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Investigating tourists' awareness of climate change in the context of the adoption of MaaS: A fuzzy hybrid analysis approach

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Abstract

Tourist destinations are introducing Mobility as a Service (MaaS) packages to satisfy tourists' needs and reduce the use of private or rental cars. The main objectives of this paper are: (1) to explore the extent to which the latent variable tourists' awareness of climate change (TACC) depends on a set of covariates with a particular focus on certain variables related to the MaaS concept; and (2) to analyse the elasticity of the latent variable (TACC), analysing the indicators that form the TACC latent variable as well as some specific MaaS-related segments. A Fuzzy Hybrid Analysis approach is applied to the information matrix provided by a survey administered to 1218 respondents in Gran Canaria and Tenerife. The results confirm statistically significant differences in the latent variable for a group of covariates with particular relevance for those more inclined to use bike-sharing systems at the destination. The results also show that the TACC index is less elastic regarding items in which environmental problems are significant today, and that it is essential to promote policies that reduce greenhouse gas emissions. Still, the responses vary widely depending on whether respondents are regular bike riders. The study offers valuable insights for destination marketing and management professionals. By understanding the connections between MaaS, climate change awareness and tourist behaviour, destinations can develop more sustainable tourism strategies that appeal to environmentally conscious travellers.

Keywords: Tourist climate change awareness; Fuzzy-Hybrid Analysis; MaaS; Sustainable mobility.

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1. Introduction

Page and Ge (2009) state that studying transportation and leisure travel or tourism is highly complex at both theoretical and empirical levels. The two sectors feed each other: i.e., the existence of tourism cannot be understood without transportation, and it is hard to imagine the transportation sector without the tourism sector. At the empirical level, it is sometimes difficult to discern whether a trip has been made for leisure or business. For this reason, although many studies analyse the connection between these two sectors, most focus on just one of them. Page (2005) recommends a holistic and multidisciplinary approach, taking into account three fundamental aspects: (1) transport as a necessary condition for tourism; (2) tourism as a necessary condition for developing the transport sector; (3) an integral vision of the two sectors that mutually feed back into each other.

Focusing on a particular destination such as Gran Canaria or Tenerife, the first aspect is reflected in the development of the airport to enable the first visitors to arrive. The second aspect is reflected in the ground transportation that takes tourists from the airport to their hotels or apartments. Finally, the third aspect involves the creation of a comprehensive tourism package that includes accommodation and travel.

Gössling *et al.* (2021) stress the importance of the debate on climate change and air travel, because the decarbonisation social concern is nowadays shifting from producers to consumers. Similarly, Núñez Alfaro and Chankov (2022) argue that, in addition to the efforts made by airlines to achieve sustainability, consumers also need to change their air travel behaviour. Nevertheless, tourists' awareness of climate change (TACC) and its potential effect on their mobility at their destination have not been sufficiently studied. Martinčević *et al.* (2022) contended that although Mobility as a Service (MaaS) can inform of more sustainable transport alternatives to tourists, there is an evident lack of studies of the use of MaaS in tourism. Indeed, MaaS can be seen as a specific direction for tourism in the context of which different stakeholders have a mutual interest in developing a common tourist product (Pedrosa *et al.*, 2025).

Social science research conducted in the past has indicated that climate change awareness is becoming a social accepted norm. In the UK, the reported increased engagement with regard to several behaviours, namely: (1) attention to the amount of water and energy used in the home; (2) attention to food waste; (3) and a willingness to do more to lead an environmentally sustainable lifestyle and to lower one's impact on the environment. Given this predisposition among respondents, the reports conclude that there is scope for increasing action in many areas to encourage people to reduce their environmental footprint (Defra, 2002, 2007, 2011; Upham *et al.*, 2009). Most of the world's population acknowledge that climate change is happening and (Poortinga *et al.*, 2006).

Climate change awareness does not significantly alter the travel behaviour of affluent mobile young urbanites (Árnadóttir *et al.*, 2021). Those authors found that this sector of the population justified their international air travel by shifting responsibility and by claiming to engage in compensatory behaviours; other factors mentioned by these respondents were insufficient information, inexistence of alternatives, emphasis on economic impacts, and support for carbon offsetting. Abbass *et al.* (2022) also reported a lack of knowledge or awareness, observing that climate change concerns were compounded by insufficient environmental education and knowledge, unsustainable consumer behaviour and lifestyles, a lack of incentives for environmental regulation and legislation, and inadequate governmental commitment to the development of an effective international climate change policy.

The dissonance of the theory of planned behaviour (Ajzen, 1985) between the tourists' awareness of climate change and what they finally do when making less sustainable mobility choices at their destination is known in the study of sustainable tourism as the attitude-behaviour gap (Juvan &

Dolnicar, 2014). The relationship between TACC and unsustainable vacation behaviour means that some tourists exhibit an unfortunate attitude-behaviour gap, justified mainly by the lack of more sustainable alternatives. Thus, minimising the negative environmental impacts of tourist mobility at destinations is a paramount concern for Destination Marketing Organisations (DMOs) which, with this aim in mind, are now developing alternatives in the context of MaaS. From a practical point of view, this study may provide insights into the underresearched topic of why it is so difficult to reduce the attitude-behaviour gap in the choice of sustainable modes of transport at tourist destinations.

Thus, the study has the following objectives: (1) to create a composite index of TACC using a multiple criteria decision-making (MCDM) tool based on a Fuzzy Hybrid Analysis TOPSIS (FHA-TOPSIS) method; (2) to find relevant socioeconomic covariates that may affect the composite index, starting with the representative segments that provide information on the ideal solutions; (3) to identify differences through an analysis of variance applied to the composite index calculated at the individual level; and (4) to analyse the elasticity of the index concerning each item for a set of covariates, finding the most and the least elastic items for each of the studied segments.

In summary, the novelty of the study lies in its contribution to the existing literature on TACC, but contextualising it by means of the study of the development of MaaS packages at mass tourism destinations. This approach may allow us to predict the possible effect on the TACC index. of specific sustainable alternatives that could be included in the MaaS alternatives, like the type of bicycles (electric or conventional), bike-sharing systems, scooters and public transport. Identifying certain segments with higher TACC could also provide salient data for the development of strategies that reduce the negative environmental externalities of tourist mobility at destinations. This knowledge could help to guide the creation of effective MaaS interventions that bridge the gap between attitudes and behaviours regarding sustainable travel.

2. Literature review

2.1. Climate change awareness

Climate change (CC) is now an essential concern in the international community. The Intergovernmental Panel on Climate Change IPCC (2023) recognises the interdependence of climate, ecosystems, biodiversity, and human societies. It also acknowledges that there are distinct forms of studying this interaction, as shown in the three working groups (WGs) created in the panel: WGI – The Physical Science Basis, WGII – Impacts, Adaptation and Vulnerability, and WGIII – Mitigation of Climate Change. The panel acknowledges that a high intersection exists between the three working groups and that multiple stakeholders are involved in developing climate policies.

The impacts of CC and the mitigation strategies proposed depend heavily on long-term global emission scenarios (Pedersen *et al.*, 2022b), as these scenarios are used as a primary input for research into CC, the assessment of its impact, and mitigation analysis. However, developing long-term emission scenarios is not straightforward, as they require many qualitative assumptions and sophisticated integrated assessment models that are difficult to contrast with the existing empirical evidence. Therefore, each scenario is grounded in a more or less consensual agreement among the panellists according to five different qualifiers (IPCC, 2023).

Pedersen *et al.* (2022a) contended that some researchers are sceptical about the applicability of emission scenarios because policymakers tend to be confused about their complexity and receive little practical policy guidance. Hausfather and Peters (2020) further concluded that the scenarios produced arbitrary and erroneous policy decisions due to the lack of understanding of the assumptions of the factual scenarios. Pedersen *et al.* (2022a) concluded that emission scenarios must be communicated more straightforwardly so that policymakers can understand them more easily.

The IPCC reports are not exempt from criticism. Pedersen *et al*. (2022b) conducted a systematic literature review of the critiques of developing IPCC scenarios and their possible impact. They found 280 papers that express criticisms since 1990, classifying them under four main headings, in which the assumptions on key scenarios were more predominant than other issues like emissions, methodology, or policy.
Regarding the criticism of key scenarios, the authors identified five subcategories: income assumptions and metrics, negative emission technologies, energy technologies, the transition to more green sources, and the lack of a plausible assumption builder. The scenarios are mainly based on highly pessimistic or optimistic assumptions regarding income convergence or abatement mitigation policies. In addition, these assumptions are strongly criticised for being aligned with politics and ideology.

De Pryck (2023) called for more decisive action, given that informed or educated citizens do not change their behaviour enough. Nevertheless, Abbass *et al*. (2022) also noted that climate change concerns are usually rooted in a lack of environmental education, a lifestyle that incentivises massive consumption, inadequate internalisation mechanisms, and a lack of governance in promoting effective climate change mitigation measures. The IPCC's reputation is indeed based on its ability to negotiate low minimum agreements between its member states, but the planet needs a broader dialogue, and the IPCC needs to forge new alliances.

2.2. Tourist behaviour towards climate change
The measurement of climate change awareness is usually based on questionnaire surveys that include several dimensions of the phenomenon, such as individual actions to mitigate CC, environmental regulations introduced by governments that mitigate CC, and the costs that CC imposes on society in the form of droughts, floods, the displacement of persons, food and water shortages, the reduction in biodiversity, and the increased risk of pandemic episodes (Yu *et al*., 2013).

Ballew *et al*. (2019) found the lack of interpersonal dialogue to be a serious obstacle to the promotion of social norms and the enhancement of climate change awareness. Those authors found that most Americans are worried but do not know whether their friends and relatives are also concerned, because it is a subject they never discuss. Agreement at social level may be decisive in raising public awareness and ultimately in triggering a consensual response. Along these lines, Gössling *et al*. (2020) discussed the effect of demonstrations in certain countries aiming to "flight shame" prospective air travellers; they found that this strategy did not directly cause a behavioural change, but increased the acceptability of market solutions to offset the carbon emission caused by air transport.

Coulter *et al*. (2019) contended that personal narratives are neither explicit nor familiar, even in high-income countries with the capacity to mitigate CC. The active adaptation might vary according to the knowledge, perception, or social norms regarding CC. The authors analysed future climate narratives by interviewing Australian and Canadian professionals who have worked directly in CC research, policy, and practice. The findings reveal four key implications for future research on CC mitigation, including "professional detachment from the need to adapt; focus on extreme risk assessments as opposed to personal vulnerability; imbalance between enacting personal and social agency; and avoidance of transformative adaptation (p.66)."

The second key implication they mention is the unfortunate attitude-behaviour gap among tourists. Juvan and Dolnicar (2014) showed that having an environmentally friendly attitude is not a good predictor of choosing sustainable vacations, and listed nineteen different categories that helped explain the gap. Similarly, Alcock *et al*. (2017) also found that pro-environmental attitudes and climate change awareness had an important effect on household consumption patterns in the UK, but air travel choice was not affected. Travel time is by far the most important factor in choosing air transport for vacation.

Oswald and Ernst (2021) also noted that a significant proportion of the increase in air transport is due to globalisation, in so far as some citizens are obliged to travel long distances to visit relatives and friends.

The development of MaaS in tourist areas where many visitors arrive by plane assumes that tourists with a higher TACC will be motivated to replace rental car mobility at their destinations with other more environmentally-friendly alternatives. However, Smith *et al.* (2019) showed that the modal shift from cars to public transport does not always produce environmental gains: for example, improving public transport might cause gains in accessibility that increase the number of tourists without car access, and the market shares of public transport would increase without reducing the number of cars, thus resulting in higher CO_2 emissions.

Based on previous studies, several scales for assessing climate change awareness have been devised, measuring climate change anxiety (Clayton, 2020); climate change perception (van Valkengoed *et al.*, 2021; Adiwena & Bramanwidyantari, 2024); climate change distress and impairment (Hepp *et al.*, 2023); climate change self-assessed knowledge (Whitmarsh, 2011); ecological identity (Walton & Jones, 2018); environmental attitude (Roser-Renouf & Nisbet, 2008); new environmental paradigm (Dunlap & van Liere, 1978); new ecological paradigm (Dunlap *et al.*, 2000); and pro-environmental behaviours (Whitmarsh & O'Neill, 2010; Larson *et al.*, 2015).

The problem with the construction of scales is that additional research is needed to validate them in different contexts and across diverse demographic segments. What is more, the wording of items can have a significant impact on the results obtained (Schuldt *et al.*, 2011). For example, using the term "global warming" instead of "climate change" introduces a difference: one term may elicit a more sceptical response than the other.

3. Data

3.1. Survey and respondents

The study objectives are addressed via a survey administered to tourists at two of the main tourist municipalities of the Canary Islands, Adeje (Tenerife) and San Bartolomé de Tirajana (Gran Canaria). These locations were strategically selected for two reasons. Firstly, Tenerife and Gran Canaria are the largest islands within the Canary Islands archipelago, and also the most visited, making them ideal sites for case studies of TACC. They attract diverse international and national tourists, offering diverse perspectives and experiences. Secondly, Adeje and San Bartolomé de Tirajana are prominent municipalities renowned for their established tourism infrastructure and high tourist density. This ensures a robust sample size and allows us to capture a broad spectrum of tourist demographics and behaviours.

The questionnaire design followed a three-step process. First, to better understand the possible attributes that affect the willingness to adapt to travel needs at the destination, a desk study was conducted to review all studies using discrete choice experiments. After the review, it was decided that the choice experiment would be based on six different attributes inside the context of a visit of a group of up to four individuals for a one-week stay. Second, a preliminary pilot study provided valuable insights that refined survey questions and redefined target groups and attribute levels. The final survey targeted tourists aged 18-75, and found that older individuals consistently declined to purchase mobility packages or use micro-mobility options. For their part, island residents involved in tourism were not surveyed, as they typically use their private vehicles. Third, to ensure that there was no demographic bias between the respondents and the representative tourists visiting Tenerife and Gran Canaria, a quota system was determined on the basis of the official statistics provided by ISTAC (2023).

The questionnaire was divided into seven sections, including the trip description, sustainable mobility habits related to bicycles, scooters, and electric cars, the choice experiment, an analysis of attitudes regarding environmental concerns and behaviour, and sociodemographic information. The final survey was administered in April 2023 by a marketing company that employs expert interviewers who have received specialised training in the administration of this type of survey. After a comprehensive data-cleaning process, we retained 921 valid responses for the final analysis. This presents a sampling error of less than 3.3%, based on an assumed population of approximately one million tourists visiting Gran Canaria and Tenerife.

3.2. Variables

Ten items formed the latent variable (TACC), for which respondents answered a set of statements about climate change awareness. For each item, they were asked to indicate their degree of agreement or disagreement, answering according to a full 5-point Likert scale in which 1 indicated "strong disagreement", 2 "mild disagreement", 3 "neither agreement nor disagreement", 4 "mild agreement" and 5 "strong agreement". The TACC scale was proposed after adapting other previous scales (Adiwena & Bramanwidyantari, 2024; Clayton, 2020; van Valkengoed *et al*., 2021; Whitmarsh, 2011).

The ten items were randomised, controlling possible biased replies, and were worded as follows: (1) I worry about the future of society when I think about the environment we are going to leave behind; (2) If society continues to maintain a consumerist lifestyle, environmental problems will be very serious; (3) I consider environmental problems to be very important today; (4) The information we receive about the consequences of climate change is accurate; (5) Politicians must become more involved in protecting the environment; (6) In order to protect the environment, we must all be willing to change our current lifestyle; (7) Environmental protection measures must be implemented, even if this may have a restrictive effect on the economy in the short term; (8) It is essential to promote policies for the reduction of greenhouse gas emissions; (9) It is essential to promote policies that contribute to an increase in the planet's forest cover; (10) Climate change is already a palpable reality.

The following twelve socioeconomic and demographic variables are included in the analysis: destination, residence, gender, primary transport mode used during holidays, use of bikes, willingness to use bikes if they are available, use of scooters, participation in car sharing, education, age, group size and income. Due to the aim of the study, it was considered necessary to include variables associated with the development of the MaaS package. The latent variable of interest in the study is the TACC and its relationship with the adoption of transport alternatives in the daily travel habits of tourists. In this respect, we assessed the use of bikes, scooters or electric car-sharing systems versus the use of private cars. Similarly, in the case of the primary transport mode used to travel to tourist attractions on the island, we compared travelling by private car, taxi, and rental car with other modes such as public transport, tourist buses, walking, and motorbikes. Further variables included in other studies were selected as variables of interest (Dütschke *et al*., 2022).

4. Methodology

Fuzzy set methods are highly effective for dealing with the imprecise information provided by respondents when answering questionnaires. Inexact information is often rooted in subjective and vague judgement rather than in a lack of precise knowledge, since certain questions cannot be answered with certainty. Zimmermann (2013) stated that "fuzzy set theory provides a strict mathematical framework (there is nothing fuzzy about fuzzy set theory!) in which vague conceptual phenomena can be precisely and rigorously studied (p. 6)."

The primary latent variable, TACC, is based on a dataset of the responses the participants gave in a full 5-point Likert scale. Therefore, using the fuzzy-hybrid multi-criteria decision-making (MCDM) method

to calculate the composite TACC index is appropriate. This approach has been recommended by experts in the field, including Martín *et al.* (2020), Saayman *et al.* (2016), and Zimmermann (2013).

Fuzzy techniques provide numerous benefits compared to traditional approaches, like structural equation models, particularly when addressing the uncertain nature of the information provided by respondents (Biasetton *et al*., 2023; D'Urso, 2007; Lin & Yeh, 2013; Sinova *et al*., 2012). The popularity of the model is evident from the increasing frequency of its applications in specialised fields, and also from the figures reported by Zimmermann (2013), who observed that the number of applications rose from four thousand to thirty thousand between 1984 and 2000. Fuzzy sets are based on a solid, well-conceptualised theory (Coppi & D'Urso, 2002; Martín & Indelicato, 2023). The fuzzy logic methods do not rely on black-box assumptions, being intuitive and easier to understand (Sinova *et al*., 2012; Sohrabi *et al*., 2012). They are flexible and versatile tools (Sinova *et al*., 2012; Sohrabi *et al*., 2012; Wang *et al*., 2014).

4.1. Triangular fuzzy numbers

Zadeh (1965) established fuzzy sets, extending the concept of classical sets by permitting the elements to belong to the set with a degree of uncertainty using a membership function. Universe of discourse between 0 and 1 and triangular fuzzy numbers (TFNs) are very common in the field (Cantillo *et al*., 2020; Luštický & Bína, 2014; Martín & Viñán, 2017; Mohsin *et al*., 2019). The use of TFNs is still very popular compared to other methods, such as trapezoidal fuzzy numbers, due to their computational simplicity and good properties in dealing with vague information (Martín & Román, 2017).

TFNs are good at capturing the imprecision inherent in answers based on semantic Likert scales. Respondents' answers are vague when they indicate agreement/disagreement with a particular issue, such as whether a society's persistence with a consumerist lifestyle poses a significant environmental risk in the future. The answer captures a subjective judgement, and it seems evident that the answers "I do not agree at all" and "I strongly agree" have different connotations regarding TACC.

Zadeh (1975) introduced the concept of a linguistic variable, which is expressed in natural language. He also proposed the use of fuzzy sets as a means of approximating reasoning. The concept involves a set of terms representing linguistic values and a universe of discourse consisting of real numbers. The quintuple component list includes the variable's name, the set of terms used for the answer format, a syntactic rule that generates the set of terms, and a semantic rule that associates each linguistic term with a fuzzy set within the universe.
In this paper, the triangular fuzzy numbers (a_1, a_2, a_3) are parameterised using $\mu_A(x)$ as the membership function:

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1}, & a_1 \le x \le a_2, \\ \frac{x-a_3}{a_2-a_3}, & a_2 \le x \le a_3, \\ 0, & otherwise. \end{cases} \qquad (1)$$

In the study, the interval [0, 100] is selected as the possible universe of discourse (Martín & Indelicato, 2023; Leon & Martín, 2021). Then, the 5-point Likert semantic scale of the linguistic terms are transformed, following Leon & Martin (2021), as follows: "I do not agree at all"-> (0, 0, 30), "I disagree on the whole"-> (20, 30, 40), "I neither agree nor disagree" ->(30, 50, 70), "I agree on the whole" -> (60, 70, 80) and "I strongly agree" -> (70, 100, 100). The membership function (equation 1) represents the degree of intensity or relative truth in each of the respondents' answers.

According to Zimmermann (2013), fuzzy set methods can be complicated for beginners to use due to their specialised nature. However, they offer a suitable way to model vague information in surveys and, in some cases, to complement classical approaches. Despite the challenges involved, the philosophy, formalism, and potential applications of fuzzy set methods make them worth exploring.

The algebraic properties of fuzzy set methods represent a significant advantage. They make it possible to aggregate TFNs based on variables of research interest, and the aggregated value results in another TFN. For instance, it is a common practice to segment responses based on socioeconomic variables like gender, age, or income. The average fuzzy number of n TFNs $\tilde{A}_i = \left(a_1^{(i)}, a_2^{(i)}, a_3^{(i)}\right)$, where $i = 1,2,3, \dots, n$, is determined by:

$$\tilde{A} = (a_1, a_2, a_3) = \left(\frac{1}{n}\right) \bullet \left(\tilde{A}_1 \oplus \tilde{A}_2 \oplus \cdots \tilde{A}_n\right) = \left(\frac{\sum_{i=1}^{n} a_1^{(i)}, \sum_{i=1}^{n} a_2^{(i)}, \sum_{i=1}^{n} a_3^{(i)}}{n}\right) \qquad (2)$$

Buckley (1985) showed that the average fuzzy number is another TFN by the properties of the algebra of fuzzy sets. It is worth noting that the new TFN inherits the vague nature of the information provided by respondents.

4.2. Defuzzifying the TFN information matrix

The information matrix is transformed into a TFN information matrix. Based on the variables included in the study, Equation 2 can be applied to determine the overall aggregated TFNs of the 921 valid responses. We use 39 covariates to classify the population into 146 segments based on our research interests. These segments are determined by using additional covariates to those mentioned in the previous section.

In the current study, given the number of items of the TACC latent variable and the number of segments provided by the covariates, the information TFN matrix has a dimension of (10, 146) [eq. 2]. The results section will show the aggregated TFNs for the whole sample and the destination categories. This will help readers unfamiliar with fuzzy set methods to understand why finding the item that produces the greatest agreement consensus among respondents is not a straightforward task. According to Yager (1996), defuzzification is central to implementing fuzzy set multi-criteria decision-making models. Defuzzification is essentially a process in which the TFN matrix obtained is finally converted into a crisp information matrix. Kumar (2017) provides a comprehensive review of the different defuzzification methods that are currently available. Moreover, Wang and Lee (2007) generalise the steps of TOPSIS within a fuzzy logic, translating max and min operations in the fuzzy sets algebra, using the operators Up and Lo. These operators are defined in a fuzzy environment satisfying the partial ordering relation on fuzzy sets.

We use the centroid or the centre of area method proposed by Chen (1996) as a defuzzification method to defuzzify the TFN matrix. It is calculated as $v_{\tilde{A}} = (a_1 + 2a_2 + a_3)/4$. It can be seen that the method is simply a weighted average which attaches more importance to the vortex of the triangle than to the inferior and superior extremes, blending or mixing the relevant information provided by the TFN. The method is robust and unaffected by the optimism or pessimism of the researchers' judgements (Kaufmann & Gupta, 1988). Kumar (2017) recently showed that it is equivalent to the total integral value. Martín *et al.* (2018) showed that the centroid method provides more robust results than other more sophisticated defuzzification methods based on complicated entropy weight calculation methods.

4.3. Technique for order performance by similarity to ideal solution (TOPSIS)

Once the crisp information matrix is obtained by applying the defuzzification method, the TACC index can be calculated using the technique for order preference by similarity to the ideal solution (TOPSIS).

TOPSIS is still one of the most widely used multi-criteria decision-making techniques in the social sciences (Hwang & Yoon, 1981; Zeleny, 1982). The method is based on obtaining the ideal solutions according to:

$$A^+ = \{(max\, V_{ij} \,|j \in J), (min\, V_{ij} \,|j \in J'), i = 1,2,\dots,m\}$$
$$A^- = \{(min\, V_{ij} \,|j \in J), (max\, V_{ij} \,|j \in J'), i = 1,2,\dots,m\} \quad (3)$$

where J and J' divide the items that form the TACC latent variable depending on whether the item is considered a benefit or a cost. In our case, all the indicators have a positive nature, i.e., higher figures mean that respondents are more concerned and aware of climate change.

Then, the ideal solutions are used to normalise all the aggregated TFNs, obtaining in this way the synthetic TACC index for each segment. Mathematically, the index is calculated using the Euclidean distances between each observation and the ideal solutions as follows:

$$S_i^+ = dist(V_i, A^+) = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - A_j^+\right)^2} \quad i = 1,2,\dots,m$$
$$S_i^- = dist(V_i, A^-) = \sqrt{\sum_{j=1}^{n} \left(V_{ij} - A_j^-\right)^2} \quad i = 1,2,\dots,m$$
$$TACC_i = \frac{S_i^-}{S_i^+ + S_i^-} \quad i = 1,2,\dots,m \quad (4)$$

It can be seen that the index of each segment is always in the interval [0,1]. Thus, the index is used to determine whether a particular segment is more or less aware than another of the effects of climate change. Segments with relative indices close to 1 are more aware of climate change.

4.4. Elasticities

The methodology section ends by introducing the concept of elasticity, which measures the sensitivity of the composite TACC index obtained to changes in the values of each item for a segment of interest. Thus, policymakers, DMO managers and transport authorities will obtain valuable results regarding whether a particular segment is more or less elastic with respect some climate indicator included in the scale. Mathematically, the *(i,j)-elasticity* of the TACC index for a segment *i* and an item j is calculated as:

$$\eta_{ij} = \frac{\Delta\%TACC_i}{\Delta\%item_{ij}} = \frac{dTACC_i}{ditem_{ij}} \frac{item_{ij}}{TACC_i} \quad (5)$$

Elasticity values are then obtained for each (segment-item) pair of interest. In the study under consideration here, 146 distinct segments are analysed for each of the ten scale items. This particular aspect of elasticities is a powerful tool, helping climate change analysts to identify the items requiring special attention with a view to raising social awareness of climate change.

5. Results

Table 1 shows the basic descriptive statistics of the twelve socioeconomic and demographic variables selected: destination, residence, gender, primary transport mode used during holidays, use of bikes, willingness to use bikes if they are available, use of scooters, disposition towards car sharing, education, age, group size and income. Each of the destinations is visited by approximately half the sample. Germans and British are the most represented, accounting for 17% and 30% of the sample respectively. About 50% of the sample use a car as the primary transport mode to move around the island, and only

a small proportion walk (7.3%). Half of the sample do not use a bike at home, but 29% will cycle at the destination if bike-sharing systems exist. Twenty-two per cent of respondents are frequent bike users at home, while only 9% are frequent scooter and car-sharing users. Respondents' level of education is very high, as 47% have a bachelor's or master's degree. Almost 65% are between 18 and 45 years old. Fourteen per cent of the sample come alone to the island, while 27% come in groups of four or more people. Thirty-four per cent of the respondents preferred not to declare their income, while 25% declared a monthly net income of above 3501 euros.

Table 1. Descriptive statistics of the socioeconomic and demographic variables.

Variable	Category	N	Percentage*
Destination	San Bartolomé de Tirajana	600	49.26
	Adeje	618	50.74
Residence	Another island	61	5.01
	Spain (except Canary Islands)	132	10.84
	Germany	209	17.16
	France	72	5.91
	Ireland	47	3.86
	Italy	108	8.87
	UK	372	30.54
	Russia	28	2.30
	Residence (other)	189	15.52
Gender	Female	592	48.60
	Male	626	51.40
Primary transport mode at destination	Car hire (driver)	182	14.94
	Car hire (passenger)	102	8.37
	Private car (driver)	65	5.34
	Private car (passenger)	88	7.22
	Taxi	176	14.45
	Tourist bus	61	5.01
	Regular bus	288	23.65
	Motorbike	7	0.57
	Walking	89	7.31
	I will only use one mode of transport when travelling to and from the airport.	80	6.57
	Other transport mode	80	6.57
Use of bike at home	Not a bike user	619	50.82
	Frequent bike user	268	22.00
	Occasional bike user	331	27.18
Willingness to use bikes if available	Bike-Willingness to Use. Zero	375	30.79
	Bike-Willingness to Use. Definitely	137	11.25
	Bike-Willingness to Use. Probably	217	17.82
	Bike-Willingness to Use. Not sure	212	17.41
	Bike-Willingness to Use. Probably not	111	9.11
	Bike-Willingness to Use. Definitely not	166	13.63
Scooter use	I do not know how to use a scooter	620	50.90
	Frequent scooter user	115	9.44
	Occasional scooter user	255	20.94
	Not a scooter user	228	18.72
Car-sharing	Frequent car sharer	112	9.20
	Occasional car sharer	109	8.95
	Never	997	81.86
Education	No education	30	2.46
	Primary education	37	3.04
	Secondary education	150	12.32

Variable	Category	N	Percentage*
	University entrance	229	18.80
	Vocational training	200	16.42
	University studies (diploma, degree or bachelor's degree)	468	38.42
	Master's degree or doctorate	104	8.54
Age	Age <=25	179	14.70
	Age 26-35	320	26.27
	Age 36-45	289	23.73
	Age 46-55	191	15.68
	Age 56-65	149	12.23
	Age >=66	90	7.39
Group size	Alone	174	14.29
	Two people	389	31.94
	Three people	323	26.52
	Four people	236	19.38
	Five people	75	6.16
	Six or more people	21	1.72
Net Monthly Income	Not disclosed	420	34.48
	Less than 450 €	4	0.33
	Between 450 and 900 €	47	3.86
	Between 901 and 1,500 €	111	9.11
	Between 1,501 and 2,400 €	159	13.05
	Between 2,401 and 3,500 €	168	13.79
	Between 3.501 and 4,500 €	186	15.27
	More than 4,500 €	123	10.10

*Some categories do not add up to 100 because there are some missing values.

Table 2 shows the TFNs and defuzzified values corresponding to the total sample of respondents and divided according to study site. The three respective TFN matrices contain a great deal of information because each row is represented by a TFN, and those unfamiliar with fuzzy set theory may find it challenging to interpret. Looking at the rows of the TFN matrices, it can be seen that the intersection of the TFNs is not empty. In addition, the ranking of the TFNs is not an evident, neutral issue, and numerous ranking methods have been proposed (Akyar *et al.*, 2012). The crisp value can be used to see whether some segment agrees more in some indicator of the scale.

Table 2. TFNs and defuzzified values for Total, San Bartolomé de Tirajana and Adeje

Item	Total		San Bartolomé de Tirajana		Adeje	
	TFN	Crisp	TFN	Crisp	TFN	Crisp
clim1	(47.62, 65.48, 76.40)	63.75	(42.13, 58.57, 71.40)	57.67	(52.94, 72.20, 81.26)	69.65
clim2	(49.98, 68.69, 78.83)	66.54	(42.73, 59.17, 71.80)	58.22	(57.01, 77.93, 85.65)	74.63
clim3	(50.79, 69.36, 79.31)	67.20	(43.48, 60.23, 72.48)	59.11	(57.88, 78.22, 85.94)	75.06
clim4	(46.08, 63.18, 74.64)	61.77	(39.85, 55.38, 68.87)	54.87	(52.12, 70.74, 80.24)	68.46
clim5	(50.12, 68.82, 78.74)	66.63	(42.85, 59.72, 72.13)	58.60	(57.18, 77.65, 85.16)	74.41
clim6	(49.34, 67.94, 78.28)	65.88	(42.65, 59.62, 72.23)	58.53	(55.84, 76.02, 84.16)	73.01
clim7	(48.69, 67.08, 77.68)	65.13	(42.43, 59.17, 71.90)	58.17	(54.77, 74.76, 83.28)	71.89
clim8	(50.49, 69.00, 79.03)	66.88	(42.45, 59.12, 71.63)	58.08	(58.30, 78.59, 86.21)	75.42
clim9	(50.89, 69.72, 79.59)	67.48	(42.78, 59.40, 72.02)	58.40	(58.75, 79.74, 86.94)	76.29
clim10	(52.50, 72.45, 81.41)	69.70	(43.90, 60.95, 73.05)	59.71	(60.84, 83.61, 89.53)	79.40

clim1: I worry about the future of society when I think about the environment we are going to leave behind; **clim2**: If society continues to maintain a consumerist lifestyle, environmental problems will be very serious; **clim3**: I consider environmental problems to be very important today; **clim4**: The information we receive about the consequences of climate change is accurate; **clim5**: Politicians must become more involved in protecting the environment; **clim6**: In order to protect the environment, we must all be willing to change our current lifestyle; **clim7**: Environmental protection measures must be implemented, even if this may have a restrictive effect on the economy in the short term; **clim8**: It is important to promote policies for the reduction of greenhouse gas emissions; **clim9**: It is important to promote policies that contribute to an increase in the planet's forest cover; **clim10**: Climate change is already a palpable reality

Focusing on the results obtained at the destination level, it can be seen that for all the items, respondents in Adeje present higher 3-tuples in all cases than their counterparts in San Bartolomé de Tirajana. Thus, it seems evident that respondents in Adeje will present higher composite TACC scores. Similarly, the analysis by rows shows that all the components of the TFN vector for the item "climate change is already a palpable reality" are higher than for the rest of the components. The crisp values also confirm this; item clim10 obtains higher agreement than any other item. In contrast, the item with the lowest level of agreement is "The information we receive about the consequences of climate change is accurate" for each of the segments presented in the table.

Table 3 shows the ideal solutions (A^+ and A^-) (Eq. 3), the segment achieving the figure, and the percentage variation between the two ideal solutions. Two particular segments overrepresent the ideal solutions. The tourists who do not express a preference between using an electric or conventional bike if the bike-sharing system exists at the destination are the most representative group for the positive ideal solution. Meanwhile, the two lowest income segments, namely "less than 450 euros" and "between 450 and 900 euros", are the representative segments of the negative ideal solution. It can be easily inferred that these representative segments are likely to be among the highest and lowest TACC groups. All the results will be discussed in the next section.

Table 3. Fuzzy hybrid TOPSIS ideal solutions

Item	A^+	A^+. Rep.	A^-	A^-. Rep.	Perc.Var.
I worry about the future of society when I think about the environment we are going to leave behind.	80.00	Motorbike	42.71	(*)	87.3%
If society continues to maintain a consumerist lifestyle, environmental problems will be very serious.	78.92	BPT Indifferent	39.38	(**)	100.4%
I consider environmental problems to be very important today.	79.77	BPT Indifferent	44.38	(**)	79.8%
The information we receive about the consequences of climate change is accurate.	76.90	BPT Indifferent	28.75	(**)	167.5%
Politicians must become more involved in protecting the environment.	80.09	BPT Indifferent	28.75	(**)	178.6%
In order to protect the environment, we must all be willing to change our current lifestyle.	80.22	BPT Indifferent	44.38	(**)	80.8%
Environmental protection measures must be implemented, even if this may have a restrictive effect on the economy in the short term.	80.00	Motorbike	43.40	(*)	84.3%
It is important to promote policies for the reduction of greenhouse gas emissions.	79.33	(+)	44.38	(**)	78.8%
It is important to promote policies that contribute to an increase in the planet's forest cover.	81.27	BPT Indifferent	34.38	(**)	136.4%
Climate change is already a palpable reality.	83.33	Other reason	49.89	(*)	67.0%

(*)Between 450 and 900 €; (**)Less than 450 €; Climate change is not a problem; (+)Master's degree or doctorate

Table 4 shows the figures of the synthetic *TACC* index. First, analysing the site where respondents answered the survey, the *TACC* index shows some obvious result after the comments expressed for the TFN and the crisp information, that is, that respondents in Adeje are more aware of climate change than their peers in San Bartolomé de Tirajana. The results on the segmentation residence variable also show very interesting results regarding the two extremes of the table. Second, visitors from other Canary Islands and Russians showed the least awareness, and Italians and Germans showed the most. With regard to the main transport mode to be used in the islands, the yin-yang categories of the least-most aware segments are formed by those who use taxis and motorbikes respectively. Frequent bike users are more aware than non-bike users. Similarly, those who would definitely use a bike system if available are more aware than those who would not use this system. Interestingly, those who are indifferent or prefer conventional bikes are more aware than those who prefer electric bikes.

Table 4. Tourists' composite TACC index.

Variable	Category	TACC	Variable	Category	TACC
Total	***Total***	***0.6574***	Scooter user	I do not know how to use a scooter	0.5326
Destination	San Bartolomé de Tirajana	0.4663		Occasional scooter user	0.7325
	Adeje	0.8406		Frequent scooter user	0.7646
Residence	Another island	0.2327		Never uses scooter	0.8567
	Russia	0.4140	Car sharing	Non-car sharer	0.6205
	France	0.4689		Occasional car sharer	0.7275
	UK	0.5872		Frequent car sharer	0.9119
	Spain (except Canary Islands	0.6188	Age	Age >=66	0.5836
	Ireland	0.6442		Age <=25	0.6094
	Residence (Oother)	0.7036		Age 46-55	0.6313
	Italy	0.8100		Age 56-65	0.6371
	Germany	0.9151		Age 26-35	0.6906
Main transport mode used at destination	Taxi	0.3751		Age 36-45	0.6999
	Private car (driver)	0.4798	Education	Secondary education	0.2855
	Tourist bus	0.5715		No education	0.3392
	Private car (passenger)	0.6898		Primary education	0.4276
	Other transport mode	0.6933		University entrance	0.6222
	(*)	0.6980		Vocational training	0.6327
	Regular bus	0.7010		(**)	0.7833
	Walking	0.7415		Master's degree or doctorate	0.9426
	Car hire (driver)	0.7699	Group size	Alone	0.4284
	Car hire (passenger)	0.8094		Five people	0.6692
	Motorbike	0.8901		Two people	0.6876
Bike user	Not a bike user	0.4793		Three people	0.6980
	Occasional bike user	0.7708		Four people	0.7090
	Frequent bike user	0.9290		Six people or more	0.7553
Willingness to use bike if available	Not a bike user	0.4573	Gender	Male	0.6274
	Definitely not	0.5178		Female	0.6892
	Probably not	0.6759	Income	Less than 450 €	0.0734
	Not sure	0.6776		Between 450 and 900 €	0.1835
	Probably	0.8895		Between 901 y 1.500 €	0.2872
	Definitely	0.9585		Income (NA)	0.6381
Type of bike preferred	Not a bike user	0.5506		Between 1.501 y 2.400 €	0.6506
	Electric	0.8020		Between 3.501 y 4.500 €	0.7877
	Conventional	0.9207		More than 4.500 €	0.8324
	Either	0.9762		Between 2.401 y 3.500 €	0.8427

(*)I will only use one mode of transport when travelling to and from the airport; (**)University studies (diploma, degree or bachelor's degree)

Regarding the scooter and car-sharing systems, it seems that people who use these systems are already more CC-aware than those who do not. The age results show that the least aware tourists are those older than 65 and younger than 26, the two extremes of this category. More educated tourists seem to be more aware than their less educated peers. Regarding the group size, it seems that the most aware tourists come in large groups or in groups of at least four; those who come alone comprise the least aware group. Females seem to be more aware than males. Finally, high-income tourists are more aware than those with lower incomes.

Table 5 presents the elasticity values of the composite TACC index for the whole sample and the categories extracted from the bike user segmentation covariate. The categories were determined by identifying respondents who use bicycles at their place of residence. Participants were asked, "Are you a bicycle user at your usual place of residence?" Their answers were used to create three categories based on a scale with the options: no, yes occasionally, and yes frequently.

Table 5. TACC index elasticity values

Item	Total	(1)	(2)	(3)
I worry about the future of society when I think about the environment we are going to leave behind.	0.2468	0.2577	0.2830	0.2627
If society continues to maintain a consumerist lifestyle, environmental problems will be very serious.	0.2317	0.2895	0.0739	0.1901
I consider environmental problems to be very important today.	0.2223	0.2556	0.0999	0.1670
The information we receive about the consequences of climate change is accurate.	0.2624	0.3377	0.2255	0.2742
Politicians must become more involved in protecting the environment.	0.2790	0.3849	0.1736	0.2328
In order to protect the environment, we must all be willing to change our current lifestyle.	0.2343	0.2552	0.1793	0.2209
Environmental protection measures must be implemented, even if this may have a restrictive effect on the economy in the short term.	0.2385	0.2614	0.2895	0.2339
It is important to promote policies for the reduction of greenhouse gas emissions.	0.2188	0.2565	0.1837	0.1750
It is important to promote policies that contribute to an increase in the planet's forest cover.	0.2709	0.3509	0.2155	0.2185
Climate change is already a palpable reality.	0.2336	0.2502	0.1782	0.1953

(1) Not a bike user; (2) Frequent bike user; (3) Occasional bike user

These values suggest that the composite index is inelastic concerning all the items included in the scale and for all the segment groups under analysis. As explained above, the table can be analysed two-dimensionally by each item of interest and the segmentation group pair. Focusing first on the whole sample, it can be concluded that the index is more elastic for the following two items: "It is important to promote policies that contribute to an increase in the planet's forest cover" and "Politicians must become more involved in protecting the environment". Regarding the other direction, the index is more inelastic to the item "It is important to promote policies for the reduction of greenhouse gas emissions". Similar patterns are observed for each row, but the index is seen to be more elastic for the group of non-bike users than for frequent bike users. The two lowest figures, which represent the most inelastic behaviour for the table, are obtained for the frequent bike users and the following two items: "If society continues to maintain a consumerist lifestyle, environmental problems will be very serious" and "I consider environmental problems to be very important today".

Table 6 presents an analysis of whether there are significant differences in the *TACC* index by applying a one-way ANOVA method to the individual TOPSIS values. The table includes average values and standard deviations. It also discusses whether significant differences exist based on whether the average of certain categories is significantly lower than the values indicated by their respective superscripts. For the sake of brevity, the table only displays the segmentation variables that showed statistically significant differences.

It can be seen that most of the rankings obtained in Table 6 are exactly the same as those obtained and displayed in Table 4. The only differences are observed for the main transport used at the destination. Table 6 does not include the gender and age results because the average values were not statistically different. For ease of presentation, the average differences are not discussed again, as they are similar to those displayed in Table 4. Examining the reasons behind the discrepancies between the aggregated fuzzy hybrid analysis results and those derived from averaging the individual fuzzy TOPSIS results is outside the focus of this paper; however, this might be an interesting empirical topic for future research.

The discussion column shows the statistical differences observed for each group considered in the study. Thus, in the row of San Bartolomé de Tirajana, the figure in the column is 1, meaning that the average of 0.58 recorded in the municipality is statistically lower than the one in Adeje, which is 0.76. Similarly, the average score for secondary education of 0.4878 is statistically lower than the averages for groups 3-6, which correspond to university entrance, vocational training, university studies (diploma, degree or bachelor's degree), and master's degree or doctorate respectively.

Table 6. One-way ANOVA analysis.

Name	Average	SD	Disc.
San Bartolomé de Tirajana	0.5809	0.0111	1
Adeje[1]	0.7607	0.0109	
Another island	0.4667	0.0353	3-8
Russia[1]	0.5637	0.0521	7-8
France[2]	0.5892	0.0325	7-8
UK[3]	0.6391	0.0143	7-8
Spain (except Canary Islands)[4]	0.6513	0.0240	8
Ireland[5]	0.6719	0.0402	
Residence (other)[6]	0.6852	0.0201	8
Italy[7]	0.7455	0.0265	
Germany[8]	0.7974	0.0191	
Taxi	0.5322	0.0210	3-9
Private car (driver)[1]	0.5821	0.0346	7-9
Tourist bus[2]	0.6388	0.0357	
Private car (passenger)[3]	0.6754	0.0297	
(*)[4]	0.6897	0.0312	
Normal bus [5]	0.6900	0.0164	
Other transport mode[6]	0.7036	0.0312	
Car hire (driver)[7]	0.7280	0.0207	
Walking[8]	0.7298	0.0296	
Car hire (passenger)[9]	0.7399	0.0276	
Motorbike[10]	0.8073	0.1055	
Not a bike user	0.5875	0.0109	1-2
Occasional bike user[1]	0.7246	0.0149	2
Frequent bike user[2]	0.8028	0.0166	
Bike-Willingness to Use. Not a bike user	0.5762	0.0140	2-5
Bike-Willingness to Use. Definitely not[1]	0.5983	0.0211	3-5
Bike-Willingness to Use. Probably not[2]	0.6826	0.0258	4-5
Bike-Willingness to Use. Not sure[3]	0.6852	0.0187	4-5
Bike-Willingness to Use. Probably[4]	0.7856	0.0185	
Bike-Willingness to Use. Definitely[5]	0.8156	0.0232	
Bike Preference Type. Not a bike user	0.6209	0.0093	1-3
Bike Preference Type. Electric[1]	0.7308	0.0280	3
Bike Preference Type. Conventional[2]	0.7943	0.0280	
Bike Preference Type. Either[3]	0.8382	0.0215	
I do not know how to use a scooter	0.6113	0.0112	1-3
Occasional scooter user[1]	0.7107	0.0175	
Frequent scooter user[2]	0.7130	0.0260	
Non-scooter user[3]	0.7738	0.0185	
Non-car sharer	0.6575	0.0090	2
Occasional car sharer[1]	0.6914	0.0272	2
Frequent car sharer [2]	0.7836	0.0268	
Secondary education	0.4878	0.0222	3-6
No education[1]	0.5169	0.0496	5-6

Name	Average	SD	Disc.
Primary education[2]	0.5612	0.0446	5-6
University entrance[3]	0.6525	0.0179	5-6
Vocational training[4]	0.6543	0.0192	5-6
University studies (diploma, degree or bachelor's degree)[5]	0.7349	0.0125	
Master's degree or doctorate[6]	0.8170	0.0266	
Alone	0.5578	0.0214	2-5
Five people[1]	0.6858	0.0327	
Two people[2]	0.6868	0.0143	
Three people[3]	0.6876	0.0157	
Four people[4]	0.7021	0.0184	
Six or more people[5]	0.7230	0.0617	
Less than 450 €	0.3555	0.1354	
Between 450 and 900 €[1]	0.4281	0.0395	3-7
Between 901 and 1,500 €[2]	0.4838	0.0257	3-7
Not disclosed[3]	0.6565	0.0132	5-7
Between 1,501 and 2,400 €[4]	0.6621	0.0215	6-7
Between 3,501 and 4,500 €[5]	0.7500	0.0199	
Between 2,401 and 3,500 €[6]	0.7645	0.0209	
More than 4,500 €[7]	0.7681	0.0244	

(*)I will only use one mode of transport when travelling to and from the airport.[4]

The results of the ANOVA show that destination, residence, primary transport mode used at the destination, being a regular bike or scooter user or car-sharer at home, disposition to use bikes in the MaaS packages, having a preference for electric bikes, educational level, group size and income exhibit significant differences. For example, visitors who came on their own were less aware of climate change than those coming in groups of two, three, four or more than five people.

6. Discussion

The results of the study show significant variations in responses across the different groups examined. Responses to issues such as the accuracy of the information we receive about the consequences of climate change and the duty of politicians to engage more in protecting the environment varied quite widely; in contrast, there was more consensus on the issue of whether climate change is already a palpable reality. Leiserowitz *et al.* (2013) and Poortinga *et al.* (2011) also found that views on the effects of climate change and global warming were quite heterogeneous, and that CC scepticism seemed to be quite widespread. Yan *et al.* (2022) linked the contemporary politics of climate change scepticism and populism, analysing the opposing forces between those who want to make climate change a priority on the political agenda against those who deny that it requires any substantive action or that it is a human-made or anthropogenic problem.

It is difficult to explain why respondents in Adeje are more aware of climate change than their peers in San Bartolomé de Tirajana. Despite the differences recorded, the tourists travelled to the islands by air. This might suggest that the idea of taking a break to visit an island is no longer an aspiration, but an expectation (Shaw & Thomas, 2006). In other words, the democratisation of air travel has effects that will be difficult to counteract. Similarly, the extreme differences in the results observed using the residence segmentation variable between visitors from other islands in the archipelago and Russians on the one hand and Italians and Germans on the other might be explained by cultural differences that shape a collective idea about the latent variable under study. Marsden *et al.* (2014) contended that climate change mitigation would need a significant change in approaches to the demand for travel demand.

Regarding the transport mode used at home, the results confirm that frequent bike users are more aware than non-bike users and that those who use bike-sharing systems at the destination, if available, are more aware than those who do not use these systems. Bike-sharing might be a good alternative for some short trips to the most important tourist destinations in the islands. In addition to the marginal benefits for some tourists, the bike-sharing system can also lure potential new tourists more concerned with climate change (Chen & Huang, 2021). For this reason, the development of these infrastructures in the context of tourism is receiving growing attention from researchers (Khajehshahkoohi *et al.*, 2022)

Regarding the scooter and car-sharing systems, it seems that users are already more CC-aware than non-users. These results corroborate those found in other contexts (Hjortesed & Böcker, 2020; Ramos *et al.*, 2020; Truffer, 2003). Truffer (2003) showed that in car-sharing systems in Switzerland implemented in two neighbourhoods, the most environmentally concerned members of the public contributed decisively to the development of the systems. Ramos *et al.* (2020) found that environmental concerns and personal attitudes towards the environment play a decisive role in the decision to engage in car-sharing. Those authors found that concern for the environment is the most relevant factor in predicting the distinct mobility clusters. In Norway, Hjortesed and Böcker (2020) found that concern for the environment exerted a clear positive effect on adopting a car-sharing system.

The results on age and education are also concordant with those of previous studies (Dechezleprêtre *et al.*, 2025; Lee *et al.*, 2015; Linde, 2020; Weckroth & Ala-Mantila, 2022). Weckroth and Ala-Mantila (2022) found that education was negatively associated with climate change scepticism. Nevertheless, Dechezleprêtre *et al.* (2025) found mixed patterns regarding age across countries, and it was not always the case that young respondents were systematically more concerned about climate change; those authors found evidence that support for climate policies depended more on other issues such as lifestyle, dependence on public transport, and, to a lesser extent, gas prices. They found that certain groups tend to worry more about unabated climate change, namely women, the young, the more educated, and left-leaning respondents. At the same time, higher-income, college-educated, older, or left-leaning respondents are significantly more optimistic about humans' technical ability to halt climate change (p. 17). Linde (2020) showed that partisan preferences and ideology are so strong that they reduce the impact of other sociodemographic traits like education and age. This author concluded that partisanship is the most stable predictor of climate change concern, with supporters of conservative parties commonly being less worried than those of liberal parties (p. 2004).

The lack of studies analysing climate change awareness in the tourism industry makes it impossible to compare our results regarding group size. Nevertheless, the gender and income results are similar to those obtained in other studies in more general contexts (Dechezleprêtre *et al.*, 2025; Köchling, *et al.*, 2025; Linde, 2020; Weckroth & Ala-Mantila, 2022). In particular, Köchling *et al.* (2025) found that income, age, and a desire to keep a low climate footprint profile do not significantly affect the readiness to travel long distances for tourism. In the rest of the studies, authors report empirical evidence suggesting that women are more worried about climate change than men, and that income is positively associated with climate change awareness.

7. Policy and practical implications

The results presented here broaden our understanding of the elasticity of the awareness of climate change among tourists visiting two mass-tourism municipalities in the Canary Islands and the effect on this phenomenon of a broad set of covariates. Policymakers, DMO managers and transport authorities may gain very interesting insights into the elasticity of the TACC index with regard to the individual items for bike users and non- cyclists. Interestingly, bike users represent the most inelastic segment with regard to the two distinctive items: namely, that society cannot maintain the current levels of consumerism, and that environmental problems are already a palpable outcome of human activity.

Thus, it seems that not only is more action needed to control environmental problems, but education is also vital in particular population segments, such as those who do not cycle regularly. This result expands on the findings presented by De Pryck (2023) and Abbass *et al.* (2022).

The ANOVA results do not indicate any significant differences of age and gender in relation to tourists' awareness of climate change. However, residence, the primary mode of transport used at the destination, being a regular cyclist, engaging in car-sharing or using a scooter at home, a predisposition to use bikes at the destinations, a preference for electric bikes, educational level, group size and income present significant differences. For example, tourists who travel on their own were less aware of climate change than those travelling with companions. Thus, DMO managers should prepare mobility campaigns, tailoring the necessities to each of the differences observed, although it is not clear that being climate change-aware actually predicts more sustainable mobility choices (Juvan & Dolnicar, 2014). Regarding companions, Bartl *et al.* (2025) distinguished between three subdimensions: same household, other households and travelling with children, and found that the covariate significantly affects different travel behaviour clusters.

It is beyond the scope of this paper to analyse the relationship between climate change awareness, inadequate environmental education and knowledge, and unsustainable mobility choices at tourist destinations. Regarding tourist mobility tracking, Padrón-Ávila and Hernández-Martín (2020) reported that geolocation-based techniques are the most frequently used in the literature. The Canary Islands, as a destination, are working hard to reduce their tourist carbon footprint. The regional government has reduced emissions per tourist by 22% since 2019 and emissions from tourism activities in the archipelago by 16% (Turismo de Islas Canarias, 2024). Further reductions can be achieved by developing MaaS mobility packages to foster more sustainable transport alternatives that match tourists' mobility needs.

8. Conclusions

In this study, a questionnaire was administered to 1218 tourists who were vacationing in the Canary Islands in order to investigate their awareness of climate change. This study is significant, as previous literature has largely ignored the topic. The analysis provides valuable insights into how various socioeconomic and demographic factors influence climate change awareness.

The study included twelve variables that have not been jointly examined in previous climate change studies. The scale item that achieved the greatest consensus was "climate change is already a palpable reality". The study also presented an analysis of variance which showed that climate change awareness was affected by several socioeconomic and demographic variables. In particular, it was shown that using more environmentally-friendly modes of transport such as bikes, scooters, and electric cars at home made tourists more aware of climate change.

The study has several limitations, which also present opportunities for future research. First, methodologically, the scale can be extended and validated by introducing more items specifically related to the tourism industry. Second, while fuzzy logic adequately handles the vagueness of the semantic scale used in the survey, the answer format itself could be improved by using questionnaires more closely adapted to the methodology used in the study. Third, our results show that some of the variables studied affected the composite index obtained, but the relative effect and significance are still unclear. Finally, the study only analysed the case of two particular micro-destinations on the islands of Tenerife and Gran Canaria, and it would be interesting to see whether the results can be generalised to other tourist archipelagos such as Greece, Croatia, and the Caribbean. In this regard, it will be interesting to analyse to what extent the use of private cars to access the destination affects tourists' travel behaviour during their stay.

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