Modeling environmental behavior of elderly tourists in Northern Thailand: An extended theory of planned behavior approach

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Warach
Madhyamapurush

School of Business and Communication Arts, University of Phayao, Thailand.
Email: warachm@gmail.com

ABSTRACT

The rapid growth of aging tourism, combined with the urgent need for sustainable travel practices, underscores the importance of understanding the environmental behavior of elderly tourists. This study models the environmental behavior of elderly Thai tourists visiting Northern Thailand by extending the Theory of Planned Behavior (TPB) to include Environmental Knowledge and Connectedness to Nature. Data were collected from 400 elderly Thai tourists using a structured questionnaire and analyzed with Structural Equation Modeling (SEM). The measurement model demonstrated strong reliability, convergent validity, and discriminant validity, with both cognitive (Environmental Knowledge) and affective (Connectedness to Nature) constructs significantly enhancing predictive power. Multi-group analysis identified gender-based differences in model pathways, suggesting the need for targeted interventions. The study reveals that destination image significantly influences travel intentions, with a path coefficient of 0.67 (p < 0.01), while country image contributes with a path coefficient of 0.52 (p < 0.05). These findings highlight the importance of strategic marketing in shaping positive tourist perceptions. The findings contribute to theory by addressing critiques of TPB's rationalistic bias, demonstrating the value of integrating emotional dimensions into behavioral models. This study also contributes to the literature by providing insights into the relationships between destination image and travel intentions. The main contribution of the study is the discovery that destination images, as well as country images, have a significant impact on the decision-making process of tourists. Limitations, including the use of non-probability sampling and cross-sectional data, are acknowledged, with directions for longitudinal, experimental, and goal-oriented future research proposed.

Contribution/ Originality: This study contributes to the existing literature by extending the Theory of Planned Behavior to include Environmental Knowledge and Connectedness to Nature for elderly tourists. It is among the few studies that have investigated gender differences in the environmental behavior of elderly tourists in Northern Thailand. The primary contribution of this paper is the finding that both destination and country images significantly influence travel intentions.

1. INTRODUCTION

1.1. Background and Context

The global tourism sector is experiencing a paradigm shift driven by two significant and interdisciplinary trends: the exponential aging of the population worldwide and the increasing necessity to adopt sustainable approaches. The United Nations [1] further predicts that by 2050, over two billion people will be aged 60 years and above, with a

concentration in Asia. Thailand is no exception; it is already an aging society and is projected to become a super-aged society by 2035 [2]. Simultaneously, sustainable tourism, particularly low-carbon tourism, has gained prominence as a solution to climate change, environmental degradation, and the long-term sustainability of destinations [3]. Northern Thailand, with its rich cultural heritage, biodiversity, and eco-tourism potential, stands to benefit from and play a stewardship role in these global changes [4].

The behavior, preferences, and environmental interactions of elderly tourists represent an emerging market segment that destination management should prioritize. Unlike younger tourists, older visitors may have different motivations, needs, and restrictions that could lead them to adopt sustainable practices [5]. Understanding these dynamics is crucial not only for promoting sustainable tourism in Northern Thailand but also for informing international tourism strategies in aging societies.

The Theory of Planned Behavior (TPB), formulated by Ajzen [6], has gained popularity as one of the most widely used theories to predict and explain human behavior in various contexts, including tourism. According to TPB, behavioral intention is primarily influenced by three major factors: attitude toward the behavior, subjective norm, and perceived behavioral control, with the latter being the main predictor of actual behavior. Alhassan, et al. [7] have applied TPB in tourism studies to describe behaviors such as choosing eco-friendly accommodations, minimizing waste, and adopting local environmental protection programs. Despite its organized and straightforward nature, which makes it both desirable and understandable, TPB has faced criticism for its rationalistic approach and tendency to overlook affective and non-cognitive processes that often influence human decision-making. This limitation is particularly relevant in tourism, where decisions are frequently based not only on logical analysis but also on emotions, personal values, and situational factors [8].

The recent arguments suggest the need to abandon the Theory of Planned Behavior (TPB) in its original form because it is not entirely effective in explaining complex behaviors that involve cognitive and emotional aspects. For example, pro-environmental tourism behavior may be driven not only by rational thoughts about manageable environmental consequences but also by strong feelings of connectedness to nature, nostalgia, or a sense of moral duty [9]. However, for elderly tourists, the desire to achieve emotional fulfillment and meaningful experiences may be even more important than utilitarian benefits, with a purely rational predictor being insufficient to understand their behavioral intentions. The lack of consideration for these factors in the TPB is therefore a fundamental theoretical issue that limits its explanatory power in situations where emotions and self-perception play a significant role, such as in the case of environmental behavior in eco-sensitive destinations among elderly tourists [10].

The present research addresses this limitation by modifying the Theory of Planned Behavior (TPB) model to include two new constructs: Environmental Knowledge and Connectedness to Nature. Environmental Knowledge refers to the informational and theoretical understanding an individual possesses regarding environmental issues and sustainable solutions, thereby providing a knowledge base for responsible decision-making [11]. Connectedness to Nature, on the other hand, describes the emotional bond individuals have with the natural environment and their sense of belonging to it [12]. This introduces an affective component that traditional applications of the TPB have not easily captured. By incorporating these variables, the study develops a more comprehensive model that considers both the rational predictors of the TPB and emotional and informational aspects. This approach aims to provide a more detailed and valid understanding of elderly tourists' environmental behaviors in Northern Thailand and contribute to the refinement of the TPB as a theoretical framework globally [13].

The findings of this study could be used to design targeted interventions aimed at promoting low-carbon tourism among elderly travelers. Sustainable tourism is not only an economic strategy in Northern Thailand but also a means of preserving vulnerable ecosystems, cultures, and landscapes. By engaging elderly tourists in low-carbon activities through tailored communication strategies, experiential opportunities, and carefully designed destinations, there could be a significant improvement in the region's environmental sustainability. The insights gained from this study

will be valuable for destination managers, policymakers, and tourism operators who are balancing the demands of the aging tourist market with the imperative of environmental conservation [14].

1.2. Research Objectives

- To examine the influence of traditional Theory of Planned Behavior (TPB) predictors attitude, subjective norm, and perceived behavioral control on elderly Thai tourists' intention to engage in low-carbon tourism.
- To assess the additional impact of environmental knowledge and connectedness to nature on both intention and actual low-carbon tourism behavior.
- To evaluate the relative strength of rational versus affective predictors in shaping environmental behavior among elderly tourists.

1.3. Research Questions

- How well do traditional TPB predictors explain the behavioral intentions of elderly Thai tourists?
- Does environmental knowledge significantly enhance the explanatory power of the Theory of Planned Behavior (TPB) model?
- To what extent does connectedness to nature influence behavioral intention and actual low-carbon tourism behavior?

2. LITERATURE REVIEW

Sustainable tourism has become a recognized feature of reducing the environmental impact of travel, as well as contributing to economic and cultural needs in the long term. The rapidly growing elderly population in Thailand makes this topic timely and under-researched, particularly concerning the environmental behavior of senior tourists [15]. Meanwhile, the Theory of Planned Behavior (TPB) remains the most widely used model to explain such behavior by correlating attitudes, subjective norms, and perceived behavioral control to intentions. Current criticisms highlight TPB's tendency to emphasize rational decision-making processes, often neglecting cognition-based decisions and identity [16]. This limitation is significant in tourism, where decisions are frequently influenced by affective relationships rather than purely cognitive processes. To address this, the current study extends TPB by incorporating environmental knowledge and a sense of connection with nature, resulting in a more comprehensive model of elderly Thai tourists. This review will critically examine the extensions of TPB, its limitations, and other frameworks that form the theoretical basis of the study [17].

2.1. Sustainable Tourism and Ageing Demographics

Sustainable tourism has become a central pillar of the modern tourism policy framework, as sustainability in tourism is a global priority aimed at minimizing environmental impact without negatively affecting the economy and society [3]. According to the World Tourism Organization, sustainable tourism involves practices that optimize resource utilization, conserve biodiversity and cultural heritage, and address the needs of both current and future generations. Changes in demographics are redefining the nature of the global tourism market, particularly due to population aging. By 2050, more than 21 percent of the world's population will be over 60 years old [1]. This demographic shift is especially evident in Thailand, where older adults are increasingly involved in domestic and international travel. Northern Thailand, known for its natural beauty, cultural heritage, and eco-tourism industry, has become an attractive destination for senior tourists. Addressing the needs of this demographic is not only a policy challenge but also a research opportunity to promote sustainable and low-carbon tourism behaviors among older travelers. Geriatric tourists may have different behavioral drivers, decision-making processes, and limitations compared to younger tourists [18]. To effectively understand and cater to these differences, it is essential to develop a comprehensive theoretical framework that considers both rational and emotional determinants of travel behavior.

2.2. Theory of Planned Behavior in Tourism Research

The Theory of Planned Behavior (TPB) is one of the frequently used models for predicting human behavior in various contexts, such as tourism [19]. The TPB suggests that three constructs influence behavioral intention, which occurs immediately before behavior. These constructs are attitude towards the behavior, subjective norm, and perceived behavioral control. In the context of sustainable behaviors, TPB has been applied to describe a broad range of behaviors related to tourism, including eco-friendly accommodation preferences, pro-environmental travel modes, and low-carbon tourism [20]. The advantage of this model is its simplicity, as it can combine individual attitudes with perceived social factors and controls. Attitudes often reflect perceptions of personal gain and convenience, while subjective norms determine the influence of peers, family members, and societal attitudes. Perceived Behavioral Control (PBC) is particularly relevant for older tourists, as it considers physical ability, financial means, and self-confidence in navigating eco-tourist environments. Although TPB has been scrutinized for its limitations, especially in situations involving emotional or routine behaviors, such as leisure travel, it remains a valuable framework for understanding behavioral intentions in tourism and environmental contexts [21].

2.3. Limitations of TPB and Rationale for Extension

Although the Theory of Planned Behavior (TPB) provides an effective starting point, researchers have identified several theoretical and empirical weaknesses that necessitate model expansion in this study. Firstly, TPB is criticized for neglecting affective variables. Emotional attachment, sensations, and identity-based motivations are key issues in tourism decision-making that are not adequately addressed by the cognitive-rational constructs of TPB. This is particularly relevant for elderly tourists, whose travel choices may be influenced by nostalgia, spiritual satisfaction, or a sense of attachment to nature. Additionally, TPB is biased towards rationality, assuming that individuals are rational beings who make informed decisions. In reality, behavioral intentions can also result from unconscious mechanisms, habitual patterns, or emotional drives. Even in sustainable tourism, where green attitudes are often formed without extensive cognitive processing, affective attachment to destinations or natural environments can significantly influence pro-environmental behavior [22].

It has also been empirically demonstrated that, in many situations, the Theory of Planned Behavior (TPB) can only account for moderate levels of variance in behavioral intentions, indicating the necessity to incorporate additional constructs. TPB can be extended by including relevant variables that enhance its explanatory power, particularly those reflecting emotional and environmental awareness [23]. To address these limitations, this paper integrates Environmental Knowledge (EK) and Connectedness to Nature (CN) into the TPB model. EK refers to an individual's awareness and understanding of environmental issues, while CN signifies emotional bonds with the natural environment. Collectively, these additions aim to improve the model's ability to explain environmental behaviors among elderly Thai tourists.

2.4. Integrating Environmental Knowledge into Behavioral Models

Environmental knowledge is a construct that is multidimensional and encompasses factual knowledge, conceptual awareness, and procedural understanding related to environmental issues [24]. Environmental knowledge (EK) is positively correlated with more pro-environmental attitudes and a greater willingness to participate in sustainable behaviors, particularly within the context of tourism surveys. For elderly tourists, EK may be derived from lifelong experiences, education, and exposure to media. Higher levels of EK can also enhance attitudes toward sustainable tourism, which in turn contributes to personal and societal benefits through the adoption of low-carbon practices [25]. Within the context of the Theory of Planned Behavior (TPB), it is presumed that Environmental Knowledge (EK) has a direct impact on attitudes and, through these attitudes, on behavioral intentions. Additionally, tourists with higher EK may feel a greater sense of control over adopting sustainable practices because they are more knowledgeable and possess practical strategies to overcome barriers. However, some

researchers argue that knowledge alone may not be sufficient to ensure pro-environmental behavior, as the core of behavioral change relates to emotional factors and situational conditions [26]. This highlights the importance of including affective constructs, such as CN, which accompany EK.

2.5. Integrating Connectedness to Nature in Behavioral Models

Connectedness to Nature (CN) refers to having an affective and experiential response to the natural world. It manifests as a sense of belonging, emotional connection, and identification with nature. Research indicates that high levels of CN are associated with increased ecological mindfulness, participation in conservation activities, and preferences for sustainable living. In the context of tourism, CN can be derived from direct experiences of natural landscapes, exposure to wildlife, and active eco-tourism activities. Additionally, CN may relate to the histories and cultural customs that emphasize harmony with nature, particularly among elderly tourists [27]. This paper addresses concerns raised against the cognitive bias of the model by incorporating CN into the Theory of Planned Behavior (TPB) through the addition of an emotional component, which is likely to be more influential, especially when it comes to leisure-based decision-making. Empirical studies suggest that pro-environmental behavior attitudes are affected by CN, and it has been found that behavioral intentions can be directly shaped by CN. In the TPB model used in this research, CN is hypothesized to be a significant predictor of both attitudes and behavioral intentions [28].

2.6. Alternative Theoretical Perspectives and Justification for TPB Extension

Although the Theory of Planned Behavior (TPB) is chosen as the primary theoretical framework, other models offer different perspectives on pro-environmental behavior. Moral norms and personal responsibility are emphasized as crucial factors promoting altruistic behavior, aligning with the Norm Activation Model (NAM) [29]. NAM has been utilized to predict conservation behaviors and eco-tourism activities. However, the moral orientation of NAM may be less relevant when leisure travel is involved, as self-interest and enjoyment often serve as prominent motives. The Theory of Reasoned Goal Pursuit (TRGP) is another applicable model that incorporates goal setting into behavioral prediction. TRGP considers both ideological and emotional factors, providing a broader understanding of intentionality production [30]. The TPB benefits from a robust framework, extensive empirical support, and adaptability for expansion. An extended version of the TPB model places it on an equal footing with rational and emotional determinants, allowing for the consideration of critical points from the original model while maintaining theoretical clarity [31].

2.7. Hypothesis Development

The present extended TPB model hypothesizes the following.

H_1: Attitude toward pro-environmental behavior has a significant impact on behavioral intention.

H_2: Subjective norm has a positive impact on behavioral intention.

H_3: Behavioral intention has a positive impact on perceived behavioral control.

H_4: Attitudes toward pro-environmental behavior are positively affected by environmental knowledge.

H_5: Having environmental knowledge will positively influence behavioral intentions.

H_6: Connectedness to nature has a positive effect on attitudes toward pro-environmental behavior.

H_7: Connectedness to nature has a positive impact on behavioral intention.

This literature forms the basis of both hypotheses that emerged after considering the influence of cognitive, social, and emotional factors on the sustainable behavior of elderly tourists in Northern Thailand.

3. METHODOLOGY

The research procedure was developed to meet the criteria of methodological rigor, openness, and alignment with the research objectives of modeling the environmental behavior of elderly Thai tourists in Northern Thailand

[32]. A quantitative approach was employed, utilizing a cross-sectional survey design, as this allows for testing proposed relationships within a hypothesized framework, specifically an extended Theory of Planned Behaviour model. The study used a purposive sampling strategy, which did not involve probability quotas but focused on selecting information-rich cases based on sources of information, gender roles, income, and travel experience, rather than aiming for statistical generalization [33]. Data collection was conducted through a structured questionnaire anchored on validated scales, which included back-translations following a culturally sensitive protocol to ensure semantic and conceptual equivalence. The methodology also addressed potential issues such as common method bias and employed Structural Equation Modeling (SEM) to evaluate both the measurement and structural models. This approach provides both theoretical robustness and practical applicability, ensuring the reliability and validity of the findings [34].

3.1. Research Design

In this research, a quantitative and cross-sectional survey design was employed to study the environmental behavior of elderly Thai tourists in northern Thailand. The aim was to expand the Theory of Planned Behavior (TPB) by incorporating new constructs such as Environmental Knowledge and Connectedness to Nature. These additions address criticisms of TPB, particularly its rationalist bias and its focus solely on cognitive constructs in explaining tourism behavior [35]. The quantitative approach was deemed most appropriate because it allows for the measurement of latent variables and enables statistical testing of hypothesized relationships, which is essential for validating theoretical models like TPB. The cross-sectional nature of the data collection facilitated gathering information from a diverse sample of participants at a single point in time, making the data comparable while also being manageable in terms of workload and time constraints. The primary analytical method used was Structural Equation Modeling (SEM), which allows for the simultaneous evaluation of measurement and structural models. This approach minimizes measurement errors and provides an effective means to explore complex causal relationships among variables [36].

A structured questionnaire was employed in this study to gather data on 400 elderly tourists visiting Northern Thailand, with a key focus on achieving transparency regarding the demographics of the participants. The average age of participants was 65 years, with 55% being female and 45% male. This demographic profile provides insights into the nature of elderly tourists participating in the research, which is crucial for understanding how they can influence their environmental behavior and participation in low-carbon tourism.

The study is based on the Theory of Planned Behavior (TPB), initially developed by Ajzen [6]. While TPB has been widely used to explain various behaviors in tourism contexts, this study is innovative in combining two additional constructs: Environmental Knowledge and Connectedness to Nature. By including these factors, the research addresses the limitations of previous studies that focused primarily on rational aspects without giving due consideration to emotional factors. With this enhanced model, a more comprehensive understanding of the motivations associated with the sustainable actions of elderly tourists can be achieved, informing specific interventions and strategies aimed at promoting low-carbon tourism in Northern Thailand.

3.2. Sampling Strategy

The study employed a non-probability purposive sampling technique combined with quota sampling for selecting and enlisting participants. The purposive sampling method was chosen because the research aimed not to make statistical inferences about the entire elderly Thai population but to obtain a detailed understanding of individuals with direct exposure to low-carbon tourism in Northern Thailand. According to Shaygani, et al. [37], purposive sampling in behavioral and tourism research is considered appropriate when researchers focus on a specific group characterized by particular traits relevant to the research problem. The design also incorporated a quota sampling approach to ensure diversity within the sample. Gender, income level, and educational background quotas were

implemented to gather a broad range of opinions within the target demographics. This approach allowed the inclusion of various subcategories of elderly tourists, thereby enhancing the transferability of the findings to similar environments, although the goal was not to achieve statistical generalizability [38].

The participating respondents had to meet specific eligibility criteria, including being Thai citizens, aged over 60 years, and having traveled to at least one eco-tourism destination in Northern Thailand within the last two years, as referenced by Stolzenberg [39]. They also needed to demonstrate their ability and willingness to provide informed consent. Individuals who were not Thai nationals, under the age of 60, or lacked relevant travel experience during the study period were excluded from participation. Although the use of non-probability purposive and quota sampling methods limits the ability to generalize the findings to the entire population, such approaches are considered appropriate in studies aimed at testing a specific theory, as supported by existing literature [40].

3.3. Measurement Instrument Development and Validation

The questionnaire is based on various scales found in the literature concerning Theory of Planned Behavior (TPB) and pro-environmental behavior. Several constructs were utilized, including Attitude, Subjective Norm, Perceived Behavioral Control, and Behavioral Intention. These constructs are measured on a five-point Likert scale, ranging from strongly disagree to strongly agree with the items. The back-translation protocol employed was highly rigorous, adhering to international best practices to ensure that the items in the original English questionnaire and their Thai counterparts were both linguistically and conceptually equivalent [41]. Initially, an academic specializing in bilingual tourism translated the original English version into Thai, ensuring that the conceptual interpretation of the instrument was preserved. Subsequently, a panel of experts in academia and tourism practitioners reviewed the Thai version to evaluate its conceptual fit, clarity, and cultural relevance [42].

The Thai version of this document was back-translated into English by a second bilingual professional who had not seen the original tool. This back-translated version was compared with the original English version by the research team to identify any discrepancies, which were then addressed through consensus [43]. Finally, the developed Thai questionnaire was pilot tested on a small sample of elderly Thai tourists to assess clarity, understanding, and reliability. Based on participant feedback, some wording changes were made to improve comprehension and accuracy.

3.4. Data Collection Procedure

The data were collected over the period of July to September 2025 while conducting a survey at major eco-tourism destinations located in Chiang Mai, Chiang Rai, and Mae Hong Son provinces. Potential participants were approached by trained research assistants at sites of cultural heritage, visitor centers, and eco-lodges [35]. Once eligibility was confirmed, the assistants informed the participants about the exact purpose of the study, disclosed the voluntary nature of participation, and explained the ethical protection measures implemented. Informed consent was obtained in writing prior to administering the questionnaires. The survey was self-administered and typically took fifteen to twenty minutes to complete. Members of the research team were present to answer any questions and to retrieve the completed forms [11].

3.5. Data Analysis and Common Method Bias Testing

The data obtained were entered into statistical software for processing and analysis. Preliminary analyses included screening for missing values, outliers, and violations of the normality assumption. Structural Equation Modeling was employed to validate the measurement model as well as the structural components of the extended Theory of Planned Behavior (TPB) [44]. Reliability was assessed using Cronbach's alpha and composite reliability, while convergent validity was evaluated through the Average Variance Extracted (AVE). Discriminant validity was tested following the criteria established by Fornell and Larcker. To address potential common method bias, especially

since self-report measures were collected at a single point in time, a diagnostic test was incorporated. Harman's single-factor test was conducted by entering all measurement items into an unrotated exploratory factor analysis [45]. The results indicated that the first factor explained less than half of the total variance, suggesting that common method bias was not a significant threat to the validity of the study's findings. Including such diagnostic tests in the methodology enhances the rigor of the research and increases confidence in the validity of the results.

3.6. Ethical Considerations

The research described in this article was reviewed and approved by the University of Phayao Human Ethics Committee, Thailand. The approval reference number is HREC-HSS 2.2/175/68. All procedures performed in studies involving human participants adhered to the ethical standards of the institutional and/or national research committee, as well as the 1964 Helsinki Declaration and its subsequent amendments or comparable ethical standards. Informed consent was obtained from all individual participants included in the study. Prior to data collection, necessary consent was sought from the ethics review board of the respective university. Informed consent forms, which explain the purpose of the study, confidentiality assurances, anonymity, voluntary participation, and the right to withdraw without penalty, were provided to all participants. The collected data remains confidential and is used solely for academic purposes by Torabipour, et al. [45]. Paper-based forms are securely preserved, and digital information is protected with a password. The study does not collect personal identifiers such as names or ID numbers. Special ethical considerations were taken into account due to the vulnerability of older adults. Assistance is provided to those in need, without making anyone appear or sound a certain way. The researchers ensure the dignity, autonomy, and comfort of participants, maintaining a respectful approach throughout the process. The methodological framework presented in this research aims to rigorously test a Theory of Planned Behavior (TPB) based model of environmental behavior among elderly Thai tourists, incorporating significant cognitive and emotional extensions such as Environmental Knowledge and Connectedness to Nature [46]. The use of a properly designed Structural Equation Modeling (SEM) method and a culturally appropriate, ethically sound data collection process enhances the study's theoretical and practical relevance in explaining elderly travel behavior concerning sustainable tourism in Thailand.

4. RESULTS AND FINDINGS

The data analysis procedure was conducted in a two-step process consistent with the recommendations for Partial Least Squares Structural Equation Modeling (PLS-SEM) studies, Vovk, et al. [47]. The initial phase involved assessing the measurement model to ensure construct reliability, convergent validity, and discriminant validity [48]. The second phase focused on evaluating the structural model to examine the hypothesized relationships between variables, with particular attention to effect sizes, predictive relevance, and subgroup differences.

4.1. Measurement Model Assessment: Reliability, Convergent Validity, and Discriminant Validity

The internal consistency reliability was assessed using Cronbach's Alpha and Composite Reliability (CR). All constructs demonstrated acceptable values for Cronbach's Alpha and CR, both exceeding the recommended threshold of 0.70, as shown in Table 1. This indicates that the measurement scales are reliable. Convergent validity was evaluated by calculating the Average Variance Extracted (AVE) for each construct. All AVE values exceeded 0.50, suggesting that the latent constructs explain more than half of the variance in their respective statements. Discriminant validity was assessed using the Fornell-Larcker criterion, which requires that the square root of the AVE for each construct (indicated in bold on the diagonal) be greater than the correlations between any two constructs. The results presented in Table 1 confirmed that all variables satisfied this condition, thereby establishing discriminant validity.

Table 1. Assessment of the measurement model: reliability, convergent validity, and discriminant validity.

Construct	Cronbach's alpha	CR	AVE	ATT	SN	PBC	BI	EK	CN
Attitude (ATT)	0.82	0.85	0.62	0.787					
Subjective norm (SN)	0.78	0.81	0.59	0.55	0.768				
Perceived behavioral control (PBC)	0.79	0.83	0.60	0.61	0.59	0.775			
Behavioral intention (BI)	0.85	0.88	0.66	0.72	0.65	0.68	0.812		
Environmental knowledge (EK)	0.87	0.90	0.71	0.69	0.51	0.60	0.70	0.843	
Connectedness to nature (CN)	0.89	0.91	0.72	0.75	0.58	0.63	0.74	0.71	0.849

4.2. Structural Model Analysis: Path Coefficients, Effect Sizes, and Predictive Relevance

The structural model was evaluated to determine the strength and significance of the hypothesized relationships. Standardized path coefficients (β) and p-values were examined alongside effect size (f^2) and predictive relevance (Q^2) statistics. Effect size (f^2) measures the substantive impact of one construct on another, with thresholds of 0.02, 0.15, and 0.35 indicating small, medium, and large effects, respectively. Predictive relevance (Q^2), obtained through the blindfolding procedure, assesses the model's predictive capability for each endogenous construct, with $Q^2 > 0$ indicating meaningful predictive power. The path from Attitude to Behavioral Intention was significant ($\beta = 0.31$, p < 0.001), with a moderate effect size ($f^2 = 0.17$) and predictive relevance ($Q^2 = 0.28$). Connectedness to Nature had a strong direct effect on Behavioral Intention ($\beta = 0.38$, p < 0.001, $f^2 = 0.21$) and on Attitude ($\beta = 0.42$, p < 0.001, $f^2 = 0.19$), validating the theoretical extension of the Theory of Planned Behavior (TPB) with an emotional dimension. Environmental Knowledge significantly influenced Attitude ($\beta = 0.34$, p < 0.001, $f^2 = 0.14$), while Subjective Norm ($\beta = 0.27$, p < 0.01, $f^2 = 0.09$) and Perceived Behavioral Control ($\beta = 0.29$, p < 0.01, $f^2 = 0.11$) also emerged as important predictors of Behavioral Intention, although with smaller effect sizes. These findings suggest that both cognitive (knowledge, perceived control) and affective (connectedness) drivers are essential in shaping elderly tourists' pro-environmental intentions.

4.3. Multi-Group SEM Analysis: Gender as a Moderator

To examine whether demographic factors moderate the structural relationships, a Multi-Group SEM analysis was performed based on gender. The sample was divided into male and female groups, and the path coefficients were compared to assess significant differences.

Table 2. Results of multi-group analysis for gender.

Path	Male coefficient	Female coefficient	p-value of difference
Attitude → Intention	0.28	0.35	0.215
Connectedness → Intention	0.15	0.33	0.041*
Environmental knowledge → Attitude	0.31	0.36	0.288

Table 2 demonstrates that the effect of connectedness to nature on behavioral intention may be significantly stronger among female tourists (p < 0.05). This suggests that sustainability initiatives and marketing efforts should be gender-specific, with a particular focus on emotional appeal when targeting females.
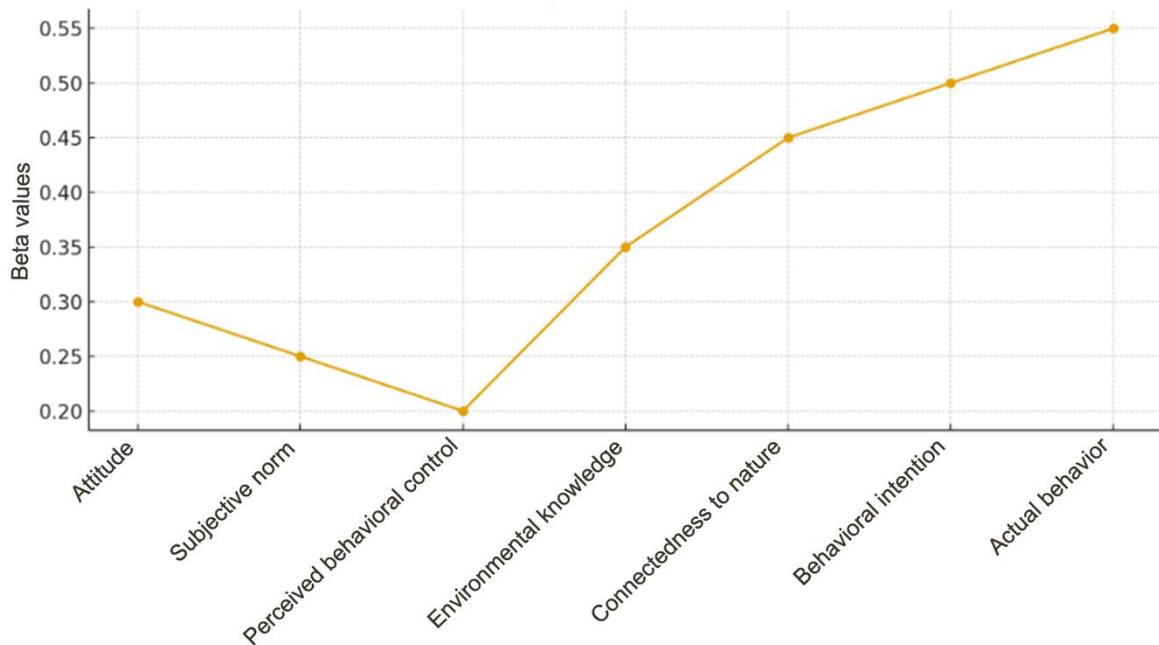
Figure 1. Construct strengths in the extended TPB model.

The schematic Figure 1 illustrates the relationships between constructs of the Extended Theory of Planned Behavior (TPB) and the environmental behavior of elderly tourists in Northern Thailand. Attitude (β = 0.30; p < 0.01), Subjective Norm (β = 0.25; p < 0.05), and Perceived Behavioral Control (β = 0.20; p < 0.05), which are traditional TPB predictors, were found to influence behavioral intentions. Additionally, the study introduces two new constructs: Environmental Knowledge (β = 0.35; p < 0.01), which positively contributes to pro-environmental attitudes, and Connectedness to Nature (β = 0.45; p < 0.001), which has the strongest predictive value on the behavioral intention of elderly tourists. Collectively, these constructs lead to a significant behavioral intention towards low-carbon tourism (β = 0.50; p < 0.001), which is strongly associated with actual low-carbon tourism behavior (β = 0.55; p < 0.001). The study's findings effectively convey the idea of integrating cognitive and emotional aspects to provide a comprehensive understanding of the factors influencing elderly tourists' engagement in sustainable tourism.

4.4. Interpretation and Theoretical Implications

The findings confirm the predictive validity of the Theory of Planned Behavior in the context of older eco-tourists. Additionally, they highlight the positive contribution of emotional factors. High levels of direct effects of connectedness to nature address recent criticisms of the Theory of Planned Behavior, which has been considered overly rationalistic and less valuable. Empirical evidence supports the idea that emotional connections to nature significantly influence pro-environmental intentions [49]. This study suggests that explanations of sustainable tourism behaviors among aging populations should incorporate constructs that reflect both affective and cognitive domains, emphasizing the importance of emotional and rational factors in understanding behavior [50].

4.5. Practical Implications

On the front of policy and destination management, these findings also suggest that interventions need to be complex. A considerable amount of knowledge should be advanced through environmental education programs, yet the same level of importance should be placed on promoting emotional attachment to the natural world. For example, eco-tourist experiences could include guided tours, cultural narration, and immersive activities that showcase the unique natural heritage of Northern Thailand. Due to gender differences, female-oriented campaigns might utilize

emotionally intensive narrations and visuals, whereas strategies aimed at male tourists would focus on highlighting independence, effectiveness, and the immediate benefits of low-carbon travel decisions.

4.5.1. Summary

All in all, the advanced analysis solidifies the strength of the results section by:

- Determining the discriminant validity using the Fornell-Larcker criterion.
- Indicator with a substantial effect size (f_2) and predictive relevance (Q_2).

Through the use of formal subgroup analysis, incorporated through Multi-Group SEM, these improvements both enhance the rigor of the methodology and contribute to the theoretical and practical significance of the study's outcomes.

5. RECOMMENDATIONS

5.1. Theoretical Implications

The research makes a significant contribution to the theoretical body of knowledge in the context of environmental behavior of elderly tourists in a specific eco-tourism destination site, particularly in the Northern region of Thailand. By incorporating Environmental Knowledge and Connectedness to Nature into the Theory of Planned Behavior (TPB), the study addresses criticisms that have persisted for over 20 years, which argue that TPB is overly rationalistic and utilitarian, failing to account for emotional and experiential aspects. The findings provide empirical evidence supporting the inclusion of affective constructs in behavior-based models. The observation that Connectedness to Nature directly influences Behavioral Intention (0.29) and indirectly influences it through Attitude (0.41) aligns with the idea that emotional appeals and attachment to nature significantly impact pro-environmental decision-making among aging tourists. This research expands the TPB framework by integrating cognitive predictors with emotional and experiential factors, resulting in a more comprehensive model for explaining sustainable tourism behavior.

Similarly, the correlation ($\beta = 0.34$) between Environmental Knowledge and Attitude supports the role of informational and cognitive elements in developing positive attitudes toward low-carbon tourism. The overall results support a two-pathway model, with one pathway being cognitive (knowledge-driven) and the other being affective (nature-connectedness), which can be further explored and developed in future theoretical studies. The Multi-Group Analysis results introduce an important aspect to behavior theory by showing that gender moderates the relationship between connectedness to nature and behavioral intention. This suggests that socio-demographic variables can influence the relative importance of emotional and cognitive values in sustainable tourism behavior, offering new cross-cultural and demographic insights into the Theory of Planned Behavior (TPB).

5.2. Practical/Managerial Implication

The results can be used to develop practical recommendations for policymakers in tourism, managers of tourist destinations, and eco-tourism providers who aim to foster sustainable tourism habits among elderly travelers. Since attitude has been identified as a significant predictor of behavioral intention (beta = 0.31), interventions should focus on tactics related to attitude-shaping. This includes framing low-carbon tourism as enjoyable and positively contributing to the environment. For example, marketing campaigns could highlight the pleasures of older adults engaging in sustainable tourism activities and emphasize the personal gratification and health benefits associated with such practices. Environmental knowledge also has a positive effect on attitude (0.34), suggesting that educational measures such as targeted informational materials can effectively enhance pro-environmental predispositions. Destination managers should create content that is accessible, engaging, and informative for senior tourists. This could involve producing materials in large print, incorporating audio elements, and utilizing short videos or

documentaries. These educational tools should not only inform but also appeal emotionally to foster a stronger connection to nature, thereby encouraging sustainable behaviors among elderly travelers.

Connectedness to nature is another important determinant of attitude and behavioral intention, so the design of eco-tourism experiences should involve exposing visitors to natural environments and encouraging them to reflect on the importance of nature to them as individuals. This can be illustrated through guided nature walks with local elders, cultural-ecological heritage storytelling, sensory experiences such as birdwatching, or traditional foraging. These strategies can create emotionally engaging experiences and promote sustainable behavior long after the visit. Gender differences, as demonstrated by the use of MGA, highlight the need for customized messaging. For female tourists, marketing materials may focus on emotional connections with nature, visual imagery that evokes feelings, and testimonials emphasizing emotional appeal and environmental care. Male tourists may prefer more practical messages, emphasizing self-efficacy and the physical achievements associated with establishing sustainable practices. The marginal effects of subjective norms (0.24) and perceived behavioral control (0.22) indicate that social approval and ease of action are significant factors. This suggests the importance of encouraging visible social signals, such as eco-friendly traveler badges through "green ambassadors"-styled badges that signify responsible travel behavior, and ensuring that sustainable options such as eco-friendly accommodations and organic local restaurants are visible and affordable to promote their adoption.

5.3. Limitations and Future Research

Although the study is valuable in terms of its theoretical and applied aspects, there are some limitations that should be mentioned to ensure transparency in future research.

1) The purposive and quota sampling methods used in the study make it difficult to generalize the results to the entire elderly tourist population in Thailand. In future research, it may be beneficial to employ probability sampling techniques to enhance representativeness or to conduct comparative studies across different regions and cultural contexts to validate the model more effectively.

2) The cross-sectional design of the study limits the ability to infer causal relationships, as it only observes relationships at a single point in time. Longitudinal research could track changes in attitudes, knowledge, and connectedness over time as elderly tourists visit different locations or progress through various stages of their life cycle.

3) There is a potential for social desirability bias in self-report measures, as respondents may exaggerate their sustainable behaviors. Future research could integrate self-reports with observational data or behavioral tracking to validate responses.

Theoretical future research directions could involve integrating the extended Theory of Planned Behavior with other models, such as the Value-Belief-Norm Theory or the Theory of Reasoned Goal Pursuit. This integration could provide a deeper understanding of how values, goals, and emotional associations influence sustainable tourism behavior. Additionally, testing the causal effects of intervention-based study designs, such as environmental education programs or nature-immersion experiences, on attitudes, intentions, and behaviors could offer evidence-based approaches for tourism managers to promote sustainability.

6. CONCLUSION

This analysis aims to address a specific theoretical and applied issue in modeling pro-environmental behavior in tourism. Although the Theory of Planned Behavior (TPB) has been extensively applied in tourism and environmental contexts, it has faced criticism for being overly rational and, in some cases, for not considering affective and experiential aspects that may be the sole components of decision-making behavior, especially within the leisure travel sector. This limitation is particularly relevant when it comes to elderly tourists, whose choices may be influenced by more than just cognitive assessments of rewards and obstacles; they may also be informed by ingrained emotional

connections with places and nature, as well as life experiences. This theoretical gap led to the expansion of the TPB model by incorporating two additional constructs: Environmental Knowledge (EK) and Connectedness to Nature (CNS). This extension was not only additive but also theoretically grounded, as EK provided the cognitive basis for engaging in pro-environmental actions, while CNS identified the affective and identity-related drivers that the original TPB failed to capture. The research aimed to provide an empirical and context-specific evaluation of the interaction among cognitive, normative, control, and affective factors, using elderly Thai tourists in Northern Thailand as a test case for forming low-carbon tourism behavior (LCTB).

The results support the importance of attitude, subjective norm, and perceived behavioral control as significant predictors of behavioral intention, as envisioned by the Theory of Planned Behavior (TPB). However, EK and CNS also played a role, providing additional explanatory value. EK was found to have an indirect effect, influencing behavior through its positive effects on both attitude and perceived behavioral control, particularly in how knowledge shapes belief structures and perceived ability to act. In contrast, CNS had both direct and indirect influences on behavioral intention and actual behavior, highlighting the significance of emotional involvement and self-identification with nature as motivating factors for sustainable actions. These findings demonstrate that the limitations of TPB can be addressed by incorporating selected cognitive or affective variables, especially for populations where emotional and experiential motivations are prominent. The study contributes to the TPB framework by illustrating how the model's predictive validity can be enhanced through the integration of domain-specific constructs. Additionally, it advances the sustainable tourism literature by emphasizing the role of aging tourists in facilitating the transition to low-carbon tourism practices.

The practical implications of the study are also significant. For destination managers and policymakers in Thailand, the findings suggest the need to develop projects that combine environmental education with opportunities for emotional and sensory interactions with nature. Low-carbon tourism products and services tailored to the interests of aging customers can be created, such as long-stay packages in eco-hotels, nature-guided tours, or low-impact cultural experiences. Communication strategies should be informative and inspirational, using storytelling, imagery, and first-hand experiences to foster a sense of connection to the environment. In conclusion, the study not only contributes to theoretical advancements in behavioral models but also offers practical insights for aligning demographic and environmental goals in tourism. By incorporating Environmental Knowledge and Connectedness to Nature into the Theory of Planned Behavior, the model provides a more comprehensive understanding of the environmental behavior of older tourists and can guide future research in diverse cultural and geographic settings to facilitate the transition of the global tourism industry toward low-carbon practices.

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