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Article

From Awareness to Action: Modeling Sustainable Behavior Among Winter Tourists in the Context of Climate Change

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Abstract

Given the increasing prominence of sustainable tourism in light of climate change, this study investigates the sustainable tourist behavior of winter tourists through psychological and demographic factors in relation to climate change. Based on the Theory of Planned Behavior and a cognitive–affective combination of variables, we outline a structural equation model to investigate the direct and indirect effect of climate change awareness (CCA), environmental attitude (ATT), and perceived responsibility (PR) towards sustainable behavior (SB). Environmental concern (EC) and perceived behavioral control (PBC) are employed as mediators in a test. A total of 518 Greek winter tourists' data were examined using SEM and multi-group analysis (MGA). It is indicated that CCA and PR directly predict SB with significant effects, and ATT's influence is fully mediated. EC and PBC are used as significant psychological mediators, and PBC is indicated to possess a strong effect. MGA discloses significant gender, age, education, climate salience, and frequency of tourism behavior differences, provoking contextual differences that inform sustainability response. There is a theoretical contribution in the form of specification of dual roles played by cognitive control and emotional concern in determining sustainable tourism behavior. Practical implications inform the planning of interventions, particularly for policymakers, educators, and tourist managers. Future studies need to incorporate behavior information, examine causality, and carry out analysis to cultural and season levels.

Keywords: sustainable behavior; winter tourism; climate change awareness; environmental concern; perceived behavioral control; structural equation modeling (SEM)

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1. Introduction

Winter tourism is a cornerstone of economic and cultural survival in large parts of alpine and mountainous regions, generating employment, the building of infrastructure, and global tourist movements. The industry is nevertheless experiencing unprecedented pressure from the impacts of climate change (Aman et al., 2021; Esfandiar et al., 2021). Rising global temperatures have resulted in less reliable snowfall, a greater frequency of rain-on-snow, and shorter ski seasons, particularly in lower- and mid-altitude regions. Research suggests that most European and North American ski resorts will see significant reductions in natural snow cover by the middle of this century, with an increased reliance on artificial snowmaking—a resource- and expense-intensive adaptation measure (Holmes et al., 2021; Leal Filho et al., 2024). These climatic changes not only affect the financial viability of winter tourism industries but also destroy the long-term environmental health of mountain ecosystems.

The Intergovernmental Panel on Climate Change (IPCC) regards tourism as a climate-exposed sector that needs to adjust quickly to changing environmental threats. While ski resorts adjust their infrastructure in terms of snowmaking, diversification of activities beyond snow, and season extension measures, the climate adaptation behavior factor has emerged as more dominant in the literature (Li et al., 2024; López-Mosquera & Sánchez, 2012; Pai et al., 2024). Specifically, there is growing recognition that tourists themselves are key stakeholders in the sustainability process. Winter tourists' carbon footprint, sourced from transport modes, accommodation options, consumption habits, and waste generation, can actually amplify the susceptibility of mountain regions significantly if not controlled (Holmes et al., 2021; Leal Filho et al., 2024).

Simultaneously, modern trends in tourism are indicative of a tendency to more sustainable travel behavior. Tourists worry about global warming and prefer destinations that hold the values of sustainability, including availability of eco-certified accommodations, green transportation, or nature tourism (Qiu et al., 2025; Raza et al., 2024). Younger generations, and even tourists on the whole, pay more attention to the environment when planning their vacation (Sahabuddin et al., 2024). But contrary to this growing sensitivity, research has repeatedly found that pro-environmental behavior during the holiday fails. Tourists report higher energy and water use, greater personal mobility use, and less emphasis on waste reduction than in the rest of their lives (Seong et al., 2021; Si et al., 2019). This gap between belief in sustainability and what actually happens while traveling is one of the largest challenges in creating climate-resilient tourism.

This background highlights the need for greater insight into psychological determinants of sustainable behavior in winter tourism settings. Compared to conventional environmental behavior, tourist behavior is shaped by a distinct combination of situational constraints, social norms, and motivational trade-offs. Snow resorts are an excellent setting to investigate how awareness of environmental threat—i.e., climate change—translates (or fails to translate) into behavior change (Steiger et al., 2021; Tian & Jiang, 2025; Vicente, 2024). Consequently, it is essential to analyze the cognitive, affective, and motivational processes of sustainable behavior in winter holidays for effective climate adaptation strategy formulation beyond infrastructure in order to involve tourists as agents of change towards sustainability.

While there has been considerable media coverage and public awareness of climate change, the distance between such awareness and the daily practice of sustainable behavior, particularly with regard to leisure tourism such as winter tourism, remains unbridged. Earlier studies have shown that environmental concerns are not correspondingly put into practice when people are away from their daily life and are in holiday contexts where hedonic desires and lowered personal responsibility dominate (Sahabuddin et al., 2024; J. Wang et al., 2022; Zhang et al., 2025). In winter tourism, however, the actual activities performed by tourists—e.g., skiing or snowmobiling—generate carbon and are environmentally aggressive by nature. In spite of such problems, scant empirical studies have modeled psychological processes that can possibly address this in climate-exposed tourist scenarios.

Current studies on sustainable tourism have either focused on infrastructure-level adaptation (e.g., artificial snowmaking, green certifications) or general attitudinal surveys, with minimal focus on mediating cognitive and affective processes that translate climate change awareness into actual pro-environmental behavior (Leal Filho et al., 2024; Li et al., 2024; Pai et al., 2024). Although the Theory of Planned Behavior (TPB) has seen application in general tourist settings, applications within the snow-based or seasonal tourism setting are limited. In addition, theoretical concepts like environmental concern and perceived behavioral control—while theoretically applicable—have seldom been examined as mediating variables for sustainable behavior among winter tourists. Similarly, variables such as perceived personal responsibility and eco-destination image, which can influence behavioral intention through moral obligation or destination perception, are underrepresented in SEM studies in this area.

This research bridges these gaps through the development and empirical validation of an extended TPB-based structural equation model specific to the winter tourism setting. Based on environmental psychology, tourism literature, and climate adaptation theory, this paper involves awareness of climate change, environmental concern, and perceived responsibility as antecedents of environmentally responsible behavior, with environmental concern and perceived behavioral control as the mediators (Leal Filho et al., 2024; Li et al., 2024; Pai et al., 2024). Sustainable behavior is measured by particular, discernible behavior over winter holiday periods, providing a behaviorally anchored outcome measurement instead of vague intentions or hypothetical situations.

The study outcomes indicated that awareness of climate change and perceived behavioral control were the most significant predictors of sustainable winter tourist behavior, followed by environmental concern and perceived responsibility. Contrary to expectations, environmental attitudes indirectly affected behavior via both cognitive as well as affective mediators. Multi-group analysis also provided significant gender, age, education, and behavior subgroup differences, unequivocally defining the value in approaching demographic and psychological diversity through sustainability. These results have significant implications for determining determinants of pro-environmental behavior for tourist settings and advancing theoretical and practical application.

The rest of the paper is presented as follows: Section 1.1 discusses the literature review and creates the research model. Section 2 formulates the methodology and data analysis method. Section 2.5 presents the results, i.e., direct, mediating, and moderating effects. Section 3 offers practical implications. Section 3.3 concludes with presenting key findings and the future research agenda.

1.1. Literature Review

1.1.1. Climate Change, Tourism, and Behavioral Response

Ski tourism, which is one of the most significant winter tourism sectors, is one of the most exposed sectors in the context of increasing climate change. Various studies identify that rising temperatures, unpredictable snowfall, and declining snow seasons are becoming an escalating menace to the economic sustainability and environmental viability of ski resorts (Leal Filho et al., 2024; Steiger et al., 2021). These environmental changes have a disproportionate impact on low-altitude resorts, which tend to be the earliest to suffer from snow reliability declines, resulting in severe employment, local economy, and long-term planning risks (Fella & Bausa, 2024; Vrtana et al., 2020).

To such climatic stresses, adaptation strategies have been the primary answer for winter resorts' survival. Synthetic snow production, though extensively carried out, has economic and environmental costs in terms of increased energy usage and excess exploitation of water resources (Walters & Ruhanen, 2015). Diversification into snow-independent attractions such as summer festivals and footpaths is a medium- to long-term strategy for seasonality buffering and competing for other groups of tourists (Steiger et al., 2021). But these interventions at the destination level need to be supplemented with an increased insight into tourist-side behavior—i.e., how individual tourists recognize, respond to, and acquire climate-related risks.

Recent empirical research emphasizes the reality that tourists are not reacting identically towards the problems triggered by climate change. Behavioral adaptations include trip rescheduling, destination substitution, and avoidance of snow-based recreation (Witting et al., 2021; Von Gal et al., 2024). The reactions are mediated by diverse factors including environment concern, perceived control of behavior, place attachment, and personal values (Qiu et al., 2025; Raza et al., 2024). For instance, Qiu et al. (2025) discovered that destination psychological ownership and environment responsibility tourists had greater behavioral responses towards environmental protection, although the interaction was found more in the older generations compared to Gen Z tourists. Such a finding brings in the need to integrate affective and cognitive measures in the prediction of pro-environmental behavior within tourist spaces.

Specifically, Theory of Planned Behavior (TPB) has also been widely used to explain tourist environmental behaviors. A meta-analytic and bibliometric review by Si et al. (2019) attests that TPB is still one of the major theories explaining behavioral intention in environmental science, from environmental tourism to waste management and environmental green consumption. Despite this, it also has criticisms regarding what it lacks—particularly its relative underperformance in capturing emotional drivers like guilt, moral duty, and green identity (Esfandiar et al., 2021; Holmes et al., 2021). To reverse these shortcomings, some scholars suggest adding the Norm Activation Model (NAM) or Value-Belief-Norm (VBN) theory to TPB and thus adding normative beliefs and moral aspects to behavioral modeling (Esfandiar et al., 2021; López-Mosquera & Sánchez, 2012).

Moral obligations become strong moderators in green travel behavior analysis. Raza et al. (2024) proved that moral duty strongly mediates the relationship between environmental attachment and pro-environmental behavior, although perhaps not to an equal degree with all motivational constructs (e.g., green consumption value). Likewise, Zhang et al. (2025) used the Stimulus-Organism-Response (S-O-R) model to demonstrate that felt duty enhances the effect of eco-marketing and identity on sustainable tourist behavior in the tourism industry of China. The implications are that policy and marketing interventions evoking personal norms, identity, and responsibility can be more effective than information-based campaigns.

Apart from psychological predictors, as will be elaborated in the following section in more details, situational and physical setting is also of the paramount importance. J. Wang et al. (2022), through a mixed-methods study, concluded that guided eco-tours and interpretive signage as environmental education in situ have the capacity to augment tourists' responsible behavioral intentions and actual responsible behaviors. Such interventions also affect core TPB constructs such as attitudes, perceived control, and subjective norms. More significantly though, the COVID-19 pandemic added a new risk factor to the equation. According to Seong et al. (2021), perceived health risk adversely affected tourists' attitudes and behavior control but fortified coping capacity in natural environments such as national parks—suggesting intricate relationships between sources of risk and action.

Interestingly, tourists are not merely passive victims of climate change effects, but also potentially mitigators. Their decision—means of transport, accommodation, consumption of resources, and waste management—contributes significantly to the overall carbon footprint of winter tourism (C.-L. Yang et al., 2021; Y. Yang et al., 2025). As Vicente (2024) noted, pro-environmental behavior among tourists is more likely to return to eco-destinations, hence implying a virtuous circle between sustainable action and long-term participation. But current research report more on intentions than actual behavior, with little longitudinal evidence for long-term change.

In conclusion, adaptive action by ski resorts is required but supplemented with profound behavior insight of tourists' climatic behavior. Existing studies converge toward the significance of multi-modal models that integrate cognitive, affective, and normative components. However, there are blind spots regarding the unique channels where climate change awareness is framed into tangible sustainable behavior among winter tourists. The current research fulfills this requirement by using a TPB-guided structural equation model supplemented with constructs of environmental concern and perceived responsibility to generate knowledge about the processes underlying sustainable conduct in winter tourism. To bridge these gaps and empirically confirm the suggested associations by previous research, the present study develops a set of hypotheses from the theoretical and empirical underpinning presented in this review:

H1. *Climate Change Awareness (CCA) positively influences Sustainable Behavior Intention During Winter Vacation (SB).*

H2. *Environmental Attitudes (ATT) positively influence Sustainable Behavior Intention During Winter Vacation (SB).*

1.1.2. Theory of Planned Behavior and Environmental Psychology in Tourism

Theory of Planned Behavior (TPB) is one of the most dominant theories in describing pro-environmental behavior, e.g., sustainable tourist choices (Leal Filho et al., 2024; Li et al., 2024; Steiger et al., 2021). TPB postulates that intention to behave is the most direct precursor to action and depends on attitude toward behavior, subjective norms, and perceived behavioral control (PBC). Most of these studies have used the model to account for tourism behaviors, testing its predictive ability in a range of sustainability behaviors including sustainable accommodation selection, green travel, and waste conduct (J. Wang et al., 2022; Chandran et al., 2021). Visitors with positive attitudes towards sustainability and who feel that social norms are with them will be inclined to be predisposed towards acting in environmentally friendly manners. Among the TPB elements, PBC is typically an excellent predictor (Yuriev et al., 2020), particularly when tourists perceive that they possess the ability, knowledge, and resources to act in a sustainable way—e.g., existence of green modes of transport or recycling facilities (Pai et al., 2024).

Albeit having strong empirical evidence, TPB has not escaped criticism for its failure to capture the complexity of environmentally significant behavior, particularly climate change. One of the recurring shortcomings is the intention, i.e., the behavior gap. Although winter vacation destinations have a lot of tourists with pro-environmental intentions, they do not translate these into behavior because of habits, convenience, economic costs, or unavailability of facilitating conditions (Wut et al., 2023). Subjective norms can also be disregarded in tourist environments, where peer pressure regarding sustainable travel choices is absent or indistinct (Tian & Jiang, 2025). Second, TPB's rational choice orientation is apt to dampen the roles of emotion, moral duty, and self—factors increasingly known to be pivotal in climate-sensitive behavior fields.

To fill these gaps, TPB has in recent times been complemented with environmental psychology theories. Environmental concern is such a complement, which is a motivational construct that mediates the influence of awareness and knowledge on behavior. Aman et al. (2021) showed that environmental concern of tourists mediated the relationship between awareness and action very strongly, revealing that awareness by itself would not be successful with the lack of emotional engagement. Likewise, Hwang et al. (2024) concluded that climate change awareness indirectly increased sustainable behavior intentions by building up attitudes and perceived norms. The findings confirm a cognitive–affective mechanism where awareness gives rise to concern, and concern subsequently strengthens behavioral intention through TPB factors.

But yet another core construct throughout the extended TPB literature is perceived behavioral control. In addition to its explanatory power, PBC further mirrors tourists' instrumental constraints and facilitators, e.g., convenience of transport or clarity of eco-certifications (J. Wang et al., 2022). Tourists tend to act more sustainably when they find sustainable behavior to be rationally and economically viable. Therefore, initiatives for increasing PBC, like green infrastructure upgrading or the delivery of comprehensible information, can be effective behavioral modification tools (Yuriev et al., 2020; C. Wang et al., 2018; Wu et al., 2022; Zaman, 2024).

In addition to TPB theory, environmental behavior is accounted for by the Value–Belief–Norm (VBN) theory and its source in the Norm Activation Model, an ethical and value-based theory of environmental behavior (López-Mosquera & Sánchez, 2012; Sahabuddin et al., 2024; Lind et al., 2015). According to VBN, individual values shape awareness of consequences and ascription of responsibility, which in turn activate individual moral norms that shape behavior. Within tourism environments, it translates to tourists with high biospheric or altruistic values who feel responsible for making environmental impacts and therefore would be inclined to make sustainable choices through a sense of moral duty. Studies by Lind et al. (2015) have established that inclusion of personal norms in TPB models has greatly improved predictive power, especially in such choices as green accommodations or low-impact holidays. These hybrid frameworks more accurately depict the more integrated concept of tourist behavior, where moral duty and empathy are coupled with rational thinking.

The link of TPB to environmental psychology is also evident in identity, responsibility, and moral obligation-based research. Zhang et al. (2025), for instance, spoke to the way pro-environmental self-identity and subjective duty enhance the impact of green marketing in tourism, while J. Wang et al. (2022) illustrated how environmental meanings of tourist places moderate the intention–behavior relationship for sustainable behavior. Such findings suggest that contextual and psychological incentives, such as value-congruent communication or immersive learning experiences, can strengthen the intention–behavior link.

Cumulatively, the developing consensus calls for the application of extended TPB models that include environmental concern, climate change awareness, personal norms, and situational factors to more fully account for sustainable behavior in tourism. More elaborate models such as these are especially well-suited to climate-vulnerable tourism contexts—like winter tourism—where ecological threat and moral obligation are foregrounded. By incorporating constructs from both TPB and VBN, and controlling for both the motivational and structural constraints to sustainable behavior, the current research provides a more integrated explanation of when and why tourists engage in sustainable behavior. By carrying this out, it answers repeated demands for both applied relevance and theoretical synthesis within environmental behavior research (Holmes et al., 2021; Raza et al., 2024; Mitrică et al., 2025; Gil-Giménez et al., 2021), placing itself within an increasing literature attempting to shift "from awareness to action". Based on the established relationship between sustainable behavior and TPB, we propose the following hypothesis:

H3. *Perceived Responsibility (PR) positively influences Sustainable Behavior Intention During Winter Vacation (SB).*

H4a. *Environmental Concern (EC) positively influences Sustainable Behavior Intention During Winter Vacation (SB).*

H4b. *Perceived Behavioral Control (PBC) positively influences Sustainable Behavior Intention During Winter Vacation (SB).*

1.1.3. Sustainable Tourist Behavior (STB)

Sustainable tourist behavior (STB) has been a prevailing subject of tourism scholarship over the last decade, at least in part due to increasing environmental issues like climate change and overtourism. STB has been conceptualized for the most part and includes environmentally sound, socially equitable, and economically beneficial activities by tourists with a vision to reduce undesired effects and create maximum long-term value to destinations (Li et al., 2024; Mitrică et al., 2025). Yet, despite increasing in profile, the sector still grapples with conceptual uncertainties since there is no consensus definition—partly because of the context-specific nature of sustainability across the range of tourist activities and types of destinations.

Climate change is imposing deep pressures on winter tourism demand and supply. As reported by Witting et al. (2021), tourists' behavioral reactions to climate-driven change—like declining snow reliability—are shaped not just by environmental factors but also by lifestyle and socio-demographic traits. This is echoed in Bai and Zhang's (2025) stakeholder-based review which highlights that climate change shortens ski seasons, disrupts loyalty patterns, and pushes tourists to seek alternative destinations or adjust their travel behavior. While operational adaptation strategies (e.g., artificial snowmaking) are gaining traction, the behavioral adaptation of tourists themselves—what they choose to do or avoid—plays a pivotal role in fostering sustainable transitions. C.-L. Yang et al. (2021), for example, discovered that low-carbon behavior is positively affected by tourism engagement through the mediation function of affective constructs such as environmental responsibility and place attachment.

Theory of Planned Behavior (TPB) has been used widely in STB theory modeling, providing a framework to study the influence of attitudes, subjective norms, and perceived behavioral control on intentions and behavior. This is extended by Sahabuddin et al. (2024) through the use of attitudes towards ecotourism and self-control as critical factors in influencing pro-environmental behavior. In a similar vein, Chandran et al. (2021) has conceptualized STB as a higher-order construct with social responsibility, cultural sensitivity, and destination-specific environment behaviors dimensions, supported through confirmatory factor analysis. The results support the multi-dimensionality of STB and echo the necessity for advanced theory and empirical models in untangling its determinants.

Emotion- and identity-based predictors are also gaining interest. Visitor environmental self-identity, expressed in how much visitors perceive themselves as environmentally friendly, has been shown to correlate positively with sustainable behavior (Gil-Giménez et al., 2021). Wut et al. (2023) continues that green self-identity and the "warm glow" effect of the positive feeling of doing good boost willingness to consume sustainably, an effect with potent marketing appeal for tourism. These findings are in accord with Value-Belief-Norm (VBN) theory, which suggests that internalized values (e.g., biospheric concern), operating via beliefs and personal norms, are predictors of pro-environmental behavior.

However, gaps still exist. As Wut et al. (2023) illustrates in a comprehensive review, the attitude–behavior and intention–behavior gaps continue to be unsolved issues for STB research. While numerous tourists claim concern for sustainability, it does not necessarily translate into actual behavior—owing to perceived inconvenience, lack of trust in green marketing, or insufficient behavioral control. In addition, much writing ignores behavioral variations across cultures and modes of tourism, and hence constrained generalizability. Bai and Zhang's (2025) research, for instance, was limited to a single latitude area, while Maoela et al. (2025) refers to the underrepresentation of the Global South context, demonstrating that within South African national parks, the visitors were open to adopting sustainable practice but were not well informed on how to carry out the practice successfully.

Methodologically, structural equation modeling (SEM) has been crucial in the unraveling of the intricate mechanisms among predictors and STB. It provides the opportunity to explore direct and indirect effects, mediating (e.g., place attachment) and moderating variables like environmental literacy or perceived behavioral control (Zaman, 2024). Other research, for example, Hwang et al. (2024), has also applied TPB to embrace climate awareness and proved its indirect effect on behavior intention through examples in sports tourism, whereas Cipriani et al. (2024) presents a new psychometric evaluation of perceptual climate awareness—proving the increasing interdisciplinary confluence between environmental psychology and tourism scholarship.

Even with such methodological refinement, however, two issues persist. First, no standardization of STB measurement across contexts has been achieved by scholars. Although there are some superb, reliable scales for constructs such as environmental concern or climate change denial (De Graaf et al., 2023), operational variation prevents meta-analytical integration. Second, very few studies operationalize at the policy or systemic levels. As Bai and Zhang's (2025) and Zaman (2024) assert, individual behavior must be supplemented with institutional facilities—green transport, green lodgings, or educational interventions—to trigger scalable change.

Collectively, the literature recognizes that STB is shaped by an interaction of cognitive (knowledge, attitudes), affective (place identity, place attachment), normative (social and moral norms), and structural (policy, accessibility) factors. However, it requires a more holistic and context-sensitive approach—especially for sensitive topics like winter tourism. Follow-up studies need to establish how climate sensitivity is activated under situations of practical constraint, how STB differs among demographic or cultural groups, and how destinations can foster sustainable norms and behavior through system support. This study aims to fill the above gaps by using a validated structural equation model to estimate the determinants of STB for winter tourism, namely climate change awareness, environmental identity, and perceived behavioral control. In this sense, it further advances theoretical knowledge along with the practical repertoire in a changing climate to facilitate sustainable tourism. Therefore, we propose the following hypotheses:

H5a. *Environmental Concern (EC) mediates the relationship between Climate Change Awareness (CCA) and Sustainable Behavior Intention During Winter Vacation (SB).*

H5b. *Perceived Behavioral Control (PBC) mediates the relationship between Climate Change Awareness (CCA) and Sustainable Behavior Intention During Winter Vacation (SB).*

H6a. *Environmental Concern (EC) mediates the relationship between Environmental Attitudes (ATT) and Sustainable Behavior Intention During Winter Vacation (SB).*

H6b. *Perceived Behavioral Control (PBC) mediates the relationship between Environmental Attitudes (ATT) and Sustainable Behavior Intention During Winter Vacation (SB).*

H7a. *Environmental Concern (EC) mediates the relationship between Perceived Responsibility (PR) and Sustainable Behavior Intention During Winter Vacation (SB).*

H7b. *Perceived Behavioral Control (PBC) mediates the relationship between Perceived Responsibility (PR) and Sustainable Behavior Intention During Winter Vacation (SB).*

Following the above theoretical argumentation and hypotheses formulation, the suggested conceptual model, presented in Figure 1, combines the direct and mediated processes by which awareness of climate change, environmental concern, and perceived responsibility are anticipated to affect sustainable behavior in winter tourism. The model incorporates cognitive, affective, and normative constructs of the Theory of Planned Behavior and Value–Belief–Norm theory into a comprehensive framework for studying the psychological processes of pro-environmental tourist behavior.

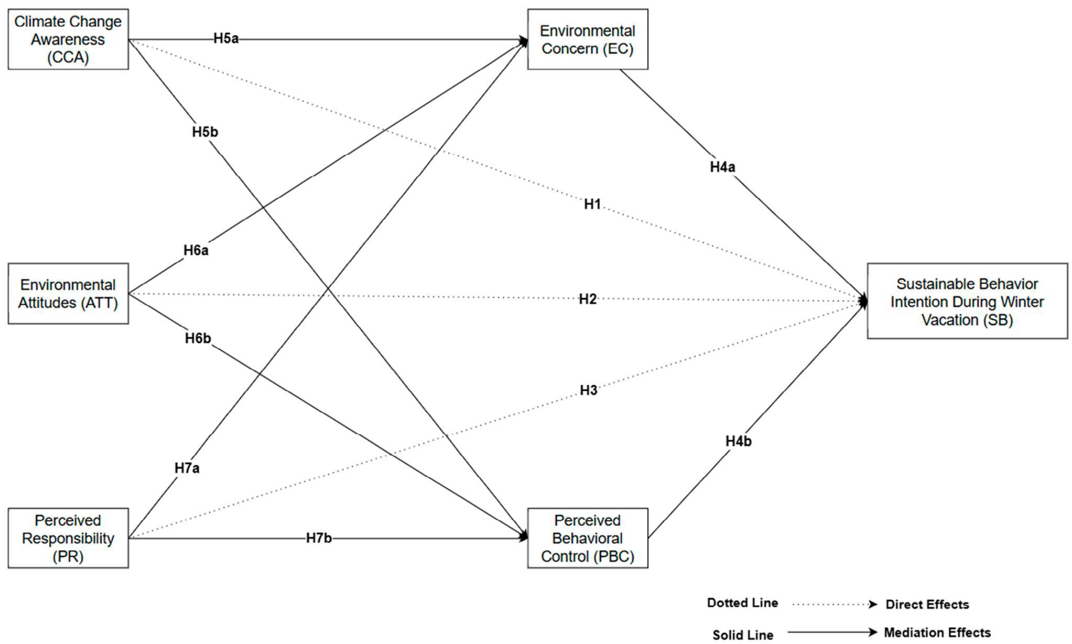

Figure 1. Conceptual framework of the hypothesized relationships among climate change awareness (CCA), environmental attitudes (ATT), perceived responsibility (PR), environmental concern (EC), perceived behavioral control (PBC), and sustainable behavior (SB), incorporating both direct and mediated pathways.

2. Material and Methods

2.1. Conceptual Model and Rationale

This research aims to model the psychological and perceptual determinants of sustainable behavior for winter tourism, based on the Theory of Planned Behavior and environmental psychology extensions. The suggested conceptual framework incorporates three independent variables—climate change awareness (CCA), environmental attitudes (EA), and perceived responsibility (PR)—and two mediating constructs—environmental concern (EC) and perceived behavioral control (PBC)—to predict sustainable behavior during winter vacation (SB). Figure 1 displays the conceptual model.

Climate change awareness (CCA) refers to people's knowledge of the impact of climate change on winter tourism, with concern about its implications for the environment and seeking information. Empirical evidence shows that increased awareness of climate change is an intellectual antecedent to pro-environmental behavior (Hwang et al., 2024; Maoela et al., 2025; Clayton & Karazsia, 2020). For tourism, environmentally conscious tourists who are attuned to the environmental danger of winter holidays (such as snow loss, ski resort contamination) would become increasingly anxious and, as a result, more likely to behave sustainably. Thus, we anticipate that CCA will have a positive impact on environmental concern and behavior control and thus sustainable behavior.

Environmental attitudes (ATT) represent generalized attitudes towards nature preservation and reducing the damage to the environment due to tourism. According to the Revised New Ecological Paradigm (Tian & Jiang, 2025; J. Wang et al., 2022), ATT covers ecological limits awareness, sensitivity of mountain environments, and encourages sustainable development in tourism. TPB assumes that behavior attitude is the immediate predictor of intention, and data from research confirm their contribution toward developing sustainable travel behavior tendencies (C. Wang et al., 2018). ATT are assumed in this study to influence environmental concern as well as perceived control, which mediate behavior.

Perceived responsibility (PR) stems from the Norm Activation Model and from the Value–Belief–Norm theory, from an internalized moral obligation of a tourist to be sustainable. If they perceive themselves as responsible for the environmental impact of tourism, they will become environmentally concerned and activate their values. Moral responsibility is therefore intended to act as a distal antecedent, influencing the affective (concern) and cognitive (control) streams to sustainable behavior.

Two mediators are suggested to connect the variables mentioned earlier with behavior: environmental concern (EC) and perceived behavioral control (PBC). Environmental concern relates to the affective salience of environmental threats and was earlier established to mediate sense of responsibility–awareness–sustainable action relationship (Aman et al., 2021). Perceived behavioral control represents an individual's belief regarding whether they are capable of being environmentally conscious while vacationing, based on availability, information, and ease of making more environmentally friendly choices. Similarly to most TPB-based studies, PBC, typically strongly, rather than directly, relates to the behavioral outcome (Pai et al., 2024; Clayton & Karazsia, 2020).

Lastly, the sustainable behavior during winter vacation (SB) outcome measurement includes tangible behaviors like choosing environmentally certified accommodations, taking public transport, avoiding single-use plastics, and using local or organic inputs (Hwang et al., 2024; Lind et al., 2015). These behaviors are most appropriate for winter destinations, for which use levels and tourism emission levels are high.

This integrative model adds to the literature in a number of ways. Firstly, it is explicitly tested in seasonal, winter-specific tourism settings, where the effects of climate change are direct and apparent. Secondly, it integrates cognitive and moral psychological variables, capturing interactive dynamics among knowledge, values, responsibility, and control. Third, by operationalizing environmental concern and behavioral control as twin mediators, it offers a detailed explanation of the process whereby values and higher-order awareness are translatable into action implications (Yuriev et al., 2020; Wut et al., 2023; Bai & Zhang's, 2025). The model makes theoretical contributions by TPB extension with the inclusion of environmental psychological variables and practical contributions by informing destination managers and policymakers regarding how to stimulate more sustainable tourist behavior through education, infrastructure, and value-based communication.

2.2. Data Collection and Sampling

The research utilized a quantitative cross-sectional survey design, and is suitable for analyzing the intricate inter-relations among attitudinal, affective, and behavioral determinants that shape sustainable behavior for winter tourism. The design enabled effective data collection at a point in time and permitted empirical validation of a hypothesized structural model based on the Theory of Planned Behavior (TPB) and environmental psychology. This method is especially suitable to apply in examining patterns of conduct and their motivational psychology without longitudinal follow-up (Kesmodel, 2018; Rahman, 2023; Spector, 2019).

The study population sampled comprised those who had participated in winter tourism activities—like skiing, snowboarding, or nature travel—within the last twelve months. Since the recent and situation-specific behavior was the emphasis of the research, a purposive sample technique was used to select only those respondents who were identified to fulfill this experience criterion. To further ensure dataset representativeness, a stratified sample design was also included based on gender, residence, and age group for demographic balance purposes and to facilitate possible subgroup analyses. Snowball sampling was also employed to access populations that are less accessible using traditional recruitment methods, such as independent travelers or ecologically aware tourists visiting less commercialized tourist destinations (Naderifar et al., 2017; Noy, 2008).

Data were gathered via a standardized online survey tool created in Google Forms. The survey link was disseminated via various electronic media, including university email lists, environmental and outdoor recreation discussion lists, and winter sports online forums on social media sites. This multi-mode method of distribution enabled the research team to secure geographic and demographic coverage to the best possible degree while ensuring an environmentally conscious tourist population target. It was conducted in January–March 2025, coinciding with the height of the European winter season and its post-winter season.

The survey contained two wide-ranging sections: the first gathered demographic and travel information, such as winter traveling frequency, most enjoyed activities, and accommodation choice. The second part contained items aligned with the latent constructs of the study using tested scales and adapted to suit the winter tourist context. To secure construct clarity and context appropriateness, pilot testing was conducted with a small sample (n = 25) of Greek winter visitors. Pilot feedback was used to inform minor changes to wording and instructions on items to make them linguistically acceptable and culturally appropriate. After data collection, 518 questionnaires were kept after checking for eligibility and completeness. This sample is above the Structural Equation Modeling (SEM) lowest specifications of 10 participants per estimated parameter. Since there are more than 30 observed variables in the target model, a sample of 300 or more was enough to be statistically powerful, model-stable, and representative.

2.3. Measurement Scales

The measures used in this study were modified from validated scales that have been utilized in environmental psychology and sustainable tourism with appropriate adjustments to fit the winter tourist situation (Appendix A, Table A1). Climate change awareness (CCA) was assessed with four items adapted from Clayton and Karazsia (2020), Simon et al. (2022), and Cipriani et al. (2024), measuring respondents' awareness, concern, and knowledge regarding the consequences of climate change on snow-based tourism on a five-point Likert scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). Environmental attitudes were measured through five NEP scale items that C. Wang et al. (2018) modified for ecological limit beliefs, impacts of tourism, and the vulnerability of nature. Perceived responsibility was measured through six modified items from Aziz et al. (2021) and associated Norm Activation Model studies, tapping into tourists' sense of moral duty and personal responsibility to be environmentally friendly during travel. The two mediating variables were also included: environmental concern (EC), scored on four items taken from Mahasuweerachai and Suttikun (2022), assessing affective and cognitive concern towards the environment; and perceived behavioral control (PBC), taken from Mahasuweerachai and Suttikun (2022), and having four items assessing self-efficacy and control over sustainable holiday decisions. The dependent variable, sustainable behavior during winter vacation (SB), was assessed using four behavior-specific items by al. Chandran et al. (2021), rated on a five-point scale of frequency from 1 (Never) to 5 (Always). A five-point scale was selected to align with the original scales from which the items were adapted, all of which employed five-point formats in similar behavioral and tourism research contexts, thus ensuring scale compatibility and comparability with past findings. Each item was pre-tested in the context and pilot-tested for exactness, dependability, and conceptual model fit.

2.4. Sample Profile

The last sample comprised 518 individuals who had visited on holiday during winter in the last 12 months (Table 1). In terms of gender distribution, 48.1% of participants were male (n = 249), and 51.9% were female (n = 269). The age range was fairly evenly spread, with the most common age bracket being 35–44 years (26.4%), followed by 25–34 years (22.8%), 18–24 years (21.4%), 55+ (16.8%), and 45–54 years (12.5%). In terms of educational degree, 32.8% of the participants held a bachelor's degree, 30.7% held a master's degree, 18.9% held a high school diploma, and 6.4% held a doctoral degree, while 11.2% refused to answer what their educational degree was. Volunteers were also requested to disclose their biggest reason for having their most recent winter vacation. Answers were divided among nature discovery (22.6%), snow or sport activity (21.0%), visit to friends or relatives (20.7%), leisure or relax (18.9%), and other (16.8%). Based on how many winter holidays had been taken during the last five years, 57.3% of the sample said they had taken two to three winter holidays, followed by 28.2% who took one, and 14.5% who took four or more. A total of 22.2% answered that they always applied sustainable holidays when queried about whether they ever performed sustainable holiday practices (e.g., green accommodation, local cuisine, environmentally friendly tourism), 20.5% did so frequently, 14.3% occasionally, 24.1% seldom, and 18.9% never. Lastly, respondents' salience of climate change when planning vacations differed: 28.6% answered that they often took climate change into consideration, 25.5% always took climate change into consideration, 21.8% occasionally, 21.0% seldom, and 3.1% hardly ever.

Table 1. Sample profile.

		Frequency	Percentage
Gender	Male	249	48.1%
	Female	269	51.9%
Age	18–24	111	21.4%
	25–34	118	22.8%
	35–44	137	26.4%
	45–54	65	12.5%
	55+	87	16.8%
What is the highest level of education you have completed?	High School	98	18.9%
	Bachelor's Degree	170	32.8%
	Master's Degree	159	30.7%
	Doctoral	33	6.4%
	Prefer not to say	58	11.2%
What best describes your main reason for the winter vacation?	Leisure/Relaxation	98	18.9%
	Sports/Skiing/Snowboarding	109	21.0%
	Nature-based exploration	117	22.6%
	Visiting friends/family	107	20.7%
	Other	87	16.8%
How many times have you taken a winter vacation in the past 5 years?	Once	146	28.2%
	2–3 times	297	57.3%
	4 or more times	75	14.5%
How often do you actively try to make sustainable choices (e.g., eco-lodging, green transport, local food) during your vacations?	Never	98	18.9%
	Rarely	125	24.1%
	Sometimes	74	14.3%
	Often	106	20.5%
	Always	115	22.2%
How often do you think about climate change when planning your vacations?	Never	109	21.0%
	Occasionally	16	3.1%
	Sometimes	113	21.8%
	Frequently	148	28.6%
	Always	132	25.5%

2.5. Data Analysis and Results

The analysis in this present study was carried out using the Structural Equation Modeling (SEM) approach according to SmartPLS 4 (Version 4.1.1.4). SEM, and more so its variance-based counterpart, is essentially a good method for research in both the social sciences and management, according to Nitzl et al. (2016). Partial Least Squares SEM (PLS-SEM) was used because of its ability to estimate causal relationships with maximum explanation of variance in dependent latent variables (Hair et al., 2016, 2006). Multi-group analysis (MGA) was used in order to test for possible subgroup differences, enabling context differences in structural relationships usually left out when employing ordinary regression methods to be determined (Hair et al., 2006; Cheah et al., 2023). The estimation process followed Wong (2013) methodology principles of securing the proper computation of path coefficients, standard errors, and reliability indices. For the reflective measurement model, indicator reliability was determined using outer loadings higher than 0.70, thus establishing sufficient indicator-construct fit.

2.5.1. Common Method Bias

To examine the reliability and validity of the findings, common method bias (CMB) was examined systematically based on the methodological procedure suggested by (Podsakoff et al., 2003). Harman's single-factor test was used to see if one factor accounted for the majority of the variance in the model. Unrotated principal component analysis showed that the largest factor accounted for only 31.191% of the overall variance, which was well below the generally accepted value of 50%. Although CMB was not confirmed as a considerable threat in this investigation, its analysis lends validity to the constructs measured and removes the possibility of systematic bias, thus increasing the validity of the findings (Podsakoff et al., 2003, 2012).

2.5.2. Measurement Model

The first step of the PLS-SEM process is to measure the measurement model, which, in this research, consists of reflective indicators. According to guidelines given by Hair et al. (2006), measurement deals with key psychometric attributes such as composite reliability, indicator reliability, convergent validity, and discriminant validity. Indicator reliability, as termed by Vinzi et al. (2010), is the degree to which variance in an indicator is accounted for by its related latent construct. This is usually estimated using outer loadings, where loading scores of above 0.70 are rated as valid, as elaborated by Wong (2013) and Chin (2009). It is recognized, however, that these loading scores may be lower for social science studies. Therefore, such decisions need to be taken on the basis of whether the exclusion of indicators with loadings between 0.40 and 0.70 would immensely raise composite reliability or AVE, as proposed by Hair et al. (2021). According to these guidelines, and as explained by Gefen and Straub (2005), the measurement model was purged of one indicator, EC4, because its loading was less than 0.500, as presented in Table 2.

Reliability in this research was measured using Cronbach's alpha, rho_A, and composite reliability. In line with the 0.70 recommended by Wasko and Faraj (2005), measurements like ATT, CCA, EC, PBC, PR, and SB had acceptable internal consistency. The rest of the measurements ranged from moderate to high and were in the same trend as evidenced by prior research studies (Hair et al., 2016, 2006, 2021). The rho_A coefficient, as theoretically in between Cronbach's alpha and composite reliability, was in all but a few instances above the 0.70 cut-off, hence further confirming the reliability demonstration by Hair et al. (2021) and Henseler et al. (2015). Average variance extracted (AVE) values for convergent validity were significantly above the Fornell and Larcker (1981)-endorsed threshold value of 0.50 for most constructs. Where AVE failed to meet this standard, constructs were still satisfactory since their composite reliability was greater than 0.60, based on Fornell and Larcker (1981) requirement. Discriminant validity was determined using inter-construct correlation comparison whereby the square root of every construct's AVE was higher than its correlations with other constructs and further supported by a heterotrait–monotrait (HTMT) ratio approach (Hair et al., 2016). All HTMT statistics were less than the conservative threshold of 0.85, which attested to sufficient discriminant validity as clear from Tables 3 and 4. Besides the Fornell–Larcker and HTMT criteria, discriminant validity was also checked at the indicator level by cross-loadings in order to verify that each item loads highest on its measured construct. The whole cross-loading matrix is given in Appendix A (Table A2) to increase transparency and confirmatory purposes.

Table 2. Factor loading reliability and convergent validity.

Constructs	Items	Factor Loadings	Cronbach's Alpha	rho_A	CR	AVE
Environmental Attitudes	ATT1	0.822	0.829	0.842	0.874	0.582
	ATT2	0.762				
	ATT3	0.751				
	ATT4	0.690				
	ATT5	0.783				
Climate Change Awareness	CCA1	0.747	0.790	0.790	0.864	0.614
	CCA2	0.794				
	CCA3	0.805				
	CCA4	0.786				
Environmental Concern	EC1	0.737	0.657	0.708	0.807	0.584
	EC2	0.844				
	EC3	0.705				
Perceived Behavioral Control	PBC1	0.899	0.873	0.874	0.922	0.797
	PBC2	0.881				
	PBC3	0.898				
Perceived Responsibility	PR1	0.884	0.902	0.903	0.932	0.774
	PR2	0.831				
	PR3	0.905				
	PR4	0.896				
Sustainable Behavior During Winter Vacation	SB1	0.726	0.790	0.826	0.878	0.707
	SB2	0.912				
	SB3	0.874				

Table 3. HTMT ratio.

	ATT	CCA	EC	PBC	PR	SB
ATT						
CCA	0.141					
EC	0.179	0.654				
PBC	0.172	0.458	0.507			
PR	0.090	0.693	0.735	0.538		
SB	0.061	0.710	0.595	0.586	0.599	

Note: This table shows the HTMT ratios between each pair of latent constructs. HTMT values below the threshold of 0.85 indicate acceptable discriminant validity. All values in this analysis meet this requirement, confirming that each construct is empirically distinct.

Table 4. Fornell and Larcker criterion.

	ATT	CCA	EC	PBC	PR	SB
ATT	**0.763**					
CCA	0.046	**0.783**				
EC	−0.121	0.507	**0.764**			
PBC	−0.159	0.381	0.382	**0.893**		
PR	−0.017	0.586	0.585	0.479	**0.880**	
SB	0.004	0.571	0.465	0.489	0.514	**0.841**

Note: The diagonal values (in bold) represent the square roots of the AVE for each construct, which should be greater than the inter-construct correlations in the corresponding rows and columns. This condition is met across all constructs, supporting discriminant validity in the measurement model.

2.5.3. Structural Model

The structural model was checked by examining the coefficient of determination (R^2) and predictive relevance (Q^2) and the statistical significance of the path coefficients estimated, as per guidelines presented by Hair et al. (2016). The R^2 values achieved—0.441 for sustainable behavior intention, 0.399 for environmental concern, and 0.27 for perceived behavioral control—are at an acceptable explanatory power level in that they fall within the standard 0 to 1 limit. In addition, the Q^2 values confirmed the predictability of the model with sustainable behavior intention at 0.366, environmental concern at 0.387, and perceived behavioral control at 0.257, displaying moderate to strong predictability strength. Figure 2 illustrates the full results of the PLS-SEM analysis, including all measurement and structural model relationships.

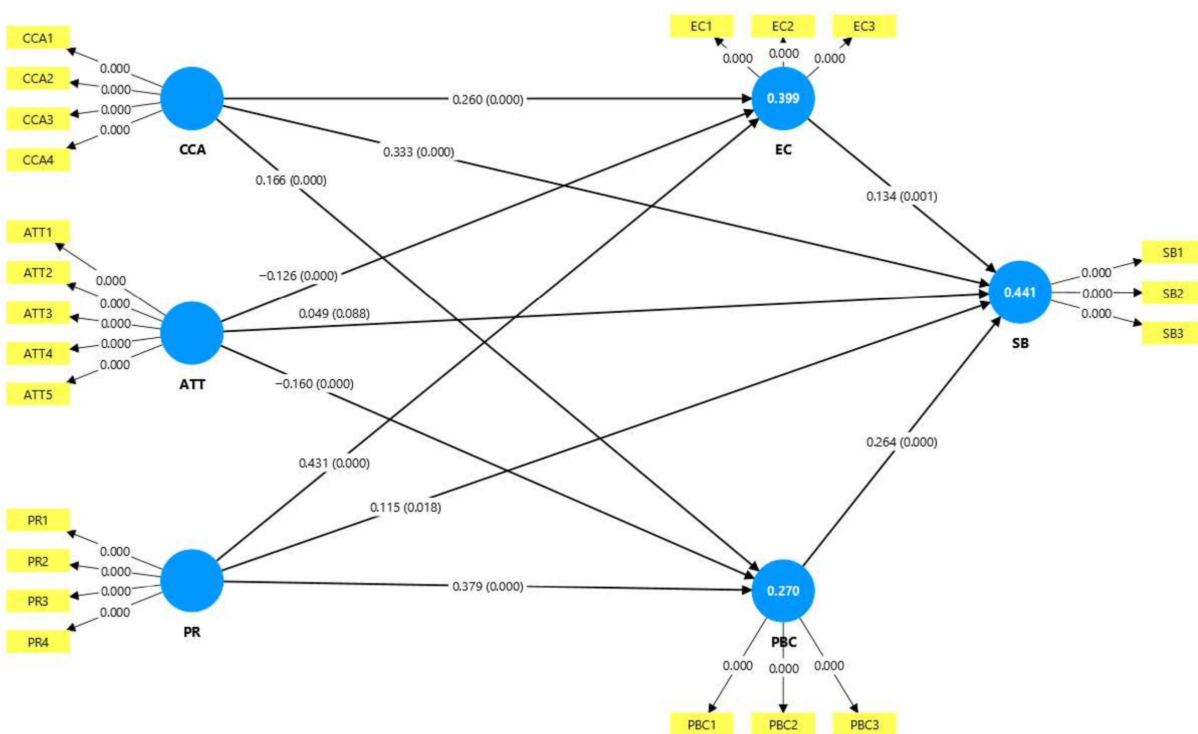

Figure 2. Final PLS-SEM model output. Standardized outer loadings (indicator-to-construct), inner model path coefficients, and associated *p*-values (in parentheses) are shown. The numbers inside the blue circles represent R^2 values, indicating explained variance in each endogenous construct.

Hypothesis testing was subsequently conducted to confirm the significance of structural relationships among latent variables, and path coefficients were then estimated through a bootstrapping procedure following Hair et al. (2021). Mediation effects were examined using a one-tailed bias-corrected bootstrap procedure following Preacher and Hayes (2008) and Streukens and Leroi-Werelds (2016) procedure with 10,000 bootstrap samples. The results of the structural model are summarized in Table 5.

Table 5. Hypotheses testing.

Hypothesis	Path	Coefficient (β)	SD	t-Value	*p*-Value	Results
H1	CCA → SB	0.333	0.040	8.322	0.000	Supported
H2	ATT → SB	0.049	0.036	1.352	0.088	Not Supported
H3	PR → SB	0.115	0.055	2.096	0.018	Supported
H4a	EC → SB	0.134	0.044	3.068	0.001	Supported
H4b	PBC → SB	0.264	0.048	5.498	0.000	Supported

Note: This table summarizes the direct relationships between latent variables and sustainable behavior (SB), including standardized path coefficients (β), bootstrapped standard deviations (SD), t-values, and *p*-values obtained from bias-corrected bootstrapping with 10,000 samples. Significant results ($p < 0.05$) are marked as "Supported" and indicate acceptance of the corresponding hypotheses (H1–H4b).

Regarding hypothesis H1, a positive predicting relationship between climate change awareness (CCA) and sustainable behavior (SB) was confirmed (β = 0.333, t = 8.322, $p < 0.001$) with a very strong significant effect. Environmental attitudes (ATT) were not a significant predictor of sustainable behavior (H2), i.e., the path coefficient was very small and nonsignificant (β = 0.049, t = 1.352, $p = 0.088$). Perceived responsibility (PR) played a significant role in sustainable behavior (H3; β = 0.115, t = 2.096, $p = 0.018$), supporting the hypothesis. Both environmental concern (EC) and perceived behavioral control (PBC) played significant roles as mediators for sustainable behavior. More precisely, EC had a moderate positive contribution (H4a; β = 0.134, t = 3.068, $p = 0.001$), whereas PBC was strongly related (H4b; β = 0.264, t = 5.498, $p < 0.001$).

These findings suggest that among the variables entered into the model, awareness of climate change and perceived behavioral control were the most direct predictors of sustainable winter tourism action. Environmental concern and perceived responsibility were also significant, with measured attitudes toward the environment playing no statistically significant influence.

2.5.4. Mediation Analysis

To examine the underlying mechanisms in which climate change awareness (CCA), environmental attitudes (ATT), and perceived responsibility (PR) have an impact on sustainable behavior during winter vacations (SB), mediation analysis was carried out. Environmental concern (EC) and perceived behavioral control (PBC) were tested as mediating effects with a bias-corrected bootstrapping method using 10,000 samples, as shown in Table 6.

H5a and H5b postulated that EC and PBC, respectively, act as intermediaries between climate change awareness (CCA) and sustainable behavior (SB). The hypotheses were confirmed through the analysis. CCA significantly predicted SB indirectly through EC (β = 0.035, t = 2.439, $p = 0.007$), and also through PBC (β = 0.044, t = 3.081, $p = 0.001$). As the direct effect of CCA on SB still existed (β = 0.333, $p < 0.001$), all the above findings affirm partial mediation, thus lending evidence for H5a and H5b. H6a and H6b posited that PBC and EC are mediators between attitude towards the environment (ATT) and sustainable behavior (SB). Both indirect models were statistically significant: ATT → EC → SB (β = 0.017, t = 2.519, $p = 0.006$) and ATT → PBC → SB (β = 0.042, t = 2.726, $p = 0.003$). However, the direct relationship of ATT on SB was nonsignificant (β = 0.049, $p = 0.088$) but the total effect was significant (β = –0.059, $p < 0.001$). This indicates that the relationship is fully mediated by EC and PBC, therefore supporting H6a and H6b and showing full mediation. H7a and H7b tested whether EC and PBC are the mediators of the PR-SB relationship. Both indirect effects were significant: PR → EC → SB (β = 0.058, t = 2.957, p = 0.002) and PR → PBC → SB (β = 0.100, t = 4.162, p < 0.001). The strong direct relationship between PR and SB was also substantial (β = 0.115, p = 0.018), suggesting partial mediation. Therefore, H7a and H7b were supported as well.

Table 6. Mediation analysis.

Hypothesis	Direct Effects	Coeff. (β)	SD	t-Value	*p*-Value	Results	Mediation Type
	CCA → SB	0.333	0.040	8.322	0.000		
	ATT → SB	0.049	0.036	1.352	0.088		
	PR → SB	0.115	0.055	2.096	0.018		
	Total Effects	**Coeff. (β)**	**SD**	**t-Value**	***p*-Value**		
	ATT → SB	−0.059	0.017	3.472	0.000		
	CCA → SB	0.079	0.020	4.013	0.000		
	PR → SB	0.158	0.034	4.634	0.000		
	Specific Indirect Effects	**Coeff. (β)**	**SD**	**t-Value**	***p*-Value**		
H5a	CCA → EC → SB	0.035	0.014	2.439	0.007	Supp.	Partial Mediation
H5b	CCA → PBC → SB	0.044	0.014	3.081	0.001	Supp.	Partial Mediation
H6a	ATT → EC → SB	0.017	0.007	2.519	0.006	Supp.	Full Mediation
H6b	ATT → PBC → SB	0.042	0.015	2.726	0.003	Supp.	Full Mediation
H7a	PR → EC → SB	0.058	0.020	2.957	0.002	Supp.	Partial Mediation
H7b	PR → PBC → SB	0.100	0.024	4.162	0.000	Supp.	Partial Mediation

Note: The table includes direct, total, and specific indirect effects for each hypothesized path including standardized path coefficients (β), bootstrapped standard errors (SE), t-values, and *p*-values, obtained from bias-corrected bootstrapping with 10,000 resamples. The results classify mediation as full, partial, or not supported, following Preacher and Hayes' bias-corrected bootstrap method.

In general, all six hypothesized paths of mediation were statistically supported. Emotional (EC) and cognitive (PBC) processes together explained the effect of awareness, attitudes, and perceived responsibility for sustainable behavior. The most dominant path of mediation was via PBC in the case of perceived responsibility. It implies that sustainable tourist consumption by winter tourists is not only elicited by affective concern or environmentalism but yet more powerfully by perceptions of control and feasibility. That is, the belief that one can easily do sustainable things (e.g., book eco-friendly accommodation, move around using public transport, avoid plastic) is a more powerful behavioral impulse than merely caring about the environment. This is why it becomes imperative to design tourism policies and interventions to promote perceived convenience, green availability, and tourists' sense of competence so that they can act in an environmentally friendly manner. If sustainable solutions are made visible, accessible, and hassle-free, then the prospect of adoption skyrockets—particularly in the context of leisure like winter holidays where hedonic needs are set against ethical values.

2.5.5. Multi-Group Analysis

Multi-group analysis (MGA) was employed to examine whether the structural paths between the hypothesized model's latent variables varied significantly in subgroups such as gender, age group, education level, climate change awareness, how often one exhibits sustainable behavior, and how often one takes winter holidays. Below, only those statistically significant differences in path coefficients are presented; the rest of the tests resulted in nonsignificant outcomes (p > 0.05).

Gender Differences

There were significant gender differences in a set of crucial variables for key structural pathways. The influence of environmental concern on sustainable behavior (EC → SB) was considerably higher for females than for males ($\Delta\beta = -0.310$, $p < 0.001$). In the same way, women's attitude strength in influencing sustainable behavior (ATT → SB) was stronger ($\Delta\beta = -0.278$, $p = 0.002$), and attitude strength influencing environmental concern (ATT → EC; $\Delta\beta = -0.154$, $p = 0.030$) was also stronger. Conversely, men showed stronger positive associations of climate change awareness to perceived behavioral control (CCA → PBC; $\Delta\beta = 0.220$, $p = 0.009$) and sustainable behavior (CCA → SB; $\Delta\beta = 0.180$, $p = 0.014$). The association between perceived responsibility and environmental concern (PR → EC) was higher for men ($\Delta\beta = 0.151$, $p = 0.054$).

Age Group Variations

Age-based MGA revealed some extreme differences. Age 25–34 experienced more environmental concern impacting sustainable behavior (EC → SB) than age 18–24 ($\Delta\beta = 0.365$, $p = 0.002$) but less than 35–44 ($\Delta\beta = -0.463$, $p < 0.001$) and 55+ ($\Delta\beta = -0.290$, $p = 0.016$). The effect of perceived responsibility on sustainable behavior (PR → SB) was less strong for the 25–34 compared to the 18–24 ($\Delta\beta = -0.372$, $p = 0.005$), but more so than in the 35–44 ($\Delta\beta = 0.576$, $p < 0.001$) and 45–54 ($\Delta\beta = 0.495$, $p = 0.004$) age ranges. For PR → EC, there were considerable differences between 18–24 and 25–34 ($\Delta\beta = 0.322$, $p = 0.018$) and 25–34 and 55+ ($\Delta\beta = -0.389$, $p = 0.011$). CCA → EC's effect was weaker for 25–34 than 18–24 ($\Delta\beta = -0.306$, $p = 0.022$), but greater compared to 35–44 ($\Delta\beta = 0.262$, $p = 0.017$) and 55+ ($\Delta\beta = 0.423$, $p = 0.011$). ATT → EC was more robust for younger participants (18–24 compared with 35–44: $\Delta\beta = 0.189$, $p = 0.039$; 25–34 compared with 35–44: $\Delta\beta = 0.348$, $p = 0.005$). ATT → PBC had stronger influences on participants aged 25–34 than 35–44 ($\Delta\beta = 0.431$, $p = 0.019$) and 45–54 ($\Delta\beta = 0.656$, $p = 0.002$), and 35–44 also had stronger influences than 45–54 ($\Delta\beta = 0.225$, $p = 0.021$). There was a reverse trend between 45–54 and 55+ ($\Delta\beta = -0.503$, $p = 0.005$), i.e., a declining influence with age. The PR → PBC path was greater in the 25–34 group than in the 55+ group ($\Delta\beta = -0.266$, $p = 0.044$).

Climate Salience Moderation

Differences between high and low salience of climate change participants exhibited strongly divergent patterns. The CCA → EC effect was significantly stronger for the high salience group than for both low ($\Delta\beta = -0.388$, $p < 0.001$) and medium ($\Delta\beta = -0.264$, $p = 0.020$) groups. PR → EC significantly differed between high and low salience ($\Delta\beta = 0.394$, $p < 0.001$). ATT → EC was also greater for high > low ($\Delta\beta = -0.325$, $p = 0.002$) and high > medium salience ($\Delta\beta = -0.302$, $p = 0.005$). Other notable comparisons are CCA → PBC (high vs. low: $\Delta\beta = -0.206$, $p = 0.045$; high vs. medium: $\Delta\beta = -0.506$, $p < 0.001$; low vs. medium: $\Delta\beta = -0.300$, $p = 0.007$), PR → PBC (high vs. medium: $\Delta\beta = 0.320$, $p = 0.004$), and ATT → SB (high vs. medium: $\Delta\beta = 0.346$, $p = 0.009$). For sustainable behavior frequency, PR → PBC was higher for high frequency compared to low ($\Delta\beta = 0.257$, $p = 0.009$). ATT → EC was weaker in the high frequency group compared to low group ($\Delta\beta = -0.146$, $p = 0.035$). CCA → PBC was higher for medium group compared to high frequency ($\Delta\beta = -0.317$, $p = 0.003$). EC → SB significantly improved for high vs. medium ($\Delta\beta = -0.235$, $p = 0.016$) and low vs. medium ($\Delta\beta = -0.217$, $p = 0.035$) groups. For winter vacation frequency, the influence of CCA → SB was stronger in subjects who had winter vacations 2–3 times a year compared to 4+ ($\Delta\beta = 0.324$, $p = 0.016$), and considerably weaker in 4+ compared to once ($\Delta\beta = -0.419$, $p = 0.004$). PBC → SB was more pronounced in the 4+ group than the 2–3 group ($\Delta\beta = -0.265$, $p = 0.042$), and in the once group compared to the 2–3 group ($\Delta\beta = -0.139$, $p = 0.046$). The other notable differences were PR → EC (2–3 vs. 4+: Δβ = 0.324, p = 0.044), EC → SB (2–3 vs. once: Δβ = −0.227, p = 0.004), PR → SB (2–3 vs. once: Δβ = 0.339, p = 0.001), ATT → EC (2–3 vs. once: Δβ = −0.169, p = 0.040), ATT → SB (2–3 vs. once: Δβ = 0.213, p = 0.007), and CCA → PBC (2–3 vs. once: Δβ = −0.358, p < 0.001; 4+ vs. once: Δβ = −0.336, p = 0.014).

Education-Level Contrasts

For educational level, there were large differences between educational groups for many structural paths. PBC → SB was larger for bachelor's degree recipients than for doctoral degree recipients (Δβ = 0.512, p = 0.019) and nonrespondents (Δβ = 0.295, p = 0.011). CCA → PBC and CCA → SB were also significant among bachelor's graduates relative to doctoral graduates (Δβ = 0.571, p = 0.029; Δβ = 0.410, p = 0.043, respectively). Doctoral group members had higher path coefficients in PR → SB compared to high school and master's groups (Δβ = 0.620, p = 0.015; Δβ = 0.491, p = 0.032). ATT → PBC and ATT → EC were different between bachelor's and high school groups (Δβ = 0.335, p = 0.006; Δβ = 0.235, p = 0.026, respectively). Lastly, PR → PBC and ATT → SB routes were notably stronger in high school members than in other schooling levels (e.g., PR → PBC: Δβ = 0.325, p = 0.003).

These results validate partial measurement invariance and evidence for the existence of significant structural differences among socio-demographic and behavioral subgroups in the relationships between the paths, validating the existence of moderating effects in the proposed structural model (Table 7).

Table 7. Significant MGA results with group comparisons.

Pathway	Significant Group	Δβ	*p*-Value
EC → SB	Female > Male	−0.310	0.000
ATT → SB	Female > Male	−0.278	0.002
CCA → PBC	Male > Female	0.220	0.009
CCA → SB	Male > Female	0.180	0.014
ATT → EC	Female > Male	−0.154	0.030
PR → EC	Male > Female	0.151	0.054
EC → SB	18–24 vs. 25–34	0.365	0.002
	25–34 vs. 35–44	−0.463	0.000
	25–34 vs. 55+	−0.290	0.016
PR → SB	18–24 vs. 25–34	−0.372	0.005
	25–34 vs. 35–44	0.576	0.000
	25–34 vs. 45–54	0.495	0.004
PR → EC	18–24 vs. 25–34	0.322	0.018
	25–34 vs. 55+	−0.389	0.011
CCA → EC	18–24 vs. 25–34	−0.306	0.022
	25–34 vs. 35–44	0.262	0.017
	25–34 vs. 55+	0.423	0.011
ATT → EC	18–24 vs. 35–44	0.189	0.039
	25–34 vs. 35–44	0.348	0.005
ATT → PBC	25–34 vs. 35–44	0.431	0.019
	25–34 vs. 45–54	0.656	0.002
	35–44 vs. 45–54	0.225	0.021
	45–54 vs. 55+	−0.503	0.005
PR → PBC	25–34 vs. 55+	−0.266	0.044
CCA → EC	Climate Change Salience High vs. Low	−0.388	0.000
	Climate Change Salience High vs. Medium	−0.264	0.020
PR → EC	Climate Change Salience High vs. Low	0.394	0.000
ATT → EC	Climate Change Salience High vs. Low	−0.325	0.002
	Climate Change Salience High vs. Medium	−0.302	0.005

Table 7. *Cont.*

Pathway	Significant Group	Δβ	*p*-Value
CCA → PBC	Climate Change Salience High vs. Low	−0.206	0.045
	Climate Change Salience High vs. Medium	−0.506	0.000
	Climate Change Salience Low vs. Medium	−0.300	0.007
PR → PBC	Climate Change Salience High vs. Medium	0.320	0.004
ATT → SB	Climate Change Salience High vs. Medium	0.346	0.009
PR → PBC	Frequency of Sustainable Choices High vs. Low	0.257	0.009
ATT → EC	Frequency of Sustainable Choices High vs. Low	−0.146	0.035
CCA → PBC	Frequency of Sustainable Choices High vs. Medium	−0.317	0.003
EC → SB	Frequency of Sustainable Choices High vs. Medium	−0.235	0.016
	Frequency of Sustainable Choices Low vs. Medium	−0.217	0.035
CCA → SB	Winter Vacation Frequency 2–3 times vs. 4+ times	0.324	0.016
	Winter Vacation Frequency 4+ times vs. Once	−0.419	0.004
PBC → SB	Winter Vacation Frequency 2–3 times vs. 4+ times	−0.265	0.042
	Winter Vacation Frequency 2–3 times vs. Once	−0.139	0.046
PR → EC	Winter Vacation Frequency 2–3 times vs. 4+ times	0.324	0.044
EC → SB	Winter Vacation Frequency 2–3 times vs. Once	−0.227	0.004
PR → SB	Winter Vacation Frequency 2–3 times vs. Once	0.339	0.001
ATT → EC	Winter Vacation Frequency 2–3 times vs. Once	−0.169	0.040
ATT → SB	Winter Vacation Frequency 2–3 times vs. Once	0.213	0.007
CCA → PBC	Winter Vacation Frequency 2–3 times vs. Once	−0.358	0.000
	Winter Vacation Frequency 4+ times vs. Once	−0.336	0.014
PBC → SB	Bachelor's vs. Doctoral	0.512	0.019
	Bachelor's vs. Prefer not to say	0.295	0.011
	Doctoral vs. High school	−0.419	0.042
	Doctoral vs. Master's	−0.476	0.030
CCA → PBC	Bachelor's vs. Doctoral	0.571	0.029
	Doctoral vs. High school	−0.714	0.014
	Doctoral vs. Master's	−0.600	0.025
	Doctoral vs. Prefer not to say	−0.681	0.019
PR → SB	Bachelor's vs. Doctoral	−0.448	0.034
	Doctoral vs. High school	0.620	0.015
	Doctoral vs. Master's	0.491	0.032
CCA → SB	Bachelor's vs. Doctoral	0.410	0.043
	Doctoral vs. High school	−0.469	0.032
	Doctoral vs. Prefer not to say	−0.489	0.037
ATT → PBC	Bachelor's vs. High school	0.335	0.006
	Doctoral vs. High school	0.658	0.049
	Doctoral vs. Prefer not to say	0.590	0.072
ATT → EC	Bachelor's vs. High school	0.235	0.026
	Bachelor's vs. Prefer not to say	0.343	0.020
	Doctoral vs. Prefer not to say	0.540	0.051
PR → PBC	Bachelor's vs. High school	0.325	0.003
	High school vs. Master's	−0.304	0.009
ATT → SB	Bachelor's vs. High school	0.193	0.038

Note: This table reports only the statistically significant differences in structural path coefficients (Δβ) between groups.

3. Discussion

The general aim of the current study was to investigate the psychological and cognitive precursors of sustainable behavior (SB) of winter tourism based on an extended Theory of Planned Behavior (TPB). The results provide important contributions to the predictability of pro-environmental behavior in winter tourists, confirming some established theoretical connections and disproving others.

First and foremost, the study tested and validated a positive and statistically significant association between sustainable behavior and climate change awareness (CCA), establishing CCA as a robust cognitive antecedent (H1). This finding is consistent with past studies that inducing environmental threats, such as global warming, will influence action behavior when people subject the issue to personal relevance and temporariness (Mitrică et al., 2025; Bai & Zhang's, 2025; Maoela et al., 2025). In the context of winter tourism, where climate change impacts are actual and concrete—e.g., reduced ski seasons or unreliable snow cover—awareness has a better chance of manifesting into action. This result puts an end to the extensive "awareness-action gap" in tourism research (Hwang et al., 2024; Maoela et al., 2025; Cipriani et al., 2024), at least for climate-risky host destination laboring tourists.

Interestingly enough, however, no statistical significance was observed between attitudes towards the environment (ATT) and environmentally sustainable behavior (H2). This finding is contrary to the typical TPB specification, where attitude acts as a primary predictor of intention and behavior (Wut et al., 2023; Bai & Zhang's, 2025). But in tourism contexts, and most notably in hedonic environments such as vacations, perhaps environmental attitude can be a secondary concern to more practical or affective ones. Prior studies have also indicated that while tourists tend to support green attitudes, these might not necessarily be converted into pro-environmental behavior when on a trip (C. Wang et al., 2018; Gil-Giménez et al., 2021; Aziz et al., 2021). The result might reflect the compartmentalization of pro-environmental values in recreational spaces whereby hedonic stimuli take precedence over normative concerns. This research provides empirical evidence for the attitude–behavior gap contested over a period of time, which proves that attitudes will be insufficient to alter sustainable tourism behavior unless it is supplemented with affective commitment or perceived control. The nonsignificant path ATT $\rightarrow$ SB illustrates a fundamental weakness in most conventional behavior change models centered on informational or attitudinal change as the point of influence. In tourist settings—particularly leisure or hedonic ones—pro-environmental attitudes might not be behaviorally expressed because of psychological distancing, the presence of competing alternative motivations (e.g., relaxation, fun), or the absence of behavioral efficacy. This finding supports the pleas in the literature to move beyond the simplistic attitudinal appeal and, rather, develop multi-faceted interventions that engage emotional concern, perceived ease of action, and moral salience to effectively shape sustainable decisions. This discrepancy also calls for more requirements to transcend older attitudinal measures in environmental behavior theory and incorporate more situational and affect-based variables (Wut et al., 2023).

In contrast to this, perceived responsibility (PR) also served as a significant predictor of sustainable behavior (H3), noting the existence of moral obligation and internalized responsibility. This finding accords with work from Value–Belief–Norm (VBN) theory and Norm Activation Model (NAM), which both suggest that a person's own sense of duty and responsibility motivate pro-environmental behavior, specifically where the person feels there is a moral interest in the outcome (López-Mosquera & Sánchez, 2012; Sahabuddin et al., 2024; Lind et al., 2015). In winter tourism, where tourists are highly attuned to their own environmental footprint—e.g., carbon dioxide-emitting vacations or snow-based recreation—this internalization of responsibility can be an impetus to more sustainable choice-making. The expectation is that efforts to instill a sense of personal responsibility in climate communication campaigns may work better than awareness or overall attitudinal change focus.

Both perceived behavioral control (PBC) and environmental concern (EC) were found to be important mediators, further clarifying how psychological factors influence behavior. EC was shown to have a statistically significant though moderate influence (H4a), whereby, in earlier studies, concern is established as an emotional connection between cognitive awareness and intention to perform an action (Leal Filho et al., 2024; Steiger et al., 2021; Witting et al., 2021). Concern can also be a motivator amplifier as people who are not only cognitively responsive to environmental issues but also affectively committed to them have greater likelihood of taking action. To that end, EC can render environment messages more salient and urgency-sense-related, hence bypassing behavioral inertia.

The single most direct predictor other than CCA was perceived behavioral control (PBC) (H4b), endorsing its top spot among TPB-based models of sustainable behavior. This is corroborated by extensive literature showing that if consumers believe they are able to access sustainable behaviors—whatever they may be, from recycling to public transport to green-labeled accommodation—then the more they will be able to adapt these behaviors (Leal Filho et al., 2024; Steiger et al., 2021). In winter tourism, perceived control will refer to physical facilitators (e.g., buildings, signs, green options) and psychological ones (e.g., self-efficacy, cognition) as well. The result focuses on the practical utility of eliminating structure barriers to sustainable behavior, which are typically more influential than a shift in attitude in predicting results (Wut et al., 2023; Hwang et al., 2024; Zaman, 2024; Aziz et al., 2021).

Combined, these results demonstrate that cognitive (CCA, PBC), emotional (EC), and normative (PR) factors are each essential for describing sustainable winter tourism behavior. While attitude was not significantly impactful, what appears is that behavior is more driven by perceived feasibility, moral duty, and climate salience than by orientation towards the environment. This is empirical evidence for the integration of TPB and environmental psychology constructs as per more recent suggestions of more integrated models of behavior for tourism research (Leal Filho et al., 2024; Steiger et al., 2021; Witting et al., 2021). Theoretically, the findings confirm the continued development of TPB-informed theories. The findings confirm the utility of extended TPB models to explain pro-environmental behavior complexity in recreational settings, especially when augmented by emotionally and morally congruent variables. Practically, the findings imply that winter resorts in holiday and environmentally oriented campaigns need to target down-to-earth pursuits, climatic salience, and individual responsibility over purely abstractly conceived attitude formation or information provision alone.

3.1. Mediation Analysis Results

In order to have a closer look at mechanisms linking major psychological predictors to sustainable behavior in winter tourism, mediation analysis was conducted with EC and PBC as mediators. The results showed a coherent and statistically significant pattern: all hypothesized mediation paths were confirmed, providing strong empirical support for the theoretical model integrated in this research.

Climate change awareness (CCA) exerted partial mediation effects via EC and PBC (H5a and H5b). The indirect effect of CCA on sustainable behavior (SB) via EC lends support to the argument that affective concern with the environment magnifies the behavioral effect of cognitive awareness (C. Wang et al., 2018; Gil-Giménez et al., 2021; Aziz et al., 2021). At the same time, the PBC path illustrates that knowledge itself is not sufficient unless one feels they can do something about it. These results validate previous assertions that CCA alone must be combined with psychological or situational facilitators—such as control over behavior or easily accessible alternatives to produce meaningful change (Raza et al., 2024; Lind et al., 2015; Fu & Zhao, 2024; Ngxongo, 2021). In particular, CCA's direct effect on SB continued to be robust, indicating partial mediation: consciousness does indeed have direct influence on behavior, but it is enhanced when being channeled through concern and control.

Attitude towards the environment (ATT) indirectly affected only SB, lending support to full mediation by EC (H6a) and PBC (H6b). ATT was not a statistically significant direct predictor of SB but came into focus when the mediators were controlled. This finding signals the bounded individual predictive capability of general environmental attitudes, particularly in tourism settings in which behavior will be more likely influenced by affective, habitual, or pragmatic considerations (Raza et al., 2024; Lind et al., 2015; Ngxongo, 2021). Rather, ATT is a distal level antecedent that influences only if funneled through more proximal ones—i.e., concern and belief in the ability to act. This aligns with current iterations of TPB and VBN which propose mediational processes between action and attitude (Steiger et al., 2021; J. Wang et al., 2022; Walters & Ruhanen, 2015).

Perceived responsibility (PR) also had indirect effects on SB through EC (H7A) and PBC (H7b), in addition to its strong direct effect, suggesting partial mediation. The stronger mediation chain through PBC highlights the action-directed conception of personal responsibility: visitors making themselves responsible are more inclined to perceive that they can make sustainable decisions. This result confirms the moral-normative orientation of the Norm Activation Model (NAM), which implies that others' personal norms influence behavior by influencing self-efficacy and control (Steiger et al., 2021; Yuriev et al., 2020; Wut et al., 2023). And although concern is an affective bridge, it also implies that responsibility provokes affective involvement in environmental issues.

Taken together, the mediation results shed light on the interactive roles of emotional (EC) and cognitive–behavioral (PBC) processes in taking awareness, attitudes, and responsibility and turning them into long-term behavior. PBC was the stronger mediator across the pathways, implying actionability—i.e., feeling in control and capable of doing something—is a more enduring spur to behavior than emotional connection alone. This understanding has deep implications for promoting sustainable tourism: raising concerns is valuable but making people skilled, knowledgeable, and self-reliant for sustainable living might make more of a difference. In conclusion, the mediation results validate the complex psychological process of environmentally conscious winter tourism behavior. With the separation of indirect effects of witnessed antecedents, the research elucidates improved understanding of how awareness of climate, nature attitude, and moral obligation influence behavioral outcomes—providing researchers and practitioners with insights to foster environmentally friendly tourism (Steiger et al., 2021; J. Wang et al., 2022; Walters & Ruhanen, 2015).

3.2. Multi-Group Analysis Results

The multi-group analysis (MGA) yielded rich insight into the way demographic, behavioral, and contextual variables moderate structural relationships between the proposed model. Statistically significant differences among groups being identified not only verifies winter tourism sustainable behavior complexity, but also highlights the necessity of diversified intervention methods (Steiger et al., 2021; J. Wang et al., 2022; Walters & Ruhanen, 2015).

Gender differences were most prominent. Females possessed more significant path coefficients between environmental concern (EC) and environmental attitudes (ATT) to sustainable behavior (SB), and from ATT to EC. These findings are consistent with past studies that have proven that women are emotionally invested and responsive to ecological problems (Zaman, 2024; Y. Yang et al., 2023). On the other hand, men showed stronger effects of climate change awareness (CCA) on both PBC and SB, and from perceived responsibility (PR) to EC. This would imply a more cognitive and efficacy-based process among males, in line with earlier research that implies gendered variation in environmental action mechanisms.

The age profile showed significant variation. The young adults (18–24) were most sensitive to CCA and PR in the effect they had on EC and SB, as a sign of higher emotional and normative sensitivity. The 25–34 age group, on the other hand, showed stronger PBC-based models, possibly as a sign of a transitional phase to more behavioral control and responsibility. Trends were more consistent in older cohorts (35–44 and 55+) and can represent longer internalization of values. They are consistent with stage models of environmental behavior and indicate the success of age-segmented messages in green campaigns (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025). Higher salience of climate change actors consistently exhibited stronger CCA, ATT, and PR toward both mediators, that is, EC, who are more sensitive and with greater internalization of environmental concerns. This corroborates earlier research that climate salience functions as a cognitive filter in information processing and intention to behave.

Level of education also affected some of the most relevant pathways. Holders of a bachelor's degree showed higher correlations between SB and PBC, and CCA, indicating that moderate levels of formal education might increase environmental responsiveness without the risk of criticism or distancing skepticism characteristic in a few cases at the doctoral level (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025). Interestingly, high school graduates showed stronger flows from PR and ATT to PBC, suggesting that affective and moral communications would be more salient when formal environmental knowledge is diminished. Structural heterogeneity was also better accounted for by behavior segmentation. Participants who practiced sustainable behavior more frequently or had more frequent winter holidays practiced stronger PBC and EC flows, highlighting habituation and situational familiarity with sustainable tourism. The frequency-based differences also point to the practical potential of targeting behavioral regularity rather than static traits.

In total, these results provide empirical support for moderation effects and explicit evidence for the context-dependency of environmental behavior. The group differences found provide support for segmentation measures to be used in sustainable tourism policy-making and direct focus to the value of tailoring communication and interventions to demographic and behavioral characteristics. These subgroup mechanisms require longitudinal and experimental extension in future work to advance causal inference and practical utility (Vicente, 2024; Shin et al., 2025; Nunkoo et al., 2013).

3.3. Practical Implications

This research has various applied implications for the primary stakeholders in the promotion of winter tourism sustainably—policymakers, tourism business managers, and environmental education specialists. Through defining both direct and mediated routes to sustainable behavior, and through revealing real demographic and behavioral heterogeneity with multi-group analysis, this research offers an evidence-based stage for more focused and efficacious intervention formulation.

3.3.1. Implications for Policymakers

Policy-wise, the powerful influence of climate change awareness (CCA) and perceived behavioral control (PBC) on sustainable action necessitates that environmental campaigns promoting communication highlight both the urgency of doing something about climate change right away and a feeling of being in control. Awareness raising, while effective, is evidently considerably increased when combined with efficacy-supporting messaging and control messaging (Pai et al., 2024; Raza et al., 2024; Maoela et al., 2025). So, national and regional tourist authorities need to make environmental literacy programs an educational priority that not only enlighten the public on environmental hazards but also present tangible, doable actions that visitors can incorporate during their trip (e.g., staying at ecotourism hotels, eating at local green-certified restaurants, or reducing transport emissions).

In addition, the mediational function of environmental concern (EC) points to the critical need to increase emotional connection to environmental problems. The incorporation of narrative interventions, for example, storytelling of local climatic changes in hilly areas, by policymakers is likely to generate concern and empathy among groups, such as young or less-concerned groups. Emotionally evocative interventions have better prospects of generating long-term attitudinal and behavioral changes (Pai et al., 2024; Raza et al., 2024; Maoela et al., 2025).

Apart from that, age, gender, and educational level differences in behavior streams were revealed by the research. These results demand demographically tailored campaigns. For example, young adults are more responsive to socially motivated sustainability appeals (e.g., peer-to-peer appeal, influencer marketing), while older adults assume influence from tradition-, heritage-, or conservation ethics-based appeals. Gender-sensitive messaging should also occur; since women showed more emotional concern and behavioral intention, care, community, and family could be prioritized, while men's action can be centered on action, responsibility, and environmental leadership.

3.3.2. Implications for Tourism Business Managers

For winter tourism businesses—i.e., ski resorts, accommodations, and tour operators—these results lead to a number of tangible steps. On the one hand, one can promote perceived behavioral control by offering sustainable options: offering highly visible recycling bins, promoting vegan options, making environmentally friendly transport options easy (e.g., shuttle buses, train holidays), and clearly communicating efforts to obtain environmental certificates or sustainability labels.

The responsibility (PR) to have direct and indirect behavior effects would imply that tourism enterprises can sell an overall sense of responsibility through co-branded sustainability initiatives. For instance, enterprises could promote visitors to engage in eco-experiences (e.g., garbage cleanups, tree planting), express commitments towards sustainability on social media, or support local nature conservation initiatives through minor monetary donations made during payment. This would be capable of transforming passive awareness to active engagement.

Also, differences between groups suggest that guest experience design by frequency of behavior and environmental salience can work. For example, frequent visitors or repeat winter holiday-goers showed varying motivational mechanisms—suggesting loyalty schemes offering incentives for sustainable behavior (e.g., green discount or contributions to conservation funds) will be particularly effective with this customer segment.

Staff training to effectively and tastefully communicate sustainability messages is a simple implication. Since attitudes were completely mediated by EC and PBC, good attitudes do not suffice to change behavior. Staff training must incorporate attempts empowering guests with information and facilities to take environmentally friendly decisions throughout the length of stay, developing efficacy and affective connection to the environment (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025).

3.3.3. Implications for Environmental Educators and Campaign Designers

For environmental education programs of tourism-dependent communities, particularly including young people, young adults, and residents, implications highlight the importance of holistic pedagogies. As the research indicates that attitudes indirectly influence behavior, the curricula must move beyond attitude modification to explicitly develop behavioral competence and emotional empathy. This may be in the form of problem-solving learning modules modeling sustainability challenges of tourism, role playing, or collaborative activities that prompt students to plan and execute green activities.

University studies, especially hospitality, tourism, or environmental studies students, can utilize this evidence by having action-based modules to learn not just the theory of sustainable tourism but also implement it. These may include participatory workshop training, experiential learning among mountain communities, or internship with eco-tourism companies (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025).

Additionally, the multi-group outcomes of the study offer potential for tailoring instruction. For example, instruction content could be designed to be attractive in one way or another to learners based on age, climate applicability, or current sustainable behavior. Individualized learning technology (e.g., an application or a learning management system) might monitor learner reaction and adapt material either to highlight control of behavior or emotional engagement depending on learner needs (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025).

Finally, teachers and non-profits developing public campaigns would need to use overt behavior cues and emotionally engaging narratives, especially among groups that are more dependent on EC and PBC. Campaigns can use testimonials of good travelers or narratives of how climate change had affected mountain ecosystems in an attempt to raise concern and perceived ability to act.

3.4. Limitations and Future Directions

While this study provides much information about the psychological mechanisms behind winter sustainable tourism, several promising areas for future research remain open. These opportunities are not only avenues for further research but also possible research design refinement and methodological enhancement (Qiu et al., 2025; Vicente, 2024; Shin et al., 2025). Second, future research would be beneficial for imposing longitudinal or experimental designs to more accurately examine the temporal dynamics and causal mechanisms proposed by this research. While the current study used Structural Equation Modeling (SEM) to examine theoretically derived relationships, it was cross-sectional in nature. Subsequent research can follow behavior intent and longitudinal change—i.e., to significant climate events or interventions of concern—gaining further information regarding how sustainable behavior evolves across various stages of a tourist's decision-making process.

In addition, future research can complement self-report measures and enhance ecological validity by incorporating behavioral and observational data, such as including measures like ecological momentary assessment (EMA), mobile tracking, or digital records of consumption. Since this research was based on participants' subjective reports of awareness, attitude, and sustainable behavior, adding measures like EMA, mobile tracking, or digital consumption records can enhance ecological validity and minimize response bias. Cross-cultural comparisons provide yet another rich area for potential future research. The present research targeted Greek winter tourists, presenting context-specific results applicable to Southern European tourism. Attitudes towards sustainability, climatic salience, and behavioral norms, however, could differ significantly by region. Comparisons between countries in nations exposed to various climate risks, policy settings, or cultural orientations towards nature would validate the generalizability of the model as well as reveal culturally distinctive drivers of sustainable tourism.

Moreover, there exists the possibility of refining measurement of sustainable behavior by looking at the examination of analysis of certain behavioral domains—such as transport decisions, eco-accommodation choices, or buying local products—instead of considering sustainability as an aggregated measure. This would enable later researchers to identify those psychological or demographic predictors that exert the greatest influence on each behavior category and feed into more targeted interventions. In addition, extending the conceptual model to other psychological constructs may provide a fuller explanation of sustainable tourist behavior (Zaman, 2024; Nunkoo et al., 2013). Subjective norms, habit strength, perceived climate control, or even digital nudges (such as individual recommendations or gamified feedback from tourist portals) may even account for more variance in behavior and fill in the gaps among what has been known from environmental psychology, behavioral economics, and persuasive technology (Steiger et al., 2021; Walters & Ruhanen, 2015; Wu et al., 2022).

According to the results of multi-group analysis (MGA), future studies would specifically investigate life stage, educational level, and frequency of travel as moderators of sustainability trajectories more thoroughly. For instance, younger customers are more susceptible to appeals based on emotion, whereas older tourists would be more responsive to efficacy beliefs or stronger values. In the same way, future research can investigate the connection between the type of tourism (e.g., ecotourism, cultural tourism, high-end tourism) and perceived responsibility or perceived control (Zaman, 2024; Nunkoo et al., 2013). Lastly, since climate messaging and social media engagement resources have become very fashionable in the tourism sector recently, future research can experimentally manipulate whether or not framing climate urgency, personal responsibility, or local effect differentially influences tourists' attitudes and behavior. It would be highly relevant to the role of creating evidence-based destination marketer, environmental NGO, and policy actor guidelines that aim to encourage low-impact tourist behavior (Zaman, 2024; Nunkoo et al., 2013).

4. Conclusions

This research investigated the psychological and behavioral predictors of sustainable behavior in winter tourism, namely the predictive roles of climate change awareness (CCA), environmental attitudes (ATT), and perceived responsibility (PR). Using Structural Equation Modeling (SEM), the research validated CCA and PR as effective predictors of sustainable behavior (SB), whereas ATT was recognized as having an indirect effect on SB via environmental concern (EC) and perceived behavioral control (PBC). Mediation analysis indicated that EC and PBC are key psychological processes involved in the translation of values, attitudes, and perceptions into behavior. Multi-group analysis also indicated that there were significant differences between demographic and behavioral subgroups, suggesting communication, education, and policy interventions need to be targeted. Overall, the results highlight the value of a dual-process model that incorporates cognitive appraisals (e.g., beliefs about control) and affective responses (e.g., worry), as well as the heterogeneity of these pathways by age, sex, education, and travel frequency. These findings add to existing scholarship in sustainable tourism and offer evidence-based recommendations to practice and policy.

Overall, the current research has illuminated the complex psychological tapestry of sustainable behavior in winter tourism—where cognition and emotion intersect, and consciousness is translated into action. By navigating responsibility, concern, and perceived control, we have moved a step further toward grasping how people respond to climate change in the privacy of their vacation decisions. Still, as with all valuable inquiry, this we have uncovered more avenues than have been shut off. Subsequent research can chart these avenues further—across cultures and latitudes, through improved behavior understanding, and unlocking virtual horizons. By carrying this out, we shift from forecasting to positive transformation, enabling policymakers, educators, and entrepreneurs to create policies not just on the premise of facts, but on emotion, gut feeling, and optimism. The challenge of sustainability is not just scientific—it is profoundly human. And in winter resort trails, we find both a mirror and a map of that shared search.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Measurements used in data collection.

	Climate Change Awareness (CCA)	
CCA1	I am aware that climate change is affecting winter tourism destinations.	Clayton and Karazsia (2020), Simon et al. (2022) and Cipriani et al. (2024)
CCA2	I understand that global warming is shortening ski seasons.	
CCA3	I am concerned about the long-term impacts of climate change on snow-based activities.	
CCA4	I try to stay informed about how climate change affects nature and tourism.	
	Environmental Attitudes (ATT)	
ATT1	The Earth is reaching its limit in terms of how much tourism and development it can support.	C. Wang et al. (2018)
ATT2	Winter tourism should be developed in a way that protects the natural environment.	
ATT3	Tourism activities in mountain areas can harm the environment if not managed properly.	
ATT4	The balance of nature in winter tourism destinations is fragile and needs protection.	
ATT5	Climate change is a serious environmental issue that affects winter tourism destinations.	
	Perceived Responsibility (PR)	
PR1	I have a moral obligation to behave sustainably at tourist destinations.	Aziz et al. (2021)
PR2	It is my duty to minimize my environmental impact while on vacation.	
PR3	I believe tourists like me can make a difference in protecting the environment.	
PR4	I would feel bad if I didn't make environmentally responsible choices during a trip.	
	Environmental Concern (EC)	
EC1	I worry about environmental problems like deforestation, pollution, and climate change.	Mahasuweerachai and Suttikun (2022)
EC2	I feel a personal responsibility to help protect the natural environment.	
EC3	I feel guilty when I do things that might harm the environment.	
EC4	I often think about how my actions affect the planet. (deleted)	
	Perceived Behavioral Control (PBC)	
PBC1	I feel confident that I can behave sustainably during my vacation.	Mahasuweerachai and Suttikun (2022)
PBC2	Even when it's not easy, I try to make eco-friendly choices when I travel.	
PBC3	I have control over whether I act in environmentally friendly ways while on vacation.	
	Sustainable Behavior During Winter Vacation (SB)	
SB1	I will choose accommodation with environmental or sustainability certifications.	Chandran et al. (2021)
SB2	I will avoid using single-use plastics, such as water bottles or packaging.	
SB3	I will use public transportation or shared mobility instead of a private car.	

Table A2. Cross loadings for measurement items across constructs.

	ATT	CCA	EC	PBC	PR	SB
ATT1	0.822	−0.006	−0.098	−0.157	−0.009	−0.015
ATT2	0.762	0.094	−0.040	−0.111	0.054	0.055
ATT3	0.751	0.151	−0.065	−0.139	0.057	0.011
ATT4	0.690	−0.032	−0.065	0.002	−0.028	−0.004
ATT5	0.783	−0.039	−0.154	−0.110	−0.115	−0.016
CCA1	−0.007	0.747	0.388	0.250	0.373	0.489
CCA2	0.118	0.794	0.426	0.309	0.424	0.403
CCA3	0.024	0.805	0.402	0.313	0.561	0.434
CCA4	0.011	0.786	0.371	0.321	0.476	0.463
EC1	−0.107	0.392	0.737	0.225	0.381	0.231
EC2	−0.044	0.529	0.844	0.302	0.545	0.488
EC3	−0.163	0.167	0.705	0.364	0.381	0.289
PBC1	−0.102	0.334	0.275	0.899	0.412	0.407
PBC2	−0.188	0.345	0.333	0.881	0.404	0.470
PBC3	−0.131	0.340	0.411	0.898	0.465	0.430
PR1	0.012	0.557	0.507	0.469	0.884	0.500
PR2	0.011	0.552	0.447	0.429	0.831	0.487
PR3	−0.028	0.469	0.538	0.385	0.905	0.399
PR4	−0.055	0.479	0.568	0.396	0.896	0.417
SB1	0.011	0.385	0.260	0.418	0.340	0.726
SB2	0.004	0.588	0.480	0.467	0.507	0.912
SB3	−0.004	0.439	0.405	0.342	0.430	0.874

References

Aman, S., Hassan, N., Khattak, M., Moustafa, M., Fakhri, M., & Ahmad, Z. (2021). Impact of tourist's environmental awareness on pro-environmental behavior with the mediating effect of tourist's environmental concern and moderating effect of tourist's environmental attachment. *Sustainability*, *13*(23), 12998. [CrossRef]

Aziz, F., Md Rami, A. A., Zaremohzzabieh, Z., & Ahrari, S. (2021). Effects of emotions and ethics on pro-environmental behavior of university employees: A model based on the theory of planned behavior. *Sustainability*, *13*(13), 7062. [CrossRef]

Bai, Z., & Zhang, Y. (2025). Impact of climate change on ski tourism: A review. *Journal of Resources and Ecology*, *16*, 898–906. [CrossRef]

Chandran, A., Mandal, S., Shanmugeshwari, M., Nair, G., Das, P., Ramachandran, N., & John, E. (2021). Sustainable tourist behaviour: Developing a second order scale based on three destinations. *Journal of Tourism Research*, *23*(6), 984–1005. [CrossRef]

Cheah, J.-H., Amaro, S., & Roldán, J. L. (2023). Multigroup analysis of more than two groups in PLS-SEM: A review, illustration, and recommendations. *Journal of Business Research*, *156*, 113539. [CrossRef]

Chin, W. W. (2009). How to write up and report PLS analyses. In *Handbook of partial least squares: Concepts, methods and applications* (pp. 655–690). Springer. [CrossRef]

Cipriani, E., Gemignani, A., & Menicucci, D. (2024). Awareness of everyday effects of climate change: The climate change perceptual awareness scale (CCPAS). *Heliyon*, *10*, e38461. [CrossRef]

Clayton, S., & Karazsia, B. T. (2020). Development and validation of a measure of climate change anxiety. *Journal of Environmental Psychology*, *69*, 101434. [CrossRef]

De Graaf, J. A., Stok, F. M., De Wit, J. B. F., & Bal, M. (2023). The climate change skepticism questionnaire: Validation of a measure to assess doubts regarding climate change. *Journal of Environmental Psychology*, *89*, 102068. [CrossRef]

Esfandiar, K., Dowling, R., Pearce, J., & Goh, E. (2021). What a load of rubbish! The efficacy of theory of planned behaviour and norm activation model in predicting visitors' binning behaviour in national parks. *Journal of Hospitality and Tourism Management*, *46*, 304–315. [CrossRef]

Fella, S., & Bausa, E. (2024). Green or greenwashed? Examining consumers' ability to identify greenwashing. *Journal of Environmental Psychology*, *95*, 102281. [CrossRef]

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50. [CrossRef]

Fu, Y., & Zhao, J. (2024). Applying the theory of planned behavior to understand ecotourism behavior: The role of human–land coordination and self-mastery. *Sustainability*, *16*(21), 9248. [CrossRef]

Gefen, D., & Straub, D. (2005). A practical guide to factorial validity using PLS-Graph: Tutorial and annotated example. *Communications of the Association for Information Systems*, *16*, 5. [CrossRef]

Gil-Giménez, D., Rolo-González, G., Suárez, E., & Muinos, G. (2021). The influence of environmental self-identity on the relationship between consumer identities and frugal behavior. *Sustainability*, *13*(17), 9664. [CrossRef]

Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E., & Tatham, R. L. (2006). *Multivariate data analysis* (6th ed.). Pearson Prentice Hall.

Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., Danks, N. P., & Ray, S. (2021). An introduction to structural equation modeling. In *Partial least squares structural equation modeling (PLS-SEM) using R* (pp. 1–29). Springer International Publishing. [CrossRef]

Hair, J. F., Sarstedt, M., Matthews, L. M., & Ringle, C. M. (2016). Identifying and treating unobserved heterogeneity with FIMIX-PLS: Part I–method. *European Business Review*, *28*(1), 63–76. [CrossRef]

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. [CrossRef]

Holmes, M. R., Dodds, R., & Frochot, I. (2021). At home or abroad, does our behavior change? Examining how everyday behavior influences sustainable travel behavior and tourist clusters. *Journal of Travel Research*, *60*(1), 102–116. [CrossRef]

Hwang, S., Lee, J., & Jang, D. (2024). Climate change awareness and pro-environmental intentions in sports fans: Applying the extended theory of planned behavior model for sustainable spectating. *Sustainability*, *16*(8), 3246. [CrossRef]

Kesmodel, U. S. (2018). Cross-sectional studies—What are they good for? *Acta Obstetricia et Gynecologica Scandinavica*, *97*(4), 388–393. [CrossRef]

Leal Filho, W., Dinis, M. A. P., Nagy, G. J., Fracassi, U., & Aina, Y. A. (2024). A ticket to where? Dwindling snow cover impacts the winter tourism sector as a consequence of climate change. *Journal of Environmental Management*, *356*, 120554. [CrossRef]

Li, J., Coca-Stefaniak, J. A., Nguyen, T. H. H., & Morrison, A. M. (2024). Sustainable tourist behavior: A systematic literature review and research agenda. *Sustainable Development*, *32*(5), 3356–3374. [CrossRef]

Lind, H. B., Nordfjærn, T., Jørgensen, S. H., & Rundmo, T. (2015). The value-belief-norm theory, personal norms and sustainable travel mode choice in urban areas. *Journal of Environmental Psychology*, *44*, 119–125. [CrossRef]

López-Mosquera, N., & Sánchez, M. (2012). Theory of planned behavior and the value-belief-norm theory explaining willingness to pay for a suburban park. *Journal of Environmental Management*, *113*, 251–262. [CrossRef]

Mahasuweerachai, P., & Suttikun, C. (2022). The effect of green self-identity on perceived image, warm glow and willingness to purchase: A new generation's perspective towards eco-friendly restaurants. *Sustainability*, *14*(17), 10539. [CrossRef]

Maoela, M. A., Nhamo, G., Chapungu, L., & Madikizela, A. (2025). Tourists' perceptions of climate change awareness, impact, and response mechanisms in South African national parks. *Development Southern Africa*, *42*(1), 153–175. [CrossRef]

Mitrică, B., Şerban, P.-R., Roznovieţchi, I., Micu, D., Persu, M., Grigorescu, I., Amihăesei, V., Dumitraşcu, M., & Damian, N. (2025). The tourism sector's vulnerability to climate change-related phenomena: Case study—Romania. *International Journal of Disaster Risk Reduction*, *118*, 105248. [CrossRef]

Naderifar, M., Goli, H., & Ghaljaie, F. (2017). Snowball sampling: A purposeful method of sampling in qualitative research. *Strides in Development of Medical Education*, *14*(3), 1–6. [CrossRef]

Ngxongo, N. A. (2021). The impact of climate change on visitor destination selection: A case study of the Central Drakensberg Region in KwaZulu-Natal. *Jàmbá: Journal of Disaster Risk Studies*, *13*(1), 1161. [CrossRef]

Nitzl, C., Roldan, J. L., & Cepeda, G. (2016). Mediation analysis in partial least squares path modeling: Helping researchers discuss more sophisticated models. *Industrial Management & Data Systems*, *116*(9), 1849–1864. [CrossRef]

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, *11*(4), 327–344. [CrossRef]

Nunkoo, R., Ramkissoon, H., & Gursoy, D. (2013). Use of structural equation modeling in tourism research: Past, present, and future. *Journal of Travel Research*, *52*(6), 759–771. [CrossRef]

Pai, C.-J., LePage, B. A., Ng, E., & Fang, W. (2024). Using the theory of planned behavior to examine the environmental behavior of roadrunners in Taiwan. *Discover Sustainability*, *5*, 535. [CrossRef]

Podsakoff, P. M., MacKenzie, S. B., Lee, J.-Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, *88*(5), 879–903. [CrossRef]

Podsakoff, P. M., MacKenzie, S. B., & Podsakoff, N. P. (2012). Sources of method bias in social science research and recommendations on how to control it. *Annual Review of Psychology*, *63*, 539–569. [CrossRef]

Preacher, K. J., & Hayes, A. F. (2008). Assessing mediation in communication research. In A. F. Hayes, M. D. Slater, & L. B. Snyder (Eds.), *The SAGE sourcebook of advanced data analysis methods for communication research* (pp. 13–54). SAGE Publications.

Qiu, H., Wang, X., Morrison, A. M., Kelly, C., & Wei, W. (2025). From ownership to responsibility: Extending the theory of planned behavior to predict tourist environmentally responsible behavioral intentions. *Journal of Sustainable Tourism*, *33*(6), 1122–1145. [CrossRef]

Rahman, M. M. (2023). Sample size determination for survey research and non-probability sampling techniques: A review and set of recommendations. *Journal of Entrepreneurship, Business and Economics*, *11*(1), 42–62.

Raza, S. A., Khan, K. A., & Qamar, B. (2024). Understanding the influence of environmental triggers on tourists' pro-environmental behaviors in Pakistan's tourism industry. *Journal of Tourism Futures*, *10*(1), 38–67. [CrossRef]

Sahabuddin, M., Alam, M. S., & Nekmahmud, M. (2024). How do perceived and environmental values influence tourist satisfaction, loyalty, and environmental awareness? *Environment, Development and Sustainability*. Advance online publication. [CrossRef]

Seong, B.-H., Choi, Y., & Kim, H. (2021). Influential factors for sustainable intention to visit a national park during COVID-19: The extended theory of planned behavior with perception of risk and coping behavior. *International Journal of Environmental Research and Public Health*, *18*(24), 12968. [CrossRef]

Shin, H., Kim, H., & Kang, J. (2025). Tourist ESG engagement behaviors: Conceptualization, scale development, and nomological network. *Journal of Sustainable Tourism*, 1–31. [CrossRef]

Si, H., Shi, J., Tang, D., Wen, S., Miao, W., & Duan, K. (2019). Application of the theory of planned behavior in environmental science: A comprehensive bibliometric analysis. *International Journal of Environmental Research and Public Health*, *16*(15), 2788. [CrossRef] [PubMed]

Simon, P. D., Pakingan, K. A., & Aruta, J. J. B. R. (2022). Measurement of climate change anxiety and its mediating effect between experience of climate change and mitigation actions of Filipino youth. *Educational and Developmental Psychologist*, *39*(1), 17–27. [CrossRef]

Spector, P. E. (2019). Do not cross me: Optimizing the use of cross-sectional designs. *Journal of Business and Psychology*, *34*(1), 125–137. [CrossRef]

Steiger, R., Damm, A., Prettenthaler, F., & Pröbstl-Haider, U. (2021). Climate change and winter outdoor activities in Austria. *Journal of Outdoor Recreation and Tourism*, *34*, 100330. [CrossRef]

Streukens, S., & Leroi-Werelds, S. (2016). Bootstrapping and PLS-SEM: A step-by-step guide to get more out of your bootstrap results. *European Management Journal*, *34*(6), 618–632. [CrossRef]

Tian, X., & Jiang, Y. (2025). Exploring behavioral determinants of residents' ecological conservation in rural tourism development. *Scientific Reports*, *15*, 1826. [CrossRef]

Vicente, J. M. (2024). Green tourist behavior analysis and its relationship with the choice of eco-tourism destination: An empirical study. *International Journal of Geoheritage and Parks*, *12*(4), 544–557. [CrossRef]

Vinzi, V. E., Chin, W. W., Henseler, J., & Wang, H. (Eds.). (2010). *Handbook of partial least squares* (Vol. 201). Springer. [CrossRef]

Von Gal, A., Fabiani, G., & Piccardi, L. (2024). Climate change anxiety, fear, and intention to act. *Frontiers in Psychology*, *15*, 1341921. [CrossRef]

Vrtana, D., Krizanova, A., Skorvagova, E., & Valaskova, K. (2020). Exploring the affective level in adolescents in relation to advertising with a selected emotional appeal. *Sustainability*, *12*(19), 8287. [CrossRef]

Walters, G., & Ruhanen, L. (2015). From white to green: Identifying viable visitor segments for climate-affected alpine destinations. *Journal of Hospitality & Tourism Research*, *39*(4), 517–539. [CrossRef]

Wang, C., Zhang, J., Yu, P., & Hu, H. (2018). The theory of planned behavior as a model for understanding tourists' responsible environmental behaviors: The moderating role of environmental interpretations. *Journal of Cleaner Production*, *194*, 425–434. [CrossRef]

Wang, J., Dai, J., Dewancker, B. J., Gao, W., Liu, Z., & Zhou, Y. (2022). Impact of situational environmental education on tourist behavior—A case study of Water Culture Ecological Park in China. *International Journal of Environmental Research and Public Health*, *19*(18), 11388. [CrossRef] [PubMed]

Wasko, M. M., & Faraj, S. (2005). Why should I share? Examining social capital and knowledge contribution in electronic networks of practice. *MIS Quarterly*, *29*(1), 35–57. [CrossRef]

Witting, M., Bischof, M., & Schmude, J. (2021). Behavioural change or "business as usual"? Characterising the reaction behaviour of winter (sport) tourists to climate change in two German destinations. *International Journal of Tourism Research*, *23*(1), 110–122. [CrossRef]

Wong, K. K.-K. (2013). Partial least squares structural equation modeling (PLS-SEM) techniques using SmartPLS. *Marketing Bulletin*, *24*(1), 1–32.

Wu, S., Ma, E., Wang, J., & Li, D. (2022). Experience with travel mobile apps and travel intentions—The case of university students in China. *Sustainability*, *14*(19), 12603. [CrossRef]

Wut, T. M., Lee, D., & Lee, S. W. (2023). Does attitude or intention affect behavior in sustainable tourism? A review and research agenda. *Sustainability*, *15*(19), 14076. [CrossRef]

Yang, C.-L., Huang, C.-Y., & Hsiao, Y.-H. (2021). Using social media mining and PLS-SEM to examine the causal relationship between public environmental concerns and adaptation strategies. *International Journal of Environmental Research and Public Health*, *18*(10), 5270. [CrossRef]

Yang, Y., Shamim, S., De Massis, A., & Gao, D. (2025). Defensive routines as coping mechanisms against technostress: Roles of digital leadership and employee goal orientation. *Technological Forecasting and Social Change*, *216*, 124143. [CrossRef]

Yang, Y., Sun, X., Hu, L., Ma, Y., & Bu, H. (2023). How ski tourism involvement promotes tourists' low-carbon behavior. *Sustainability*, *15*(13), 10277. [CrossRef]

Yuriev, A., Dahmen, M., Paillé, P., Boiral, O., & Guillaumie, L. (2020). Pro-environmental behaviors through the lens of the theory of planned behavior: A scoping review. *Resources, Conservation and Recycling*, *155*, 104660. [CrossRef]

Zaman, U. (2024). Nexus of tourism affinity, perceived behavioral control and green environmental literacy in support of regenerative tourism. *Pakistan Journal of Commerce and Social Sciences*, *18*(3), 781–810. Available online: https://hdl.handle.net/10419/305454 (accessed on 31 July 2025).

Zhang, Y., Zhao, H., & Zaman, U. (2025). Eco-consciousness in tourism: A psychological perspective on green marketing and consumer behavior. *Acta Psychologica*, *255*, 104951. [CrossRef] [PubMed]