially for the participants from SUT. Discounts on taxi services appear to be the drivers of bundle uptake especially among UCT and TUD students. With respect to the incentives, students prefer discounts on gym membership, and providing online shopping vouchers in the MaaS packages improves the attractiveness of the bundles. As expected, the parameter estimates for cost are negative, indicating higher preferences for cheaper MaaS packages.

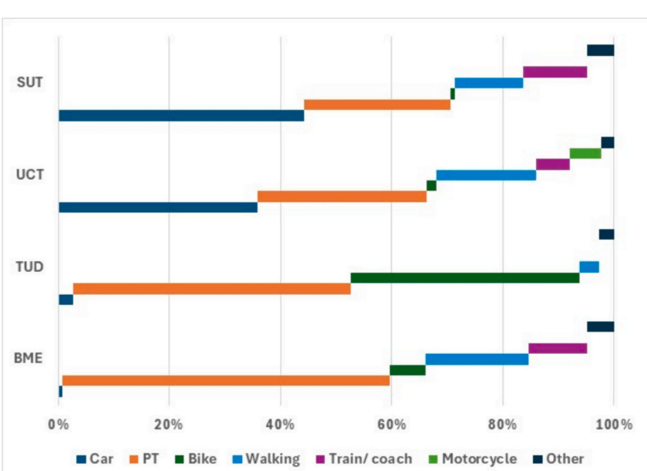

Fig. 3. The share of primary transport modes.

Table 4
Percentages of the chosen MaaS plans and shared mobility services.

	BME	UCT	TUD	SUT
Bundle	90%	77%	77%	63%
Bike-sharing	45%	38%	39%	31%
Car-sharing	60%	50%	51%	41%
E-scooter-sharing	61%	51%	N/A	42%

It is worth noting that bundle costs are mostly not significant. This may be due to the design of the stated choice experiment, in which costs closely follow the characteristics of the bundles. As a result, participants rarely encounter bundles with disproportionately low or high prices. By ensuring that all costs align closely with the value of the services included, respondents are not exposed to strictly dominated alternatives, i.e., options so disproportionately expensive or inexpensive that they would bypass complex trade-off evaluations. The use of cost levels that closely align with bundle content increases realism, which is critical for eliciting preferences that reflect actual decision-making behavior. However, it is important to acknowledge that price acceptance remains location-dependent. Due to variations in local purchasing power and baseline PT fares across the studied locations, a price considered reasonable or financially attractive in one location may not be applied in another. Nonetheless, in practice, bundles are unlikely to be priced arbitrarily low or high relative to their content. By reflecting this in the experimental design, we simulate market-consistent conditions, thereby increasing the applicability of the results to policy contexts.

Table 6 presents the results of Model-2, which extends Model-1 by incorporating the participants' socio-demographic and travel characteristics. The results provide insights into the effects of variables depending on the specific applications (Ashkrof et al., 2022). Regarding BME, the significant positive sign of the interaction between bike-sharing and males implies that male students find bike-sharing to be an important element of the bundle, thus making bundles with bike-sharing proportionally more attractive. The opposite condition applies to e-scooter-sharing, where the service is more attractive among female BME students. Meanwhile, the positive coefficient of the interaction between bike-sharing and high income suggests that the chance of choosing MaaS bundles containing bike-sharing is higher among UCT students who come from high-income households. However, the reverse trend is found among BME students. The positive interaction signs of car-sharing and high income indicate that BME, TUD, and SUT students from high-income households are more interested in bundles containing car-sharing services. Similar trends are found in the case of e-scooter-sharing and high-income interactions. Among UCT students, car-sharing is more favorable for frequent car users, as indicated by the positive interaction coefficients of the service and frequent car usage.

Compared to Model 1, Model 2 includes interaction effects aimed at capturing heterogeneity in preferences across sociodemographic groups. However, the improvements in model fit are marginal. The adjusted Rho-square values are unchanged or lower, and AIC/BIC worsens across the board. This suggests that the added complexity does not meaningfully enhance explanatory power.

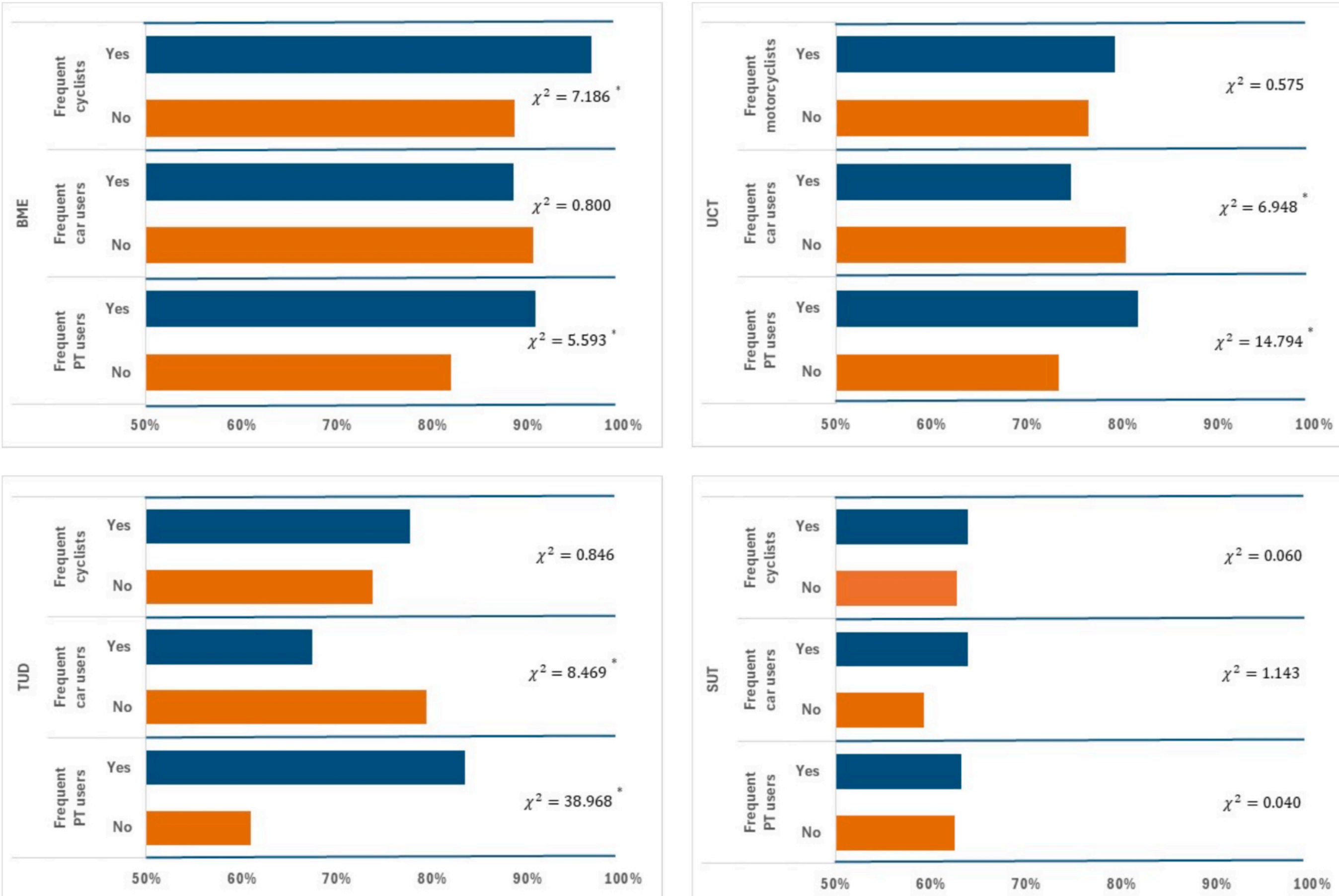

Fig. 4. The distributions of selected MaaS packages categorized by travel characteristics Note: statistically significant at 5% (*).

Table 5
The estimated effects of MaaS bundle attributes on uptake decisions (Model-1).

Variable	BME	Rob.t-rat.	UCT	Rob.t-rat.	TUD	Rob.t-rat.	SUT	Rob.t-rat.
ASC bundle	***3.19***	3.83	***2.85***	3.06	***5.70***	5.48	0.71	0.55
Bike-sharing	***0.40***	1.93	0.02	0.15	−0.69	−0.64	**0.23**	1.10
Car sharing	***−2.53***	−3.97	**−0.48**	−1.43	***−1.44***	−2.00	**−0.90**	−1.55
E-scooter-sharing	***−1.60***	−4.91	***−0.76***	−2.07	N/A	N/A	***−1.71***	−2.24
Taxi	0.01	0.90	***0.01***	2.18	***0.00***	0.38	0.00	0.48
Gym membership	**0.03**	1.57	***0.06***	6.54	0.06	2.29	***0.05***	2.27
Shopping voucher	**0.03**	1.59	***0.03***	2.97	0.02	0.93	**0.03**	1.25
Plan price	***−0.35***	−2.29	−0.01	−0.16	−0.05	−0.95	−0.01	−0.56
Standard deviation								
ASC bundle	***2.77***	5.20	***4.81***	7.11	***4.85***	4.72	***5.08***	6.27
Bike sharing	***0.53***	1.72	***0.40***	1.73	***−1.33***	−3.30	***0.58***	1.80
Car sharing	***−0.69***	−2.25	−0.09	−0.21	***0.88***	4.47	***−0.48***	−2.22
E-scooter-sharing	***0.46***	3.13	***−0.31***	−1.93	N/A	N/A	0.05	0.51
Taxi	***0.05***	3.02	−0.02	−0.92	0.00	−0.41	0.00	0.18
Gym membership	***−0.07***	−2.95	−0.03	−0.86	***0.09***	2.07	***−0.09***	−2.78
Shopping voucher	−0.01	−0.32	**−0.05**	−1.55	0.04	0.34	***0.08***	1.67
Plan price	***0.20***	4.84	***0.04***	7.36	***0.07***	3.97	***−0.02***	−6.32
Model fit								
Adj. Rho-square	0.25		0.24		0.26		0.32	
LL(0)	−1031		−2188		−834		−1015	
LL(final)	−761		−1650		−604		−670	
AIC	1555		3333		1235		1373	
BIC	1629		3419		1298		1446	

Note: Statistical significance at 5% (bold and italic) and 10% (bold).

Table 6
The determinants of MaaS bundle uptake including interaction effects (model-2).

Variable	BME	Rob.t-rat.	UCT	Rob.t-rat.	TUD	Rob.t-rat.	SUT	Rob.t-rat.
ASC bundle	***16.80***	4.61	***6.07***	3.93	***14.15***	2.91	***10.29***	3.17
Bike-sharing	**0.91**	1.53	**−0.33**	−1.23	−0.75	−0.63	**0.67**	1.31
Car sharing	***−3.58***	−4.37	**−0.49**	−1.28	***−2.20***	−2.66	***−2.06***	−2.57
E-scooter-sharing	***−2.24***	−4.01	**−0.59**	−1.44	N/A	N/A	***−2.42***	−2.85
Taxi	0.01	1.09	***0.01***	2.27	0.00	0.11	0.00	0.24
Gym membership	***0.03***	1.65	***0.07***	6.70	***0.06***	2.32	***0.05***	2.25
Shopping voucher	***0.03***	1.61	***0.04***	3.12	0.02	1.09	**0.03**	1.26
Plan price	***−0.32***	−2.22	−0.01	−0.25	**−0.06**	−1.20	−0.01	−0.82
Standard deviation								
ASC bundle	***2.51***	3.29	***4.77***	7.24	***4.52***	4.64	***3.80***	2.64
Bike sharing	0.05	0.35	**0.28**	1.45	***0.54***	2.49	**−0.50**	−1.51
Car sharing	**−0.44**	−1.22	0.19	0.91	***−0.70***	−4.32	***−0.78***	−2.18
E-scooter-sharing	−0.33	−1.62	0.16	0.54			0.02	0.32
Taxi	***0.04***	2.80	−0.01	−0.82	0.00	−0.26	0.01	0.93
Gym membership	***−0.07***	−3.01	−0.03	−0.98	***0.09***	2.12	***−0.10***	−2.77
Shopping voucher	0.00	0.01	***−0.05***	−1.79	0.05	0.74	**0.08**	1.38
Plan price	***0.19***	4.96	***0.04***	7.45	***0.09***	5.46	***−0.02***	−4.17
Interaction								
Bike-sharing × male	***0.49***	2.05	−0.07	−0.43	−0.24	−0.47	**−0.48**	−1.30
Car-sharing × male	−0.27	−1.07	***−0.25***	−1.94	0.07	0.18	−0.13	−0.41
E-scooter-sharing × male	***−0.32***	−1.73	**−0.16**	−1.18			−0.29	−0.93
Bike-sharing × high income	**−0.45**	−1.54	***0.28***	1.62	0.27	0.53	−0.10	−0.31
Car-sharing × high income	***0.74***	2.40	−0.07	−0.57	**0.53**	1.32	***0.61***	2.13
E-scooter-sharing × high income	***0.51***	2.16	−0.08	−0.60			***0.50***	1.96
Car-sharing × frequent car usage	0.08	0.33	***0.31***	2.29	0.21	0.44	0.09	0.28
Model fit								
Adj. Rho-square	0.246		0.238		0.249		0.323	
LL(0)	−1031		−2188		−834		−1015	
LL(final)	−755		−1645		−607		−664	
AIC	1555		3335		1252		1375	
BIC	1661		3459		1338		1480	

Note: Statistical significance at 5% (bold and italic) and 10% (bold).

5. Discussion

5.1. Discussion of the results and policy implications

The notion of MaaS bundles is closely related to the concept of combining several products into one package in the marketing literature. If the bundle does not satisfy customers' needs, they are unlikely to purchase it. Typically, studies on the uptake of MaaS bundles focus on one case study, which limits the understanding of how varied individual characteristics may affect the adoption. Furthermore, the impacts of socio-demographics on the preferences for specific transport modes in the bundles are rarely discussed. In this work, the data are originating from 4 universities in 4 different countries thus allowing richer investigations regarding the preferences toward MaaS bundles among university students. The interactions between socio-demographic factors and transportation-related attributes are examined as well. Nevertheless, it is worth noting that mode preference is one of the adoption determinants, and future success also relies on bridging the gap between preferred modes and consumption-related attitudes.

The descriptive results indicate that BME students are mostly frequent PT users. This is not surprising since the students in Hungary are entitled to purchase a PT pass with 90% reduced fares. Given the well-developed bicycle infrastructure and high rates of bicycle usage in the Netherlands (Ma et al., 2020), TUD students mostly cycle to university. In contrast, car users are mostly present among UCT and SUT students. Most students from these universities use cars to travel to the campus. In the case of UCT, this is consistent with the general trends in Catania, which is a city with high motorization rate in Italy. Nevertheless, the university community appears to be much more sustainable than the general population, since several mobility management strategies have recently been implemented, such as unlimited access to PT for students for a very low fixed annual fee (20 euros/year). In the case of SUT, the students come from the whole region and usually travel by car as it is faster than PT. Moreover, the cycling network in Katowice is limited to the city center; thus, cyclists must travel in mixed traffic conditions, which is neither safe nor comfortable. In general, the students who are frequent PT users are more enthusiastic about adopting MaaS bundles. This confirms previous results arguing that the early users of MaaS are those who frequently use PT (Hoerler et al., 2020; Kriswardhana & Esztergár-Kiss, 2024a). In this case, it may be safe to interpret that college students living in a city with affordable PT fares and excellent PT services are more probable to be MaaS bundle adopters. Conversely, those who frequently use cars are more unlikely to take up MaaS packages. This finding aligns with previous studies mentioning that frequent car users are not the ones that would be mobility solution adopters (Chen & He, 2023; Wang et al., 2024). Still, it can be noted that the reverse trend is found among SUT students, where car users seem to be more interested in using MaaS. This may indicate that the current choice of cars results from the lack of transportation alternatives. Although time is usually the most important criterion, to some extent, the students take the travel cost into account, which creates great potential for the development of MaaS services. Regarding bicycle use, even though the differences are mostly not statistically significant, those students who are frequent cyclists show more interest in purchasing MaaS bundles.

Turning to the utility of various mobility services in the bundles, the students at TUD show the least interest in including bike-sharing services. This finding might be intriguing since Dutch people primarily have positive attitudes toward cycling, and most bike rental users in Delft are students (Ma et al., 2020). However, as the majority of the students own their own bicycles, using a shared bicycle service is merely attractive for occasional trips outside their place of residence. Carsharing and e-scooter-sharing may contribute to students' reluctance of adopting MaaS bundles. This might be since the adoption of these shared mobility services is still low, which makes them too infrequent to be included in regular MaaS bundles (Ho et al., 2021). In contrast, discounts on gym membership and online shopping vouchers exhibit positive effects on the attractiveness of the MaaS bundles.

The interactions between primary attributes and socio-demographic characteristics present insightful findings, especially in terms of strategies to escalate the uptake of MaaS bundles, although the improvement of the model with interactions (Model-2) over the base model (Model-1) is marginal. Male students at BME report a higher stated willingness to include bike-sharing in the bundles. Although some factors, such as cycling culture, socio-economic and psychological features, might play important roles in explaining the preferences for biking (Pellicer-Chenoll et al., 2021), female students tend to cycle less than male students (Abasahl et al., 2018) due to females' perceptions of safety (Blazanin et al., 2022; Jaber & Hamadneh, 2024). Thus, providing safe environment for cycling is important, especially for female cyclists. Interestingly, female students show a higher stated interest in adopting the bundles containing e-scooter-sharing services. They might perceive that riding e-scooters requires less physical activity as their motivation to use active transport modes is low (Hohepa et al., 2006).

Another interesting finding is the positive interaction between high income and bike-sharing in the case of UCT. This could be interpreted as the willingness to include bike-sharing services is higher among high-income UCT students, who show interest in experiencing new services. Meanwhile, generally, e-scooter-sharing and car-sharing are more popular among high-income students. While more research work should be conducted to examine students' intention to own cars, this finding could be an initial promising strategy to reduce personal car usage in the future. College students, especially those who are from high-income households (Belgiawan et al., 2014), are argued to be potential future car users and owners (Belgiawan et al., 2016; Verma et al., 2016). Those students from UCT who are frequent car users have positive attitudes toward car-sharing in the bundles. Although the environmental impacts of car-sharing are still debatable (Liao & Correia, 2022), several studies (Chen & Kockelman, 2016; Nijland & van Meerkerk, 2017) confirm that the service could potentially reduce emissions and car ownership. One strategy could be to include exclusively those car-sharing companies that use electric cars.

Recent literature frequently highlights the complexity of making MaaS sustainable, with several studies mentioning challenges about its commercial viability (Hensher, 2022, 2024; Hensher et al., 2021b). The findings of this study highlight the shortcoming of positioning one-size-fits-all business models. By demonstrating how preferences vary based on local transport cultures, behaviors, and socio-demographic factors, this study indicates that aligning bundle configurations with these diverse, real-world baseline mobility behaviors is a first step toward overcoming current skepticism and achieving long-term business model sustainability.

While the findings demonstrate preferences for specific transport modes among university students, it is critical to distinguish between mobility preferences and actual MaaS adoption. MaaS is fundamentally built upon a commercial model. Thus, positive attitudes toward certain modes do not automatically translate into a willingness to adopt bundled services. Instead, acceptance is also shaped by how these mobility preferences interact with consumption-related factors, such as economic considerations and cost-benefit trade-offs. Moreover, while young people mostly possess the high technological receptiveness required for MaaS (Kriswardhana & Esztergár-Kiss, 2024b), their limited financial capacity might act as a bottleneck (Narayanan & Antoniou, 2023). Thus, MaaS bundles must offer tangible financial benefits, such as student discounts, that align with their budget limitations.

Several recommendations can be identified based on the current circumstances of the case studies. BME students show sustainable travel behavior, where more than 80% of the trips to and from the university are made by PT and active modes. The university could collaborate with shared mobility companies to provide the students with discounted rates, which can encourage the increased usage of shared mobility services. In the Netherlands, parking spaces for bikes are often overcrowded, and several stations require cyclists to pay for the facilities if they park more than 24 h. In this case, MaaS bundles could be equipped with incentives associated with incentives on own bike parking. Given the popularity of personal bikes in the Netherlands, incentives related to bicycle maintenance could be integrated in MaaS bundles, as well. Furthermore, an effective mix of emerging transport modes along with walking, cycling, and buses can create appealing multimodal hubs around Delft campus (Torabi et al., 2022). In Katowice, MaaS is anticipated to alleviate the students' inconvenience of traveling as the service often promises a seamless integration of transport modes. For the Italian case, it can be concluded that even if private cars are preferred, the different initiatives to promote PT use have increased its use in the last years (Inturri et al., 2020). MaaS could represent a boost to enhance sustainable mobility among university students thanks to its bundles including PT access and shared mobility options. UCT promotes mobility management strategies to reduce both students and employees' use of private vehicles to reach the university. Collaboration with the municipality and transportation operators is fundamental to increase the success of such strategies. In this respect, an improvement in PT offers and active mobility infrastructures is of paramount importance to promote modal shift. In terms of students who use cars more frequently, a previous work mentions that MaaS alone is unlikely to induce significant car substitution among this group under current conditions (Kriswardhana & Esztergár-Kiss, 2023b). Therefore, MaaS appears to be more effective as an alternative to private car use when it builds on existing multimodal travel patterns and good local mobility conditions, rather than trying to replace car use among students.

5.2. Limitations and future work

Some limitations are present in the current study. First, despite the geographic diversity of the sample, the results are derived from university students and reflect preferences under specific institutional and mobility contexts. We acknowledge that because local infrastructure and transport culture vary across regions, future research should focus on real-world pilot tests to see how these SP results hold up in actual, localized MaaS deployments. Participation is voluntary, and no quota procedures are applied to match university-level student demographics. Thus, self-selection bias may be present. While the sample is not representative of the overall university student population in each city, it represents a group of students who are informed and willing to engage with emerging mobility concepts such as MaaS. Consequently, the findings should be interpreted as indicative of broader patterns rather than as being directly generalizable to all populations or settings. Future studies should consider drawing data from a representative survey to reduce biases and address generalizability issues. Second, the cross-sectional survey in this study prohibits a more definitive explanation of the connection between the intention to purchase MaaS bundles and the real behavior. Third, future studies could examine the preferences toward MaaS bundles among broader groups of young generations to give a more comprehensive understanding of the adoption behavior. Fourth, it should be noted that the pricing structure within our experimental design is derived directly from the combination of included mobility services rather than being manipulated as a strictly independent attribute. While this approach is chosen to maximize market realism, it introduces potential multicollinearity between the service attributes and the overall bundle price. Consequently, the estimation results regarding cost should be interpreted with caution. Finally, while the interaction effects provide some additional insights, the main behavioral patterns are already captured by Model-1, suggesting that the explanatory power of Model-2 is limited. Future research could apply more advanced segmentation approaches, such as latent class models, to capture unobserved preference heterogeneity among student populations.

Currently, a key challenge is to reduce the share of trips made by passenger cars. One way to achieve this goal is to learn about drivers' preferences, who, as previous studies demonstrate, are less inclined to adopt MaaS packages. In the future, it would be worth considering the application and expansion of the research methodology developed in this article to detect the features that would be attractive for drivers. Assessing drivers' expectations and adapting MaaS bundles to the identified dependencies could significantly increase changes in their travel behavior and support the adoption of multimodal transportation solutions.

In the future, studies should be expanded to include more characteristics of the region, such as the local transport conditions and the travelers' routes, thus considering the PT offers to identify the impact of the indicated factors on preferences. Therefore, individual decisions can lead to a choice of more suitable bundles. Additionally, it would be worth exploring how MaaS can boost the uptake of mobility management solutions, where the trial and use of existing MaaS-like applications could help the data collection. Thus, the willingness to perform multimodal trips by using MaaS could be further investigated. Understanding potential users' expectations and preferences will allow for more adequate adjustment of the offered mobility solutions and increase the attractiveness of advanced transportation systems. For this purpose, it is necessary to ensure the participation of the city authorities and the public sector in the integration and development process. City development strategies include active measures and focus on smart and sustainable mobility that can support the efficient implementation of MaaS bundles.

6. Conclusion

The behavior of young generations shapes how urban mobility will look like in the future. University students, who represent the younger generation, have special travel behavior. Additionally, it is argued that they have more open attitudes toward emerging mobility solutions like MaaS. MaaS is often offered through MaaS bundles, in which various options for using several transport modes are included. These bundles are confirmed to be more sustainable than the PAYG option (Militão et al., 2025). This study identifies students' preferences toward MaaS bundles, where the students are from four European universities (BME, UCT, TUD, and SUT) and have diverse travel characteristics. The majority of BME students reach the university by using PT, while the students from TUD primarily use bikes. Given the varied characteristics of the sample, the preferences for the alternatives offered in MaaS bundles through SP experiments vary, as well. The students at TUD show the strongest aversion to bike-sharing in the bundles, most likely due to high bike ownership and free use of public transport. In general, students do not prefer shared mobility services. However, the interaction results provide a positive outlook on who may be more inclined to purchase the bundles. Those from high-income households are confirmed to be more interested in MaaS bundles containing e-scooter-sharing and car-sharing services. Meanwhile, car-sharing is preferred by frequent car users at UCT and SUT, where the students mostly go to the university by private cars. We acknowledge that skepticism about MaaS might appear due to the failure of several initiatives. Thus, the findings from this study might be positioned as initial looks at how different students characteristics and locations affect the uptake of transport modes included in MaaS bundles, although actual adoption will also depend on their willingness to engage with bundled subscription models.

CRediT authorship contribution statement

Willy Kriswardhana: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Michela Le Pira:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Giuseppe Inturri:** Writing – review & editing, Investigation, Conceptualization. **Nejc Geržinič:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Niels van Oort:** Writing – review & editing, Investigation, Conceptualization. **Grzegorz Sierpiński:** Writing – review & editing, Writing – original draft, Investigation, Conceptualization. **Adrian Barchański:** Writing – review & editing, Investigation, Conceptualization. **Domokos Esztergár-Kiss:** Writing – review & editing, Supervision, Project administration, Investigation, 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.

Acknowledgement

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

Data availability

Data will be made available on request.

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