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Environmental attitudes' impact on mobility-as-a-service in tourism destinations: The Canary Islands case

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ABSTRACT

This paper examines how environmental attitudes affect preferences for mobility-as-a-service (MaaS) in two major mass tourism destinations in the Canary Islands. Using data from a survey that includes a discrete choice experiment presenting a range of mobility packages and several attitudinal questions, a hybrid choice model is estimated to assess how tourists' perceptions of MaaS features vary with environmental concern and behaviour, both in daily life and during vacations. The study contributes to a better understanding of MaaS adoption among tourists by calculating their willingness to pay (WTP) for specific components and, critically, analysing their elasticity relative to key latent variables. Our research also evaluates various policy scenarios, revealing that tourists are significantly more inclined to adopt MaaS packages that integrate public transport and offer distinct benefits for excursions. These novel insights provide direct empirical support for policies promoting sustainable tourism and offer a robust framework for MaaS service design.

1. Introduction

The tourism industry faces multiple challenges that necessitate the assessment of sustainable practices and a deeper understanding of tourists' environmental attitudes and behaviours. The management of mass tourism in popular destinations has raised significant concerns regarding sustainability and quality of life for both local residents and tourists. Addressing these challenges requires a research approach that explores the underlying variables influencing tourists' environmental awareness and sustainable behaviour.

Tourism is one of the largest generators of travel. Indeed, the UNWTO (UNWTO., 2024) anticipates a full recovery of pre-pandemic figures, forecasting that 285 million tourists will travel internationally in the first quarter of 2024. The transport sector plays a pivotal role in the tourism industry; however, it accounts for a significant share of global greenhouse gas emissions. Moreover, tourist destinations also face additional challenges associated with vehicle traffic, including congestion, noise, and pollution (Curtale et al., 2024); (Davies et al., 2020); (Cavallaro et al., 2017). These issues can negatively impact the destination's image, tourist experiences, and residents' quality of life (Biagi et al., 2020). In this context, tourists' mobility habits and their environmental attitudes play a key role in ensuring the sustainability of tourist destinations (Kim et al., 2021); (Scuttari et al., 2013).

Since its introduction in the EC Green Paper on the Impact of Transport on the Environment (1992), sustainable mobility has gained increasing interdisciplinary attention. The sustainable mobility paradigm involves reducing travel distances, promoting modal shifts, and improving transport system efficiency (Banister, 2008). Sustainable mobility enhances local well-being by preserving natural areas

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and reducing air pollution and traffic congestion (Curtale et al., 2024). Additionally, it can make destinations more attractive, improving the overall tourist experience (Signorile et al., 2018). As a consequence, Mobility-as-a-Service (MaaS) has emerged as a promising solution to meet individuals' mobility needs more sustainably than traditional transport systems.

The theory of planned behaviour (Ajzen, 1991)states that individuals' attitudes and perceptions play a fundamental role in mobility-related decision-making. One area of study that has garnered considerable interest in recent years is the role of environmental concern in tourists' transport decisions. Previous studies have found that environmental concern influences transport mode choice (Bai et al., 2020); (Rotaris et al., 2021); (Scorrano and Rotaris, 2022), and more pro-environmental attitudes among tourists are associated with a higher likelihood of choosing sustainable transport modes (Xu et al., 2020). However, as Kriswardhana and Esztergár-Kiss (Kriswardhana and Esztergár-Kiss, 2025) pointed out, the study of the effects of environmental attitudes on the adoption of MaaS bundles is still scarce. In particular, the impact of environmental consciousness on MaaS bundle adoption has not yet been widely examined. This article aims to contribute to the study of this identified gap in the literature.

This study aims to gain a deeper understanding of tourists' preferences for MaaS options and investigate whether these preferences are influenced by individuals' environmental attitudes by estimating a hybrid choice model. The research was conducted in the main tourism developments of the Canary Islands, one of Europe's leading mass tourism destinations, and extends a previous study by González et al. (González et al., 2024), which analysed unobserved heterogeneity using a random parameter logit (RPL) model that also incorporated systematic heterogeneity in the means of the random parameters, based on socioeconomic variables. The novel aspect of this study is the analysis of the impact of latent variables on the perception of key MaaS package attributes. This approach enables a deeper behavioural interpretation of how individual characteristics influence both preferences and latent attitudes, offering more nuanced and policy-relevant insights into the mechanisms behind decision-making. In particular, the study considers attitudes toward environmental concern and behaviour, distinguishing between daily life and vacation contexts. In addition, the specification of the choice model incorporates these three latent variables, interacting with the attributes that define MaaS packages, allowing for a richer interpretation of tourists' preferences than other commonly used linear additive models (e.g., (Kriswardhana and Esztergár-Kiss, 2025).

Our research incorporates some add-ons in MaaS packages tailored to local circumstances perceived as valuable by visitors following (Kriswardhana and Esztergár-Kiss, 2023; Kriswardhana and Esztergár-Kiss, 2025). While previous research has explored the inclusion of various add-ons in MaaS packages—such as parking (Caiati et al., 2020); (Guidon et al., 2020), dining services (Matyas and Kamargianni, 2019), and discounted tourism incentives like shopping and attraction tickets (Chen and He, 2023)—these studies have not specifically considered excursion discounts in mass tourism destinations. Given that excursions are a fundamental component of tourist mobility, particularly in destinations like the Canary Islands, this study broadens the scope of MaaS by integrating this overlooked service. Accordingly, this study examines the inclusion of island excursion discounts in MaaS packages, acknowledging excursions as a key driver of tourist mobility.

In summary, our study contributes to the MaaS literature by focusing on mass tourism destinations. This domain has received less attention compared to urban or general tourism contexts, even though, as some authors have noted (Alyavina et al., 2020), the tourism industry, which is highly dependent on transportation, could greatly benefit from MaaS implementation.

2. Environmental attitudes and tourism sustainable mobility

Environmental attitudes play a key role in mobility decision-making, particularly in tourism, where transport choices are influenced not only by observable factors such as cost and travel time but also by personal values and sustainability perceptions. The growing awareness of environmental issues has increased interest in understanding how environmental concerns and pro-environmental behaviour influence the adoption of sustainable transport options. However, empirical findings suggest that this relationship is highly complex and context-dependent.

Some studies in Asian cities illustrate this complex issue: while pro-environmental activities are unrelated to commuting modes in Tokyo and Singapore, they are positively associated with cycling and walking in Beijing (Kumagai and Managi, 2020). In China, environmental motivation promotes green travel choices, yet self-interest frequently prevails (Geng et al., 2017). Similarly, in Jakarta, attitude is the most influential factor in postgraduate students' transport choices (Lelono et al., 2018). Furthermore, the effect of environmental concern on public transport use is partially mediated by habit, with behavioural intention, perceived behavioural control, and routine travel patterns exerting the strongest influences on decision-making (Zhang et al., 2020).

This complexity is particularly pronounced in tourism mobility, where travellers often exhibit different behavioural patterns compared to their daily routines. Research on sustainable tourism behaviour highlights a persistent gap between pro-environmental attitudes or intentions and actual travel behaviour. Budeanu (Budeanu, 2007) found that tourists frequently fail to adopt sustainable mobility choices despite expressing positive environmental attitudes. Other studies confirm that individuals who prioritise environmental concerns in their daily lives may pay less attention to sustainability when travelling away from home (Kiatkawsin and Han, 2017); (Miller et al., 2015). Even pro-environmental behaviours at home by environmental experts do not necessarily result in sustainable tourism choices, leading to cognitive dissonance (Bamdad et al., 2019).

Several explanations have been proposed for this discrepancy. Nieto-García et al. (Nieto-García et al., 2024) attribute it to consumer hypocrisy and methodological limitations in research, recommending strategies to mitigate both issues. Dolnicar and Demeter (Dolnicar and Demeter, 2024) identify five key reasons attitude-based interventions often fail: ineffective messaging, cognitive resistance, psychological reactance, entrenched habits, and perceived effort barriers. They argue that alternative theoretical constructs should be explored to enhance behavioural change strategies. Additionally, Wut et al. (Wut et al., 2023) highlight critical research themes related to the attitude-behaviour and intention-behaviour gaps, including the roles of environmental knowledge, green certification, and moral values.

However, some evidence suggests that environmentally conscious individuals may maintain their pro-environmental mobility choices across different contexts. Zamparini et al. (Zamparini et al., 2022) found that green mobility behaviours adopted at home often correlate with those exhibited at tourist destinations. One possible explanation for these disparities among research results lies in the perceived cost of behaviour change. Diekmann and Preisendörfer (Diekmann and Preisendörfer, 2003) and Farjam et al. (Farjam et al., 2019) suggest that individuals with strong environmental attitudes are likelier to choose more sustainable alternatives when costs are sufficiently low. This may explain why environmental attitudes alone fail to predict high-cost behaviours, such as reducing car use or avoiding flights (Alcock et al., 2017); (Diekmann and Preisendörfer, 2003).

Despite these challenges, innovative mobility solutions have demonstrated potential in promoting sustainable travel behaviour. One effective approach is the combination of public transport with shared mobility and discounts, which appears to facilitate the transition toward more sustainable mobility (Kriswardhana and Esztergár-Kiss, 2025). In this regard, Curtale et al. (Curtale et al., 2024) show that introducing innovative transport options, such as park-and-ride with shuttle services or bike-sharing systems, can significantly reduce car usage in natural tourist areas, further supporting the role of combined mobility solutions in fostering sustainable travel habits. Moreover, some studies indicate that pro-environmental tourists are more likely to use shared mobility services, park-and-ride facilities, and eco-friendly transport alternatives (Bai et al., 2020); (Rotaris et al., 2021); (Scorrano and Rotaris, 2022); (Xu et al., 2020).

In this context, Mobility-as-a-Service (MaaS) represents an attractive solution to encourage the use of more sustainable transport modes. However, MaaS adoption is not solely dependent on practical factors such as convenience and cost but also on latent variables such as environmental concern, trust in shared mobility, and travel habits (Paulssen et al., 2014); (Ben-Akiva et al., 2002).

Hensher et al. (Hensher et al., 2021) reaffirm the interest in MaaS as a means to align mobility with sustainability. However, as Hensher et al. (Hensher et al., 2020) noted, "the definition of Mobility-as-a-Service (MaaS) remains elusive in terms of finding a definition which is universally accepted" (p. 37). They identified 18 distinct definitions, supporting their claim. Most definitions share three fundamental elements: integrating transport systems, utilizing a digital platform to manage the entire experience, and enabling payments through a unified system.

MaaS has been recognized by numerous authors as a viable approach to managing tourist mobility sustainably (Leung et al., 2023); (Kim et al., 2021); (Martinčević et al., 2022). The primary objective of MaaS in a tourist destination is to facilitate tourist movement by integrating various transportation options—including public transport, ride-sharing, bike rentals, and even walking or cycling—into a unified platform. Additionally, as suggested by Hensher et al. (Hensher et al., 2023) and Hensher and Heitenan (Hensher and Hietanen, 2023), other tourism stakeholders can be integrated into MaaS packages, enhancing their market orientation.

However, other researchers, including Meloni et al. (Meloni et al., 2025), contend that assertions regarding MaaS's contributions to achieve more sustainable alternatives are still limited (Wong et al., 2018); (Smith et al., 2022). In addition, Kriswardhana and Esztergár-Kiss (Kriswardhana and Esztergár-Kiss, 2025) argue that the negative MaaS effects remain challenging for policymakers. The scope, timing, and direction of these impacts remain uncertain, underscoring the need for more rigorous quantitative analyses, both at the level of individual travel behaviours and preferences and in terms of broader societal implications, including social and environmental sustainability. This highlights the relevance of studies like the present one, which aim to analyse the preferences of potential users.

The integration of latent variables into discrete choice models has become essential in transport research, as it allows for the capture of psychological and attitudinal factors that influence mobility decisions (for a revision of the latent variables investigated in studies of active transportation, see Jameel and Abdulhussein, 2025). The Integrated Choice and Latent Variable (ICLV) model has enhanced predictive accuracy and captured individual heterogeneity in MaaS adoption (Kamargianni et al., 2015).

Recent studies have explored the drivers of MaaS adoption from this perspective. Kim (2019) found that psychographic lifestyles and positive attitudes toward multimodality increase the propensity to use MaaS. Alsaadi and Jameel (2025) also emphasise that perceived safety, pro-environmental attitudes, and flexibility in transport choices improve MaaS adoption when integrated into these models. Kim and Rasouli (Kim and Rasouli, 2022) found that MaaS adoption is influenced by lifestyle, with multimodal travel attitudes, personal values, and psychological traits playing key roles. Recently, Vovk et al. (2024) provided empirical evidence that environmentally conscious individuals are more likely to adopt MaaS solutions, particularly in tourism settings where eco-friendly incentives, multimodal transport options, and real-time sustainability feedback enhance their willingness to shift toward shared mobility. However, their study also highlights that habit formation, previous transport choices, and situational constraints—such as trip duration and familiarity with the transport network—can moderate this effect (Alyavina et al., 2020); Lou & Li, 2023). Additionally, a systematic review by Cisterna et al. (Cisterna et al., 2023) highlights the complex interaction between socio-demographic, technological, and attitudinal factors, with digital platform expectations and travel patterns emerging as key predictors (Kriswardhana and Esztergár-Kiss, 2023); (Molla et al., 2022). Similarly, Caiati et al. (Caiati et al., 2020) and Alonso-González et al. (Alonso-González et al., 2020) have revealed that service attributes, social influence, socio-demographic factors, and user segmentation play crucial roles in subscription intentions.

Although previous studies have addressed the environmental concerns, pro-environmental behaviour in daily life and tourism as separate constructs, few have integrated these factors into a unified model. However, the present study adopts an approach to model these three latent variables together. This integration allows for a more precise evaluation of sustainability-driven MaaS adoption in tourism and contributes to the broader discussion on the influence of environmental attitudes on travel decisions.

3. Data

The data used in this study were obtained from a survey administered to tourists visiting the Canary Islands during April 2023. The Canary Islands, located off the northwest coast of Africa and part of Spain, are one of the leading mass tourism destinations in the European Union. In 2023, the archipelago recorded 95.57 million overnight stays (Eurostat., 2023)and welcomed a total of 16.21 million tourists (ISTAC., 2023). According to Eurostat, the region also ranked among the top ten European areas in terms of overnight stays per square kilometre, with 12,834 stays/km^2 in 2023. This high volume of tourism presents significant challenges for the sustainable management of resources, as the sector increases pressure on both the environment and local infrastructure.

To ensure that the distribution of respondents by gender, age group, and country was representative of the overall tourism population, a quota sampling technique was used to select a sample of 921 individuals. Face-to-face interviews were used to gather data in the tourist areas of the municipalities of San Bartolomé de Tirajana (Gran Canaria) and Adeje (Tenerife). Individuals were recruited near the major tourist facilities including hotel areas, tourist bus stops, beach entrances, seafront promenades, bars and terraces. Participants completed a structured questionnaire covering a wide range of topics, including trip characteristics, sustainable mobility habits, attitudes towards environmental behaviour and environmental concern, as well as sociodemographic information.

The questionnaire also incorporated a discrete choice experiment (DCE). In this experiment, participants were faced with eight choice scenarios, each presenting two mobility packages designed to meet their mobility needs during their stay at the destination, along with a no-choice option. Mobility packages were defined as bundles of transport services and one attribute related to the specific context of tourism at a specific price for one week for a group of up to four persons. Regarding transport characteristics, the bundles could include the use of personal mobility vehicles such as bicycles, scooters, and electric motorcycles; electric car-sharing services; public transport; and taxis.

Given the context of a tourist destination, the experimental design also integrated the possibility of obtaining benefits when booking excursions. These benefits could appear as discounted prices, complimentary hotel pick-up and drop-off services, or convenient booking facilitated through the mobility package's dedicated mobile application.

The methodological advantages of employing face-to-face interviews in the administration of discrete choice experiments have been widely recognised in the literature. Bateman et al. (Bateman et al., 2002) highlight that the use of well-trained interviewers significantly enhances data quality by ensuring accurate respondent identification, effective information management, and support in following survey instructions. Additionally, interviewers can offer real-time clarification, improving respondents' understanding of the experimental context and choice tasks. This support is especially important in DCEs, where the hypothetical nature of the scenarios requires clear communication to ensure reliable data.

The data collected from the experiment served as the primary input for estimating the discrete choice model. The methodology for constructing the experiment is comprehensively outlined in González et al. (González et al., 2024). The specific attribute levels employed in the experiment and the visual presentation of the choice scenarios are detailed in Table A1 and Fig. A1, respectively, within Annex A. Attribute levels were defined based on comparable markets and refined through a pilot survey, which also led to improvements in attribute definitions, attitudinal item wording, and the number of choice tasks to enhance respondent comprehension and data quality. Additionally, preliminary estimates from the pilot survey were used to update the prior parameters employed in the construction of the efficient experimental design.

Recognising the heterogeneity of decision-makers arising from diverse attitudes and perceptions, researchers have extended traditional random utility models by incorporating latent factors. This enhancement expands the applicability of these models to

Table 1
List of indicators of environmental concern.

Statements related to environmental concern.
5-point Likert scale where 1 means "I do not agree at all", 2 "I slightly agree", 3 "I neither agree nor disagree", 4 "I somewhat agree" and 5 "I strongly agree"

Name	Wording	Mean	SD	Sources
I_1	I worry about the future society when I think about the environment we are going to leave behind	3.71	1.34	Diekmann and Preisendörfer (Diekmann and Preisendörfer, 2003),Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_2	If society continues to maintain a consumerist lifestyle, environmental problems will be very serious	3.83	1.27	Diekmann and Preisendörfer (Diekmann and Preisendörfer, 2003),Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_3	I consider environmental issues to be very important at the present time	3.87	1.25	Diekmann and Preisendörfer (Diekmann and Preisendörfer, 2003);
I_4	The information we receive about the consequences of climate change is accurate	3.59	1.35	Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_5	Politicians should be more involved in environmental protection	3.85	1.29	Diekmann and Preisendörfer (Diekmann and Preisendörfer, 2003),Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_6	To protect the environment, we must all be willing to change our current lifestyles	3.79	1.28	Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_7	Environmental protection measures must be implemented, even if this could have a restrictive effect on the economy in the short term	3.77	1.31	Vázquez-Paja et al. (Vázquez-Paja et al., 2024)
I_8	It is important to promote policies for the reduction of greenhouse gas emissions	3.85	1.25	Qiao and Gao (Qiao and Gao, 2017)
I_9	It is important to promote policies that contribute to an increase in the planet's forest cover	3.89	1.25	Qiao and Gao (Qiao and Gao, 2017)
I_{10}	Climate change is already a palpable reality	3.99	1.26	Vázquez-Paja et al. (Vázquez-Paja et al., 2024)

individual choice analysis (Ben-Akiva et al., 1999; Ben-Akiva et al., 2002). Within mass tourism, identifying the latent factors influencing visitors' sustainable mobility choices is crucial. To this end, a multiple indicators multiple causes (MIMIC) model will be estimated using attitudinal and sociodemographic data from the questionnaire. The model aimed to uncover latent variables impacting tourists' adoption of sustainable mobility options.

A preliminary exploratory factor analysis was conducted to investigate the underlying latent structure and assess the presence of latent factors explaining the variability in the scores derived from the measurement indicators. Details of the analysed indicators, including the question wording, response scales, mean scores, and standard deviations, are presented in Tables 1 and 2. The final column of the tables cites the sources for the selected indicators, drawing upon insights from the reviewed literature. Nevertheless, most wordings for the indicators have been adapted to our study. Building on this analysis, the indicators listed in Table 1 revealed a single factor, which was subsequently used to estimate the latent variable of environmental concern. In contrast, the indicators presented in Table 2 identified two distinct factors used to estimate the latent variables: environmental behaviour in daily life (indicators I11 to I16) and environmental behaviour during vacations (indicators I17 to I21).

The results for Table 1 indicate a generally high level of environmental concern among respondents, with mean scores across indicators ranging from 3.59 to 3.99 on the 5-point Likert scale. Statements emphasising the importance of environmental issues, policy promotion, and lifestyle changes to address climate change received a relatively strong agreement, highlighting a shared acknowledgement of the urgency and significance of environmental protection. The analysis of indicators in Table 2 suggests more moderate levels of environmentally responsible behaviour in both daily life and during vacations, with mean scores ranging from 3.10 to 3.89. Respondents reported higher engagement in actions like energy saving, recycling, and reducing plastic use. In contrast, behaviours related to sustainable transport and responsible resource use during holidays received slightly lower ratings, indicating potential areas for improvement in promoting sustainable practices.

As mentioned above, this study examines a sample of 921 tourists visiting two of the most relevant tourist municipalities in the Canarian Archipelago: Adeje and San Bartolomé de Tirajana. The sample is nearly evenly split between the islands of Gran Canaria (54.9 %) and Tenerife (45.1 %), with a balanced gender distribution. The average age of respondents is 41.24, with approximately half being under 40. While both municipalities share similar average ages, they differ significantly in educational attainment. Adeje boasts a higher proportion of university-educated respondents (55.66 %) than San Bartolomé de Tirajana (35.97 %). Income distribution also varies, with San Bartolomé de Tirajana having a more significant percentage of lower-income tourists. Regarding origin, the UK is the most prevalent nationality overall (28.77 %), but Adeje attracts a higher concentration of UK tourists, while San Bartolomé de Tirajana draws more visitors from Germany and other countries. This suggests distinct tourist profiles between the two locations.

Travel patterns also reveal differences. While travelling with one companion is the most common group size across both locations, transport preferences diverge. Adeje shows a greater reliance on regular buses, while San Bartolomé de Tirajana is characterised by more frequent use of taxis and hired cars. This likely reflects differences in tourist preferences within each municipality. Importantly, most respondents across both locations consider the environmental impact of their travel to be quite or very important, indicating a general awareness of sustainability issues. When evaluating the attributes included in the mobility packages, price and public transport were rated highly important, followed by taxis and excursion benefits. Personal mobility vehicles and electric car sharing received lower importance scores.

In summary, the sample represents a diverse tourist population with key distinctions between visitors to the two islands. These differences span demographics, socioeconomic status, origin, and travel behaviour, highlighting the need for tailored strategies when addressing mobility and sustainability concerns in these distinct tourist destinations. The high importance placed on environmental impact suggests a potential receptiveness to sustainable tourism initiatives.

Table 2
List of indicators of environmental behaviour.

Activities related to your environmental behaviour, both in your daily life and when you travel. 5-point semantic scale where 1 means "never", 2 means "hardly ever", 3 means "somewhat often", 4 means "almost always" and 5 means "always"				
Name	**Wording**	**Mean**	**SD**	**Sources**
I_{11}	On a day-to-day basis, I avoid using private cars and tend to use other more sustainable modes of transport	3.42	1.45	(Diekmann and Preisendörfer, 2003), (Ritchie et al., 2021)
I_{12}	When I renovate the appliances in my home, I consider their energy efficiency	3.70	1.42	(Diekmann and Preisendörfer, 2003)
I_{13}	In my household, I take measures to save energy	3.89	1.33	(Diekmann and Preisendörfer, 2003), (Markle, 2013), (Vázquez-Paja et al., 2024)
I_{14}	On a day-to-day basis, I carry out recycling activities (paper and cardboard, glass, plastic, etc.)	3.84	1.33	(Diekmann and Preisendörfer, 2003), (Markle, 2013), (Vázquez-Paja et al., 2024)
I_{15}	On a day-to-day basis, I try to use less plastic	3.75	1.34	(Diekmann and Preisendörfer, 2003)
I_{16}	On a day-to-day basis, I tend to consume local products	3.67	1.41	(Diekmann and Preisendörfer, 2003)
I_{17}	I try not to use the plane when I have other transport alternatives available	3.10	1.48	(Diekmann and Preisendörfer, 2003)
I_{18}	When on holiday I try to choose sustainable modes of transport	3.44	1.45	(Diekmann and Preisendörfer, 2003), (Qiao and Gao, 2017)
I_{19}	When I'm on holiday, I often reuse hotel towels	3.26	1.48	(Qiao and Gao, 2017)
I_{20}	When I am on holiday, I tend to use energy and water responsibly	3.39	1.41	(Qiao and Gao, 2017)
I_{21}	On my holidays, if I go shopping, I try to buy locally produced products	3.52	1.45	(Qiao and Gao, 2017)

4. The hybrid choice model

Hybrid choice models (HCMs) represent advanced econometric tools that combine elements of discrete choice models and structural equation models. They are particularly useful when decision-making processes are influenced by both observable and unobservable factors, such as attitudes, perceptions, or latent preferences. HCMs have emerged as a suitable methodology for incorporating the impact of latent variables into discrete choice decision processes (Ben-Akiva et al., 1999; Ben-Akiva et al., 2002). The HCM model comprises two primary components: a structural model, which estimates latent variables (LVs) based on individual socioeconomic information, and a discrete choice model that incorporates the influence of these LVs alongside utility attributes.

The MIMIC model is a specific case of structural equation modelling used to estimate latent variables through the simultaneous solution of a set of structural and measurement equations (Zellner, 1970); (Bollen, 1989). This tool has been widely used in various fields and, more recently, has become the appropriate instrument for introducing the effect of latent factors into traditional choice models through the creation of hybrid discrete choice models.

The rest of this section describes the specification of the different components of the hybrid choice model.

a) MIMIC model: Structural equations.

Within the framework of structural equation modelling, latent variables are conceptualised as being determined by a linear combination of observed factors, such as socioeconomic variables SE_k, and a residual error term. Accordingly, latent variable i, denoted as LV_i, can be represented as:

$$LV_i = \beta^s_{0_{LV_i}} + \sum_k \beta^s_{SE_k^{LV_i}} SE_k + \sigma^s_{LV_i} \varepsilon^s_{LV_i} \tag{1}$$

Where β^s and σ^s are unknown parameters, and ε^S is a random error term assumed to distribute standard normal. For notational convenience, the structural equations can be succinctly represented as:

$$LV_i = \overline{LV}_i + \sigma^s_{LV_i} \varepsilon^s_{LV_i} \tag{2}$$

Where $\overline{LV_i}$ represents the mean of the latent variable.

b) MIMIC model: Measurement equations.

Since latent variables are unobservable, they are measured indirectly through a set of indicators. Thus, each indicator is explained by the latent variable via a set of measurement equations. The J^{LV_i} equations corresponding to the latent variable LV_i are represented by the following expression:

$$I_{LVi_j} = \beta^m_{0LVi_j} + \beta^m_{LVi_j} \overline{LV}_i + \sigma^*_{LVi_j} \varepsilon^*_{LVi_j} \qquad j = 1 \cdots J^{LV_i} \tag{3}$$

Where I_{LVi_j}, is the indicator j of the latent variable LV_i, ε^* are standard normally distributed random errors; and β^m, and σ^* are parameters to be estimated.

The variables used as indicators in measurement equations can be either continuous or discrete. When discrete variables are employed, they often possess an ordinal nature, such as those measured on Likert scales. Consequently, the choice of modelling technique must be adapted to the specific characteristics of each indicator.

Suppose that the measurement of the indicator I_{LVi_j} of the latent variable LV_i is given by an ordinal variable I that takes on the values $j_1, \ldots, j_M$. The corresponding measurement equation, in this case, would be given by:

$$I = \begin{cases} j_1 & \text{if} \quad I_{LVi_j} \le \tau_1 \\ j_2 & \text{if} \quad \tau_1 < I_{LVi_j} \le \tau_2 \\ & \vdots \\ j_m & \text{if} \quad \tau_{m-1} < I_{LVi_j} \le \tau_m \\ & \vdots \\ j_M & \text{if} \quad \tau_{M-1} < I_{LVi_j} \end{cases} \tag{4}$$

Where I_{LVi_j} is now interpreted as an unobserved continuous latent variable defined as in expression (3); τ_m. are unknown parameters such that $\tau_{m-1} \le \tau_m$ with $\tau_0 = -\infty$ and $\tau_M = +\infty$, and they represent the threshold values that determine the probability of obtaining the score j_m through the following expression:

$$P(j_m) = P\left(\tau_{m-1} < I_{LVi_j} \le \tau_m\right) = F_{\varepsilon^*_{LVi_j}}(\tau_m) - F_{\varepsilon^*_{LVi_j}}(\tau_{m-1}) \tag{5}$$

Where F is the standard normal cumulative distribution function. Thus, the latent regression specified by each measurement equation can be analysed using an ordered Probit model (Greene and Hensher, 2010).

c) Choice model: Utility specification

Discrete choice models are grounded in the hypothesis of random utility maximisation by decision-makers (Domencich and McFadden, 1975). Within this framework, the utility U_{rqs} of alternative r for individual q in a specific choice scenario s is defined as the sum of two components: (i) a systematic utility V_{rqs} expressed in terms of a set of explanatory variables, which can represent characteristics of the alternative and the individual (including latent variables in our case); and, (ii) a random error term ε_{rqs} which accounts for unobserved effects.

Assuming the linear-in-the-parameters functional form for the systematic utility and considering the interactions of the latent variables and the attributes of the alternatives, the specification of the utility is as follows:

$$U_{rqs} = \beta_{PR} PR_{rqs} + \sum_{n}\left(\beta_{X_n} + \sum_{i}\beta_{X_n\_LV_i} LV_i\right) X_{nrqs} + \varepsilon_{rqs} \qquad r = 1,2$$

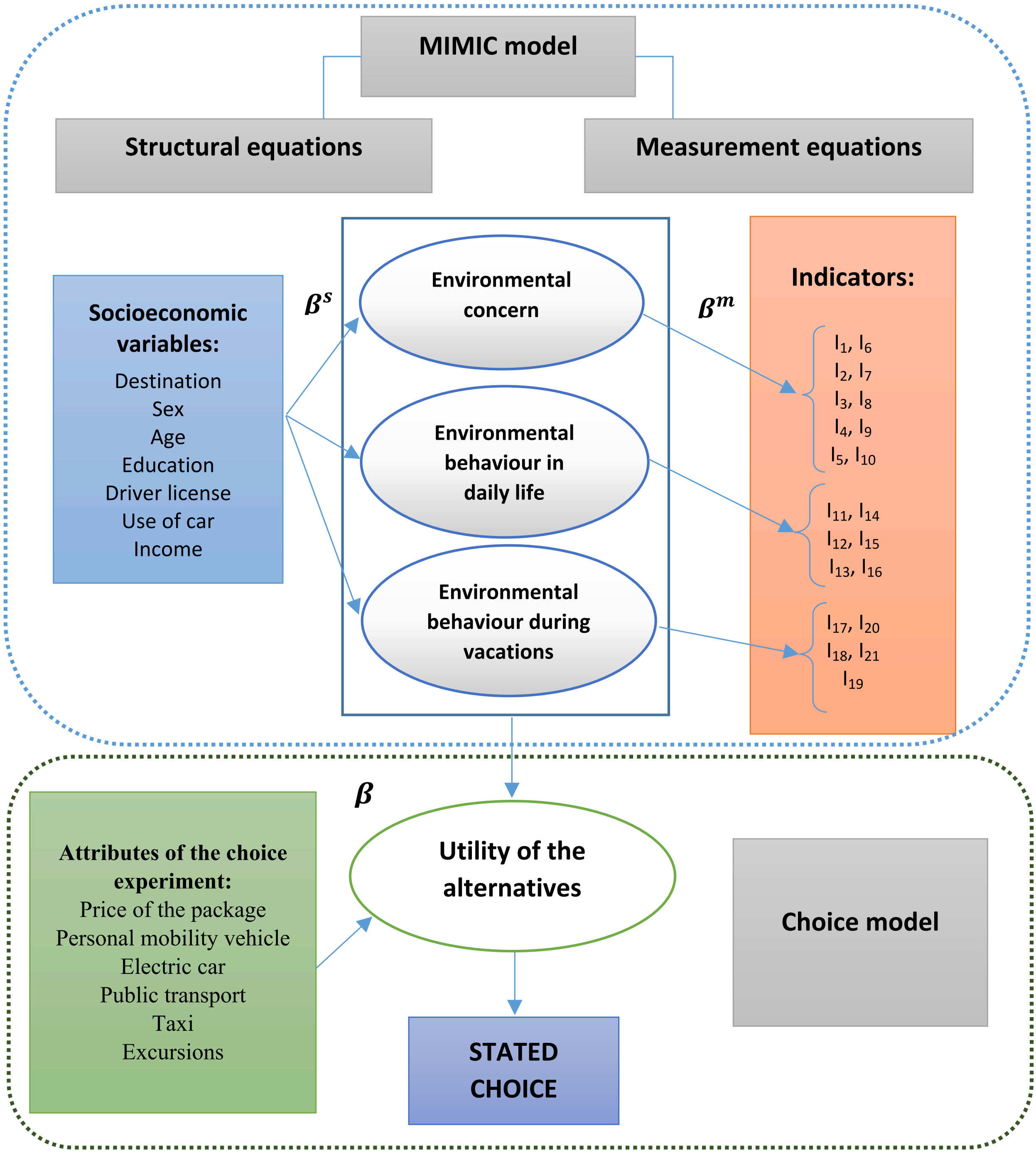

Fig. 1. Structure of the hybrid choice model.

$$U_{rqs} = \beta_{ASC} + \sum_i \beta_{ASC\_LV_i} LV_i \qquad r = 3\ (no\ choice) \tag{6}$$

Where PR_{rqs} and X_{nrqs} represent the price and the value of the attribute n of alternative r for individual q in choice scenario s, respectively; and coefficients β*'s* are unknown parameters. It is noteworthy that the terms within brackets represent the marginal utilities of the attributes of the alternative, which are, in turn, expressed in terms of the latent variables. Consequently, our model will effectively capture the influence of the latent variables on the perception of the attributes.

Given the inherent random nature of latent variables, assuming that error terms distribute iid type I extreme value distribution aligns our model with a RPL model specification (Train, 2009), wherein the randomness is notably induced by the three latent random variables.

5. Results and model application

All unknown parameters within the MIMIC and choice models are estimated simultaneously using the simulated maximum likelihood method, considering the full information likelihood function with the software Pandas Biogeme (Bierlaire, 2018). Since not all parameters are identifiable, the constant term $\beta^m_{0LVi_1}$ in the first measurement equation for each latent variable is normalised to 0, while both the slope $\beta^m_{LVi_1}$ and the standard deviation $\sigma^*_{LVi_1}$ are normalised to 1 (Bierlaire, 2018). Fig. 1 presents the structure of the hybrid choice model and how the explanatory variables are incorporated into the different model components. It is worth noting that the attributes of the experiment included as explanatory variables in the choice model were weighted by the level of importance (I_{x_n} individuals gave to these attributes during the choice experiment; i.e. X_n. in equation (6) is, in fact, $x_n I_{x_n}$. Table 3 presents the description and codification of the list of explanatory variables used in the model.

5.1. Estimation results

Estimation results of the different components of the hybrid choice model are presented in Table 4. As can be observed, most of the estimated coefficients were statistically significant, with only a few exceptions discussed below that resulted in non-significant impacts. In the measurement model, all parameters were estimated with confidence levels greater than 99 %. All slopes presented a positive sign, which is consistent with the statements used in each indicator. Furthermore, the standard deviations were statistically significant, confirming the random nature of the measurement equations.

The structural model estimates were similarly highly significant, with the majority of the coefficients significant at a confidence level of more than 99 %. Thus, when considering the effect of socio-economic characteristics on the latent variables, the analysis revealed that individuals under 40 exhibited a higher level of environmental concern (LVEC) and environmental behaviour in daily life

Table 3
Explanatory variables.

Attributes included in the choice experiment		
Variable description	**Name**	**Codification**
Price of the package	pr	Price in euros
Personal mobility vehicle	pmv	1 if this service is included in the package0 otherwise
Electric car	ec	1 if this service is included in the package0 otherwise
Public transport	pt	1 if the package includes unlimited trips by public transport0 if the package includes 8 trips by public transport
Taxi	tx	1 if the package includes 20 km taxi voucher 0 otherwise
Excursions	ex	1 if the package includes benefits when booking excursions0 otherwise
Attributes weighted by the importance (I_n) given in the choice scenarios		
Price of the package (weighted)	PR	PR = pr*I_{pr}
Personal mobility vehicle (weighted)	PMV	PMV = pmv*I_{pmv}
Electric car (weighted)	EC	EC = ec*I_{ec}
Public transport (weighted)	PT	PT = pt*I_{pt}
Taxi (weighted)	TX	TX = TX*I_{tx}
Excursions (weighted)	EX	EX = ex*I_{ex}
Socioeconomic variables		
Tenerife tourist	TF	1 if the individual is visiting Tenerife0 if the individual is visiting Gran Canaria
Males	MALE	1 if the individual is a male0 otherwise
Age < 40	AGE40	1 if the individual is younger than 40 years0 otherwise
University education	UEDU	1 if the individual has university educationotherwise
Driver license in the group	DL	1 if there is at least one driver license in the group0 otherwise
Use of car during stay	UCAR	1 if the individual uses the car during the stay0 otherwise
Income	INC	Monthly family income in thousands
Latent variables		
LV1: Environmental concern	LVEC	–
LV2: Environmental behaviour in daily life	LVBD	–
LV3: Environmental behaviour during vacations	LVBV	–

Table 4
Estimation results.

Parameters and variables		Estimate	Standard error	*t*-test	p-value	
Choice model						
β_{ASC3_LVBV}	ASC3 * LVBV	−1.380	0.82	−1.68	0.09	*
β_{ASC3_LVBD}	ASC3 * LVBD	−5.130	1.76	−2.92	0.00	***
β_{ASC3_LVEC}	ASC3 * LVEC	4.720	0.95	4.95	0.00	***
β_{ASC3}	ASC3	−2.750	0.36	−7.66	0.00	***
β_{EC_LVBV}	Electric car (EC) * LVBV	−1.320	0.23	−5.77	0.00	***
β_{EC_LVBD}	Electric car (EC) * LVBD	2.270	0.47	4.81	0.00	***
β_{EC_LVEC}	Electric car (EC) * LVEC	−0.868	0.25	−3.42	0.00	***
β_{EC}	Electric car (EC)	0.188	0.10	1.89	0.06	*
β_{EX_LVBV}	Excursions (EX) * LVBV	−0.238	0.12	−1.97	0.05	**
β_{EX_LVBD}	Excursions (EX) * LVBD	−0.164	0.25	−0.65	0.52	
β_{EX_LVEC}	Excursions (EX) * LVEC	0.279	0.14	2.00	0.05	**
β_{EX}	Excursions (EX)	0.032	0.05	0.62	0.53	
β_{PMV_LVBV}	Personal mobility vehicle (PMV) * LVBV	−0.696	0.11	−6.34	0.00	***
β_{PMV_LVBD}	Personal mobility vehicle (PMV) * LVBD	0.088	0.23	0.38	0.70	
β_{PMV_LVEC}	Personal mobility vehicle (PMV) * LVEC	0.415	0.13	3.32	0.00	***
β_{PMV}	Personal mobility vehicle (PMV)	−0.204	0.05	−4.28	0.00	***
β_{PR}	Price (PR)	−0.006	0.00	−24.30	0.00	***
β_{PT_LVBV}	Public transport (PT) * LVBV	−0.066	0.13	−0.50	0.62	
β_{PT_LVBD}	Public transport (PT) * LVBD	−0.865	0.28	−3.07	0.00	***
β_{PT_LVEC}	Public transport (PT) * LVEC	0.719	0.15	4.82	0.00	***
β_{PT}	Public transport (PT)	−0.098	0.05	−1.82	0.07	*
β_{TX_LVBV}	Taxi (TX) * LVBV	−0.067	0.12	−0.55	0.58	
β_{TX_LVBD}	Taxi (TX) * LVBD	0.123	0.26	0.48	0.63	
β_{TX_LVEC}	Taxi (TX) * LVEC	−0.051	0.14	−0.37	0.72	
β_{TX}	Taxi (TX)	0.145	0.05	2.88	0.00	***
Measurement model						
Environmental concern (LV1 = LVEC)						
$\beta^m_{0_2}$	Constant I2	0.193	0.02	8.50	0.00	***
$\beta^m_{0_3}$	Constant I3	0.252	0.02	11.60	0.00	***
$\beta^m_{0_4}$	Constant I4	−0.125	0.03	−4.79	0.00	***
$\beta^m_{0_5}$	Constant I5	0.236	0.02	9.75	0.00	***
$\beta^m_{0_6}$	Constant I6	0.168	0.02	7.20	0.00	***
$\beta^m_{0_7}$	Constant I7	0.079	0.02	3.21	0.00	***
$\beta^m_{0_8}$	Constant I8	0.209	0.02	9.75	0.00	***
$\beta^m_{0_9}$	Constant I9	0.271	0.02	12.60	0.00	***
$\beta^m_{0_{10}}$	Constant I10	0.429	0.02	18.40	0.00	***
$\beta^m_{LV1_2}$	Slope I2	0.925	0.02	51.90	0.00	***
$\beta^m_{LV1_3}$	Slope I3	0.912	0.02	53.40	0.00	***
$\beta^m_{LV1_4}$	Slope I4	0.952	0.02	48.20	0.00	***
$\beta^m_{LV1_5}$	Slope I5	0.956	0.02	50.20	0.00	***
$\beta^m_{LV1_6}$	Slope I6	0.915	0.02	50.40	0.00	***
$\beta^m_{LV1_7}$	Slope I7	0.988	0.02	50.30	0.00	***
$\beta^m_{LV1_8}$	Slope I8	0.914	0.02	53.80	0.00	***
$\beta^m_{LV1_9}$	Slope I9	0.910	0.02	53.70	0.00	***
$\beta^m_{LV1_{10}}$	Slope I10	0.952	0.02	51.90	0.00	***
σ^*_2	Standard deviation I2	0.793	0.02	51.90	0.00	***
σ^*_3	Standard deviation I3	0.700	0.01	50.80	0.00	***
σ^*_4	Standard deviation I4	1.060	0.02	54.80	0.00	***
σ^*_5	Standard deviation I5	0.895	0.02	51.70	0.00	***
σ^*_6	Standard deviation I6	0.888	0.02	52.80	0.00	***
σ^*_7	Standard deviation I7	0.887	0.02	52.70	0.00	***
σ^*_8	Standard deviation I8	0.671	0.01	50.30	0.00	***
σ^*_9	Standard deviation I9	0.687	0.01	50.10	0.00	***
σ^*_{10}	Standard deviation I10	0.785	0.02	48.50	0.00	***
Environmental behaviour in daily life (LV2 = LVBD)						
$\beta^m_{0_{12}}$	Constant I_{12}	0.261	0.02	11.90	0.00	***
$\beta^m_{0_{13}}$	Constant I_{13}	0.498	0.02	25.10	0.00	***
$\beta^m_{0_{14}}$	Constant I_{14}	0.490	0.02	25.40	0.00	***
$\beta^m_{0_{15}}$	Constant I_{15}	0.335	0.02	17.80	0.00	***
$\beta^m_{0_{16}}$	Constant I_{16}	0.217	0.02	9.87	0.00	***
$\beta^m_{LV2_{12}}$	Slope I_{12}	1.100	0.03	41.00	0.00	***
$\beta^m_{LV2_{13}}$	Slope I_{13}	0.971	0.02	42.20	0.00	***

(*continued on next page*)

Table 4 (*continued*)

Measurement model						
$\beta^m_{LV2_{14}}$	Slope I_{14}	0.887	0.02	41.60	0.00	***
$\beta^m_{LV2_{15}}$	Slope I_{15}	0.950	0.02	42.70	0.00	***
$\beta^m_{LV2_{16}}$	Slope I_{16}	1.110	0.03	41.10	0.00	***
σ^*_{12}	Standard deviation I_{12}	0.835	0.02	51.30	0.00	***
σ^*_{13}	Standard deviation I_{13}	0.728	0.01	50.30	0.00	***
σ^*_{14}	Standard deviation I_{14}	0.811	0.02	51.50	0.00	***
σ^*_{15}	Standard deviation I_{15}	0.699	0.01	52.20	0.00	***
σ^*_{16}	Standard deviation I_{16}	0.821	0.02	51.60	0.00	***
Environmental behaviour during vacations (LV3=LVBV)						
$\beta^m_{0_{18}}$	Constant I_{18}	0.303	0.02	14.90	0.00	***
$\beta^m_{0_{19}}$	Constant I_{19}	0.143	0.02	7.19	0.00	***
$\beta^m_{0_{20}}$	Constant I_{20}	0.273	0.02	15.20	0.00	***
$\beta^m_{0_{21}}$	Constant I_{21}	0.385	0.02	18.30	0.00	***
$\beta^m_{LV3_{18}}$	Slope I_{18}	1.210	0.03	39.20	0.00	***
$\beta^m_{LV3_{19}}$	Slope I_{19}	1.120	0.03	38.00	0.00	***
$\beta^m_{LV3_{20}}$	Slope I_{20}	1.010	0.03	38.90	0.00	***
$\beta^m_{LV3_{21}}$	Slope I_{21}	1.260	0.03	39.50	0.00	***
σ^*_{18}	Standard deviation I_{18}	0.826	0.02	54.40	0.00	***
σ^*_{19}	Standard deviation I_{19}	0.939	0.02	55.40	0.00	***
σ^*_{20}	Standard deviation I_{20}	0.833	0.01	56.00	0.00	***
σ^*_{21}	Standard deviation I_{21}	0.812	0.02	53.70	0.00	***
α_1	Threshold ordered Probit (LV1)	0.356	0.01	61.00	0.00	***
α_2	Threshold ordered Probit (LV1)	0.749	0.01	69.30	0.00	***
δ_1	Threshold ordered Probit (LV2)	0.574	0.01	67.80	0.00	***
δ_2	Threshold ordered Probit (LV2)	0.967	0.01	71.20	0.00	***
γ_1	Threshold ordered Probit (LV3)	0.337	0.01	64.10	0.00	***
γ_2	Threshold ordered Probit (LV3)	0.686	0.01	71.80	0.00	***
Structural model						
$\beta^s_{0_{LV1}}$	Constant (LV1)	−0.607	0.08	−7.91	0.00	***
$\beta^s_{0_{LV2}}$	Constant (LV2)	−0.709	0.06	−11.50	0.00	***
$\beta^s_{0_{LV3}}$	Constant (LV3)	−0.587	0.05	−10.90	0.00	***
$\beta^s_{AGE40_{LV1}}$	Age less than de 40 years (LV1)	0.189	0.04	4.45	0.00	***
$\beta^s_{AGE40_{LV2}}$	Age less than de 40 years (LV2)	0.069	0.03	2.06	0.04	**
$\beta^s_{AGE40_{LV3}}$	Age less than de 40 years (LV3)	0.012	0.03	0.41	0.68	
$\beta^s_{DL_{LV1}}$	Driver license in the group (LV1)	0.254	0.05	5.17	0.00	***
$\beta^s_{DL_{LV2}}$	Driver license in the group (LV2)	0.165	0.04	4.30	0.00	***
$\beta^s_{DL_{LV3}}$	Driver license in the group (LV3)	0.019	0.03	0.54	0.59	
$\beta^s_{UEDU_{LV1}}$	University education (LV1)	0.239	0.05	5.13	0.00	***
$\beta^s_{UEDU_{LV2}}$	University education (LV2)	0.170	0.04	4.68	0.00	***
$\beta^s_{UEDU_{LV3}}$	University education (LV3)	0.138	0.03	4.26	0.00	***
$\beta^s_{INC_{LV1}}$	Income (LV1)	0.306	0.02	18.50	0.00	***
$\beta^s_{INC_{LV2}}$	Income (LV2)	0.228	0.01	17.60	0.00	***
$\beta^s_{INC_{LV3}}$	Income (LV3)	0.182	0.01	15.90	0.00	***
$\beta^s_{MALE_{LV1}}$	Male (LV1)	−0.132	0.04	−3.18	0.00	***
$\beta^s_{MALE_{LV2}}$	Male (LV2)	−0.113	0.03	−3.51	0.00	***
$\beta^s_{MALE_{LV3}}$	Male (LV3)	−0.131	0.03	−4.53	0.00	***
$\beta^s_{TF_{LV1}}$	Tenerife tourist (LV1)	0.837	0.05	18.60	0.00	***
$\beta^s_{TF_{LV2}}$	Tenerife tourist (LV2)	0.561	0.04	15.80	0.00	***
$\beta^s_{TF_{LV3}}$	Tenerife tourist (LV3)	0.311	0.03	10.20	0.00	***
$\beta^s_{UCAR_{LV1}}$	Use of car (LV1)	−0.191	0.04	−4.52	0.00	***
$\beta^s_{UCAR_{LV2}}$	Use of car (LV2)	−0.088	0.03	−2.62	0.01	***
$\beta^s_{UCAR_{LV3}}$	Use of car (LV3)	−0.140	0.03	−4.77	0.00	***
σ_1	Standard deviation (LV1)	1.720	0.03	52.50	0.00	***
σ_2	Standard deviation (LV2)	1.330	0.03	47.70	0.00	***
σ_3	Standard deviation (LV3)	1.160	0.03	46.30	0.00	***
l*(0)	−252027.8					
l*(θ)	−169837.3					
ρ^2	0.326					
Observations	7368					

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

(LVBD) compared to those over 40. Interestingly, no significant differences were found between the two age groups in terms of the latent variable related to environmental behaviour during vacations (LVBV). Having a driving license in the group did not significantly influence LVBV. However, they did show a more positive impact on LVEC and LVBD than those travelling in groups without any driving licence.

Individuals with a university education show significantly different attitudes towards the three latent variables than those with a lower level of education, revealing a larger impact. The same is valid for income, which has a positive marginal effect across all three latent variables. Men also showed different attitudes than women. In this case, their impact on the three latent variables is negative, indicating that the men are less concerned about the environment and exhibit a lower engagement with environmental behaviour. Similarly, those planning to use the car during their stay on the island showed lower environmental concern and behaviour. Finally, tourists from Tenerife showed a greater impact on the three latent variables than those from Gran Canaria. These disparities could be attributable to the differences observed in terms of income, education and nationality, as the islands host different tourist profiles.

The choice model results evidence the presence of heterogeneity regarding the preference for the services included in the mobility package and their interaction with the latent variables. The most significant effects reveal that the preference for the electric car increases for those presenting a higher environmental behaviour in daily life and diminishes with higher environmental concern and behaviour during holidays. Personal mobility vehicles are more preferred by individuals with higher environmental concerns and less preferred by those with higher environmental behaviour during vacations. The higher environmental concern positively impacts the preference for using public transport. In contrast, higher environmental behaviour in daily life reduces the preference for this mode. The result consistent with those found by other authors regarding the dissonance between behaviour at home and sustainable mode choices at the tourist destination (Budeanu, 2007); (Bamdad et al., 2019); (Kiatkawsin and Han, 2017); (Miller et al., 2015). The preference for enjoying benefits when booking excursions increases with environmental concern and decreases with environmental behaviour during vacations. Finally, the preference for having some taxi rides available did not vary with the latent variables studied. It is also interesting to note that the alternative-specific constant specified in the no-choice option could be negative for those presenting a higher commitment to environmental behaviour. This result suggests an overall preference for the existence of sustainable mobility options, such as the MaaS packages considered in the experiment, even when the effect of the packages' characteristics is negligible. Conversely, higher levels of environmental concern could result in a preference for the no-choice option, which is compatible with less transport use even if sustainable mobility options are offered.

Socioeconomic variables indirectly influence the utility function through latent variables. Therefore, the indirect effect of a socioeconomic variable (SE_k) on the perception of an attribute (x_n), while keeping the effects of other socioeconomic variables constant, can be calculated using the partial derivative of the marginal utility of the attribute with respect to the socioeconomic variable in question, expressed as follows:

$$\text{Indirect effect of } SE_k = \frac{\partial}{\partial SE_k}\left(\frac{\partial U_r}{\partial x_{nr}}\right) = \sum_i \beta_{X_n\_LV_i}\beta^{s}_{SE_k^{LV_i}} I_{x_n} \tag{7}$$

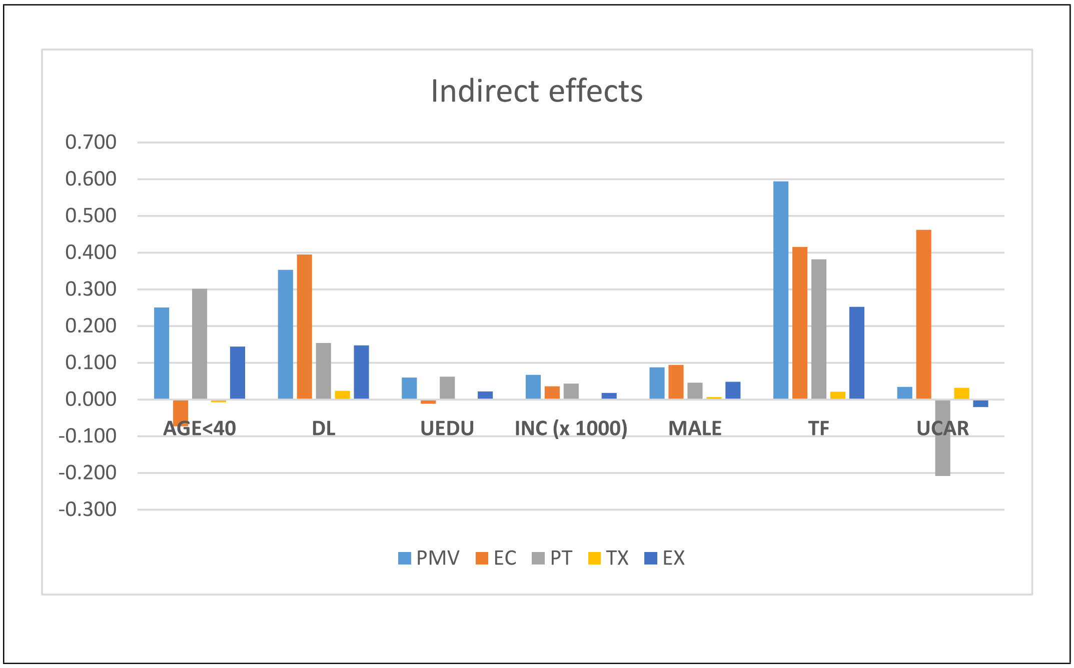

Fig. 2. Indirect effects of the socioeconomic variables.

Fig. 2 shows the indirect effects of the socioeconomic variables calculated at the mean importance of each attribute within the sample. In most cases, the effect is positive with respect to the reference group, indicating a higher preference for the MaaS attributes. The only exceptions are the electric car, which is less preferred by individuals younger than 40 and those with a university education, and the

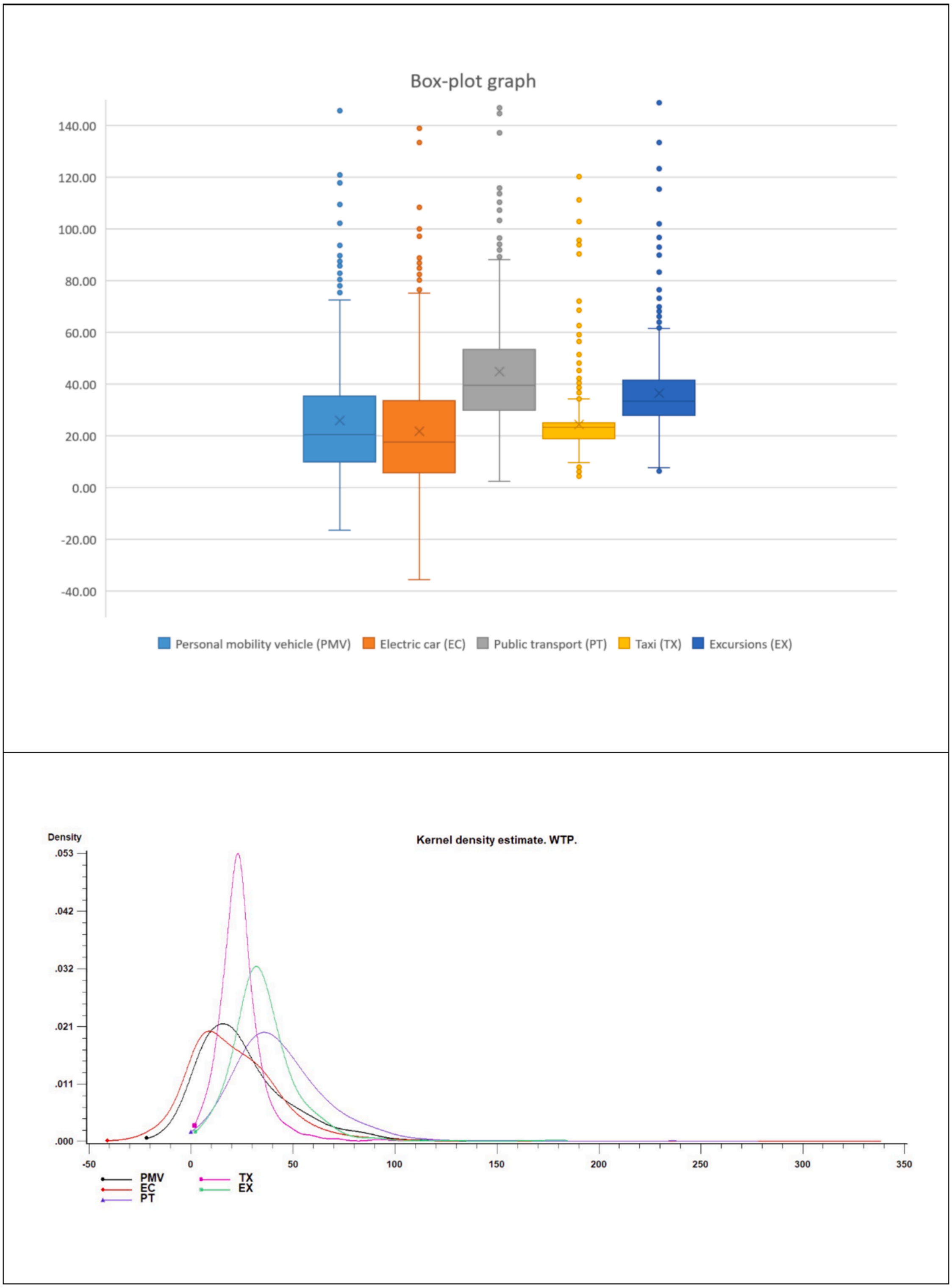

Fig. 3. Distribution of the willingness to pay for MaaS attributes.

unlimited use of public transport and excursions' benefits, which are less preferred by those who intend to use a car during their stay on the island.

5.2. Willingness to pay for MaaS attributes

The willingness to pay (WTP) provides a way of evaluating the monetary value people assign to changes in specific attributes. It can be calculated using the estimates of the choice model by taking the negative ratio of the marginal utility of the attribute of interest to that of the monetary cost (price). For discrete explanatory variables, as explored in this study, the concept of marginal utility shifts to the finite difference in utility between two distinct states of the variable—for example, comparing scenarios where a mobility service is included in the package versus when it is not. Additionally, incorporating the interaction of the latent variables and the attributes of the alternatives (as shown in equation (6)) results in the following expression for the WTP for including the attribute x_n in the mobility package, which depends on the latent variables:

$$WTP_{x_n} = -\frac{V_{r|x_{nr}=1} - V_{r|x_{nr}=0}}{\frac{\partial V_r}{\partial pr_r}} = -\frac{\left(\beta_{X_n} + \sum_i \beta_{X_n\_LV_i} LV_i\right)}{\beta_{PR}} \bullet \frac{I_{x_n}}{I_{pr}} \tag{8}$$

Since the latent variables are influenced by the socioeconomic characteristics of the individual, expression (8) varies across

Table 5
Willingness to pay for MaaS attributes.

	Personal mobility vehicle	Electric car	Public transport	Taxi	Excursions
Total sample WTP (€)					
Mean	25.85	21.66	44.81	24.48	36.52
Median	20.36	17.54	39.53	23.29	33.42
Q1	9.85	5.79	29.86	18.89	27.97
Q3	35.35	33.58	53.39	25.04	41.35
Sample median by socioeconomic groups					
Island					
Gran Canaria tourist	14.25	15.00	33.31	23.31	32.46
Tenerife tourist	34.77	18.85	52.86	22.91	34.61
Gender					
Female	19.07	12.04	40.26	23.02	32.90
Male	21.83	20.53	38.61	23.42	33.89
Age < 40					
No	15.72	19.02	34.95	23.65	31.40
Yes	25.57	14.46	44.89	22.92	35.82
University education					
No	15.32	15.00	35.90	23.23	31.44
Yes	29.32	19.25	47.78	23.35	36.19
Residence					
Spanish mainland/Balearic Islands	14.60	22.11	34.88	23.00	31.53
Germany	23.59	21.96	38.82	23.25	35.01
United Kingdom	23.27	19.38	43.45	23.95	33.61
Other countries	19.36	12.27	39.60	23.25	32.91
Driver license in the group					
No	11.28	4.06	38.67	22.29	28.64
Yes	23.05	24.26	39.73	23.92	35.20
Use of car during stay					
No	21.09	7.07	47.30	22.82	32.91
Yes	20.36	31.24	32.54	24.34	33.61

respondents. Fig. 3 presents a box-plot graph and kernel density estimates showing interesting characteristics of the distribution of the WTP for the attributes analysed. These results reveal the existence of considerable heterogeneity among individuals, including the presence of some outliers and even negative WTP figures for personal mobility vehicles and electric cars. This latter finding appears to be linked to a negative perception of including these services in the MaaS packages. Although the underlying reasons for this behavior remain uncertain, identifying these segments is valuable for tailoring mobility packages to individual preferences.

In our sample, only 31 and 57 individuals exhibited negative WTP for personal mobility vehicles and electric cars, respectively. These individuals share certain characteristics: they are predominantly visitors to Gran Canaria, lack a drivers license within their group, and do not have university-level education. Furthermore, a greater proportion of individuals over the age of 40 showed negative WTP for personal mobility vehicles, whereas those under 40 were more likely to perceive shared electric cars negatively.

Table 5 shows the representative WTP figures obtained for the entire sample and across different socioeconomic groups. These values have been calculated in the mean of the latent variables and to avoid the influence of outliers and negative values, the median of the WTP distribution is considered. Additionally, the sample mean as well as the first and third quartiles are also reported for the entire sample. Coloured bars in the table represent the highest willingness to pay within each socioeconomic group for the attributes considered in the mobility package.

In general, the maximum median WTP is obtained for unlimited use of public transport (€39.53), followed by the benefits obtained when booking excursions (€33.42) and having a 20 Km voucher for taxi use (€23.29). Conversely, the least valued services are the personal mobility vehicle and electric car at €20.36 and €17.54, respectively.

The willingness to pay for MaaS attributes vary across the different socioeconomic groups. In general, those with a university

Table 6
Elasticity of the willingness to pay for MaaS attributes with respect to the environmental concern.

	Personal mobility vehicle	Electric car	Public transport	Taxi	Excursions
Elasticity with respect to the environmental concen					
Total sample elasticity					
Mean	2.22	-3.46	2.56	-0.34	1.13
Median	2.18	-4.64	2.51	-0.30	1.08
Q1	1.44	-9.99	1.50	-0.50	0.59
Q3	2.82	-1.91	3.62	-0.15	1.64
Sample median elasticity by socioeconomic groups					
Island					
Gran Canaria tourist	2.07	-2.76	1.80	**-0.17**	**0.71**
Tenerife tourist	2.19	-6.92	3.21	**-0.50**	1.53
Gender					
Female	2.28	-5.54	2.61	**-0.33**	1.18
Male	1.96	-4.00	2.35	**-0.27**	**0.96**
Age < 40					
No	2.48	-4.64	2.84	**-0.31**	1.16
Yes	1.94	-4.62	2.21	**-0.30**	1.03
University education					
No	1.62	-2.76	1.86	**-0.19**	**0.75**
Yes	2.48	-6.92	3.28	**-0.49**	1.58
Residence					
Spanish mainland/Balearic Islands	1.62	-2.03	1.87	**-0.17**	**0.70**
Germany	2.22	-4.98	2.51	**-0.33**	1.15
United Kingdom	2.19	-5.32	3.15	**-0.42**	1.40
Other countries	2.18	-5.12	2.35	**-0.26**	**0.96**
Driver license in the group					
No	2.46	-5.56	2.33	**-0.25**	**0.97**
Yes	2.12	-4.26	2.75	**-0.33**	1.12
Use of car during stay					
No	2.51	-9.87	2.77	**-0.38**	1.29
Yes	1.86	-2.76	2.49	**-0.23**	**0.89**

education and those with at least one driving licence in the group show a higher willingness to pay for all attributes compared to their counterparts. Comparing island destination, tourists in Gran Canaria are willing to pay more for taxis, while those in Tenerife exhibit higher willingness to pay for the rest of the attributes, especially personal mobility vehicles and public transport. Regarding gender, men present higher willingness to pay for all attributes except public transport, which is more valued by women. Age also plays an interesting role, observing than younger tourists, under 40, show a higher willingness to pay for personal mobility vehicles, public transport, and the benefits when booking excursions, while those over 40 are more willing to pay for electric cars and taxis. English and German tourists present the highest willingness to pay for all attributes except electric cars, which are more valued by Spanish tourists. Furthermore, visitors intending to use a car during their stay report a higher willingness to pay for electric cars, taxis and excursions, while those without such intentions are more willing to pay for the inclusion of personal mobility vehicles and unlimited public transport use in the mobility packages.

5.3. Elasticity of the willingness to pay with respect to the latent variables

To assess the sensitivity of WTP for MaaS to environmental attitudes, the elasticities of the WTP with respect to the three latent variables are calculated as follows:

$$E_{LV_i}^{WTP_{x_n}} = \frac{\partial WTP_{x_n}}{\partial LV_i}\frac{LV_i}{WTP_{x_n}} \approx \frac{\Delta\%WTP_{x_n}}{\Delta\%LV_i} \tag{9}$$

Table 7
Elasticity of the willingness to pay for MaaS attributes with respect to the environmental behaviour in daily life.

	Personal mobility vehicle	Electric car	Public transport	Taxi	Excursions
Elasticity with respect to the environmental behaviour in daily life					
Total sample elasticity					
Mean	0.39	-3.98	-1.70	0.43	-0.35
Median	0.23	6.21	-1.60	0.35	-0.31
Q1	0.13	3.25	-2.49	0.19	-0.52
Q3	0.35	12.66	-0.83	0.63	-0.18
Sample median elasticity by socioeconomic groups					
Island					
Gran Canaria tourist	0.23	5.00	-1.30	0.25	-0.27
Tenerife tourist	0.23	8.26	-1.88	0.59	-0.43
Gender					
Female	0.24	8.08	-1.46	0.36	-0.32
Male	0.22	5.48	-1.68	0.35	-0.31
Age < 40					
No	0.28	6.19	-1.85	0.38	-0.36
Yes	0.20	6.26	-1.30	0.35	-0.28
University education					
No	0.20	5.00	-1.29	0.27	-0.25
Yes	0.25	8.33	-2.05	0.58	-0.45
Residence					
Spanish mainland/Balearic Islands	0.22	4.92	-1.38	0.32	-0.28
Germany	0.20	5.87	-1.14	0.31	-0.28
United Kingdom	0.25	7.29	-1.95	0.47	-0.44
Other countries	0.23	6.28	-1.42	0.31	-0.28
Driver license in the group					
No	0.18	6.13	-1.09	0.27	-0.26
Yes	0.23	6.26	-1.69	0.37	-0.33
Use of car during stay					
No	0.24	12.13	-1.50	0.39	-0.36
Yes	0.22	4.33	-1.68	0.35	-0.29

The right-hand term in the above expression approximates the elasticity by the percentage change in the willingness to pay resulting from a one per cent increase in the corresponding latent variable. Tables 6, 7, and 8 present the elasticity values of WTP with respect to each latent variable, both for the total sample and for each socioeconomic group. The coloured bars compare the magnitude of elasticities within each group, with negative figures shown in red, while the bold numbers indicate inelastic values, i.e. those for which the elasticity is less than 1 in absolute value.

Overall, the analysis reveals that environmental concern has a differentiated effect on willingness to pay (WTP) for the various components of the MaaS bundle. It is worth noting that the WTP for the inclusion of the electric car and taxi voucher shows negative elasticity values, indicating that greater environmental concern would lead to reductions in willingness to pay for these attributes.

The reduction is particularly pronounced for the electric car, with a median elasticity of −4.64 for the total sample. This suggests that environmentally concerned individuals may be sceptical about the real environmental benefits of electric vehicles, possibly due to concerns over battery production, electricity sources, or congestion issues. As a result, increased environmental concern leads to a more-than-proportional reduction in their WTP for this option.

In the case of taxis, the negative elasticity is much lower (−0.30) but still indicates a small disincentive. One possible explanation is that taxis, even if occasionally used, are still perceived as private motorized transport, often associated with fuel consumption and emissions. Even though their use may be infrequent, environmentally concerned users might see taxis as inconsistent with their ecological values, especially if public transport or non-motorized options are available within the MaaS package.

In contrast, the inclusion of personal mobility vehicles (PMVs), unlimited public transport, and excursion-related benefits shows positive elasticity values (2.18, 2.51, and 1.08 respectively), suggesting that increased environmental concern makes users more

Table 8
Elasticity of the willingness to pay for MaaS attributes with respect to the environmental behaviour during vacations.

	Personal mobility vehicle	Electric car	Public transport	Taxi	Excursions
Elasticity with respect to the environmental behaviour during vacations					
Total sample elasticity					
Mean	-2.97	10.16	-0.09	-0.15	-0.35
Median	-1.02	-2.53	-0.08	-0.14	-0.31
Q1	-2.17	-4.66	-0.14	-0.23	-0.52
Q3	-0.42	-0.94	-0.03	-0.06	-0.14
Sample median elasticity by socioeconomic groups					
Island					
Gran Canaria tourist	-1.76	-2.97	**-0.09**	**-0.14**	**-0.36**
Tenerife tourist	**-0.71**	-2.07	**-0.06**	**-0.13**	**-0.25**
Gender					
Female	-1.05	-2.81	**-0.08**	**-0.13**	**-0.30**
Male	-1.02	-2.07	**-0.08**	**-0.14**	**-0.31**
Age < 40					
No	-1.09	-2.47	**-0.08**	**-0.14**	**-0.31**
Yes	**-0.92**	-2.88	**-0.07**	**-0.14**	**-0.31**
University education					
No	-1.24	-2.63	**-0.08**	**-0.14**	**-0.31**
Yes	**-0.94**	-2.31	**-0.07**	**-0.14**	**-0.30**
Residence					
Spanish mainland/Balearic Islands	-1.14	-2.91	**-0.09**	**-0.17**	**-0.40**
Germany	-1.02	-1.88	**-0.06**	**-0.09**	**-0.23**
United Kingdom	**-0.91**	-2.61	**-0.08**	**-0.15**	**-0.32**
Other countries	-1.19	-2.61	**-0.07**	**-0.13**	**-0.28**
Driver license in the group					
No	**-0.91**	-2.47	**-0.06**	**-0.09**	**-0.23**
Yes	-1.09	-2.55	**-0.08**	**-0.14**	**-0.32**
Use of car during stay					
No	-1.03	-3.70	**-0.06**	**-0.14**	**-0.27**
Yes	-1.02	-1.73	**-0.09**	**-0.14**	**-0.32**

willing to pay for these attributes. These components are likely perceived as more sustainable or environmentally friendly. PMVs and public transport offer alternatives to car-based mobility, while excursions may be considered an added value without a direct environmental cost if low-emissions vehicles are used, as in this case.

When disaggregating by socioeconomic segments, Tenerife tourists, women, visitors aged 40 or older, those with university education, and travellers from Germany or the UK consistently display higher sensitivity (greater elasticities) to environmental concern, particularly in their support for sustainable options. Interestingly, those who did not plan to use a car during their stay also show a more elastic WTP response, reinforcing the idea that pre-trip mobility intentions align with their environmental attitudes. (Table 6).

Regarding sustainable behaviour in daily life, the results show a notably high and positive elasticity for the electric car (6.21), suggesting that individuals who already demonstrate pro-environmental behaviour in their daily routines are significantly more willing to pay for this option. This likely reflects a perception of the electric car as a consistent extension of their personal values during travel. In contrast, negative elasticities were observed for public transport (−1.60) and excursions (−0.31), possibly indicating that these individuals may associate these services with less personalized or potentially less sustainable experiences. In the case of excursions, the negative elasticity could be due to the perception that organized tours may not always align with sustainable values, perhaps because of concerns about over-tourism or the environmental impact of some activities.

Personal mobility vehicles (0.23) and taxi vouchers (0.35) showed relatively low, positive elasticities, indicating limited responsiveness to environmental behaviour in daily life. Among socioeconomic groups, those with university education, tourists from the UK, and groups including someone with a driving license displayed more elastic willingness to pay, suggesting stronger alignment between their daily sustainable habits and their preferences for more environmentally friendly travel options during their stay (Table 7).

Finally, Table 8 presents the elasticity of the willingness to pay with respect to environmental behaviour during vacations. In this case, all median elasticities are negative, indicating that greater environmentally friendly behaviour during vacations is associated with a decrease in WTP for all MaaS attributes. The reductions are particularly significant for the electric car (−2.53) and personal mobility vehicles (−1.02), suggesting that individuals who adopt greener behaviours during vacations may prefer low-impact transport options such as walking, cycling, or limiting mobility altogether, thus reducing their interest in these services.

For public transport, taxis, and excursions, WTP is relatively inelastic (elasticities close to zero), which may reflect a general disinterest in additional services among those focused on minimizing their environmental footprint while travelling.

No clear patterns emerge across socioeconomic groups, though Gran Canaria tourists consistently show higher (more elastic) reductions in WTP compared to Tenerife tourists. This could suggest contextual or destination-based differences in the way environmentally motivated behaviours are translated into mobility preferences.

5.4. Evaluation of policy scenarios in terms of the latent variables

This section evaluates the choice probabilities of the model alternatives under various policy scenarios. In all scenarios, Alternative 1 is represented by a basic MaaS package offering only 8 public transport trips on any route within the island at 30 euros. Alternative 2 corresponds to an improved MaaS package offering various mobility services characterised by the attributes included in the choice experiment. In Scenario A, the package includes 2 MaaS options at a price of 50 euros; Scenario B offers 3 MaaS options for 80 euros; and Scenario C offers 4 MaaS options at 100 euros. The prices considered in these scenarios align with the price levels in the discrete choice experiment (Table A.1). Additionally, Scenario D was included, offering a complete package −5 MaaS options- at a price of 130 euros (see Table 9). This price was determined to be consistent with the sum of the willingness to pay values for each service included. In this regard, it is important to note that the choice sets in the experiment offered packages with a maximum of four mobility services. In all cases, Alternative 3 represents the no-choice option.

The services included in the improved MaaS package (Alternative 2) were selected to maximize the probability of choosing this alternative (P_{imp}). Thus, if k services are offered ($k = 2, 3, \text{or } 4$) at price p^*, the services provided would be determined by the vector $\left(x^*_{n,\text{imp}}\right)$ such that:

Table 9
Choice probabilities in policy scenarios.

Policy scenarios	MasS options included *(as described in the choice experiment)*	Choice probabilities *(Sample mean)* Basic MaaS	Improved MaaS	No choice
Scenario base(Basic MaaS package)	8 trips by public transport	–	–	–
Scenario A:(Optimal package including 2 MaaS options)	Price: 50 eurosUnlimited use of public transportExcursions	0.220	0.752	0.028
Scenario B:(Optimal package including 3 MaaS options)	Price: 80 eurosUnlimited use of public transportTaxiExcursions	0.250	0.718	0.031
Scenario C:(Optimal package including 4 MaaS options)	Price: 100 euros Personal mobility vehicleUnlimited use of public transportTaxiExcursions	0.252	0.720	0.028
Scenario D:(Complete package: 5 MaaS options)	Price: 130 euros Personal mobility vehicle Electric carUnlimited use of public transportTaxiExcursions	0.301	0.664	0.034

$$\underset{\substack{x_{n,\mathrm{imp}}=\{0,1\} \\ \sum_n x_{n,\mathrm{imp}}=k}}{\operatorname{argmax}}\ P_{\mathrm{imp}} = \left\{ \left(x^{*}_{n,\mathrm{imp}} \right) \right\} \tag{10}$$

Where $P_{\mathrm{imp}} = \frac{e^{V_{\mathrm{imp}}}}{e^{V_{\mathrm{basic}}} + e^{V_{\mathrm{imp}}} + e^{V_{\mathrm{no\ choice}}}}$; and V_{basic}, V_{imp}, and $V_{\mathrm{no\ choice}}$ represent the systematic component of the utility of alternatives 1,2, and 3, respectively as specified in expression (6). The calculation of the utilities is subject to the following constraints: $pr_{\mathrm{basic}} = 30$, $pr_{\mathrm{imp}} = p^{*}$, and $x_{n,basic} = 0\ \forall n$. Note that attributes in (6) are represented in capital letters because they are weighted by the importance as has been previously mentioned.

The composition of the optimal scenarios and the choice probability of the alternatives are shown in Table 9. It is interesting to note that unlimited use of public transport and benefits in excursions are present in all scenarios, whereas the electric car only appears in the scenario where all options are considered. In all cases, the improved MaaS services present higher choice probabilities, ranging from 0.66 to 0.75. This indicates that tourists generally perceive MaaS services as an attractive mobility solution. Notably, the scenario where the improved MaaS presents the highest probability (0.75) is the one where only unlimited use of public transport and benefits when booking excursions are offered. Conversely, the no-choice option presents very low probability values (less than 0.03) across all the scenarios analysed, highlighting tourists' interest in adopting MaaS programs.

Fig. 4 presents graphs depicting the sample choice probabilities (vertical axis) against each latent variable (horizontal axis) for the different policy scenarios. In general, we observe that the probability of choosing the improved MaaS package (P_{imp}) increases with the latent variable, and the probability of choosing the basic package (P_{basic}) diminishes; with the latter being surpassed by the probability of the no-choice option ($P_{\mathrm{no\ choice}}$) in some cases. This effect is much more pronounced in scenarios A and B, where the improved package is offered at lower price levels. In these cases, the point clouds represented in orange (improved MaaS) and blue (basic MaaS) are more clearly separated, indicating that for the majority of observations, $P_{\mathrm{imp}} > P_{\mathrm{basic}}$. However, in scenarios C and D, which correspond to higher price levels, a greater number of observations show that the probability of choosing the basic package exceeds that of the enhanced package.

These results highlight the relevance of incorporating the analysis of environmental attitudes into the study of tourists' preferences for sustainable mobility options. Accordingly, policies aimed at promoting environmental concern and sustainable behaviour could enhance individuals' engagement with MaaS. As indicated by the analysis, pricing plays a fundamental role in the adoption of such mobility programs.

5.5. Discussion

The structural equation model revealed that the selected socioeconomic variables significantly influence the three latent variables examined. Kriswardhana and Esztergár-Kiss (Kriswardhana and Esztergár-Kiss, 2023) contended, after conducting a literature review on 29 relevant articles, that the effects of socioeconomic variables on MaaS preferences presented inconsistent results. The comparison of our results with other previous studies is challenging because our model specification included the socioeconomic variables in the

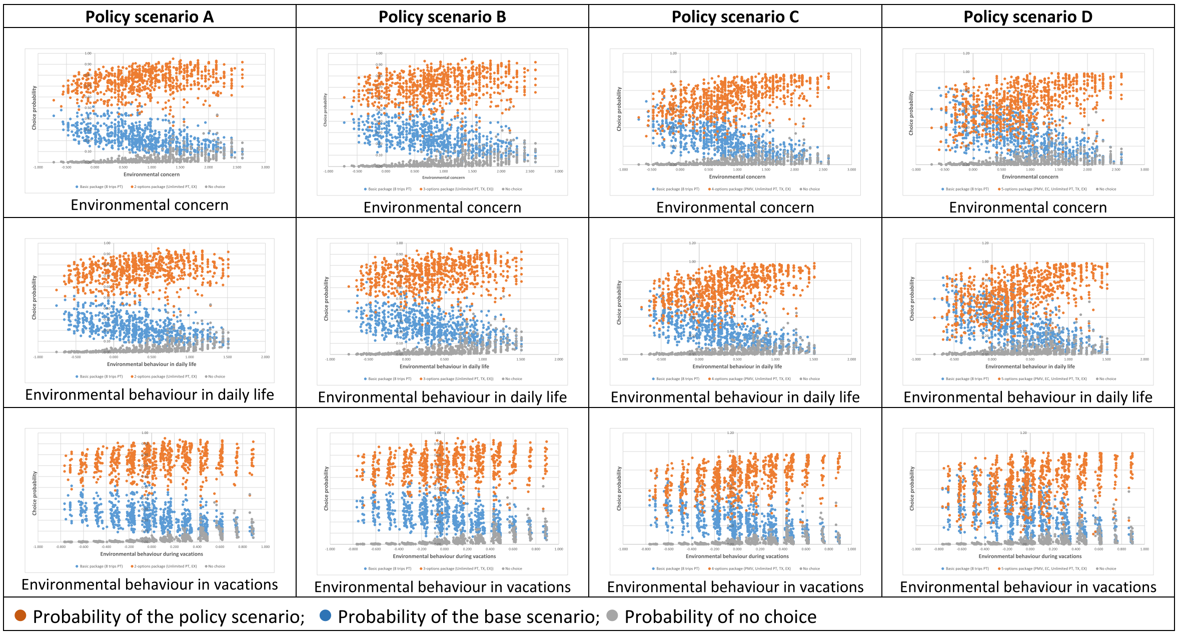

Fig. 4. Policy scenarios. Analysis of choice probabilities in terms of the latent variables.

structural model for the explanation of the latent variables, and the latent variables interacted with the main attributes included in the description of each package.

For this reason, the results of the socioeconomic variables will be compared through the indirect effects obtained in the study. Thus, our results showed that younger tourists prefer all the features included in the package more than those 40 years or older, except electric cars. These results concord with those by Farahmand et al. (Farahmand et al., 2021) and López-Carreiro et al. (2021), as the authors confirmed that older and retired individuals are more reluctant to use MaaS than younger generations. Regarding gender, our results found that men preferred all the MaaS features more than women, as in Ko et al. (Ko et al., 2022). However, this result is not robust, as in many other studies, contrary evidence has been found (Hensher et al., 2021); (Hasselwander et al., 2022).

In relation to the result that men are less concerned about the environment and exhibit lower engagement with environmental behaviour, these findings align with those reported by other authors. For example, Zamparini et al. (Zamparini et al., 2022) find that men exhibit less environmentally friendly transport mode choices at tourist destinations. Similarly, Briscoe et al. (Briscoe et al., 2019) report that women are more likely than men to engage in pro-environmental behaviours, including transportation, in the Intermountain West region of the US. Kawgan-Kagan (Kawgan-Kagan, 2020), although in the context of urban mobility, finds similar results, specifically noting that women tend to choose more environmentally friendly alternatives than men. Hyldig and Faber (Hyldig and Faber, 2024), in the study of gender differences, conclude that men seem to be less committed to climate change and ecological transition than women.

Regarding education, our results showed a similar pattern for those with a university degree to the commented age results, i.e. tourists with university degrees preferred all the MaaS features over the rest of the tourists, except for the electric cars. These results were also commented on in other studies (Ye et al., 2020); (Tsouros et al., 2021). High-income tourists preferred the MaaS packages more than their low-income counterparts. Our income results were also found in previous studies, such as those of Jang et al. (Jang et al., 2021) and Zijlstra et al. (Zijlstra et al., 2020). In addition, our destination results are not comparable. However, they can be partly explained by the different tourist compositions regarding income and education, and some other cultural factors related to tourists' nationality can also be relevant to this observed difference, for which Tenerife tourists preferred MaaS more than Gran Canaria tourists. The driving licence in the group and plans to use a vehicle at the destination cannot be found in other studies. Our results showed the MaaS preference of the reference group for all the features included except for public transport in the case of tourists planning to use a vehicle. Nevertheless, in urban contexts, a similar result was that car lovers usually find MaaS less attractive (Fioreze et al., 2019); (Ho et al., 2020).

Regarding the effect of latent variables, the elasticity analysis helped us to conclude that environmental concern separated quite well the features to be included in the MaaS package because the WTP was affected negatively for the case of electric cars and taxies, and positively for the case of the environmentally friendly transportation options and the benefits when booking excursions. Fioreze et al. (Fioreze et al., 2019) found that more environmentally concerned users adopt MaaS more profusely. Furthermore, Kriswardhana and Esztergar-Kiss (2025) found that more environmentally sensitive individuals are more keen to adopt MaaS packages. For the environmental behaviour in daily life and during vacations, our results showed that WTP diminished for all the MaaS features except for personal mobility vehicles, electric cars and taxis when the daily environmental behaviour was more significant. There seems to be a contradiction between the daily pro-environmental routines and the environmental behaviour at tourist destinations, with a focus on the use of taxis. This apparent contradiction was also found in the analysis of air travel, as Alcock et al. (Alcock et al., 2017) argued that pro-environmental routines might not be reflected in substituting air travel with more environmentally friendly alternatives. Moreover, our result is consistent with those found by other authors regarding the dissonance between behaviour at home and sustainable transport choices at tourist destinations (Budeanu, 2007); (Bamdad et al., 2019); (Kiatkawsin and Han, 2017); (Miller et al., 2015).

Our results, which indicate that electric car sharing received lower importance scores, are consistent with those of other studies. Indeed, according to the review by Kriswardhana and Esztergár-Kiss (Kriswardhana and Esztergár-Kiss, 2023), the impact of car-sharing on MaaS adoption remains inconclusive in the literature. For instance, Guidon et al. (Guidon et al., 2020) suggest that incorporating car-sharing into MaaS offerings may enhance users' willingness to pay for such packages. In contrast, findings by Matyas and Kamargianni (Matyas and Kamargianni, 2019) indicate that car-sharing could actually deter users from adopting MaaS bundles.

The section ends with the results of the policy scenarios analysis. The remarkable insights regarding the importance of including unlimited use of public transport and benefits in excursions for developing the MaaS packages obtained in our case study cannot be compared with previous studies. However, regarding the MaaS packages analysed in the literature, we can conclude that all the transport modes have already been considered, except for including benefits when booking excursions (Kriswardhana and Esztergár-Kiss, 2023). In addition, there is currently limited evidence regarding the inclusion of scooters in mobility packages, as this mode of transport has been minimally studied. Only one study (Krauss et al., 2023) and González et al. (González et al., 2024) have integrated scooters into MaaS packages.

6. Conclusions

This paper has investigated how attitudinal variables of environmental concern and sustainable behaviour affect individuals' preferences for different transport services offered within the framework of mobility-as-a-service. The study was carried out in two of the main tourist destinations in the Canary Islands, a leading mass tourism destination in Europe, where problems related to the environmental impact caused by tourists can jeopardise not only the quality of the services offered but also the image of the destination. Thus, the aim of the study was framed within the search for more sustainable mobility solutions for tourists.

The estimates obtained from a hybrid choice model indicate that the latent variables explored in this research are influenced by diverse socio-demographic profiles, which significantly impact preferences for the mobility options examined in the choice experiment. This analysis emphasises the importance of segmenting tourists based not only on basic demographics but also on their environmental attitudes and behaviours. This heterogeneity extends to the willingness to pay for various services, as age, gender, and education significantly differentiate the WTP for shared mobility modes. In contrast, WTP for other services is more consistent across the tourist population, with public transport being the most valued. Tourists also found it a very attractive option to enjoy the benefits of booking excursions through the program's app.

Regarding the package characteristics, one novelty feature of the study is to include bicycles, scooters, and electric motorcycle sharing systems as options for personal mobility. To our knowledge, there is only one study that included the supply of e-scooters in the MaaS packages (Kraus et al., 2023). However, Kraus et al. (2023) included shared e-scooters in a context of mobility in 62 German cities, denominated as metropolis or large cities, focusing on the residents' mobility –not directly comparable to our current study based on tourist mobility.

The analysis of different policy scenarios provides valuable insights for implementing sustainable mobility solutions in island tourism areas. The investigated tourism sample generally shows a predisposition to adopt a MaaS program, either in a basic package that only includes public transport or a more enhanced one with additional options. In this sense, it is especially relevant for one up-and-coming area to implement packages that can include additional benefits when booking excursions, as this is an option in the realm of travel and tourism.

By offering curated packages, MaaS could enhance the overall customer experience, making it more appealing for tourists. For instance, these packages could include not only the main excursion itself but also extras like complimentary local meals that promote the gastronomy of the Canary Islands, priority access to attractions, and guided tours beyond the own transportation options. This not only adds value for the customer but can also encourage higher booking rates and customer loyalty. This result has been recently recognised by Hensher and Nelson (2025), where non-mobility service providers could foster the development of MaaS solutions.

In addition, the results provide valuable insights to service providers for developing successful MaaS solutions in the Canary Islands. We highlight the critical importance of integrating unlimited public transport use and specific benefits for excursions, a combination that has not been explored very much in previous studies. Furthermore, our analysis contributes to the emerging body of research on micro-mobility integration, noting the limited evidence regarding the inclusion of scooters in mobility packages. Crucially, the elasticities obtained in our study provide vital guidance for tailoring MaaS solutions to the diverse and specific mobility needs of tourists, ensuring effective adoption and promoting sustainable travel patterns in the Canary Islands.

While the study offers novel and valuable results for academics, practitioners, and MaaS service providers in the context of tourist mobility in the Canary Islands, it is essential to acknowledge its inherent limitations. These limitations not only define the scope of our findings but also highlight avenues for future research to increase our understanding of MaaS adoption among tourists.

One significant limitation lies in the composition of the MaaS alternatives presented to participants, which were constrained to six core components. While the components were carefully selected based on a thorough literature review and preliminary qualitative insights, they do not encompass the full spectrum of potential MaaS development that could enhance the tourist experience. Specifically, our experimental design did not include consideration for more experiential or specialised tourism products, such as the integration of experiential tour guides, access to unique cultural events, or nature-based tourism packages (e.g., guided hikes, marine activities). The omission of these potentially highly valued components means that our WTP estimates and elasticity analyses are specific to the predefined set of components. Further research could explore how their inclusion might alter tourist preferences.

Our study focused exclusively on tourists in the Canary Islands. While this provides valuable context-specific insights, it may limit the generalizability of our findings to other tourist destinations with different demographic profiles, transportation infrastructure, or tourism offerings. In particular, a unique archipelagic context where most tourists arrive by air and typically do not bring private vehicles might influence tourists' mobility needs and options, potentially leading to an overestimation of MaaS acceptance compared to other mainland or urban destinations. Future work could replicate this study in diverse geographical settings to test the transferability of our model and findings.

As with all stated preference methods, our reliance on surveys means that responses reflect intentions rather than actual behaviours. While choice experiments are a robust method for eliciting preferences, there can be a hypothetical bias, where participants' stated choices may differ from their actual actions in real-world situations. Future research could integrate revealed preference data, where available, or conduct pilot programs to validate these stated preferences against actual MaaS demand.

While our use of latent variables provides a deeper understanding of the underlying psychological drivers, their measurement relies on self-reported perceptions and attitudes, not exempt from introducing social desirability bias. The operationalisation of these constructs, although informed by established theory, could be refined or expanded in future studies to capture even more nuanced behavioural determinants, such as prior experience with multimodal apps and innovation enthusiasts.

Finally, this study employed a cross-sectional design, capturing preferences at a single point in time. Tourist preferences and MaaS offerings are dynamic, evolving in response to technological advancements, infrastructure improvements, and societal trends. Longitudinal studies could offer valuable insights into how WTP and elasticities change over time, perhaps in response to increased MaaS familiarity or policy interventions.

CRediT authorship contribution statement

Concepción Román: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Rosa Marina González:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Data curation, Conceptualization. **Juan Carlos Martín:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization.

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Declaration of generative AI in scientific writing.

Generative AI and AI-assisted technologies were only used in the writing process to improve the readability and language of the manuscript.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Appendix A

Annex A. The discrete choice experiment.

Table A1
Attributes and levels used in the choice experiment.

Attributes of the sustainable mobility package	Priors	Levels			
		Level 0	Level 1	Level 2	Level 3
Price of the package	−0.0196	30 €	50 €	80 €	100 €
Use of personal mobility vehicles:(Electric bike/Electric scooter/Mechanical bike/Electric motorbike)	0.3136	Not included	Unlimited number of rentals. First 30 min per rental are free of charge	–	–
Use of 4-seater electric car sharing	0.49	Not included	45 min of free use per week	–	–
Use of public transport throughout the island	0.392	8-trip voucher	Unlimited number of trips by public transport	–	–
Taxi	0.4312	Not included	20 Km voucher	–	–
Benefits when booking excursions to points of interest on the island	0.294	Not included	Included	–	–

Source: González et al (González et al., 2024).

Scenario 1		
Sustainable Mobility Package Attributes	**Option 1**	**Option 2**
Price of the package	100 €	30 €
Use of personal mobility vehicles: (Electric bike/Electric scooter/Mechanical bike/Electric motorbike)	-	Unlimited number of rentals First 30 minutes per rental are free of charge
Use of 4-seater electric car sharing	45 min of free use per week	-
Use of public transport throughout the island	Unlimited number of trips by public transport	8-trip voucher
Taxi	20 Km voucher	-
Benefits when booking excursions to points of interest on the island	Included	Included
Which option would you prefer?		

☐ **Option 1**

☐ **Option 2**

☐ **Neither of the two mobility packages interests me**

Fig. A1. Example of presentation of the choice scenarios. *Source:* González et al (2024).

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.trd.2025.104997.

Data availability

The authors do not have permission to share data.

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