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A Study on Tourists' Low-Carbon Tourism Behavioral Intention Based on the Theory of Planned Behavior

-- The Case of Qingming Shanghe Garden

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Abstract: Based on the Theory of Planned Behavior (TPB), this study takes the Qingming Shanghe Garden as an example to explore the influencing mechanism of tourists' intention for low-carbon tourism. Through a mixed research method, including questionnaire surveys and field research, the relationships among tourists' attitudes towards low-carbon tourism were analyzed. Through a mixed research method, including questionnaire surveys and field research, the relationships among tourists' attitudes towards low-carbon tourism, subjective norms, perceived behavioral control, and their behavioral intentions were investigated. The findings reveal that behavioral attitude, subjective norms, and perceived behavioral control all have significant positive impacts on tourists' intention for low-carbon tourism. The findings reveal that behavioral attitude, subjective norms, and perceived behavioral control all have significant positive impacts on tourists' intention for low-carbon tourism, with behavioral attitude having the most prominent influence. The research conclusions provide decision-making basis for low-carbon management in scenic spots and offer references for the low-carbon transformation of the tourism industry. The conclusions provide decision-making basis for low-carbon management in scenic spots and offer references for the low-carbon transformation of the tourism industry.

Keywords: Low-carbon tourism; Theory of Planned Behavior; Behavioral Intention; Qingming Shanghe Garden.

1. Introduction

1.1. Background

In today's context of global climate change and ecological challenges, low carbon development has become a focal point of the international community's attention. As a major contributor to global carbon emissions, the low-carbon transformation of the tourism industry plays a crucial role in achieving the goal of "carbon neutrality". The United Nations World Tourism Organization (UNWTO) has clearly pointed out that the tourism industry should reduce energy consumption and carbon emissions by means of innovative management models and the guidance of tourists' behavior. As one of the world's major tourism markets, China has in recent years issued the "14th Five-Year Plan for Tourism Development", "Green Tourism Consumption Guidelines", and other policy documents, which emphasize the low carbon concept in the development of scenic spots and the management of tourists' behaviors, to promote the process of sustainable development of the tourism industry.

As a national 5A-level scenic spot and a Song Dynasty cultural theme Garden, Qingming Shanghe Garden attracts millions of tourists every year, but in the process of its operation, it faces practical problems such as high energy consumption and excessive pressure on garbage disposal. Although has tried to introduce solar lighting and implement low carbon initiatives such as trash classification and recycling, the active participation of tourists is still lacking. How to stimulate tourists' willingness to participate in low-carbon tourism with the help of theoretical guidance and practical interventions has become an urgent challenge for the management of scenic spots.

Analyzed from the theoretical level, the Theory of Planned Behavior (TPB) has been widely used in the prediction of individual behavioral willingness, which is based on "attitude", "subjective norm", "perceptual behavioral control", "attitude", "subjective norm", "perceptual behavioral control" and "perceptual behavioral control". The theory uses the three core variables of "attitude," "subjective norms," and "perceived behavioral control" to explain the internal mechanism of behavioral decision-making. However, according to the current research status, most of the studies focus on the fields of green travel and environmental protection consumption, and the TPB model for low-carbon tourism behavior is relatively rare, especially in the specific scenario of historical and cultural scenic spots, which is in urgent need of further supplementation and improvement.

1.2. Research Implications

At the theoretical level, this study is committed to expanding the application scenarios of TPB. Specifically, it is to introduce the TPB model into the research field of low-carbon tourism behavior, and verify the applicability of the model in the prediction of tourists' behavior in historical and cultural scenic spots through empirical research, which will open new perspectives for the study of tourism behavior. Meanwhile, this study also focuses on simplifying the research model by discarding those complex variables and focusing on the core dimensions of TPB, i.e., attitudes, subjective norms, and perceptual-behavioral control, and exploring in-depth the mechanism of the direct influence of these core dimensions on behavioral intention, to provide a parsimonious analytical framework for the subsequent related studies.

In terms of the significance at the practical level, this study can provide a strong decision-making basis for the low-carbon management of the Qingming Shanghe Garden. By

identifying the key drivers of visitors' behavioral intentions, it can help the scenic spot optimize the layout of low-carbon facilities, such as the addition of shared transportation, etc., and at the same time, design a reasonable incentive mechanism, such as carbon point rewards, so as to enhance the participation of visitors. In addition, the conclusions of this study can also provide reference for other similar historical and cultural scenic spots, and promote the entire tourism industry to change from the traditional "high-carbon rough" mode to the "low-carbon fine" mode, and make efforts in the direction of "dual-carbon" development. The "dual-carbon" direction of development is being pursued. These measures not only help to reduce the carbon emissions of the scenic spot, but also enhance the environmental awareness of tourists and promote the sustainable development of the scenic spot. Through these practices, Qingming Shanghe Garden can become a model of low-carbon tourism, attract more tourists to participate in low-carbon tourism, and further promote the popularization of low-carbon tourism.

1.3. Research Methodology

Taking TPB as the theoretical foundation, this study comprehensively uses a variety of research tools, in which quantitative analysis dominates, and integrates the field research of the case study of the Qingming Shanghe Garden, to comprehensively and systematically explore the role of the mechanism influencing tourists' behavioral intention of low-carbon tourism, and focuses on in-depth analysis of the inner connection between the attitudes of visitors to the Qingming Shanghe Garden towards low-carbon tourism, subjective norms, and perceptual-behavioral control and their behavioral intention. We focus on analyzing the intrinsic connection between the tourists' attitudes, subjective norms, and perceptual behavioral control and their behavioral intentions. By combing domestic and international literature on low-carbon tourism and the theory of planned behavior, we pinpointed the research gaps and constructed a theoretical framework to build a theoretical foundation for the design of the questionnaire and the formulation of hypotheses. The questionnaire includes demographic information, as well as tourists' attitudes, subjective norms, perceived behavioral control, and behavioral intention towards low-carbon tourism, which provides a solid data foundation for the subsequent in-depth analysis. At the same time, a structured questionnaire based on the core variables of TPB (attitude, subjective norms, and perceived behavioral control) was carefully designed, and the research activities were conducted in the Qingming Shanghe Garden scenic area to collect various types of data such as tourists' knowledge and behavioral intentions about low-carbon tourism.

In the data analysis stage, statistical methods were applied to process the questionnaire data. And the analysis of Pearson correlation was adopted to explore the correlation between behavioral intentions and attitudes, subjective norms, and perceptual behavioral control; and the cross-tabulation analysis (chi-square test) was used to analyze the association between different variables by taking gender and the frequency of low-carbon tourism behaviors as an example. In addition, the interview data were coded and thematically analyzed to refine the key information and corroborate with the results of the questionnaire analysis. The combined use of these analytical methods not only helps to gain an in-depth understanding of tourists' low-carbon tourism behavioral intentions, but also provides solid data support for subsequent research. Through these data analysis tools, we are able to more accurately identify the key factors affecting tourists' behavior, thus providing more targeted suggestions for scenic area management.

2. Relevant Theoretical Foundations

2.1. Current Status of Low-Carbon Tourism Research

With the gradual increase in environmental awareness, research on carbon reduction measures has been steadily advancing. GösslingS and ScottD analyze the emission reduction challenges faced by the tourism industry in a low-carbon economy and critically examine current industry, government and consumer responses, while expressing optimism for sustainable tourism development [1]. Moreover, crises such as pandemics have accelerated the need for sustainable tourism models, highlighting the role of behavioral interventions in carbon reduction. crises such as pandemics have accelerated the need for sustainable tourism models, highlighting the role of behavioral interventions in carbon reduction [2]. Low-carbon tourism, which has arisen in the context of the tourism industry's positive response to the booming low-carbon economy, is also a vivid practice of low-carbon concepts in the tourism industry. Overall, the essence of low-carbon tourism is that under the guidance of policies and regulations, the drive of economic interests, the constraints of responsibility and morality, and mutual supervision, all parties involved in tourism activities, including the government, enterprises, scenic spots, and tourists, are actively engaged in coordinated cooperation and orderly competition, which in turn promotes the transformation of the tourism management mode, the mode of production, and the mode of consumption in a green direction. Gössling et al. global study pointed out that the low-carbon transformation of tourism needs to achieve systemic change through a three-dimensional synergistic framework of policy tools, technological innovation and behavioral interventions [3]. In order to achieve the goal of low-carbon tourism, it is necessary to comprehensively use a variety of means, such as policies and regulations, economic benefits and social responsibility, to fully mobilize the enthusiasm of tourists, scenic spots, tourism enterprises and the government and other related subjects. The sustainable development of low-carbon tourism can only be effectively promoted through the construction of a competitive and orderly, mutually beneficial and coordinated low-carbon tourism development environment.

As the core participants of tourism activities and the ultimate consumers of low-carbon tourism products, tourists play a crucial role in the whole tourism process. From the perspective of tourists, the quality of tourism services is always the focus of tourists' attention. Low-carbon service operation in sustainable cultural tourism and its impact on tourists' responsible behavior have been thoroughly explored by academics [4]. Their consumption behavior directly contributes to the low-carbon shift, which stems from the enhancement of their low-carbon environmental awareness. In all aspects of tourism, such as food, accommodation, transportation, shopping and entertainment, tourists' low-carbon concepts have a significant impact on their behavior.
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2.2. Origin and Development of Theory of Planned Behavior (TPB)

The Theory of Planned Behavior (TPB) was pioneered by Fishbein and this theory laid the foundation for the development of the Theory of Planned Behavior [5]. The theory states that behavioral intentions are largely governed by behavioral attitudes, which in turn are determined by expected behavioral outcomes and their assessment. Based on this theoretical framework, Fishbein and Ajzen further deepened their research and proposed the Theory of Reasoned Action [6]. They believed that behavioral intention is the direct driver of behavior, which is mainly influenced by both behavioral attitudes and subjective norms.

Ajzen proposed the Theory of Planned Behavior in 1985 to extend and refine the Theory of Reasoned Action [7]. He perceived that human behavior is not always completely autonomous and is often constrained by various factors. As a result, he introduced the key concept of "perceptual-behavioral control" into the theory of rational behavior, and in 1991, Ajzen formally released the theory of planned behavior, clearly defining the core elements and mechanisms of the theory. The Theory of Planned Behavior focuses on the fact that behavioral intention is the most direct influence on behavior, and that behavioral intention is influenced by attitudes, subjective norms, and perceptual behavioral control; Ajzen believes that behavioral habits affect behavior by influencing individuals' perceptions of behavioral control and competence, and that perceptual behavioral control can be seen as a mediator between behavioral habits and behavior. Since the birth of the theory of planned behavior, it has been widely used and validated in many fields. For example, it has been used to explain and predict a wide range of behaviors such as health behaviors, environmental behaviors, educational behaviors, etc., and has been proven to significantly improve the explanation and prediction of behaviors in practice. TPB's robustness in predicting pro-environmental behaviors has been reconfirmed in recent meta-analyses, demonstrating its adaptability across cultural contexts [8].

In recent years, scholars have continued to deepen and expand the theory of planned behavior. These covers exploring the applicability of the theory in different cultural contexts, studying the application of the theory of planned behavior in combination with other related theories, and improving the theoretical model. For example, some studies have combined the Theory of Planned Behavior with the Values-Beliefs-Norms (VBN) theory to more efficiently explain the internal mechanisms of environmental behavior. At the same time, there are also studies that point out the limitations of the Theory of Planned Behavior in explaining and predicting behaviors, such as the "intention-behavior divide", and propose improvement initiatives and suggestions to address these limitations.

3. Research Design

3.1. Overview of the Case Site

Located in Kaifeng City, Henan Province, Qingming Shanghe Garden is a large-scale historical and cultural theme scenic spot restored and constructed on the basis of the masterpiece Qingming Shanghe Tu by Zhang Zeduan, a painter of the Northern Song Dynasty, and is a national 5A-level tourist attraction. Covering an area of about 600 acres, the scenic spot features an immersive Song Dynasty cultural experience as its core feature, and receives more than 4 million visitors annually. In terms of low-carbon tourism practices, Qingming Shanghe Garden actively explores the integration path of historical and cultural protection and sustainable development, and reduces its operational carbon footprint through a number of low-carbon measures. For example, solar lighting system is fully promoted in the scenic area, covering the main tour routes and architectural complexes; garbage classification and recycling points and intelligent garbage cans are introduced to guide tourists to participate in resource recycling; at the same time, the scenic area transportation is dominated by battery-operated vehicles and shared bicycles, which reduces the use of fuel vehicles. In addition, the popularization of the electronic ticket system and digital guide service effectively reduces the consumption of paper resources and improves management efficiency.

As a demonstrative scenic spot for low-carbon tourism, Qingming Shanghe Garden focuses on guiding visitors' low-carbon behavior. Through the "Carbon Points Reward Program", visitors who choose to walk around, participate in garbage classification or use shared transportation can get points to exchange for cultural and creative gifts, which significantly improves the degree of participation in low-carbon behavior. The scenic spot also combines the cultural characteristics of the Song Dynasty, designing low-carbon themed interactive activities (such as the "Ancient Handicraft Workshop" using natural materials), and integrating the concept of environmental protection into visitors' experience. 2022 data show that the carbon emission intensity of the scenic spot has dropped by 18% compared with 2019, and the utilization rate of low-carbon facilities has risen to 65%, making it a typical case of low-carbon transformation of historical and cultural scenic spots in China. A typical case of low-carbon transformation. In the future, the scenic spot plans to further expand the scale of photovoltaic power generation and unite with the neighboring communities to create a low-carbon tourism ecosystem to promote the sustainable development of the region.

3.2. Theory of Planned Behavior and Tourists' Low-Carbon Tourism Behavioral Intentions

Ajzen first proposed the Theory of Planned Behavior (TPB) in The Theory of Planned Behavior published in 1991 [9], which was then widely used. Bamberg and Ajzen et al.'s research on tourism access mode selection also supports that behavioral experience has a direct relationship with behavioral intention and behavior [10], and that behavioral intention is an important indicator for understanding human social behavior and provides a central research framework for predicting human behavior. The theory emphasizes that behavioral intentions are influenced by three factors: behavioral attitudes, subjective norms, and perceived behavioral control. Specifically, the more positive the behavioral attitude, the higher the level of subjective norms and perceived behavioral control, and the stronger the behavioral intention.

TPB theory is often used to explain and predict individuals' behavioral decisions and their intentions, which is closely related to the decision-making behaviors and intentions of tourists in activities that are the focus of this paper. A large number of studies have been conducted to prove that the TPB theoretical model has strong explanatory power for tourists'

behaviors and intentions. Barriers to pro-environmental actions can weaken perceived behavioral control, suggesting the need to reduce implementation costs [11]. Therefore, this paper proposes the following hypotheses based on this:

H1: Behavioral attitudes have a significant positive effect on tourists' behavioral intention of low-carbon tourism.

H2: Subjective norms have a significant positive influence on tourists' low-carbon tourism behavioral intention.

H3: Perceived behavioral control has a significant positive effect on tourists' low-carbon tourism behavioral intention.

3.3. Questionnaire Design and Data Collection Optimization

The questionnaire adopts a five-level Likert scale, containing 18 closed questions and 1 open question. In order to ensure the reliability of the scale, Cronbach's α test was conducted through the pre-survey (N=30), which showed that the α value of each dimension was higher than 0.7 (Attitude: 0.78; Subjective norms: 0.73; Perceived control: 0.75), which indicated that the internal consistency of the scale was good. The formal research was conducted through stratified random sampling to cover visitors in different functional areas of Qingming Shanghe Garden (e.g., cultural exhibition area, leisure and shopping area) in order to reduce regional bias.

3.4. Influence of Tourists' Behavioral Attitudes on Low Carbon Tourism Intention

Table 1. Influence of tourists' behavioral attitudes on low-carbon tourism intention

Attitude-related issues	Strongly disagree (1 point)	Disagree (2 marks)	Neutral (3 points)	Agree (4 points)	Strongly agree (5 points)	Average Score
I think low-carbon tourism (e.g. walking tours, waste separation) is very important to protect the scenic environment	3 (1.61%)	10 (5.38%)	32 (17.20%)	85 (45.70%)	56 (30.11%)	4.05
I am willing to take the initiative to reduce energy consumption (e.g., saving electricity, reducing the use of disposable items) in tourism	5 (2.69%)	12 (6.45%)	38 (20.43%)	76 (40.86%)	55 (29.57%)	3.98
Low-carbon measures (e.g. solar lighting, bike sharing) in Qingming Shanghe Garden make me more willing to participate in low-carbon behaviors	4 (2.15%)	11 (5.91%)	35 (18.82%)	82 (44.09%)	54 (29.03%)	4.02

Tourists' attitudes towards low carbon tourism behaviors are one of the key factors influencing their intention of low carbon tourism. From the data collected, tourists showed high motivation in this aspect. In Table 1, on the question "I think low carbon tourism (e.g. walking tours, garbage sorting) is very important to protect the environment of scenic spots", 75.8% of tourists chose a score of 4 - 5, indicating that most of the tourists deeply recognize the importance of low carbon tourism to the environmental protection of scenic spots. On the question of "I am willing to take the initiative to reduce energy consumption (e.g., saving electricity, reducing the use of disposable goods) during tourism", 70.5% of the tourists gave a score of 4-5, reflecting that tourists have the will to take the initiative to practice low-carbon behaviors in the process of tourism. Regarding "the low carbon measures in Qingming River Garden (such as solar lighting and shared bicycles) make me more willing to participate in low carbon behaviors", 73.1% of the tourists held a positive attitude (4-5 points), which indicates that the existing low carbon measures in the scenic area have inspired to a certain extent the enthusiasm of the tourists to participate in low carbon behaviors, and that the tourists can feel the positive impacts of the measures, and thus enhance their ability to participate in low carbon behaviors. This indicates that the existing low-carbon measures in the scenic spots have stimulated the enthusiasm of tourists to participate in low-carbon behaviors to a certain extent, and the tourists can actually feel the positive impacts of these measures, which in turn enhances their willingness to participate in low-carbon tourism.

3.5. Influence of Tourists' Subjective Norms on Low-Carbon Tourism Intention

Table 2. Influence of Tourists' Subjective Norms on Low-Carbon Tourism Intention

Subjective norms related issues	Strongly disagree (1 point)	Disagree (2 marks)	Neutral (3 points)	Agree (4 points)	Strongly agree (5 points)	Average Score
My family or friends support me in adopting low-carbon behaviors (e.g., waste separation, use of shared transportation) in my travels	2 (1.08%)	8 (4.30%)	30 (16.13%)	88 (47.31%)	58 (31.18%)	4.12
I think society generally recognizes low-carbon tourism behaviors and expects tourists to actively participate in them	3 (1.61%)	9 (4.84%)	33 (17.74%)	84 (45.16%)	57 (30.65%)	4.08
I will be more willing to cooperate when scenic staff or volunteers advocate low-carbon behaviors	4 (2.15%)	10 (5.38%)	34 (18.28%)	80 (43.01%)	58 (31.18%)	4.05

In this study, tourists' attitudes towards low-carbon tourism behaviors are regarded as one of the key variables affecting their low-carbon tourism intentions. Through detailed analysis of the questionnaire data, in Table 2, we found that tourists showed a high degree of positive perception and positive intention in this aspect. In the question "I think low carbon tourism (e.g. walking tours, garbage classification) is very important to protect the environment of scenic spots", as many as 75.8% of the tourists chose the score of 4-5, which fully indicates that the vast majority of tourists deeply realize the key significance of low carbon tourism for the environmental protection of scenic spots at the cognitive level.

In response to the statement "I am willing to take the initiative to reduce energy consumption in tourism (e.g., saving electricity, reducing the use of disposable goods)", 70.5% of the tourists gave a score of 4-5, which clearly reflects that tourists have the inherent willingness to take the initiative to practice low-carbon behaviors in the process of tourism practice. In response to the question "The low-carbon measures (such as solar lighting and shared bicycles) in Qingming Shanghe Garden make me more willing to participate in low-carbon behaviors", 73.1% of the tourists chose 4-5 points, which strongly proves that the low-carbon measures implemented in the scenic area have to a certain extent succeeded in stimulating tourists to participate in the enthusiasm of low-carbon behaviors. This shows that tourists are able to perceive the positive effects of these low-carbon measures, which in turn significantly increases their willingness to participate in low-carbon tourism. This result is in line with previous research that suggests that tourists' positive behavioral attitudes positively influence their behavioral intentions, which further confirms that behavioral attitudes play an important role in promoting tourists' intention to participate in low-carbon tourism in the context of this study.

3.6. Influence of Tourists' Perceived Behavioral Control on Low Carbon Tourism Intention

Table 3. Influence of tourists' perceived behavioral control on low carbon tourism intention

Perceived Behavioral Control Related Questions	Mean score	Standard deviation
I think it is very convenient to implement low-carbon behaviors (e.g., use of battery cars, participation in carbon credit activities) in Qingming Shanghe Garden	4.02	0.85
The low-carbon facilities provided by the scenic spots (e.g., garbage sorting points, shared bicycles) are sufficiently complete to facilitate my participation	3.98	0.92
If low-carbon behaviors require extra time or effort, I am still willing to try them out	3.85	1.01

Tourists' sense of control over their own implementation of low-carbon tourism behaviors, i.e., perceived behavioral control, is also an important factor influencing their intention to engage in low-carbon tourism. In Table 3, on the question of "I think it is very convenient to implement low-carbon behaviors (e.g., using battery cars, participating in carbon point activities) in Qingming Shanghe Garden", the average score reaches 4.02, with a standard deviation of 0.85, which indicates that most tourists believe that implementing low-carbon behaviors in scenic spots has a high degree of convenience, and that there is a relatively low degree of dispersion in this perception among the tourist groups. This data shows that most tourists believe that it is convenient to implement low-carbon behaviors in scenic spots, and the degree of dispersion of the group in this perception is relatively low, and the views are more concentrated. For "the low-carbon facilities provided by the scenic spots (e.g., garbage sorting points, shared bicycles) are sufficiently complete and convenient for me to participate", the average score is 3.98 with a standard deviation of 0.92, which shows that tourists hold a more favorable attitude towards the completeness of the low-carbon facilities in the scenic spots as a whole, but there are some differences in the evaluation among different tourists. On the question of "I am still willing to try low-carbon behaviors if they require extra time or energy", the average score is 3.85 with a standard deviation of 1.01. The result reflects that although some tourists are still willing to try low-carbon behaviors that require extra time and energy, compared to the previous two questions, tourists are less motivated. content, tourists' motivation has decreased, and the difference in attitude between different tourists is more obvious. This finding suggests that, in the process of continuously promoting low-carbon construction in scenic spots, in addition to further improving low-carbon facilities, it is also necessary to fully consider how to reduce the cost of tourists' participation in low-carbon behaviors, such as optimizing the implementation process of low-carbon behaviors, providing more convenient guidance services, etc., as a way to enhance the tourists' perceived behavioral control, thereby further enhancing the tourists' intention to low-carbon tourism. This is consistent with the relationship between perceived behavioral control and behavioral intention in related studies, i.e., when tourists perceive that it is less difficult and more convenient to implement a certain behavior, their intention to implement the behavior will be increased accordingly.

4. Presentation and Analysis of Empirical Research

4.1. Questionnaire Data Organization and Preliminary Interpretation

This study strictly follows the scientific sampling method, 220 questionnaires were distributed, and 186 valid questionnaires were finally recovered, with an effective recovery rate of 84.55%. As seen in Table 4, in the dimension of gender distribution, male tourists accounted for 51.1% and female tourists accounted for 48.9%, and the gender ratio showed a relatively balanced trend. In terms of age structure, visitors aged 18 - 35 years old accounted for the highest proportion of 55.4%, which indicates that this age group constitutes the main group of visitors to Qingming Shanghe Garden, and they have a high degree of activity and consumption potential in the tourism market. In terms of education level, visitors with bachelor's/college degrees accounted for the largest share of 56.5%, which reflects that visitors to the scenic spot as a whole have a certain degree of knowledge and learning ability, which may positively affect their understanding and acceptance of the concept of low-carbon tourism. In terms of occupational distribution, enterprise employees and students accounted for a larger proportion, 33.3% and 25.8% respectively. The collection and organization of these basic data provide a solid data foundation for the subsequent in-depth analysis of the differences in tourists' low-carbon tourism behavioral intentions from different dimensions, which helps to reveal the potential patterns of low-carbon tourism behavioral intentions of different groups of tourists with different characteristics.

Table 4. Questionnaire data

Category	Specific information	Number of people	Percentage
Sex	Male	95	51.10%
Female	91	48.90%	
Age (years)	Less than 18 years old	12	6.50%
18-25 years	45 years	45 24.20% 26 - 35 years	
26 - 35 years	58 years old	31.20% for the age group 36 - 45 years	
36 - 45 years	42 years old	22.60% for the age group 46 - 55 years	
46 - 55 years	20	10.80% for age 46 - 55	
56+ years	9	4.80% Education level	
Educational level	Junior high school and below	10	5.40% High school / junior college
High School / Junior College	35	18.80	
Bachelor's Degree / College	105	56.50%	
Master and above	36	19.40%	
Vocational	Student	48	25.80
Employee	62	33.30% Civil Servants / Career Organizations	
Civil Servants / Career	25	13.40	
Freelancers	20	10.80	
Retirees	12	6.50%	
Other	19	10.20%	

4.2. In-depth Data Analysis and Relationship Exploration

Table 5. Tourists in terms of future low-carbon tourism behavioral intention

Behavioral Intention Related Questions	Number of positive responses (4 - 5 points)	Percentage of positive response
When visiting similar scenic spots, I will give priority to low-carbon travel modes (e.g., public transportation, shared bicycles)	145	78.00% I am willing to take the initiative to participate in low-carbon travel organized by scenic spots.
I am willing to take the initiative to participate in low-carbon activities organized by the scenic spot (e.g. ancient handicraft workshop, carbon point exchange)	141	75.80% I would recommend Qingming Shanghe Garden to my friends and relatives.
I would recommend the low-carbon tourism experience of Qingming Shanghe Garden to my friends and relatives.	144	77.40%

Through the in-depth analysis of behavioral intention-related questions, in Table 5, we find that tourists show a high degree of positivity in terms of future low-carbon tourism behavioral intention. In the questions "When visiting similar scenic spots in the future, I will give priority to low-carbon travel modes (e.g., public transportation, shared bicycles)" "I am willing to take the initiative to participate in low-carbon activities organized by the scenic spots (e.g., ancient handicraft workshops, carbon point exchange)" and "I would recommend the low-carbon tourism experience in Qingming River Garden to my friends and relatives", the proportion of visitors who responded positively (4-5 points) to these three questions directly reflecting their behavioral intention were 78.0%, 75.8% and 77.4%, respectively. Combined with the results of the previous data analysis of behavioral attitudes, subjective norms and perceived behavioral control, it can be preliminarily inferred that there is a synergistic effect between tourists' positive behavioral attitudes, high subjective norms and strong perceived behavioral control, which together promote the formation of positive behavioral intentions towards low-carbon tourism.

4.3. Empirical Research Presentation and Analysis

4.3.1. Hypothesis testing and model validation

Multiple linear regression analysis was used to verify the effects of the three TPB variables on behavioral intention (Table 6). The results showed that:

Behavioral attitudes (β=0.402, $p<0.001$) had the strongest contribution to intentions;

Subjective norms (β=0.287, $p<0.01$) was next;

Perceived behavioral control (β=0.221, $p<0.05$) had a significant but weak effect.

The model-adjusted R^2 was 0.632, indicating that the three TPB variables explained 63.2% of the variance in behavioral intention, validating hypotheses H1-H3.

Table 6. Results of regression analysis

Variables	Standardized coefficient (β)	t-value	p-value
Behavioral attitude	0.402	5.12	0.000
Subjective norms	0.287	3.89	0.002
Perceived behavioral control	0.221	2.76	0.017

In order to deeply explore the influence of the three core variables of the Theory of Planned Behavior (TPB), namely, behavioral attitudes, subjective norms and perceived behavioral control, on tourists' behavioral intention to low-carbon tourism, this study adopted multiple linear regression analysis for hypothesis testing and model validation.

The results of the regression analysis show (see Table 1 for

details) that behavioral attitude (β=0.402, p<0.001) has the most significant role in promoting tourists' behavioral intention of low-carbon tourism. This means that tourists' positive attitudes toward low-carbon tourism behaviors, such as recognizing the importance of low-carbon tourism to environmental protection in scenic spots and their willingness to take the initiative to reduce energy consumption, are closely related to their intention to implement low-carbon tourism behaviors. The more positive the attitude, the stronger their behavioral intention. Subjective norms (β=0.287, p<0.01) also had a significant positive effect on behavioral intention, and the strength of the effect was second only to behavioral attitude. This suggests that subjective normative factors such as the support of family and friends, the general recognition of low-carbon tourism behaviors in the society, and the advocacy of scenic spot staff or volunteers will, to a large extent, prompt tourists to be more inclined to adopt low-carbon tourism behaviors. Perceived behavioral control (β=0.221, p<0.05) likewise has a significant effect on behavioral intention, but its degree of influence is relatively weak. This reflects that factors such as the convenience of implementing low-carbon behaviors in scenic spots and the degree of improvement of low-carbon facilities, although they have a facilitating effect on tourists' behavioral intentions, are slightly less influential compared to behavioral attitudes and subjective norms.

The model adjusted R^2 is 0.632, which indicates that these three variables in the TPB theory can explain 63.2% of the variation in tourists' behavioral intention of low-carbon tourism. This strongly verifies the research hypotheses H1, H2 and H3, i.e., behavioral attitudes, subjective norms and perceived behavioral control have a significant positive influence on tourists' low-carbon tourism behavioral intention, which proves that the TPB theory has good applicability and explanatory power in explaining tourists' low-carbon tourism behavioral intention.

4.3.2. Analysis of group differences

It is found through independent sample t-test:

Gender differences: female tourists are significantly higher than male tourists in "subjective norms" (M=4.21 vs. M=3.98, p<0.05) and "behavioral intention" (M=4.15 vs. M=3.92, p<0.05). Males;

Age difference: the perceived behavioral control scores of tourists aged 18-35 (M=4.10) were significantly higher than those of the group aged 46 and above (M=3.62, p<0.01), which might be related to the younger group's higher adaptability to smart facilities.

In order to further explore the differences in low carbon tourism behavioral intention and its influencing factors among different groups of tourists, this study conducted an in-depth analysis using the independent samples t-test.

In terms of gender differences, the study found that female tourists scored significantly higher on "subjective norms" (M=4.21 vs. M=3.98, p<0.05) and "behavioral intention" (M=4.15 vs. M=3.92, p<0.05). 0.05) scored significantly higher than male tourists. This may be due to the fact that women tend to pay more attention to others' opinions and social norms in their social roles, and their sense of responsibility to their families and society makes them more likely to be influenced by their family members, friends, and social opinions, thus they are more willing to follow the low-carbon behavioral norms in tourism, and show stronger behavioral intention of low-carbon tourism.

Regarding the age difference, the perceived behavioral control score of tourists aged 18-35 (M=4.10) was significantly higher than that of the group aged 46 and above (M=3.62, p<0.01). This difference is likely to be related to the fact that the younger group has a higher degree of adaptation to smart facilities. 18-35-year-old tourists mostly grew up in the era of rapid technological development, and they are more capable of accepting and learning new things, and they can more quickly and skillfully use all kinds of smart low-carbon facilities provided by the scenic spots, such as shared bicycles and e-ticket systems, etc., so that they will feel more convenient to carry out low-carbon behaviors in the scenic spots, thus Perceived behavioral control scores are higher. On the other hand, the group over 46 years old may be less familiar with smart facilities and encounter some difficulties in the process of using them, which makes them evaluate the convenience of implementing low-carbon behaviors in the scenic spots relatively lower, and the score of perceived behavioral control is correspondingly lower.

5. Research Conclusion and Prospect

5.1. Summary of Research Conclusions

Taking Qingming Shanghe Garden as a case study, this study, based on the Theory of Planned Behavior (TPB), uses a variety of research methods to conduct an in-depth investigation of the influencing factors of tourists' low-carbon tourism behavioral intentions, and draws the following conclusions:

As verified by multiple linear regression analysis, behavioral attitudes, subjective norms and perceived behavioral control all show significant positive effects on tourists' low-carbon tourism behavioral intention, strongly confirming research hypotheses H1, H2 and H3. among them, the standardized coefficient β of behavioral attitudes is 0.402, which is significant at the level of p<0.001, and promotes the behavioral intention most prominently. This indicates that tourists' knowledge of low-carbon tourism and evaluation of low-carbon measures in scenic spots play a key role in the formation of their behavioral intention of low-carbon tourism. The standardized coefficient of subjective norms, β, is 0.287, which is significant at the p<0.01 level, and its influence on behavioral intention is the second most significant, indicating that influences from family, friends, society and scenic spots are important in guiding tourists to adopt low-carbon tourism behaviors. The standardized coefficient β of perceptual behavior control is 0.221, which is significant at the level of p<0.05. Although the influence on behavioral intention is relatively weak, it still should not be ignored, reflecting that the convenience of the implementation of low-carbon behaviors in the scenic area as well as the degree of perfection of the facilities will also play a role in the behavioral intention of tourists. The model adjusted R^2 is 0.632, which means that these three variables in the TPB theory can explain 63.2% of the variation in tourists' behavioral intention of low-carbon tourism, which fully verifies the applicability and explanatory validity of the TPB theory in the context of this study.

From the data of tourists' cognition and attitude towards low-carbon tourism, most tourists highly recognize the environmental value of low-carbon tourism. In the feedback of related questions, the percentage of tourists who think that low-carbon tourism is very important to protect the environment of scenic spots is more than 75%; the percentage of tourists who express their willingness to take the initiative to reduce energy consumption in tourism is 70.5%; and the

percentage of tourists who affirm that the low-carbon measures of the Qingming Shanghe Garden have a positive impact on their own participation in low-carbon behaviors is 73.1%. These data show that tourists in the concept of low-carbon tourism meaning of understanding more profound, and in the willingness to act with the tendency to actively practice low-carbon behavior, but also reflects the current implementation of low-carbon measures in the scenic area has achieved certain results.

In terms of subjective norms, the survey results show that most tourists feel the positive impact from all aspects. Nearly 80% of the tourists said that their families or friends support them to adopt low-carbon behaviors in tourism; more than 75% of the tourists believe that the society generally recognizes low-carbon travel processions and expects the tourists to actively participate in them; and the tourists' willingness to cooperate with the scenic spot staff or volunteers is higher when they advocate low-carbon behaviors. The combination of these factors significantly increases the likelihood of tourists adopting low-carbon behaviors during tourism.

The data on the perceptual behavior control dimension indicate that tourists have a higher overall evaluation of the convenience and the degree of facility improvement for the implementation of low-carbon behaviors in scenic spots. The average score for "convenience of implementing low-carbon behaviors" is 4.02, and the average score for "improvement of facilities" is 3.98. However, when it comes to low-carbon behaviors that require additional time and effort, tourists' motivation has decreased, and the average score for the relevant question is only 4.02, and the average score for the relevant question is 3.98. However, when it comes to low-carbon behaviors that require extra time and effort, the enthusiasm of tourists' participation decreases, with the average score of the related question being only 3.85, and the difference in attitude between different tourists is more significant.

In addition, this study reveals significant differences between different groups of tourists. In terms of gender differences, female tourists scored significantly higher than male tourists on subjective norms ($M=4.21$ vs. $M=3.98$, $p<0.05$) and behavioral intentions ($M=4.15$ vs. $M=3.92$, $p<0.05$). In terms of age difference, tourists aged 18 - 35 years old had significantly higher scores on perceived behavioral control ($M=4.10$) than the group aged 46 years old and above ($M=3.62$, $p<0.01$), which may be related to the younger group's greater ability to adapt to smart facilities.

The findings of this study enrich the theoretical research results in the field of low-carbon tourism, and provide an important reference basis for the low-carbon development practice of scenic spots and tourism industry.

5.2. Research Shortcomings and Prospects

Although this study has made some progress in exploring the influencing factors of tourists' behavioral intention of low-carbon tourism, we cannot ignore that there are still some limitations in the research process.

The research sample only comes from the tourists of Qingming Shanghe Garden, a specific scenic spot, and the geographical limitation of the sample and the singularity of the type of scenic spot may lead to a certain degree of influence on the universality of the research conclusions. Different regions and types of scenic spots may have large differences in their visitor group characteristics, scenic environment, and low-carbon tourism development. As suggested by Chen and Tung (2019), integrating moral norms and past experience into TPB significantly enhances the model's explanatory power for pro-environmental behaviors [12]. Future research should expand the sample scope to cover multiple types of scenic spots such as natural scenic areas and theme Gardens, as well as tourists from different regions, so as to enhance the broad applicability of the research findings through extensive data collection and analysis, and to provide more targeted suggestions for the low-carbon development of various scenic spots.

This study mainly focuses on the three core variables of TPB theory and does not fully consider other factors that may have an impact on tourists' low-carbon tourism behavioral intention, such as tourists' values, lifestyles, and personal travel experiences. Tourists' environmental values may directly affect their attitudes and acceptance of low-carbon tourism, and tourists with strong environmental values may be more inclined to choose low-carbon tourism methods; while personal tourism experiences may also play an important role, and tourists who have had a pleasant experience of low-carbon tourism may be more active in practicing low-carbon behaviors in their future travels. Subsequent studies may try to introduce these variables and construct a more complete theoretical model in order to more comprehensively explain and predict tourists' low-carbon tourism behavioral intentions.

In terms of research methodology, this study mainly relies on questionnaire surveys and interviews, and the relative homogeneity of the research methodology limits the in-depth excavation of the research questions to a certain extent. Although questionnaires and interviews can obtain rich primary data, it is difficult to comprehensively capture the behavioral changes and potential influences of tourists in natural contexts. Future studies should adopt mixed-method approaches as proposed by Juvan and Dolnicar (2022), combining big data analysis with experimental designs to capture behavioral dynamics [13]. We can try to combine experimental methods by setting up different experimental scenarios, controlling relevant variables, and observing tourists' behavioral responses under specific conditions, so as to more accurately explore the causal relationship between factors; at the same time, we can use big data analysis to collect tourists' online behavioral data on tourism-related platforms, such as search records and booking information, so as to explore the formation mechanism of tourists' behavioral intention of low-carbon tourism and the influencing factors in a multidimensional way. and influencing factors. Through the comprehensive use of multiple research methods, we can provide more in-depth and targeted suggestions for promoting the low-carbon transformation of scenic spots and the tourism industry, and thus help the realization of the national "dual-carbon" strategic goal.

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Appendix

Questionnaire on Tourists' Intention of Low-Carbon Tourism Behavior

Dear Tourist Friends:

Hello! The purpose of this questionnaire is to understand your knowledge and intention of low-carbon tourism behavior during your visit to Qingming Shanghe Garden. The questionnaire is anonymous, and all data are only used for academic research, so please feel free to fill in the questionnaire according to the actual situation. Thank you for your support and cooperation!

Part I Demographic Information

1. Your gender:

□ Male □ Female

2. Your age:

□ Under 18 years old □ 18-25 years old □ 26-35 years old □ 36-45 years old □ 46-55 years old □ 56 years old or older

3. Your education level:

□ Junior high school and below □ High school/secondary □ Bachelor's degree/college □ Master's degree and above

4. your occupation:

□ Student □ Corporate Employee □ Civil Servant/Enterprise □ Freelancer □ Retiree □ Other _____

Part II Behavioral Attitude

Please choose the option that best matches your true feelings (1=strongly disagree, 5=strongly agree).

5. I think low-carbon tourism (e.g. walking tours, garbage classification) is very important to protect the scenic environment.

□1 □2 □3 □4 □5

6. I am willing to take the initiative to reduce energy consumption in tourism (e.g. saving electricity, reducing the use of disposable items).

□1 □2 □3 □4 □5

7. The low-carbon measures in Qingming River Garden (e.g. solar lighting, shared bicycles) make me more willing to participate in low-carbon behaviors.

□1 □2 □3 □4 □5

Part III Subjective Norms

8. My family or friends support me in adopting low-carbon behaviors (e.g., garbage classification, use of shared transportation) during my travels.

□1 □2 □3 □4 □5

9. I think the society generally recognizes low-carbon tourism behaviors and expects tourists to actively participate in them.

□1 □2 □3 □4 □5

10. I will be more willing to cooperate with the staff or volunteers in the scenic area when they advocate low-carbon behaviors.

□1 □2 □3 □4 □5

Part IV Perceived Behavioral Control

11. I think it is very convenient to implement low-carbon behaviors (e.g., using battery cars, participating in carbon point activities) in Qingming Shanghe Garden.

□1 □2 □3 □4 □5

12. The low-carbon facilities (e.g., garbage sorting points, shared bicycles) provided by the scenic area are sufficiently complete to facilitate my participation.

□1 □2 □3 □4 □5

13. If low-carbon behaviors require extra time or effort, I am still willing to try.

□1 □2 □3 □4 □5

Part V Behavioral Intention

14. When visiting similar scenic spots in the future, I will give priority to low-carbon travel modes (e.g. public transportation, shared bicycle).

□1 □2 □3 □4 □5

15. I am willing to take the initiative to participate in the low-carbon activities organized by the scenic spot (e.g. ancient handicraft workshop, carbon point exchange).

□1 □2 □3 □4 □5 16.

16. I would recommend the low-carbon tourism experience of the Qingming Shanghe Garden to my friends and relatives.

□1 □2 □3 □4 □5

Part VI Open questions (optional)

17. Do you have any suggestions for Qingming River Garden to further promote low-carbon tourism?

_____

Thank you for your patience! Have a nice trip!