

Mechanism of low-carbon sports tourism behavior based on an extended theory of planned behavior

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Abstract:

This study extended the theory of planned behavior (TPB) by integrating two additional factors: low-carbon sports tourism cognition and environmental literacy. Subsequently, the expanded model was tested to gauge its effectiveness in determining low-carbon sports tourism behavior. The results showed that including environmental literacy and low-carbon sports tourism cognition considerably enhances the extended TPB model's capacity to elucidate low-carbon sports tourism behavior. The independent variables in the comprehensive model account for 20.5% of the variation in low-carbon sports tourism behavior conflict and 36.4% of the variability in behavioral intention. Upon comparing the augmented TPB model for low-carbon sports tourism behavioral intention to the original model, there was a rate of change in the explanatory power of $\Delta R^2 = 0.65$. Similarly, for low-carbon sports tourism behavior, the developed TPB model demonstrated a rate of change in the explanatory power of $\Delta R^2 = 0.41$. Several recommendations emerged from the findings, including the need for heightened awareness of low-carbon sports tourism, fostering greater accountability among tourists for their low-carbon sports tourism activities, enhancing publicity and educational efforts regarding low-carbon sports tourism, and reducing the financial barriers associated with low-carbon sports tourism for travelers. Further examination suggests that these strategies not only enhance the practical applicability of the model but also promote more sustainable practices within the industry. In conclusion, the study underscores the need to integrate environmental considerations into sports tourism planning and promotion because such integration can substantially enhance individual and collective environmental responsibility.

Keywords: Sustainable Tourism; Environmental Literacy; Behavioral Change; Theory of Planned Behavior; Sports Tourism Management

Introduction

"Carbon neutrality" was initially introduced in the late 1990s. With the full implementation of the Paris Agreement, countries begun announcing their carbon neutrality objectives, drawing global attention to the concept. In 2020, General Secretary Xi Jinping declared during the seventeenth session of the United Nations General Assembly that China would vigorously strive to peak its carbon emissions by 2030 and attain carbon neutrality by 2060. The introduction and realization of the "dual-carbon" goal aim to fundamentally reshape China's socioeconomic framework amidst an unprecedented century of transformation, thus significantly reshaping the global economic landscape. As a key driver of economic and industrial restructuring, the tourism sector has emerged as a quintessential green and low-carbon industry characterized by extensive integration and robust sustainability principles.

With the advent of "dual-carbon" tourism, low-carbon sports tourism has emerged as a fresh travel trend crucial for the sustainable growth of the sports tourism sector and ecological preservation. Achieving sustainable sports tourism necessitates active engagement and collaborative efforts among tourists, travel agencies, and governmental bodies. In low-carbon sports tourism, travelers play a pivotal role in driving low-carbon practices. Their actions considerably impact the realization of low-carbon sports tourism activities, influenced by factors such as their awareness, willingness, and decision-making processes across various aspects of travel, including accommodation, transportation, food, purchases, and leisure activities. Elevating the prevalence of low-carbon sports tourism, both in terms of visitation rates and overall consumption, contributes substantially to reducing carbon emissions across the sports tourism industry. Hence, discerning the root causes of carbon emissions in sports tourism by scrutinizing the behaviors of low-carbon sports tourists and the factors influencing them is instrumental in advancing the "dual-carbon" objective within sports tourism.

Theoretical background

Theory of planned behavior (TPB)

The theory of rational behavior posits that behavioral and normative beliefs have the most significant influence on an individual's inclination to act. Normative views, termed subjective norms and attitudes, shape an individual's willingness to act and their subsequent behaviors, while behavioral beliefs have the potential to shape the attitudes of those engaging in behaviors. Implicit in the concept of rational behavior is the assumption

that an individual's subjective consciousness entirely governs their actions. However, in certain social contexts, individuals may find themselves unable to enact behaviors solely based on their own volition, as they are influenced by external factors beyond their control. Building upon this premise, Ajzen developed the theory of planned behavior (TPB) by integrating perceptual behavior control variables into the framework of rational behavior theory. Perceived behavioral control, representing the degree of control over intended behavior and an individual's assessment of their capability to execute a planned action, is pivotal. The likelihood of someone engaging in an action is directly influenced by their self-efficacy or confidence in their ability to accomplish the task. Nevertheless, even with a favorable attitude toward the task and susceptibility to social influences, an individual's motivation to act may diminish if they lack the necessary resources and feel powerless to effect change. The TPB is a theoretical construct employed to elucidate and forecast human behavior within societies. Following a meta-analysis, Armitage and Conner (2001) determined that 39% of the variance in inclination to engage in activities could be accounted for by attitudes, subjective norms, and perceived behavioral control as per the TPB. This finding has cemented the TPB as one of the foremost theories in human behavior research.

This study predominantly employed the TPB as its principal analytical framework, given that low-carbon sports tourism is an individual decision-making process demonstrating typicality and representativeness. In the context of low-carbon sports tourism, a tourist's behavioral intention toward low-carbon sports tourism is defined as the level of commitment they are willing to invest in adopting such behaviors. *Subjective norms* are defined as the social pressures perceived by tourists when deciding to engage in low-carbon sports tourism, while attitudes denote tourists' favorable judgments regarding the adoption of these behaviors. Conversely, perceptual behavioral control gauges the extent to which tourists perceive the ease or difficulty of implementing low-carbon sports tourism behaviors. While the TPB has been extensively applied in various social examples, such as environmental protection (Yujun & Yun, 2021), rural tourism (Xiaomei & Xin, 2021), and eco-tourism (Ben et al., 2015), literature validating its application to low-carbon sports tourism behaviors is lacking. The link between environmental protection and low-carbon sports tourism behaviors, coupled with the necessity to consider additional factors to fortify the TPB model, could explain this gap. The model's efficacy in elucidating disparities between visitors' intended and actual behaviors in the context of low-carbon sports tourism is highlighted. This research integrates the concepts of low-carbon sports tourism cognition and environmental literacy with the core variables of the TPB model, encompassing the variables of attitude, subjective norms, perceived behavioral control, behavioral intentions, and behaviors. The objective of this expanded TPB model is to provide insight into the intricate interplay between visitors' psychological traits and environmental concerns, shaping both intentions and actions in low-carbon sports tourism. Consequently, the study focused on achieving the following goals:

1. To develop an extended TPB model for low-carbon sports tourism through a comprehensive literature review to validate and analyze the main factors influencing low-carbon sports tourism behavior;
2. To assess and contrast the explanatory capability of the traditional TPB model with the enhanced TPB model in the context of low-carbon sports tourism; and
3. To formulate targeted recommendations for advancing low-carbon sports tourism based on analytical findings, with the goal of fostering sustainable growth in the low-carbon sports sector and bolstering the local green economy.

Extended model of TPB based on low-carbon sports tourism cognition and environmental literacy

Xiaojun and Lei (2021) studied the field of tourism and found that the TPB has a 68.4% explanatory power in forecasting shifts in behavioral intentions and a 56.5% explanatory power in predicting actual behavior. Their empirical study on the impact of ecotourism behavior underscores the theory's robustness in elucidating tourism phenomena. Nonetheless, various scholars contend that existing research within the TPB should offer a more thorough exploration of the link between attitudes and behaviors (Xiaoli, 2006). Armitage and Conner's analysis showed a variance ranging from 19% to 38% in explaining behavioral intentions. Attitudes and subjective norms can elucidate 33% to 50% of intentions, while cognitive behavioral control contributes an additional 3.5% to 12% (Mark & Christopher, 1998). While these findings underscore the efficacy of adopting the TPB in studies, there is a significant amount of unexplained variability between intention and behavior. Moreover, it is essential to recognize that a portion of this variability remains unaccounted for due to random errors in research techniques and social surveys. Furthermore, it is advisable to integrate additional variables into the model to improve its overall predictive capacity.

Expanding upon the concept of planned behavior, this study focused on "low-carbon tourism awareness." Initially, from a theoretical perspective, while the TPB delineates the "attitude-behavior" response relationship, it falls short in the triadic attitude model (i.e., emotion, intention to act, and cognition). This suggests that individual cognition and volition to act are mediated through a complex mechanism, wherein cognition relies on object perception, an individual's reservoir of knowledge, emotions, and intention to act. Cognition encompasses the process of perceiving objects and an individual's knowledge base, and it serves as the foundation for emotional and intentional development. Emotion is a fundamental component of individual attitudes and subjective feelings, serving as the intermediary factor in the "cognition and behavioral intention" relationship. Behavioral intention reflects the individual's emotional attitude and stems from cognitive and emotional attitudes. In this transmission mechanism, individuals form attitudinal inclinations toward perceived

objects and behavioral intentions based on the cognitive system, subsequently leading to social behaviors (Deqing, 2003). A structural hierarchical relationship exists among cognition, affective attitude, and behavioral intention. Chen Zhi further analyzed the spatial tourist attraction mechanism in sports-characteristic towns based on this theory. Therefore, incorporating the variable of "low-carbon tourism cognition" is instrumental for enhancing the structural dimension of the TPB. Moreover, it is imperative for the tourism industry to proactively address the adverse impacts of global climate change, chiefly driven by carbon dioxide emissions, and actively contribute to climate mitigation efforts (Gössling Stefan et al., 2009). According to Jacquelin et al. (1998), tourists, as primary participants in tourism activities, contribute significantly to carbon emissions compared to local residents of tourist destinations. Understanding low-carbon tourism is pivotal for cultivating low-carbon tourism attitudes and behaviors. A heightened low-carbon tourism understanding will foster the promotion of accurate low-carbon tourism attitudes, translating into positive low-carbon tourism behaviors (Aizhong et al., 2011; Changjiang et al., 2020). Therefore, comprehending tourists' current low-carbon tourism cognition and effectively altering tourists' high-carbon tourism behaviors to reduce carbon emissions is critically important.

Moreover, this study integrated "environmental literacy" as an expanded factor within the framework of the TPB. Jianhua and Lulu (2021) argued that the TPB should be enriched when applied in the context of environmental tourism. Wang's empirical research concluded that environmental literacy has a substantial positive predictive influence on green consumption intention (Miaopin, 2019). Environmental literacy means having a broad understanding of environmental issues, including awareness of environmental challenges, a sense of responsibility towards environmental protection, values promoting a harmonious human-nature relationship, and the capacity to identify and address pertinent environmental concerns (Stern Paul, 2000). The hierarchical structure of environmental literacy is illustrated by the foundational role of environmental issues, the inclination of environmentally literate individuals to express their emotions, and the elevation of environmental consciousness through environmental values. Environmental behavioral skills represent the ultimate objective of environmental literacy, with environmental values embodying environmental responsibility. Initially, Stern integrated value theory with the new environmental paradigm, creating the value-belief-norm theory, which is theoretically based on the norm activation theory. According to this theory, individuals reinforce their environmental behaviors by activating personal norms derived from values, including beliefs regarding the human-nature relationship, the consequences of destructive behaviors, and personal responsibility (Cheng et al., 2018). This integration of the values-beliefs-norms theory underscores the importance of incorporating environmental responsibilities and values into the analytical model, suggesting a potential positive correlation between low-carbon tourist objectives and environmental literacy. Enhancing the application of the theory of planned behavior in the context of low-carbon sports tourism involves integrating the values-beliefs-norms theory and expanding the variable of "environmental literacy," which is based on the theory of environmental literacy. To effectively mitigate environmental degradation resulting from carbon emissions, fostering awareness and accountability among individuals towards the environment is imperative. Therefore, the study of low-carbon sports tourism should encompass ethical considerations. Environmental literacy includes elements, such as an individual's environmental concern, responsibility, and capability to safeguard the environment, all of which influence their behavioral intentions. Miaopin (2019) underscored the significant impact of environmental literacy on an individual's behavior in low-carbon and environmentally friendly sports tourism.

Conceptual model and hypothesis

This study employed the TPB to explore the interplay between low-carbon sports tourism and cognitive-emotional-behavioral intention. It integrates the variable of "low-carbon tourism cognition" into the existing theoretical framework and introduces the variable of "environmental literacy" based on the value-belief-norm theory to clarify the ethical aspects of low-carbon sports tourism. Furthermore, aligning with the value-belief-norm theory, it is imperative to broaden the examination of low-carbon sports tourism to encompass moral considerations. The variable of "environmental literacy" should be integrated to construct a novel theoretical framework. This framework could elucidate how attitudes, subjective norms, perceived behavioral control, and environmental literacy directly influence behavioral intention. By expanding the TPB, it is anticipated that the expanded theory will have an enhanced explanatory capacity for predicting low-carbon sports tourist behaviors. The research hypotheses and analytical framework for this study are outlined below.

Research hypotheses:

- H1: Attitude, subjective norms, perceived behavioral control, low-carbon tourism cognition, and environmental literacy have a positive predictive influence on low-carbon sports tourism behavioral intention.
- H2: Perceived behavioral control and low-carbon sports tourism behavioral intention positively influence low-carbon sports tourism behavior.
- H3: Attitude serves as a mediator between low-carbon tourism cognition and low-carbon sports tourism behavioral intention.

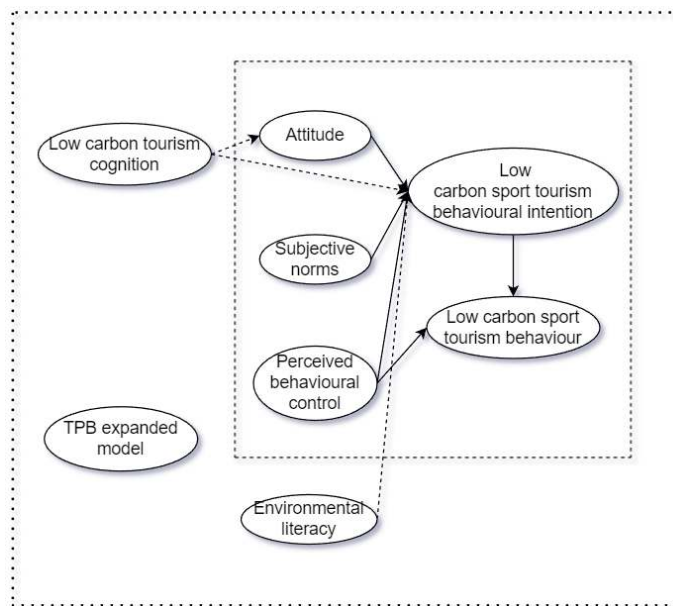


Figure 1. Extended Theory of Planned Behavior Model

Methodology

Participants and data collection

Two methods were employed for distributing the questionnaires: online and on-site. In alignment with the concept of "low-carbon sports tourism," on-site distribution targeted specific locations, namely the South Taihang Tourism Resort in Xinxiang City, the Olympic Sailing Centre in Shandong Province, and the Rainbow Valley Scenic Spot in Xueshan City, Linyi City. Conversely, the online survey targeted individuals who had visited the Liuzhou City Baili Liujiang River Sports Tourism Demonstration Base, the Guilin City Yulong River Leisure Sports Tourism Resort, the Ningde City Bayshuiyang Sports Tourism Demonstration Base, and Beijing Olympic Park in Chaoyang District. A total of 1,126 questionnaires were distributed, with 71 invalid questionnaires excluded, resulting in a valid sample size of 1,055. In terms of demographics, females slightly outnumbered males, constituting 53.7% of the sample. Respondents' ages were predominantly concentrated in two stages: 22–27 and 36–45 years old. Their education levels ranged from the specialist level to undergraduate degrees. Occupations were diverse, encompassing public officials, service industry professionals, and self-employed individuals. In terms of demographics, tourism with family/relatives accounted for the majority at 50.61%, followed by tourism as couples at 22.65%. Overall, low-carbon sports tourists in this study were predominantly young adults aged 22–27 and middle-aged individuals aged 36–45, with a slight female majority.

Statistical analysis

Data analysis for this study was performed by using SPSS Statistics version 26.0 (IBM Corporation, Armonk, New York, USA).

Measurement of variables

To establish and test the hypotheses, we indexed each conceptual variable and developed corresponding question items. Low-carbon tourism cognition, drawing from Icek (2002) and Yaping and Qing (2013), comprised five items encompassing three dimensions: low-carbon travel, low-carbon shopping, and low-carbon recycling. Environmental literacy, following Wang's study, included eight items across four dimensions: environmental values, a sense of environmental responsibility, perception of environmental problems, and environmental behavioral skills. Attitudes were defined according to Ajzen's definition as "the degree of positivity or negativity individuals hold when performing specific behaviors" (Icek & Driver, 1992) and were established using three statements types, such as "I believe low-carbon sports tourism is crucial for sustainable development." Subjective norms, referring to Icek and Driver's definition as "the extent to which individuals perceive social pressure to perform or not perform a particular behavior" (Yuangang et al., 2019), were represented by three items, such as "People important to me (family/classmates/friends/colleagues) support my participation in low-carbon sports tourism activities." Perceived behavioral control, adopting Ajzen and Driver's definition as "the degree to which an individual perceives a particular leisure behavior to be easy or difficult" (Icek & Driver, 1992), comprised three items, such as "I feel confident that I can engage in low-carbon sports tourism behavior." Behavioral intention, following Ajzen and Driver's definition as "an individual's willingness to act and commit to performing a specific behavior" (Yuangang et al., 2019), was assessed with three items, including "I intend to participate in low-carbon sports tourism in the future." Behavior was defined according to Ajzen as "whether an individual performs a particular behavior" (Icek & Driver, 1992) and was measured using three items, such as "I consistently practice

low-carbon behaviors during sports tourism." All scales utilized a 7-point Likert scale, and Table 1 provides a concise overview of the measurement scales employed.

Reliability pertains to the consistency of responses across all questions related to a specific variable, often evaluated using Cronbach's coefficient. The Cronbach's coefficient for the entire scale is 0.735, with coefficients for the seven subscales, as detailed in Table 1, exceeding 0.7, indicating the high reliability of the scale. Additionally, questionnaire validity was assessed. Initially, the validity of the translated questionnaire content was examined using the back-translation method. The English questionnaire was translated into Chinese and then back-translated into English by an English scholar. Discrepancies between the retranslated version and the original were carefully scrutinized. When the Chinese questionnaire was created, a validity checklist was shared with five experts, resulting in two experts affirming validity and three suggesting adjustments.

The questionnaire was subsequently revised based on their feedback. Factor analysis evaluated the structural validity of the scale using SPSS 26.0, yielding a KMO value of 0.785 and a cumulative variance explained rate of 79% based on Bartlett's spherical test ($P < 0.001$). AMOS 24.0 was employed for validation factor analysis, yielding the following outcomes: Chi-Square to Degrees of Freedom Ratio (CMIN/df) = 4.025, Comparative Fit Index (CFI) = 0.911, Incremental Fit Index (IFI) = 0.903, Normed Fit Index (NFI) = 0.923, and Root Mean Square Error of Approximation (RMSEA) = 0.055, indicating acceptable validation factor analysis results. However, the item "Carbon Emission" did not meet the expected criteria, resulting in its removal.

All observed variables exhibited factor loadings above 0.5 on their corresponding latent variables, except for two items, "Carbon emissions mainly refer to the emission of greenhouse gases, mainly carbon dioxide" and "I find it convenient to engage in low-carbon sports tourism," which had factor loadings below 0.5 and were subsequently excluded. The range of 0.783–0.957 for all instances exceeded the permissible threshold of 0.7. Finally, the discriminant validity of latent variables was assessed by comparing correlations among latent variables with the square root of the average variance extracted values (AVE). Table 2 shows that the square root of AVE for all factors exceeds correlation coefficients with other factors, indicating superior discriminant validity. Consequently, the reliability test of the scale confirms the exceptional quality of the acquired data, meeting the criteria for further analysis.

Table 1. Results of the confirmatory factor analysis

Measurement dimensions and measurement items	Standardization	CR	AVE	Cronbach's α
Low-carbon tourism cognition		0.930	0.728	0.808
Recognizing hiking or cycling as low-carbon and energy-saving travel options	0.855			
Willingness to prioritize the purchase of sports goods with a low-carbon logo	0.788			
Acknowledging the close connection between protecting the ecological environment and low-carbon sports tourism	0.892			
Commitment to minimizing the use of disposable goods during sports tourism activities	0.851			
Preference for choosing local food materials to reduce carbon emissions	0.877			
Environmental literacy		0.957	0.736	0.875
Environmental and ecological protection outweighs the development of a sports tourism economy	0.911			
Belief in harmonious coexistence between humanity and nature	0.845			
Advocacy for green production and consumption to mitigate pollution from sports tourism	0.871			
Experiencing remorse for contributing to environmental pollution and degradation through sports tourism activities	0.856			
Attainment of proficiency in low-carbon sports tourism	0.866			
Capacity to promptly identify carbon emissions issues during sports tourism	0.831			
Ability to assess the underlying causes of environmental issues in sports tourism	0.825			
Willingness to learn strategies for reducing carbon	0.885			

emissions through sports tourism

Attitude		0.818	0.599	0.726
I believe that low-carbon sports tourism is a crucial step towards developing ecological sports tourism.	0.744			
I believe that low-carbon sports tourism serves as a significant means to protect the environment.	0.781			
I believe that low-carbon sports tourism is a responsibility shared by all citizens.	0.796			
Subjective norms		0.832	0.623	0.719
I am supported by significant others, such as family, classmates, friends, and colleagues, in my pursuit of low-carbon sports tourism activities.	0.883			
The influential individuals in my life, including family, classmates, friends, and colleagues, applaud my involvement in low-carbon sports tourism endeavors.	0.787			
If the majority of my family, classmates, friends, and colleagues endorse the importance of participating in low-carbon sports tourism activities, I am more likely to join them.	0.745			
Perceived behavioral control		0.783	0.546	0.715
Engaging in low-carbon sports tourism behavior comes naturally to me.	0.765			
I possess the necessary knowledge to incorporate sustainable practices into sports tourism.	0.717			
Every aspect of my situation facilitates my participation in low-carbon sports tourism behavior.	0.734			
Behavioral intention		0.844	0.643	0.812
In the future, I am enthusiastic about participating in low-carbon sports tourism.	0.795			
I am committed to advocating for the advancement of low-carbon sports tourism to influence individuals.	0.788			
I diligently uphold the adoption of low-carbon practices throughout the sports tourism process.	0.823			
Behavior		0.852	0.658	0.789
I have maintained unwavering adherence to low-carbon practices during my participation in sports tourism.	0.837			
I have refrained from contributing to environmental damage or wasteful resource utilization throughout the sports tourism process.	0.779			
Throughout my engagement in sports tourism, I have consistently prioritized the principle of ecological environmental preservation.	0.815			

Table 2. Correlation and descriptive statistical findings for each variable within the prediction model

	1	2	3	4	5	6	7	M	SD
1 Attitude	0.774	0.137	0.275*	0.431**	0.152*	0.315*	0.266**	4.717	1.525
2 Subjective norms		0.789	0.255*	0.065	0.107*	0.245*	0.082	5.028	1.674
3 Perceived behavioral control			0.739	0.055	0.037	0.545***	0.207*	4.545	1.383
4 Low-carbon sports tourism behavioral intention				0.853	0.273**	0.385**	0.294*	4.009	1.296
5 Low-carbon tourism cognition					0.858	0.144*	0.175*	3.897	1.401
6 Behavioral intention						0.802	0.466**	3.959	1.401
7 Behavior							0.811	4.029	1.355

Results

Model testing and modification

The chi-square degrees of freedom ratio (χ^2/df), comparative fit index (CFI), standardized root mean square residual (SRMR), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA) were carefully selected to assess the model's goodness of fit. Initially, the TPB model was evaluated (see Figure 2), yielding the following results: $\chi^2/df = 4.1$, $P < 0.01$; CFI = 0.951; TLI = 0.903; SRMR = 0.043; RMSEA = 0.08. The model exhibited a good fit, with all indices falling within acceptable ranges.

The independent variable explained 30% of the variance in behavioral intention and 18.2% in behavior. Notably, attitude ($\beta = 0.251$, $P < 0.01$) and perceived behavioral control ($\beta = 0.498$, $P < 0.001$) significantly influenced low-carbon sports tourism behavioral intention, while behavioral intention ($\beta = 0.414$, $P < 0.05$) significantly impacted low-carbon sports tourism behavior.

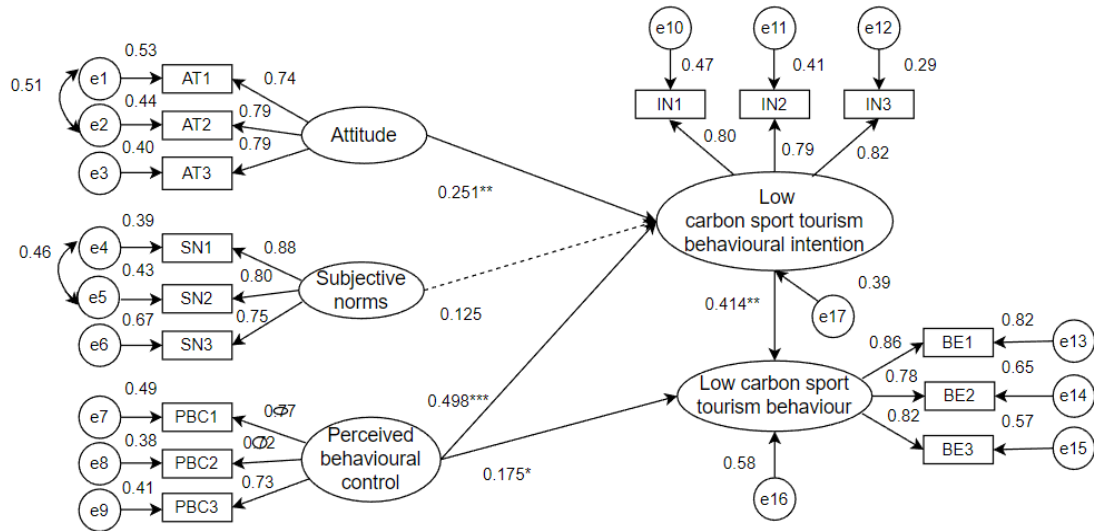


Figure 2. TPB prediction model

The TPB extended model underwent testing (see Figure 3). The results indicated the following: $\chi^2/df = 1.427$, $R < 0.01$; CFI = 0.724; TLI = 0.525; SRMR = 0.915; RMSEA = 0.147. The model's fit was deemed inadequate, prompting consideration for expansion, particularly by including the "Environmental Literacy→Low-Carbon Sports Tourism Awareness" pathway.

According to Cheng Zhanhong's analysis (Yaping & Qing, 2013), factors influencing tourists' low-carbon sports tourism cognition encompass human–Earth values, individual–social responsibility, and individual professional skills, similar to the dimensions of environmental literacy in this study. Therefore, to enhance the model fit, the path "Environmental Literacy→Low-Carbon Sports Tourism Cognition" should be incorporated. Upon modification, the revised model exhibited improved the fit: $\chi^2/df = 2.24$, $R < 0.05$, CFI = 0.945, TLI = 0.923, SRMR = 0.037, and RMSEA = 0.045.

The test results confirmed most of the proposed hypotheses. Specifically, low-carbon sports tourism cognition ($\beta = 0.362$, $P < 0.001$), attitude ($\beta = 0.264$, $P < 0.05$), and perceived behavioral control ($\beta = 0.527$, $P < 0.001$) significantly influenced low-carbon sports tourism behavioral intention.

These effects were also mediated by attitude. However, subjective norms ($\beta = 0.025$, $P > 0.05$) significantly correlated with low-carbon sports tourism behavioral intention. Furthermore, perceived behavioral control ($\beta = 0.185$, $P < 0.05$) and low-carbon sports tourism behavioral intention ($\beta = 0.446$, $P < 0.001$) were significantly correlated. Moreover, the independent variables of the study accounted for 36.4% of the variance in low-carbon sports tourism behavioral intentions, in contrast to only 20.5% of the variance in low-carbon sports tourism behavior.

The extended TPB model showed an increase in the explanatory power of $\Delta R^2 = 0.65$ for low-carbon sports tourism behavioral intention and $\Delta R^2 = 0.41$ for low-carbon sports tourism behavior compared to the unexpanded model.

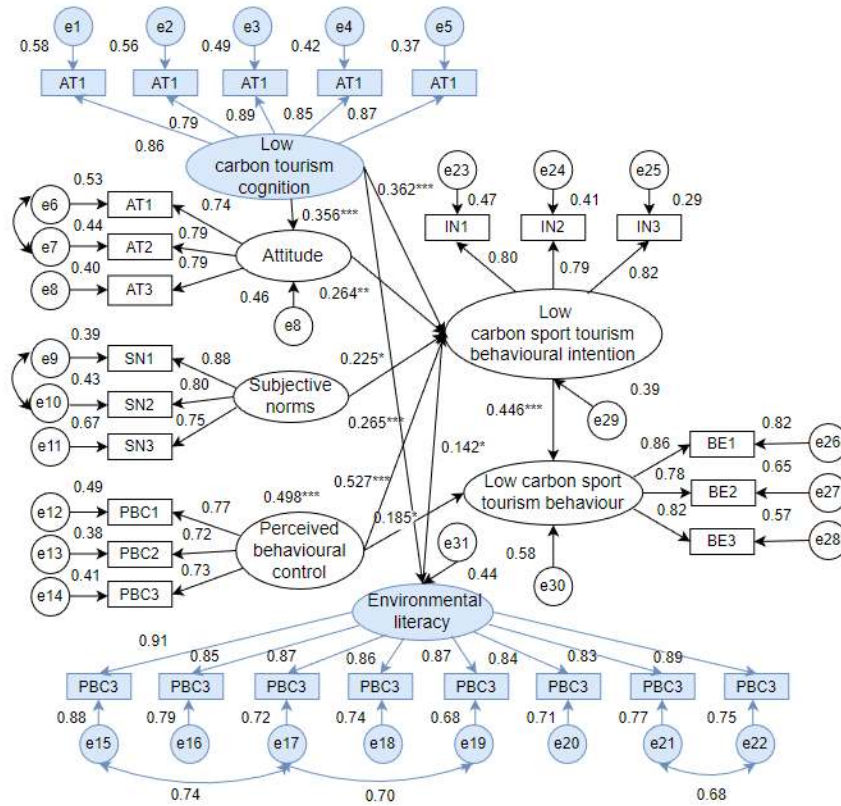


Figure 3. TPB extended prediction model

Discussion

Validation of the TPB extended model

This study examined the relationships between visitors' intentions and behaviors in low-carbon sports tourism, considering their environmental literacy and low-carbon sports tourism understanding. By incorporating attitudes, subjective norms, perceived behavioral control, low-carbon sports tourism cognition, and environmental literacy as predictors of low-carbon sports tourism intentions, we extended the TPB model. Furthermore, we explored the mediating role of attitudes between low-carbon sports tourism cognition and behavior. The study validated the explanatory and predictive capacity of the extended TPB model in forecasting low-carbon sports tourism intentions and behaviors. However, the study results offer only partial support for the research hypotheses. The results indicate that the TPB model accounted for 18.2% of the variance in low-carbon sports tourism behaviors and 30% of the variance in low-carbon sports tourism behavioral intentions. In contrast, the TPB extended model's constituent elements explained 20.5% of the variance in low-carbon sports tourism behaviors while capturing 36.4% of the differences in low-carbon sports tourism intentions. Thus, by incorporating variables, such as low-carbon sports tourism awareness and environmental literacy, the TPB extended model can enhance its explanatory power regarding both intention and behavior. Additionally, previous research has highlighted that a portion of the variance in behavioral intention remains unexplained. As Ajzen suggested, the TPB model is not without flaws and may benefit from refinement and supplementation by introducing context-specific factors. For instance, Qiu Hongliang introduced variables of local attachment and moral code to the TPB model upon analyzing the influencing mechanisms of outbound tourists' behavioral intention towards civilized tourism (Icek, 1991). Zhang Yuangang added local emotion variables in the analysis of the behavioral intention of countryside recreation. Qianqian and Bingxiong (2018) incorporated variables such as animation intention, activity imagery, celebrity and famous enterprise imagery, and ancillary imagery when examining tourists' intention to revisit an animation festival. This research underscores that, in addition to attitudes, subjective norms, and perceived behavioral control, low-carbon sports tourism cognition and environmental literacy contribute to enhancing the TPB model's explanatory power regarding both intention and behavior (Zhongjun & Qiongrui, 2020).

Relationship between attitude, subjective norms, perceived behavioral control, and low-carbon sports tourism behavioral intention and behavior

In line with the TPB model, the intention to engage in low-carbon sports tourism is notably influenced by attitude and perceived behavioral control. However, subjective norms do not significantly affect this intention, consistent with prior research. This indicates a growing awareness of environmental conservation and

knowledge amidst green development and dual-carbon initiatives. Moreover, environmental friendliness is increasingly valued as a key aspect of a desirable lifestyle, emphasizing the importance of sustainability. Consequently, there is increasing emphasis on fostering ecological awareness within sports tourism. The limited impact of subjective norms on low-carbon sports tourism intention could stem from improved education levels, enabling individuals to make independent, rational judgments. Additionally, the accessibility of information through technological advancements allows autonomous learning about low-carbon practices. This empowers individuals to access pertinent information regarding low-carbon sports tourism, diminishing the efficacy of external regulation (via friends, family members, colleagues, etc.). When forecasting tourists' behavior in low-carbon sports tourism, behavioral intention significantly influences it, whereas perceived behavioral control shows no notable correlation, contrary to earlier studies. We attribute this discrepancy to Ajzen's TPB model, which underscores the influence of perceived behavioral control on an individual's ability to execute behaviors. As people's quality of life improves, bolstered by economic means and increased leisure time, their inclination towards low-carbon sports tourism grows (Icek, 1991). Furthermore, governmental advocacy for low-carbon living and tourism heightens public awareness, fostering a sense of control among tourists over their engagement in low-carbon practices. Consequently, their participation in low-carbon sports tourism is primarily driven by personal choice rather than external constraints.

Relationship between low-carbon sports tourism cognition, environmental literacy, and low-carbon sports tourism behavioral intention

According to the TPB model, possessing knowledge about environmental issues and understanding the concept of low-carbon sports tourism can foster a favorable inclination towards engaging in such practices. This aligns with previous research findings that underscore the importance of informed awareness in shaping pro-environmental behaviors (Smith & Doe, 2020). Given the prevalence of low-carbon sports tourism as an environmentally conscious activity, individuals' decisions regarding environmental behavior are often guided by moral considerations rather than financial incentives. Thus, the decision-making process for intending to partake in low-carbon sports tourism should be framed as ethical literacy rather than purely economic activity. Under the social person hypothesis, environmental literacy emerges as a potential predictor of tourists' engagement in low-carbon sports tourism. Conversely, it has been argued that environmental knowledge can positively influence tourists' environmental concerns, subsequently impacting their environmentally responsible behaviors (Zhongjun & Qiongrui, 2020). Recent studies support this notion, indicating that individuals with a more comprehensive understanding of low-carbon concepts are better equipped to comprehend and implement low-carbon behaviors, facilitating their engagement in low-carbon tourism practices.

Conclusions

By incorporating environmental literacy and cognition specific to low-carbon sports tourism into the broader TPB model in the context of low-carbon sports tourism, we demonstrated a notable enhancement in the model's explanatory power regarding low-carbon sports tourism behavior. Environmental literacy, cognition, attitude, and perceived behavioral control are pivotal factors shaping tourists' intention to partake in low-carbon sports tourism. The adoption of low-carbon sports behaviors by tourists is directly influenced by their intention to engage and their perception of their capacity to effectively manage their behavior.

Given the provided insights, it is crucial to focus on specific factors when intervening in tourists' low-carbon behavior within sports tourism. First, to bolster awareness of low-carbon sports tourism, governmental prioritization and incentives will encourage tourists to actively participate in such endeavors. Vigorous advocacy for ecological preservation is essential, incentivizing tourists to adopt sustainable consumption patterns and lifestyles. Equally important is educating tourists about the concept of low-carbon sports tourism and its environmental implications while also guiding them towards adopting eco-friendly behaviors. Second, to bolster tourists' accountability in low-carbon sports tourism, tourism authorities must recognize the intricate link between the ecological environment and human survival. It is crucial that the promotion and education about low-carbon sports tourism strategically emphasize this connection. Issues of governmental responsibility, collective accountability, and the role of tourist destinations in environmental conservation must be addressed to enhance low-carbon responsibility. The concept of "low-carbon responsibility" should be embraced by all visitors and citizens, emphasizing their obligation and responsibility towards low-carbon sports tourism. Enhancing visitor awareness of the necessity and benefits of adopting low-carbon sports tourism practices is critical. Third, effective promotion and education strategies must be employed to bolster low-carbon sports tourism initiatives. The Chinese government, through initiatives focused on environmental literacy, low-carbon sports tourism awareness, and perceived behavioral control, should enhance educational efforts in this area. This comprehensive approach will ensure tourists grasp the responsibility and significance of engaging in low-carbon sports tourism, guiding their behavior accordingly. Fourth, efforts should be made to minimize expenses associated with low-carbon sports tourism for visitors and consistently reduce costs. Tourist destinations can incentivize low-carbon sports tourism behaviors by offering incentives and improving infrastructure supportive of such practices. Additionally, allocating financial resources towards advancing low-carbon technology and creating "carbon-labeled" tourism options can promote energy conservation and emission reduction across tourist destinations, hotels, restaurants, and entertainment venues.

This study was subject to certain limitations, such as its reliance on cross-sectional research. Future endeavors may involve conducting follow-up surveys on similar respondents to validate the predictive capacity of the extended TPB model's influencing factors on behavioral intention and subsequent behavior. Furthermore, while environmental literacy and low-carbon sports tourism cognition were integrated into the general TPB model for analysis, the study's constraints warrant consideration of additional psychological factors in future investigations to enhance the model's explanatory power regarding tourists' low-carbon sports tourism behavior. As research into low-carbon sports tourism behavior is still in its initial stage, the understanding of its influencing mechanisms, measurement tools, and guiding policies remains underdeveloped. Subsequent studies could employ qualitative research methods to clarify and refine core issues, such as the measurement tools and influence mechanisms of low-carbon sports tourism behavior.

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