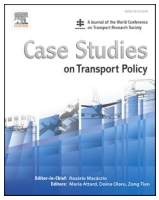
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What drives passengers towards sustainable aviation? A segmentation study of travel behaviour and environmental concern in Spain

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ABSTRACT

Air travel significantly contributes to greenhouse gas emissions, posing challenges for climate action. This study examines the attitudes and behaviours of Spanish air passengers, focusing on the relationship between environmental concerns and travel choices. Based on a survey of 1,206 participants, we employed exploratory factor analysis to identify three attitudinal clusters: "Status quo flyers," "Environmentally conscious low-flyers," and "Pragmatic moderates". These segments display significant differences in travel frequency, environmental concern, perception of aviation's impact, and willingness to adopt sustainable alternatives. While environmentally conscious travellers express willingness to reduce air travel, frequent flyers often resist behavioural changes, highlighting a persistent attitude-behaviour gap. The results emphasise the importance of targeted strategies to address the attitude-behaviour gap and promote sustainability in aviation. This research provides actionable insights for policymakers and industry stakeholders to foster sustainable travel behaviours in one of Europe's largest aviation markets.

1. Introduction

Environmental concerns and climate awareness have risen in the past decades. In the European Union, 78 % of the surveyed individuals reported being concerned about climate change, ranking Europe as the most concerned region over China and the US (EIB, 2019). Despite this, overall, climate concern is similarly distributed worldwide, with around 60 % of people considering climate change a severe problem (Running, 2013). Air transport represents 2 % of the total global CO_2 emissions and 3.5 % if we consider its non-CO_2 effects contributing to climate change (Lee et al., 2020).

Since flying is one of the most polluting activities a person can undertake, cutting back on air travel is a very effective way to reduce one's carbon footprint (Ivanova et al., 2020; Wynes and Nicholas, 2017). Despite growing awareness of the environmental impact of flying, people have diverse concerns about its contribution to climate change. Some individuals remain unaware of the extent of aviation's impact and, as a result, do not consider climate change when planning their holidays. Others, even when informed, are unwilling to change their travel behaviours (Hares et al., 2010; Cohen et al., 2013). Moreover, while the aviation industry's discourses tend to downplay the environmental impact of air travel (Gössling and Peeters, 2007), its sustainability strategies continue to prioritise technological solutions and bioeconomic approaches, all while maintaining a growth-oriented perspective (Köves and Bajmócy, 2022). Even when individuals are concerned about climate change, they may still be reluctant to reduce flying for reasons such as believing that their actions do not matter and that it is not their responsibility to act (Cocolas et al., 2020) or falling for the technology-myths (Peeters et al., 2016) that suggest technology will solve climate change and make flying carbon neutral. For many, flying is simply another routine of modern life (Gössling and Hall, 2006), where taking several flights per year for business, leisure or visiting friends and family is considered normal. Regardless of its environmental harm, social circles rarely question this behaviour, especially in wealthy countries (Morten et al., 2018).

As more people recognise the environmental costs of air travel, they start to reconsider their flying choices. Consequently, some individuals have chosen to reduce or entirely quit flying for environmental reasons. However, evidence suggests that knowing about climate change does not necessarily lead to behavioural change (Anable et al., 2006). Instead, individuals are more likely to alter their habits when they connect climate change to their personal lives (Jacobson et al., 2020; Wormbs

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and Wolrath Söderberg, 2021). Furthermore, negative emotions like anxiety or guilt play a significant role in this process (Marczak et al., 2023). This increased awareness of flying's impact on climate change has led to phenomena such as the Swedish "flight shame," which encapsulates the feelings of climate guilt associated with flying (Gössling et al., 2019). Initiatives like the *Stay Grounded* platform, which encourages individuals to pledge to limit their flights, or *Flight Free,* which provides resources for calculating air travel emissions, empower people to make informed choices about their transport habits.

This background presents opposing views on the environmental implications of flying. While some researchers have examined passenger demand segmentation in the literature (Davison et al., 2014; Morten et al., 2018), a noticeable gap remains in understanding the specific motivations of passengers regarding the environmental aspects of flying and how their environmental beliefs influence their flying practices. Specifically, there is a need for segmentation analyses that move beyond simple demographics to capture the interplay of attitudes, perceived responsibility, behavioural intentions, and receptiveness to alternatives within a major European market. Acknowledging these motivations is crucial for developing effective strategies to address sustainability concerns within the aviation industry. In contrast to other modes of travel, which have witnessed a broader societal shift towards prioritising sustainability in decision-making processes (Hamidi and Zhao, 2020, Mouratidis and Næss, 2024, Nilsson and Küller, 2000), the aviation sector appears to reflect this trend only among smaller market segments (Cohen et al., 2013). This suggests that while sustainability is a significant factor for some travellers, it may not yet be a widespread consideration for the majority. Therefore, it is important to investigate the reasons behind the limited integration of sustainability into air travel preferences.

Our research aims to address these gaps through a large-scale survey followed by a segmentation analysis using clustering techniques. Understanding passenger segmentation provides actionable insights for policymakers and the aviation industry to design targeted interventions. By identifying distinct attitudinal groups, such as those resistant to change versus environmentally conscious travellers, tailored strategies can be developed to promote sustainable behaviours. We use Spain, one of Europe's most prominent aviation markets, as a case study. As part of the European Union, Spain is influenced by the EU's active role in environmental regulation. The EU has implemented initiatives like the EU Emissions Trading System (EU ETS) to reduce greenhouse gas emissions across its member states. These efforts show the EU's commitment to tackling environmental issues, which suggests that people in Spain and other EU countries may be more aware of environmental concerns than those in areas with less strict regulations. Spain's position as a key player in the global tourism industry (UNWTO, 2024) makes it an ideal setting to explore passenger attitudes towards sustainability in air travel. In this study, we want to analyse passengers' perspectives on environmental concerns related to flying, providing results that can inform the development of targeted strategies to promote sustainability in the aviation sector. Through our research in Spain, we aim to shed light on the factors influencing passenger behaviour and preferences, ultimately supporting a shift towards a more sustainable future for air travel.

The remainder of this paper is structured as follows. Section 2 presents a literature review, highlighting key studies and discussions relevant to our research. Section 3 outlines the data collection methods and analytical approaches used in this study. Section 4 presents the results of the analysis and offers a discussion of their implications. The concluding section 5 summarises the key findings and discusses their significance.

2. Literature review

2.1. Climate concern as a travel decision driver

Multiple factors affect people's environmental concerns. Research shows that a lack of knowledge about climate change or the solutions to avoid it is related to lower levels of concern and less behaviour change (Dunlap et al., 2000; Tobler et al., 2012). However, knowledge alone is not enough to drive action. For most people, simply understanding and being concerned about the ecological impact of their actions does not necessarily lead to behavioural shifts (Anable et al., 2006), this phenomenon is known as the attitude-behaviour gap (Kollmuss and Agyeman, 2002). In addition to knowledge, emotions also play a key role in driving climate concern and action, as emotional ties to one's "objects of care" can encourage support for climate change policies and influence attention, reflection, and action (Wang et al., 2018). Furthermore, negative emotional responses can increase acceptance of climate change and willingness to act (Wong-Parodi and Feygina, 2021).

Biospheric values, which prioritise the well-being of nature, and altruistic values, focused on the welfare of others, shape perceptions of climate impacts and adaptation, influencing attitudes towards climate change (Marshall et al., 2019; Wolf et al., 2013). These findings suggest that a combination of emotional engagement, knowledge, and values can trigger climate concern and action.

Research on transport and climate change tends to focus on the environmental impact of different transport modes, their sustainability, and the willingness of people to switch to low-carbon transport options. A common example is car use, where evidence shows that people worried about climate change tend to use public transport more often instead of driving their cars (Árnadóttir et al., 2024) and generally opt for more eco-friendly transport choices (Javaid et al., 2020). Moreover, Andersson (2020) found that in Swedish mobility management initiatives, climate morality is the key motivator for reducing private car use. Conversely, those sceptical about climate change are more likely to maintain traditional car ownership and usage patterns (Thøgersen et al., 2021).

Recently, some European countries, led by citizens' concerns and complaints, have proposed more active demand management strategies to influence travel decisions directly. Some of these initiatives aim to reduce short-haul flights and encourage train travel to lower transport emissions (Avogadro et al., 2021; Baumeister, 2019; Dalkic et al., 2017; Reiter et al., 2022). Although some argue that these policies have had a limited impact (Dobruszkes et al., 2022), a 2020 survey found that 62 % of European citizens support a ban on short-haul flights (EIB, 2019), highlighting strong public support for such restrictions.

2.2. The contradiction of air travel climate concerns

Research shows a contradictory response regarding transport: many individuals consider themselves environmentally aware and concerned about climate change, yet they continue to engage in behaviours that are harmful to the environment. This contradiction becomes more evident in the context of air transport.

First, we can highlight the concept of compensatory behaviours (Becken, 2007; Buckley, 2011), which usually plays an integral part in soothing cognitive dissonance when it comes to travelling. This extends to the notion of being home versus being on holiday, which acts as a temporary exemption for an individual's usual climate-friendly behaviour (Barr et al., 2010; Higham et al., 2016; Alcock et al., 2017). Some people justify their current environmentally damaging behaviours, believing that future technologies will mitigate the impact (Gössling et al., 2019; Lorenzoni et al., 2007). However, the promise of advancements in sustainable aviation fuels, electric aircraft, and improved efficiency will not likely be ready on time (Peeters et al., 2016).

The normalisation of air travel is also problematic, as business and leisure travel have become well-established social practices deeply ingrained in our society. According to the World Tourism Organization (2019), air travellers fall into three categories based on travel intentions: leisure, business, and visiting friends and relatives (VFR). In 2018, leisure travel accounted for 56 % of international arrivals, followed by VFR at 27 %, which makes them the most significant travel purposes. The

remaining percentage was allocated to business travel and unspecified trips. Leisure and VFR travel are important because, in many cases, individuals have the greatest freedom of choice when deciding on a destination and transport mode. Moreover, frequent flyer programs, social norms around travel, and the perception of flying as a necessity rather than a privilege may reinforce the disconnect between environmental concerns and air travel behaviour (Hares et al., 2010).

The available evidence shows that other people's opinions can impact someone's decision to fly (Morten et al., 2018). Individuals, even the environmentally concerned ones, understand the environmental cost of flying. Still, they do not feel personally responsible for this impact, making it easier to justify flying (Cocolas et al., 2020). Furthermore, despite the environmental impact, people are less likely to give up air travel for leisure or visiting friends and family (Kantenbacher et al., 2019; Gössling, 2019).

At the same time, travellers are becoming more conscious of climate change, primarily in Northern Europe (Cohen et al., 2013; Hares et al., 2010; Higham et al., 2016). The flight shame trend has gained significant attention in Europe, supported by extensive social media and press coverage (Becken et al., 2021). This movement reflects a growing environmental consciousness among travellers and a shifting sentiment against unnecessary flying due to the climate crisis. Consequently, these travellers seek to reduce or eliminate air travel, opting instead for more sustainable transport alternatives. However, the effectiveness of flight shame as a motor for change depends on how inclined individuals are to change their travel behaviour and whether there are available alternatives (Gössling et al., 2020). Although *flygskam* may not become mainstream just yet, the travel industry needs to adapt to evolving market attitudes (Mkono, 2020).

2.3. From concern to behaviour: Approaches to air travel behaviour and segmentation

The contradiction between climate concerns and air travel behaviours calls for a closer examination of the psychological factors behind these decisions. Two key theories in environmental psychology, the Norm Activation Model (NAM) (Schwartz, 1977) and the Theory of Planned Behaviour (TPB) (Ajzen, 1991), help explain the motivations that influence individuals' actions or inactions regarding their environmental concerns. NAM suggests that pro-social behaviour is triggered when individuals become aware of the consequences of their actions and feel a personal responsibility to act. This model emphasises altruistic motivations, focusing on how personal norms influence behaviour. On the other hand, the TPB explains behaviour through three determinants: attitude towards the behaviour, subjective norms (perceived social pressure), and perceived behavioural control (an individual's confidence in their ability to act).

Combining both models offers a key advantage: it simultaneously considers pro-social (altruistic) and self-interested motivations. This approach gives a broader perspective on the context of pro-environmental behaviour than when using each model independently. For example, TPB's perceived behavioural control can complement NAM's focus on personal norms, while subjective norms in TPB align with NAM's emphasis on moral responsibility. This combined framework has proven effective in understanding various aspects of transport behaviour, such as increased public transport usage (Bamberg et al., 2007), willingness to reduce car usage (Bamberg and Schmidt, 2003), and attitudes and behaviours associated with air travel (Davison et al., 2014; Morten et al., 2018).

Morten et al. (2018) proved that an extended TPB can predict intentions to reduce the number of flights taken for leisure or VFR in the UK. Davison et al (2014) used a combination of TBP and NAM to explain pro-environmental behaviour concerning air travel and develop consumer segments also in the UK. While these established theoretical frameworks provide a valuable foundation for understanding pro-environmental intentions, the present study utilises their core constructs within a broader interpretive approach specifically tailored for developing a nuanced passenger segmentation, as detailed in Section 3.

3. Case study, data and methodology

3.1. Spain

As the second most visited country in the world in 2023, just behind France (UNWTO, 2024), Spain's travel patterns reflect significant trends in tourism and transport. Spanish residents made 185.9 million trips in 2023, marking an 8.5 % increase compared to the previous year. Domestic trips rose 7.3 %, while international trips surged 19.6 %. Of these trips, 89.6 % had Spain as the main destination, with only 10.4 % being abroad (INE, 2024).

Moreover, Spain is home to key airlines like Iberia, the former national flag carrier and largest airline by passenger volume and fleet size operating within the country. As the primary airline based in Spain, Iberia plays a significant role in the nation's air transport infrastructure and connectivity, serving both domestic and international routes. Additionally, Vueling is among the top European low-cost carriers, making Barcelona the best-connected airport within Europe (Jimenez and Suau-Sanchez, 2020), competing head-to-head with Ryanair on many routes. In that regard, Spain has a significant presence in Europe's airport network, with three of its major airports—Madrid Barajas, Barcelona El Prat, and Palma de Mallorca—ranking among the top busiest airports in Europe. This is illustrated in Fig. 1, which maps Spanish airports by passenger size.

It is important to note that domestic air travel in Spain presents distinct operational and economic dynamics, particularly on routes serving the Balearic and Canary Islands. These regions depend on air transport for both mainland access and inter-island mobility; thin or peripheral routes can only survive through a reduction in the frequency of flights and increased prices. The traditional way of dealing with this problem in the EU has been to subsidise the population that lives in peripheral communities and impose public service obligations (PSOs) on the airlines that serve protected routes (Calzada and Fageda, 2012). In the Canary Islands, inter-island routes operate under public service obligations (Luis, 2010), while similar regulations shape transport flows in the Balearics (Martínez Raya and González-Sánchez, 2021). PSOs guarantee the service's continuity, frequency, capacity, quality and affordability. A residents discount scheme is also offered. It started in 2001, offering a 33 % price discount on domestic fares; today, it has increased to 75 %, which has significantly influenced travel behaviour, reducing the length of stay and increasing daily expenditure, particularly in the Balearics (Jiménez et al., 2022; Socorro et al., 2020).[1]

Past research on aviation travel behaviour in Spain has covered various topics, including the impact of low-cost carriers on travel patterns (Vera Rebollo and Ivars Baidal, 2009), the effects of tourism on airport traffic (Fernández et al., 2018), and the relationship between economic factors and air travel demand (Balsalobre-Lorente et al., 2021) underscoring Spain's relevance in the global air transport industry. To our knowledge, no one has conducted a large-scale analysis of air transport behaviour and climate concerns in Spain to identify underlying segments. This research will contribute to the literature on the attitude-behaviour gap by testing the idea that people care about the environment yet continue to fly frequently.

[1] While our sample included residents from the Balearic and Canary Islands, where air travel is often a necessity, their relatively small proportion in the overall sample (approx. 6%, see Table 3) suggests their specific circumstances are unlikely to fundamentally skew the overall segmentation results, although it may influence the travel frequency reported by individuals within that subgroup.

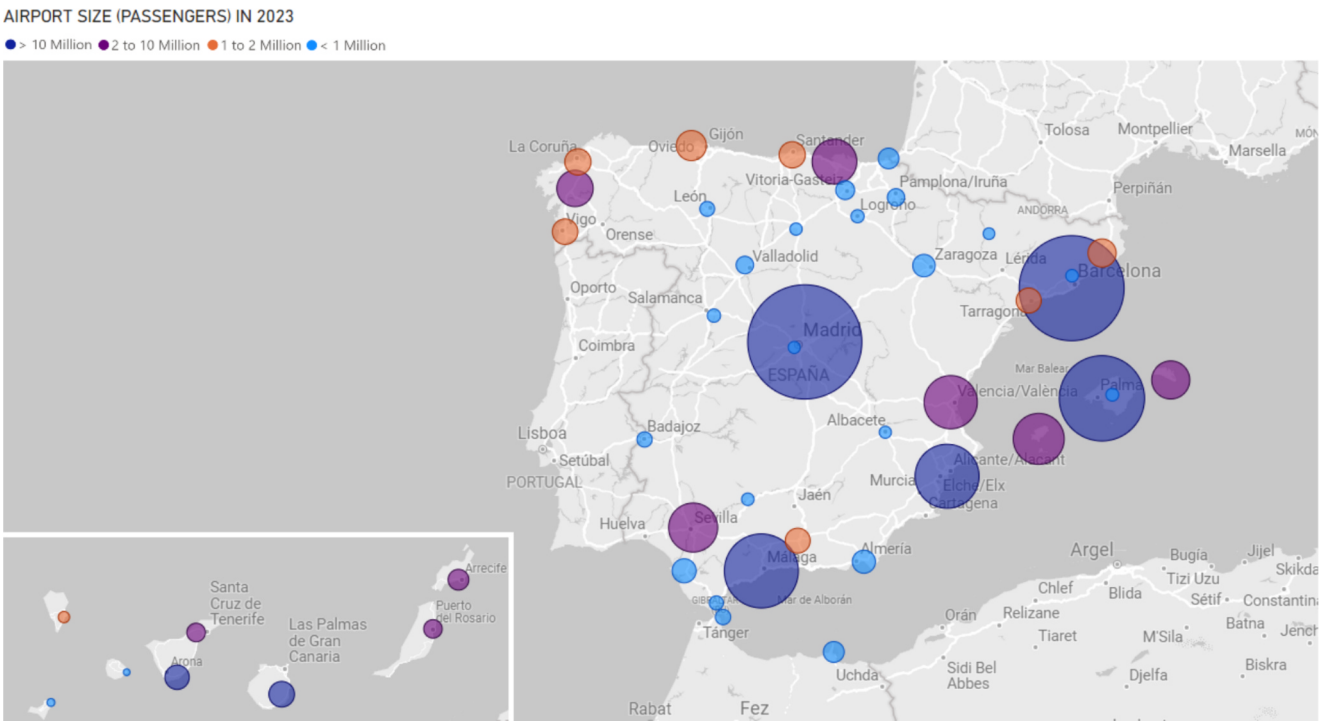


Fig. 1. Map of airport sizes in Spain. The map illustrates airport sizes determined by passenger traffic volumes in 2023. Data. Source: AENA, 2023

3.2. Questionnaire and data collection

While the broader context of sustainable aviation includes a variety of potential solutions, ranging from technological innovation to regulatory policies, this survey was specifically designed to investigate passengers' behavioural intentions and attitudinal orientations, particularly with respect to reducing air travel. Our aim was to capture these responses in a neutral way, avoiding potential framing biases that may arise from referencing specific policy measures.

Table 1
Questionnaire structure.

Topic	Items	Description
Socio-demographic factors	7	Gender, Age, Education Level Household Income, Nationality, Region and Postal code
Recent air travel behaviour	4	Number of return flights in the last 2 years (domestic, intra-EU, international) and how does current air travel compare with previous periods
Preferences regarding transport choices	8	What do they value when choosing a specific form of transport
Environmental Concern	5	Awareness of consequences and ascription of responsibility
Personal Concern about Climate Change	9	Perceived behavioural control, personal norm and subjective norm
Perception of Air Transport's Contribution to Climate Change	5	Attitudinal towards air transport's contribution to climate change
Techno-optimism in addressing climate challenges	4	Attitudes on the role of technological advances in addressing climate change and air transport
Behavioural intention	13	Intentions to reduce fly dependency, pay more to fly, adapt daily behaviours and choose alternatives to flying
Willingness to switch modes of transport	6	Willingness to switch to a more environmentally friendly mode of transport under various conditions (availability, cost, speed, comfort, safety, service quality)

We developed a questionnaire consisting of nine sections (see Table 1), each containing multiple questions or statements designed for participants to express their level of agreement on a 5-point Likert scale. Some questions were self-developed based on the literature, while others were adapted from previous studies (e.g., Davison et al., 2014; Morten et al., 2018) to align with established research. The questionnaire was originally written and distributed in Spanish. Our target sample, representative of the Spanish population,[2] included individuals aged 18 or older, residing in Spain, who had flown at least once for leisure in the past two years. In July 2024, we conducted a pilot test with a soft launch of 100 surveys to ensure the clarity and understanding of the questions. Following successful feedback, the full-scale launch of the survey took place in August 2024. The questionnaire was distributed online through an international market research and data analytics firm, with its own panel, gathering 1206 valid responses.

Although we drew inspiration from the key components of the Theory of Planned Behaviour (TPB) and the Norm Activation Model (NAM) in developing our survey (see Appendix B for full details), we did not adhere to a strict theoretical operationalisation. Rather, we adopted a broader interpretive approach designed to capture what we refer to as prevailing 'environmental concern' (Table 1), viewing this multifaceted construct as particularly pertinent for identifying distinct passenger segments based on their attitudes and behavioural intentions. In line with this approach, survey items reflecting core theoretical constructs –specifically 'awareness of consequences' and 'ascription of responsibility' (drawing from NAM), alongside 'perceived behavioural control', 'personal norm', and 'subjective norm' (drawing from both TPB and NAM)– were treated collectively as indicators of this overall environmental concern. The subsequent construction of the composite variable C.2, 'Prevailing Levels of Concern About the Environment' (detailed further in Section 3.3), utilised these indicators. To ensure the composite measure accurately reflected distinct facets of concern, the

[2] The Spanish population skews towards an older age distribution (GOV, 2023), and our sample also reflects this trend.

conceptual overlap between items was carefully managed during this construction phase. Specifically, the general statement 'I am very concerned about environmental issues', while administered in the survey, was identified as potentially redundant alongside more specific indicators of 'personal concern'. To avoid artificially inflating the measure with this general sentiment, it was treated distinctly during the composite variable calculation, effectively resulting in the five core conceptual components primarily informing 'environmental concern'.

3.3. Analytical methodology

First, we created three composite variables that cover features specific to each person. These variables were constructed by aggregating multiple related survey items, either by summing or averaging responses for each participant. This row-wise aggregation allows us to capture broader, meaningful constructs rather than individual items. Grounded in the literature (e.g., Budd et al., 2021; Davison et al., 2014; Morten et al., 2018), these variables were designed to provide a nuanced understanding of the factors influencing respondents' air travel behaviours and environmental concerns.

- C.1. Current Frequency of Air Travel: We considered the respondent's frequency of air travel since it serves as a starting point for understanding the current level of travel. We asked how often they had travelled by plane in the last two years and if it was a national or an international trip. This helps us identify frequent flyers from people flying once or twice yearly for their holidays.
- C.2. Prevailing Levels of Concern About the Environment: measures an individual's overall concern for the environment, distinguishing between general environmental concern and personal climate responsibility. It measures not only their attitudes but also their likelihood of acting based on their concerns. To choose these statements, we followed the TPB (Ajzen, 1991) and NAM (Schwartz, 1977), including the concepts of Awareness of consequences and ascription of responsibility, Perceived behavioural control, Personal norms and subjective norms.
- C.3. Perception of Air Transport's Contribution to Climate Change: measures participants' awareness and beliefs about the impact of air transport on climate change, including whether they believe people have alternatives to flying, or if experiencing new cultures is more important than saving resources.

Then, we used Exploratory Factor Analysis (EFA) to examine 31 attitude statements from the survey, we analysed the underlying relationships between the measured variables to uncover latent constructs, known as factors, which explain the correlations among the observed variables (Lawley and Maxwell, 1963). We carried out the EFA using the R programming language with the "psych" package.

To assess the data's suitability for EFA, we conducted the Kaiser-Meyer-Olkin (KMO) Test, which yielded an overall KMO value of 0.92, indicating good sampling adequacy. Each variable demonstrated a Measure of Sampling Adequacy (MSA) above 0.86, confirming their suitability for factor analysis. Additionally, Bartlett's Test of Sphericity produced a chi-square value of 10,072.05 with a p-value of 0, suggesting that the correlation matrix is significantly different from an identity matrix, thus supporting the use of factor analysis.

According to the Kaiser Criterion, we retained factors with eigenvalues greater than 1, resulting in three factors. Parallel Analysis also confirmed that three factors were appropriate for the data. Following Howard (2016), we kept variables that "(a) load onto their primary factor above 0.40, (b) load onto alternative factors below 0.30, and (c) demonstrate a difference of 0.20 between their primary and alternative factor loadings." Table A1 (in Appendix A) reports the full pattern loading matrix with variables labelled according to the order in which they appear in the survey.

To ensure the robustness of our findings, we conducted a Unidimensional Variance Analysis of Exploratory Factor Analysis (UVA-EFA), which is recommended when dealing with ordered categorical data, such as the Likert scale items used in our study. In line with the recommendations of Ledesma et al. (2021), we employed diagonally weighted least squares (WLS) and oblique rotation for this analysis. The results from this analysis were consistent with our previous EFA, which identified the same three factors. We retained the original EFA results and included the findings from the UVA-EFA in the Appendix A (Table A2).

Finally, the composite variables and the factors were used to segment respondents. To do so, we employed a two-step clustering methodology. In the first step, we determine the optimal number of clusters. To ensure a robust decision, we triangulated evidence from several techniques: we began with hierarchical clustering (using Ward's method) to explore the data's underlying structure, which was supplemented by using the Elbow Method. Furthermore, following the recommendations of Dolnicar et al. (2018) we graphed the cluster analysis for two to eight clusters and selected the point where adding more clusters did not significantly improve the results. These convergent approaches all indicated that a three-cluster solution was the most meaningful and stable representation of the data. In the second step, with the number of clusters established, we applied the non-hierarchical k-means clustering algorithm to finalise the segments. This method was selected in line with established practice in the field (e.g., Anable, 2005; Budd et al., 2014) for its efficiency and its effectiveness in partitioning the sample by minimising variance within each cluster. The analysis resulted in three distinct and interpretable segments based on the standardised data.

4. Results and discussion

4.1. EFA results

The three factors resulting from EFA together explain 50 % of the variance in our data and are described as follows:

- F.1. Alternative to flying: This factor examines participants' openness to choosing more environmentally friendly transport options instead of air travel. It measures their willingness to switch modes based on various conditions, including availability, cost, speed, comfort, safety and service quality.
- F.2. Preferences regarding transport choices: This factor measures what participants value when choosing a specific form of transport for a trip. Some key measured aspects are travelling time, comfort, price, preference for a particular mode of transport, safety, convenience, frequency of service and environmental impact.
- F.3. Behavioural Intentions: with this factor, we evaluate whether participants intend or are willing to change their behaviour in the future, such as avoiding flying or offsetting their emissions when travelling by plane. We organise this into four main subcategories: willingness to reduce flight dependency, pay more to fly sustainably, adapt everyday behaviours, and choose alternatives to flying.

Table 2
Summary of Exploratory Factor Analysis.

Factor	Highest loading item	Items loading on factor	Cronbach's alpha
F1_Alt	"I am willing to switch to a more environmentally friendly mode of transport if the quality of service is good"	6	0.91
F2_Pref	"Convenience influences my choice of transport for a trip"	7	0.80
F3_Change	"I would pay more to fly in a cleaner aircraft"	5	0.81

Table 2 summarises the structure and reliability of these three factors as identified through the EFA. For each factor, the item with the highest loading is presented as a representative example, along with the total number of items included in the factor and the corresponding Cronbach's alpha. These values indicate the internal consistency of the items within each factor. All three factors show good to excellent reliability, with alpha values ranging from 0.80 to 0.91. This supports the robustness of the factor structure and suggests that the grouped items reliably measure distinct aspects of participants' attitudes and intentions regarding sustainable air travel.

4.2. Attitudinal segmentation of leisure travellers

Our sample reveals three clusters,[3] each representing a specific leisure travel group. As shown in Table 3, the total sample of 1206 participants is segmented into Cluster 1 (28 %), Cluster 2 (39 %), and Cluster 3 (33 %). This table presents the distribution of key sociodemographic characteristics across the clusters, including age, gender, education level, income, region, and country of birth. Before detailing these profiles, it is important to note that this three-cluster solution is statistically robust. As detailed in Appendix C, a bootstrap resampling procedure confirmed high cluster stability (with Jaccard similarity indices above 0.79), demonstrating that the segments are well-separated and reliable.

Firstly, we have the group represented by the "Status quo flyers", a slightly masculinised group (men = 56 %), characterised as the group with the highest number of frequent travellers, making five or more round trips in the past two years. Their concern for the environment is low, both in terms of general global awareness and personal responsibility and action in their daily lives. Their perception of the aviation sector's environmental impact is at a medium level, indicating some awareness that aircraft are quite polluting, yet they do not trust technology to solve this issue in the future. This group shows no interest in replacing air travel with more sustainable alternatives, regardless of whether such alternatives offer similar speed, comfort, or service quality.

Secondly, we encounter the "Environmentally conscious low-flyers" group (women = 59 %) who travel the least in our sample. Their concern for the environment is high, as is their sense of personal responsibility and action. They are highly aware of air transport's impact on climate change and have some hope that technology could make air travel more sustainable. They express a moderate interest in alternatives to air travel and are significantly willing to change their everyday habits.

Lastly, the third group is balanced regarding gender (woman = 52 %) but comprises the most educated individuals among all clusters (61 % of this cluster has high education). This group can be described as centrist citizens or "Pragmatic moderates" falling between the extremes of the previous groups. They exhibit moderate concern about climate change, its consequences, and their responsibility and actions. This group is uncertain about how much air travel affects climate change and holds moderate hope that technological solutions will address the problem. Despite their moderate concern and limited awareness of aviation's environmental impact, they are willing to use alternative transport modes when available and possible. Yet, they are unwilling to make significant changes in their daily routines. The distinctions between these three segments are not merely descriptive; they are statistically significant across the core behavioural and attitudinal variables. ANOVA and subsequent post-hoc tests (Appendix C) confirm that the differences in travel frequency, climate concern, perception of aviation's impact, and willingness to change are highly significant (all $p < 0.001$),

[3] See Appendix C for detailed cluster validation results, including stability assessments via Jaccard similarity, ANOVA, Tukey HSD post-hoc tests comparing cluster differences, and Chi-square tests on sociodemographic variables.

Table 3
Sample and segment distribution by sociodemographic characteristics.

Variable	Value	Cluster 1	Cluster 2	Cluster 3	Total
		334 (28 %)	476 (39 %)	396 (33 %)	1206 (100 %)
Age	18–24	34 (10 %)	34 (7 %)	38 (10 %)	106 (9 %)
	25–34	48 (14 %)	56 (12 %)	60 (15 %)	164 (14 %)
	35–44	64 (19 %)	81 (17 %)	66 (17 %)	211 (17 %)
	45–54	72 (22 %)	78 (16 %)	72 (18 %)	222 (18 %)
	55+	116 (35 %)	227 (48 %)	160 (40 %)	503 (42 %)
Gender	Female	148 (44 %)	279 (59 %)	189 (48 %)	616 (51 %)
	Male	186 (56 %)	197 (41 %)	207 (52 %)	590 (49 %)
Education level	Low	28 (8 %)	60 (13 %)	28 (7 %)	116 (10 %)
	Medium	147 (44 %)	183 (38 %)	125 (32 %)	455 (38 %)
	High	152 (46 %)	230 (48 %)	242 (61 %)	624 (52 %)
	Other	7 (2 %)	3 (1 %)	1 (0.3 %)	11 (1 %)
Income	under 5.000€ per year	33 (10 %)	48 (10 %)	42 (11 %)	123 (10 %)
	5.000€ to 9.999€ per year	29 (9 %)	40 (8 %)	23 (6 %)	92 (8 %)
	10.000€ to 14.999€ per year	47 (14 %)	56 (12 %)	44 (11 %)	147 (12 %)
	15.000€ to 19.999€ per year	39 (12 %)	53 (11 %)	39 (10 %)	131 (11 %)
	20.000€ to 24.999€ per year	44 (13 %)	49 (10 %)	42 (11 %)	135 (11 %)
	25.000€ to 29.999€ per year	25 (7 %)	44 (9 %)	39 (10 %)	108 (9 %)
	30.000€ to 34.999€ per year	14 (4 %)	34 (7 %)	25 (6 %)	73 (6 %)
	35.000€ to 39.999€ per year	18 (5 %)	27 (6 %)	27 (7 %)	72 (6 %)
	40.000€ to 44.999€ per year	7 (2 %)	16 (3 %)	10 (3 %)	33 (3 %)
	45.000€ to 49.999€ per year	1 (0 %)	16 (3 %)	12 (3 %)	29 (2 %)
	50.000€ to 59.999€ per year	9 (3 %)	9 (2 %)	11 (3 %)	29 (2 %)
	60.000€ to 69.999€ per year	5 (1 %)	6 (1 %)	4 (1 %)	15 (1 %)
	70.000€ to 99.999€ per year	3 (1 %)	7 (1 %)	4 (1 %)	14 (1 %)
	100.000€ and over	3 (1 %)	3 (1 %)	3 (1 %)	9 (1 %)
	Don't know	18 (5 %)	17 (4 %)	23 (6 %)	58 (5 %)
	Prefer not to answer	39 (12 %)	51 (11 %)	48 (12 %)	138 (11 %)
Region	Andalusia	57 (17 %)	87 (18 %)	59 (15 %)	203 (17 %)
	Aragon	11 (3 %)	17 (4 %)	10 (3 %)	38 (3 %)
	Cantabria	8 (2 %)	5 (1 %)	4 (1 %)	17 (1 %)
	Castile and Leon	18 (5 %)	26 (5 %)	16 (4 %)	60 (5 %)
	Castile-La Mancha	3 (1 %)	14 (3 %)	10 (3 %)	27 (2 %)
	Catalonia	45 (13 %)	83 (17 %)	69 (17 %)	197 (16 %)
	Ceuta	1 (0 %)	0 (0 %)	1 (0 %)	2 (0 %)
	Navarre	2 (1 %)	8 (2 %)	4 (1 %)	14 (1 %)
	Valencia	38 (11 %)	55 (12 %)	47 (12 %)	140 (12 %)

(continued on next page)

Table 3 (*continued*)

Variable	Value	Cluster 1	Cluster 2	Cluster 3	Total
	Madrid	42 (13 %)	67 (14 %)	82 (21 %)	191 (16 %)
	Extremadura	9 (3 %)	7 (1 %)	2 (1 %)	18 (1 %)
	Galicia	16 (5 %)	26 (5 %)	20 (5 %)	62 (5 %)
	Balearic Islands	4 (1 %)	6 (1 %)	9 (2 %)	19 (2 %)
	Canary Islands	18 (5 %)	17 (4 %)	17 (4 %)	52 (4 %)
	La Rioja	2 (1 %)	1 (0 %)	3 (1 %)	6 (0 %)
	Melilla	1 (0.3 %)	0 (0 %)	0 (0 %)	1 (0.1 %)
	Basque Country	16 (5 %)	17 (4 %)	18 (5 %)	51 (4 %)
	Asturias	9 (3 %)	14 (3 %)	6 (2 %)	29 (2 %)
	Murcia	10 (3 %)	11 (2 %)	6 (2 %)	27 (2 %)
	Unknown	24 (7 %)	15 (3 %)	13 (3 %)	52 (4 %)
Country of Birth					
	Spain	263 (79 %)	384 (81 %)	319 (81 %)	966 (80 %)
	Venezuela	10 (3 %)	16 (3 %)	20 (5 %)	46 (4 %)
	Prefer not to say	8 (2 %)	11 (2 %)	5 (1 %)	24 (2 %)
	Argentina	6 (2 %)	4 (1 %)	11 (3 %)	21 (2 %)

validating the meaningfulness of this segmentation. Table 4 presents the standardised percentage deviations (z-scores) for each cluster relative to the overall sample mean across the core behavioural and attitudinal variables derived from our analysis to summarise the key distinctions between the identified segments. These z-scores provide a standardised measure of how each cluster's profile diverges from the average respondent. A positive z-score indicates that a cluster scores significantly above the sample average on that particular variable, highlighting a stronger presence of that characteristic within the segment compared to the overall sample. Conversely, a negative z-score signifies that the cluster scores are notably below the sample average, indicating a weaker presence of that characteristic. Z-scores close to zero suggest that the cluster's score on that variable is similar to the overall sample average. The magnitude of the z-score (i.e., its distance from zero) reflects the strength of this deviation, with larger absolute values pointing to more pronounced differences from the average respondent profile.

Table 4
Behavioural and attitudinal characteristics by cluster, standardised percentage deviations (z-scores).

Variable	Status quo flyers	Environmentally conscious low-flyers	Pragmatic moderates
Current frequency of air travel	8 %	−6%	0 %
Climate Concern (Awareness of Consequences and Worldview)	−74 %	64 %	−14 %
Personal Concern (Ascription of responsibility, Perceived behavioural control…)	−64 %	66 %	−25 %
Perception of Air Transport's Contribution to Climate Change	−15 %	46 %	−43 %
Techno-optimism in addressing climate challenges	−39 %	15 %	15 %
F1 Alternative to flying	−120 %	35 %	59 %
F2 Preferences (Regarding Travel)	−46 %	27 %	6 %
F3 Willingness to change (Behavioural intentions)	–23 %	86 %	−84 %

When analysing the groups in more detail, we note that in terms of transport preference, Cluster 2 (the "Environmentally conscious low-flyers" group) prioritises price, safety, and comfort when selecting their mode of transport. Cluster 3 ("Pragmatic moderates"), in contrast, places more importance on price and convenience, while Cluster 1 ("Status quo flyers") values both price and comfort most highly. Cluster 2 demonstrates the highest concern for the environmental impact of their travel choices compared to the other groups.

Regarding their hopes for technology to fix the effect of air transport on climate change, Cluster 1 ("Status quo flyers") remains neutral, showing no strong opinions on innovations that could make travel more sustainable. However, Clusters 2 ("Environmentally conscious low-flyers") and 3 ("Pragmatic moderates") express moderate optimism about technological advancements, particularly those related to improving aircraft performance and implementation of sustainable aviation fuels.

Regarding willingness to change their lifestyles and travel behaviour, Cluster 1 ("Status quo flyers") is the most resistant. They are unwilling to reduce air travel, adjust travel destinations closer to home, or pay more for carbon offsets or less-polluting planes. Their willingness to change is limited to reducing plastic use and improving household recycling efforts. In contrast, Cluster 2 ("Environmentally conscious low-flyers") is more open to a wide range of changes, including adopting long-distance train travel and choosing destinations closer to home to avoid flying. Cluster 3 ("Pragmatic moderates") shares some of Cluster 1's ("Status quo flyers") reluctance, but they are even more resistant to paying extra for carbon offsets or less-polluting planes, probably given they fly less often. However, they are slightly open to reducing plastic use and increasing recycling efforts.

Finally, in terms of preferences for alternative transport modes, Cluster 1 ("Status quo flyers") shows no interest in switching from flying, regardless of the circumstances. Conversely, Cluster 2 ("Environmentally conscious low-flyers") is open to alternatives, provided these modes are safe and offer high-quality service. Cluster 3 ("Pragmatic moderates") would consider alternative travel options if the cost is comparable to flying and the travel time is similar.

4.3. Discussion

The segmentation analysis presented provides valuable insights into the diverse attitudes and behavioural intentions of Spanish air travellers. Understanding these distinct perspectives is crucial for developing effective strategies to mitigate the environmental impact of aviation, particularly in a major European market like Spain. As described in the previous section, our findings reveal three key segments – the 'Status quo flyers', the 'Environmentally conscious low-flyers', and the 'Pragmatic moderates'– that differ significantly not just in their travel frequency but, more fundamentally, in their underlying environmental concerns and willingness to adapt their behaviour. Crucially, the validity of these segments and the significance of these differences are supported by the comprehensive statistical analysis presented in Appendix C. To summarise, we could say that the 'Status quo flyers' exhibit the lowest levels of both general environmental concern and personal acceptance of responsibility, coupled with a strong resistance to considering alternatives to flying or changing their travel habits. Conversely, the 'Environmentally conscious low-flyers' demonstrate the highest levels of concern and personal responsibility, alongside a greater stated willingness to make behavioural changes, although their openness to alternative transport modes is conditional. Positioned between these are the 'Pragmatic moderates', who express moderate

environmental concern but show limited inclination towards significant lifestyle changes, yet remain open to more sustainable transport alternatives provided they meet specific criteria like comparable cost and time.

While the primary segmentation rests on these attitudinal and behavioural dimensions, examining the demographic composition of these segments (Table 3) reveals further nuances. For instance, a slight tendency regarding gender distribution was observed, with the 'Status quo flyers' segment containing a higher proportion of men (56 %) and the 'Environmentally conscious low-flyers' a higher proportion of women (59 %). Over the past two decades, studies have highlighted that women in North America and Europe report stronger environmental values, attitudes, beliefs, and behaviours than men (e.g., McStay and Dunlap, 1983; Dietz et al., 2002; Franzen and Meyer 2010; McCright, 2010; McCright and Sundström, 2013; Ramstetter and Habersack, 2020). Interestingly, women-led airlines also present better environmental and sustainability performance (Suau-Sanchez et al., 2025). Furthermore, the 'Environmentally conscious low-flyers' cluster tended to include a larger share of older individuals (55 + age group comprising 48 % of the cluster), while the 'Pragmatic moderates' were notably characterised by the highest proportion of respondents with high education levels (61 % of the cluster). These observed demographic distributions are statistically significant. As shown in Appendix C (Table C4), Chi-square tests of independence confirm a significant association between cluster membership and the variables of gender, age, and education level, lending statistical weight to these demographic profiles. This supports Echavarren's (2016) conclusion that "being a woman, being older, and being more educated increase the probability of environmental concern". In Europe, studies suggest that higher levels of education often correlate with more pro-environmental behaviour (Meyer, 2015).

The willingness to adopt sustainable behaviours or make lifestyle changes varies across our sample. For example, Clusters 1 ("Status quo flyers") and 3 ("Pragmatic moderates") in our sample prefer to maintain their current lifestyles and are resistant to most changes. This builds on the evidence that people often gravitate towards environmental actions that require the least effort, prioritising convenience over effectiveness (Brock et al., 2023). In the mentioned clusters, individuals are more likely to adopt relatively simple measures, such as improving recycling habits or reducing plastic consumption, which are perceived as easier or less demanding and do not impact personal finances. However, they tend to avoid more impactful but demanding behaviours, like adopting a plant-based diet or opting for less polluting forms of transport, including flying less. Changing these behaviours also involves a monetary cost. Indeed, price is a central factor for the "Pragmatic moderates" and has traditionally been key in passenger travel decisions (Hess et al., 2007). Furthermore, there is a common misjudgement about the actual impact of different environmental actions. Many overestimate the benefits of minor tasks while underestimating other actions that could be more effective in mitigating environmental harm. For example, Cologna et al. (2022) observed that actions like adopting a sustainable diet were frequently underestimated in terms of their potential to mitigate environmental harm, whereas measures such as installing energy-efficient light bulbs were overestimated. Similarly, Truelove and Parks (2012) found that participants downplayed the importance of behaviours like adjusting thermostats or reducing meat consumption but emphasised the effects of actions like littering. Notably, while general knowledge about climate change mitigation strategies did not reliably predict people's intentions to act, their belief in the effectiveness of specific behaviour, regardless of its accuracy, strongly influenced their willingness to engage in that behaviour (Truelove and Parks, 2012). This could partially explain the responses from our sample, as they may focus on actions they feel capable of taking and believe to have an impact, even if that impact is not the greatest or is potentially miscalculated.

Social influences also play a critical role in shaping environmental behaviour. People are more likely to adopt behaviours that they see others around them performing, as visible practices set a perceived standard of what is normal or necessary (Mortensen et al., 2017). Conversely, when actions appear to be supported only by a small minority, people are far less likely to follow suit (Kukowski and Bernecker, 2024; Rinscheid et al., 2021). In our sample, most participants perceive their social circles as neutral regarding environmental consciousness. Only those already concerned about the environment reported feeling positive about contributing to it or being recognised for their ecological efforts. This points to the fact that broad social validation could be a key factor in encouraging collective environmental responsibility. This links with critical mass theory that suggests that a small number of individuals, through their actions and influence, can trigger a larger societal shift in behaviour. This is particularly relevant in environmental contexts where a few early adopters or visible leaders in sustainable practices can inspire broader participation and normalisation of eco-friendly behaviours. For example, dynamic norms (i.e., information about change in others or trends in norms over time) can lead people to conform to the change itself, even if it violates current norms (Sparkman et al., 2021). So, from a Theory of Planned Behaviour perspective, critical mass can shift subjective norms, thereby increasing the likelihood of environmentally responsible behaviour. In our study, social influence was measured through survey items reflecting this subjective norm component, such as: "When others around me help the environment, I feel that I should too," "Most people around me are respectful of the environment," and "I like it when people think I'm environmentally friendly." However, our findings do not show social influence as a strong behavioural change factor. In fact, our findings for the Spanish case align with recent research on Norway, which finds limited influence of social climate norms on leisure air travel (Aasen et al., 2022). This result challenges the long-term influence of movements like the 'flygskam' movement, and it shows the difficulties of changing behaviours, even when air travellers may consider part of their flights redundant (Gössling et al., 2019). At an individual level, most people do not see themselves as primary contributors to climate change. Instead, they emphasise that reducing carbon emissions should be a collective effort involving not only citizens but mainly industries and governments (Brock et al., 2023). Indeed, most individuals are not willing to reduce air travel regardless of their level of awareness. Árnadóttir et al. (2021) found the following justifications for continuing to travel internationally by air despite a general awareness of climate change: shifting responsibility, compensatory behaviours, lack of knowledge or awareness, lack of other options, benefits outweigh impacts and carbon offsetting. Our results are in this line, as individuals in our sample who do not feel personally responsible for preserving the environment are unlikely to act. Even those who care may not act, as they think protecting the environment is someone else's responsibility. This may indicate that when it comes to behavioural change, all cannot be left to the individual decision of the *Homo Economicus*; collective decisions and norms need to be part of the solution. Indeed, Schwanen et al. (2012) argue that durable behaviour changes demand changes in collective customs.

From a climate policy point of view, the extreme and rigid thinking of Cluster 1 ("Status quo flyers") makes them an inefficient target group. When designing climate policies, we should focus efforts on the segments of the population that are more likely to be receptive to change. Attempting to shift the attitudes of individuals with extreme views can be particularly challenging, as they often resist messages that conflict with their beliefs. The resistance to change increases when the challenged beliefs are connected to important ideological systems, as observed in studies on climate change scepticism (Jost, 2015). In contrast, the moderate population, often called the "silent majority," presents a more promising target for climate policy engagement. While already somewhat concerned about climate change, strengthening their understanding that it is real, human-driven, and a serious threat can further increase their support for public action (Van der Linden et al., 2015). These individuals typically hold more balanced views and are less ideologically rigid, making them more open to persuasion. Our

sample Cluster 3 ("Pragmatic moderates") represents this middle ground, positioning themselves away from the extremes. By targeting this group, we could achieve significant climate objectives and, in the process, also influence individuals in Cluster 2 ("Environmentally conscious low-flyers"), who are already concerned about climate change and are willing to act. Since people tend to exhibit inertia when it comes to their existing behaviours, it is important to nudge them with policies that encourage better choices (Thaler and Sustain, 2008). In the context of our sample, these better choices refer to environmentally sustainable transport options during leisure travel. For example, an environmentally conscious individual who prefers travelling by train might be deterred if the choice of architecture makes booking flights easier, more convenient, and almost certainly cheaper. This default setup could discourage the eco-friendly option. While they may be concerned about the environment, the actions required may seem like a significant effort with no immediate reward. By pushing them out of this inertia or creating new inertia through targeted nudges, we can help make sustainable behaviours feel more achievable and worthwhile.

5. Conclusions

This study analysed a large sample of Spanish leisure travellers (N = 1206) and employed exploratory factor analysis alongside clustering techniques to identify three distinct attitudinal segments: the 'Status quo flyers', the 'Environmentally conscious low-flyers', and the 'Pragmatic moderates'. Each segment is characterised by unique profiles regarding travel behaviours, environmental concerns, and behavioural intentions. The 'Status quo flyers' represent frequent travellers exhibiting minimal environmental concern and strong resistance towards adopting sustainable travel alternatives or modifying their lifestyles. In contrast, the 'Environmentally conscious low-flyers' travel less often, demonstrate high levels of environmental consciousness and personal responsibility, and express greater openness to sustainable options and lifestyle adaptations, contingent upon factors like the safety and service quality of alternatives. The 'Pragmatic moderates' occupy a middle ground, displaying moderate environmental concern and considering sustainable travel alternatives primarily when competitive on cost and time, while remaining generally resistant to significant personal lifestyle adjustments. The robust identification and validation of these distinct segments represent the primary contribution of this research. It provides the essential empirical foundation necessary for developing targeted, rather than monolithic, policy interventions.

These distinct attitudinal profiles present clear avenues for policy and industry action. The environmental concern driving the willingness of the 'Environmentally conscious low-flyers' suggests a potential for engagement through interventions appealing to pro-environmental values, whereas the conditional openness of the 'Pragmatic moderates' highlights the critical importance of making sustainable alternatives demonstrably competitive in terms of cost, time, and convenience. These attitudinal patterns were also observed in our sample to correlate with certain demographic characteristics; for instance, the highly concerned 'Environmentally conscious low-flyers' segment included higher proportions of women and older adults, while higher education levels were particularly notable among the 'Pragmatic moderates'. Therefore, the contribution of this study is to furnish the strategic intelligence required to design such interventions. It defines the 'who' and the 'why' of passenger behaviour, which is the necessary prerequisite before subsequent research can effectively model the potential impacts of specific policy scenarios. Acknowledging these combined attitudinal and demographic nuances allows policymakers to design more targeted interventions addressing the specific needs and sensitivities of different segments, focusing on aspects like affordability, convenience, and the quality of sustainable transport options such as trains and buses. For industry stakeholders, understanding these complex preference patterns can guide the development of competitive, high-quality services that appeal not only to the already environmentally conscious but also potentially nudge the pragmatic middle ground. Collaborative efforts between policymakers and industry to create integrated, appealing sustainable travel packages can further incentivise eco-friendly choices across the population.

Although many individuals express concern for sustainability, translating this concern into action remains challenging due to a lack of strong social validation, shifts in responsibility, inconvenience, high costs, and limited alternatives. To bridge this gap, these barriers must be addressed directly. Making sustainable travel options more affordable, accessible, and time-efficient could encourage broader adoption, enhancing the social acceptance and normalisation of sustainable travel and creating new travel routines among the population. Highlighting benefits, such as reduced carbon footprints and environmental preservation, could also help overcome resistance to change.

This study has limitations. First, it does not account for the influence of political ideology, which can shape decisions and actions in ways that may not align with individuals' intentions or stated goals. Second, we want to point out that intentions and willingness are not equivalent to actual behaviour. Since there can be a disconnect between a person's intentions or desires and actions, these are ultimately taken due to external constraints, changing circumstances, or internal conflicts. Third, the analysis relies on self-reported travel frequency data collected via the survey, which, like all self-reported behavioural data, may be susceptible to recall errors or social desirability biases influencing accuracy.

Future research could focus on strategies to drive lasting collective changes in travel behaviour. Moreover, using longitudinal samples to assess how individuals' attitudes and behaviours evolve over time and whether their intentions translate into actions, shedding light on shifting societal norms and environmental policies. In addition to examining an individual's preferences, examining intra-household dynamics related to travel choices could provide a better understanding of that person's values. Comparing their responses with the individual's could help confirm their attitudes and behaviours. Furthermore, building on the foundational segmentation provided in this paper, a valuable and methodologically distinct avenue for future studies would be to develop and test concrete policy scenarios or simulations tailored to each attitudinal segment, thereby enabling a robust evaluation of potential strategies. Finally, analysing the effectiveness of interventions designed to encourage sustainable travel would be essential for refining strategies to close the attitude-behaviour gap and promote more sustainable transport choices.

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CRediT authorship contribution statement

Helena Patino-Artaza: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation. **Pere Suau-Sanchez:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization.

Declaration of competing interest

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

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Ethical considerations

This study was approved by the UOC Research Committee (approval exp: CE24-TE06) on March 21, 2024.

Consent to participate

All participants provided informed consent prior to their inclusion in the study.

Appendix A

Table A1
Pattern loading matrix for EFA.

Item	ML1	ML2	ML3	h2	u2	com
Q3_1	0.09	0.64	0.00	0.413	0.59	1.0
Q3_2	0.11	0.72	0.04	0.532	0.47	1.1
Q3_3	0.19	0.46	−0.07	0.249	0.75	1.4
Q3_4	0.04	0.53	0.10	0.295	0.71	1.1
Q3_5	0.06	0.60	0.13	0.384	0.62	1.1
Q3_6	0.13	0.76	−0.02	0.594	0.41	1.1
Q3_7	−0.07	0.56	0.14	0.334	0.67	1.1
Q3_8	0.09	0.23	0.63	0.458	0.54	1.3
Techno	0.17	0.20	0.07	0.071	0.93	2.2
Reduce	0.20	0.05	0.64	0.456	0.54	1.2
Pay	0.12	−0.03	0.74	0.560	0.44	1.1
Adapt	0.51	0.13	0.64	0.682	0.32	2.0
Alt_transp	0.27	0.02	0.65	0.497	0.50	1.3
Q6_1	0.77	0.06	0.23	0.654	0.35	1.2
Q6_2	0.75	0.07	0.11	0.583	0.42	1.1
Q6_3	0.79	0.14	0.14	0.670	0.33	1.1
Q6_4	0.79	0.14	0.17	0.670	0.33	1.2
Q6_5	0.78	0.11	0.23	0.683	0.32	1.2
Q6_6	0.79	0.15	0.20	0.687	0.31	1.2

Table A2
Pattern loading matrix for UVA-EFA.

Item	MR1	MR2	MR3	h2	u2	com
Q3_1	0.04	0.65	−0.06	0.42	0.58	1.0
Q3_2	0.03	0.71	0.00	0.51	0.49	1.0
Q3_3	0.18	0.45	−0.14	0.26	0.74	1.5
Q3_4	−0.04	0.54	0.08	0.30	0.70	1.1
Q3_5	−0.03	0.60	0.11	0.38	0.62	1.1
Q3_6	0.07	0.75	−0.08	0.58	0.42	1.0
Q3_7	−0.17	0.58	0.14	0.35	0.65	1.3
Q3_8	−0.09	0.20	0.66	0.46	0.54	1.2
techno	0.15	0.18	0.02	0.07	0.93	1.9
Reduce	0.05	−0.01	0.66	0.46	0.54	1.0
Pay	−0.04	−0.08	0.76	0.55	0.45	1.0
Adapt	0.39	0.04	0.57	0.68	0.32	1.8
Alt_transp	0.12	−0.04	0.66	0.51	0.49	1.1
Q6_1	0.78	−0.05	0.07	0.65	0.35	1.0
Q6_2	0.80	−0.03	−0.06	0.59	0.41	1.0
Q6_3	0.83	0.04	−0.04	0.67	0.33	1.0
Q6_4	0.81	0.04	0.00	0.67	0.33	1.0
Q6_5	0.79	0.01	0.07	0.68	0.32	1.0
Q6_6	0.80	0.04	0.04	0.68	0.32	1.0

Appendix B. Full survey

Sociodemographic section

Gender, Age, Education level, household yearly gross income, post code, country of origin.

Q1. In the last 24 months (2 years), how many round-trip flights have you taken in total for leisure travel (e.g., vacations, getaways, visiting friends and family)?

[Numeric question | Open-ended].

Nationals (travel to a destination within Spain):___.

Internationals within Europe:__.

Internationals outside Europe:__.

[filter: if you haven't travelled by plane at least once in the last two years −> TERMINATE].

Q2. Please indicate your level of agreement or disagreement with this statement: "Over the past 24 months, I have reduced the frequency of my air travel compared to previous periods."

1	Strongly disagree
2	Disagree
3	Neither agree nor disagree
4	Agree
5	Strongly agree

Q3. Below you will find a series of characteristics related to your trips. To what extent would you say each of these factors influences your decision when choosing the mode of transportation for your trip? Use a scale where 1 means "no influence at all" and 5 means "a great influence.".

Travel time	1	2	3	4	5
Comfort during the trip	1	2	3	4	5
Price	1	2	3	4	5
Personal preference for a particular means of transport	1	2	3	4	5
Perception of security	1	2	3	4	5
Convenience	1	2	3	4	5
Frequency	1	2	3	4	5
Environmental impact	1	2	3	4	5

Q4. Below, you will see a series of statements related to climate change and the environment. Please indicate how much you agree with each statement, using a scale of 1 to 5, where 1 means strongly disagree and 5 means strongly agree. Remember, select the option that best reflects your personal opinion on each statement. There are no right or wrong answers; only your opinion is important.

Section_1

A	Environmental problems caused by the excessive use of resources are a threat to me and my environment.
B	Choosing more energy-efficient modes of transport helps reduce climate change.
C	Each person's behaviour can have a positive effect on society and the environment.
D	Limiting our movements guarantees a healthy environment.
E	I feel it is my responsibility to help take care of the environment as much as I can.

Section_2

A	Helping the environment seems easy to me
B	Most of the people around me/my friends are respectful of the environment
C	Most of the people around me travel by plane often.
D	When other people around me help the environment, I think I should do it too.
E	I feel guilty when I don't make an effort to conserve natural resources.
F	I like people to think that I am respectful of the environment.
G	I feel good when I do something to help the environment.
H	I consider myself an environmentally conscious person.
Y	I am very concerned about environmental issues.

Section_3

A	Air transport contributes significantly to climate change.
B	The media tends to exaggerate the effects of climate change.
C	Passengers should pay more to fly because of the negative environmental effects of aviation.
D	People can easily find an alternative to flying if they really want to.
E	Experiencing different cultures and destinations is more important than preserving natural resources.

Section_4

A	Technological advances will transform air travel, making it more sustainable.
B	It is not essential to take immediate action to address pollution, as technology will solve environmental problems in the future.
C	Aircraft efficiency will continue to improve, allowing people to enjoy air travel without leaving a significant environmental/carbon footprint.
D	Sustainable fuels are a viable option for making flights more environmentally friendly.

Q5. Below is a list of actions. Please read them carefully and answer your level of willingness to take each one in the next 12 months. Use a scale of 1 to 5, where 1 means "not at all willing" and 5 means "completely willing." Again, remember to select the option that best reflects your personal opinion on each statement. There are no right or wrong answers; only your opinion is important.

A	Do not fly for the next 12 months
B	Go on vacation near where I live (instead of far away or by plane)
C	Pay more for my flight tickets to offset carbon emissions
D	Pay more to fly on a less polluting aircraft
E	Reduce energy consumption at home
F	Choosing a more energy-efficient mode of transportation for everyday travel
G	Adopt a vegetarian or vegan diet
H	Improve recycling
Y	Buy organic/ecological products
J	Participate in local conservation activities

(*continued on next page*)

(*continued*)

K	Reduce the use of plastics
L	Choosing to travel by train for trips of 800 km or more
M	Choosing to travel by coach for trips of 800 km or more

Q6. Finally, please indicate to what extent you would be willing to switch to a more environmentally friendly mode of transportation, considering the following conditions. To do this, please use the 1 to 5 scale again, where 1 means "I would not be willing at all" and 5 means "I would be completely willing."

A	If available
B	If it is not more expensive
C	If it is just as fast
D	If it is equally comfortable and adapted to my needs
E	If it is just as safe
F	If the quality of the service is good

Appendix C

Table C1
Jaccard Similarity scores by cluster.

Cluster	Jaccard similarity
Cluster 1	0.848
Cluster 2	0.792
Cluster 3	0.796

Table C2
ANOVA results by variable.

Variable	F-value	p-value
Viajenacional	427.3	<2e-16 ***
Viajeeu	720.3	<2e-16 ***
ViajeINT	329.8	<2e-16 ***
ClimateC	286.3	<2e-16 ***
PersonalC	267.7	<2e-16 ***
AirC	107.4	<2e-16 ***
Techno	36.4	4.5e-16 ***
F1_Alternative	772.9	<2e-16 ***
F2_Preferences	57.97	<2e-16 ***
F3_Change	698.4	<2e-16 ***

Note: *** $p < 0.001$.

Table C3
Tukey HSD Post-hoc Test Results.

Variable	Comparison	Mean Diff	Lower CI	Upper CI	p-adj
Viajenacional	2–1	−9.88	−10.97	−8.80	< 0.001
	3–1	−11.98	−12.97	−10.99	< 0.001
	3–2	−2.09	−2.62	−1.57	< 0.001
Viajeeu	2–1	−0.94	−1.53	−0.34	< 0.001
	3–1	−4.99	−5.53	−4.44	< 0.001
	3–2	−4.05	−4.34	−3.76	< 0.001
ViajeINT	2–1	−4.62	−5.14	−4.11	< 0.001
	3–1	−5.12	−5.59	−4.65	< 0.001
	3–2	−0.50	−0.75	−0.25	< 0.001
ClimateC	2–1	1.20	1.08	1.32	< 0.001
	3–1	0.52	0.40	0.65	< 0.001
	3–2	−0.68	−0.79	−0.56	< 0.001
PersonalC	2–1	0.87	0.78	0.96	< 0.001
	3–1	0.26	0.17	0.36	< 0.001
	3–2	−0.61	−0.70	−0.52	< 0.001
AirC	2–1	0.38	0.29	0.48	< 0.001
	3–1	−0.17	−0.27	−0.07	< 0.001
	3–2	−0.56	−0.65	−0.47	< 0.001
Techno	2–1	0.35	0.24	0.45	< 0.001
	3–1	0.34	0.23	0.45	< 0.001
	3–2	−0.00	−0.10	0.10	0.998
F1_Alternative	2–1	1.55	1.44	1.66	< 0.001
	3–1	1.79	1.67	1.91	< 0.001

(*continued on next page*)

Table C3 (*continued*)

Variable	Comparison	Mean Diff	Lower CI	Upper CI	p-adj
	3–2	0.24	0.13	0.34	< 0.001
F2_Preferences	2–1	0.73	0.57	0.89	< 0.001
	3–1	0.51	0.35	0.68	< 0.001
	3–2	−0.22	−0.37	−0.06	0.003
F3_Change	2–1	1.09	0.98	1.20	< 0.001
	3–1	−0.61	−0.73	−0.49	< 0.001
	3–2	−1.70	−1.81	−1.59	< 0.001

Table C4
Chi-Square test results by variable.

Variable	Chi-squared (X^2)	Degrees of Freedom	p-value
Age	16.279	8	0.03855 *
Gender	18.716	2	8,63e-05 ***
Education Level	32.901	6	1,096e-05 ***
Region	53.601	38	0.04798 *
Income	26.081	30	0.671
Country of birth	105.18	104	0.4491

Note: *** $p < 0.001$, ** $p < 0.01$, * $p < 0.05$.

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What drives passengers towards sustainable aviation? A segmentation study of travel behaviour and environmental concern in Spain

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