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Pathways to sustainable travel: Examining the causal influence of low-carbon tourism, experience, and satisfaction on revisit intentions

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Abstract: The tourism industry is a significant contributor to global carbon emissions. Consequently, low-carbon tourism (LCT) plays a crucial role in mitigating environmental impacts while enhancing the competitiveness of tourism destinations. This study aims to examine the causal relationships among low-carbon tourism, tourist experience, tourist satisfaction, and revisit intentions, thereby addressing a notable gap in sustainable tourism research. Using structural equation modeling (SEM), data were collected through questionnaires from 510 Thai tourists who participated in LCT activities at Khao Yai National Park, a prominent nature-based tourism destination in Thailand. The findings reveal that low-carbon tourism significantly enhances tourists' experiences, which in turn positively influence their satisfaction and intention to revisit LCT destinations. Furthermore, tourist experience and satisfaction were found to mediate the relationship between low-carbon tourism and revisit intention. Among the variables, low-carbon tourism exerted the strongest direct influence on revisit intention, followed by tourist experience and satisfaction, respectively. This study advances sustainable travel behavior theory and offers practical recommendations for policymakers and destination managers. It emphasizes integrating low-carbon principles across tourism sectors—activities, transport, accommodation, local product consumption, and waste management—to enhance tourist experiences and promote environmental and tourism sustainability.

Keywords: *Low-carbon tourism, Revisit intention, Sustainable tourism, Tourist experience, Tourist satisfaction.*

1. Introduction

In recent decades, the concept of low-carbon tourism has emerged as a critical response to the escalating environmental challenges posed by the global tourism industry. Recognized as one of the most dynamic economic sectors, tourism contributes substantially to greenhouse gas emissions, primarily through transportation, energy-intensive hospitality services, and inadequate waste management systems. Recent research highlights that the tourism sector is responsible for approximately 8% of global carbon emissions, a figure significantly higher than earlier estimates. A study published in Nature Climate Change analyzed the tourism industry's carbon footprint between 2009 and 2013, revealing an increase from 3.9 to 4.5 billion tons of CO_2 equivalent annually. These findings underscore the substantial environmental impact of tourism and emphasize the critical need for sustainable and low-carbon strategies to mitigate its contribution to climate change [1]. Low-carbon tourism embodies the principles of reducing carbon emissions by integrating energy-efficient technologies, promoting sustainable travel behaviors, and supporting eco-friendly accommodations. These strategies align closely with international objectives, such as the United Nations Sustainable Development Goals (UN SDGs), particularly Goal 12 (responsible consumption and production) and Goal 13 (climate action) [2].

Moreover, low-carbon tourism emphasizes holistic environmental stewardship by incorporating practices like renewable energy utilization, efficient waste management, and the promotion of locally

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sourced and organic products. Such approaches aim not only to diminish adverse ecological impacts but also to safeguard the cultural and natural heritage of tourism destinations. For example, eco-friendly tourism practices often foster stronger community engagement, allowing local residents to play a significant role in preserving their environment while sharing their unique cultural experiences with visitors [3]. The increasing environmental consciousness among tourists has amplified demand for destinations that prioritize sustainability, thus redefining the industry's priorities and necessitating a deeper understanding of the interactions between tourist behaviors, destination management, and psychological factors influencing decision-making. These dynamics illustrate the growing importance of an integrated approach to advancing low-carbon tourism, ensuring it becomes a cornerstone of global sustainable development initiatives.

Low-carbon tourism integrates various eco-friendly practices, including renewable energy use, waste management, and the promotion of local and organic products. These practices not only reduce the environmental impact but also contribute to preserving the natural and cultural heritage of destinations [4]. For instance, destinations that focus on sustainable tourism practices often foster greater engagement with local communities, offering tourists authentic and meaningful experiences while supporting local economies. Furthermore, one of the most significant outcomes of these practices is their impact on tourists' intention to revisit low-carbon destinations. Tourists' decisions to return are influenced by factors such as emotional satisfaction derived from eco-friendly experiences, the perceived value of sustainable activities, and the positive environmental and cultural contributions made during their visit. Studies suggest that when travelers feel they have contributed positively to environmental preservation and local community support, their likelihood of revisiting and recommending such destinations increases substantially. Additionally, the growing awareness among travelers regarding environmental issues has heightened demand for destinations and activities that prioritize sustainability. This shift underscores the importance of understanding the interplay between tourist behavior, destination attributes, and psychological variables to advance low-carbon tourism effectively [5].

1.1. Background and Research Gap

Theoretical and empirical research on low-carbon tourism has expanded over the years, with studies highlighting its environmental, economic, and social benefits. Various frameworks and models have been developed to assess sustainable tourism practices, focusing on factors such as tourist satisfaction, destination image, and eco-friendly activities. Despite these advancements, several gaps remain in understanding the psychological dimensions influencing tourists' decisions to engage in low-carbon tourism activities. To address these gaps, this study identifies four latent variables as critical determinants of tourist behavior: emotional experience, perceived value, destination image, and engagement in eco-friendly activities.

Emotional experience is a key factor, encompassing the range of feelings and memories tourists associate with their visit to low-carbon destinations. Positive emotional experiences often lead to higher satisfaction and a stronger intention to revisit. Perceived value, another significant variable, includes functional, emotional, and monetary dimensions, influencing tourists' evaluations of the costs and benefits of sustainable practices. Destination image, characterized by the perception of eco-friendly attributes and quality services, further shapes tourists' expectations and decisions. Finally, engagement in eco-friendly activities, such as participating in waste reduction programs or supporting local and organic products, directly reflects tourists' commitment to sustainable tourism. By integrating these four latent variables into research, a comprehensive understanding of the factors shaping intentions to revisit low-carbon destinations can be achieved, addressing the interplay between psychological dimensions and sustainable tourism practices.

Furthermore, research on sustainable tourism often overlooks the interconnection between destination attributes and psychological variables, such as awareness, responsibility, and engagement. For instance, although studies highlight the importance of sustainable accommodations and waste management, the underlying motivations and psychological triggers that drive tourists to select these

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options remain underexplored. Similarly, the role of experiential factors, such as learning and emotional engagement, in fostering sustainable behaviors and intentions has not been comprehensively examined.

Additionally, there is a lack of robust comparative studies analyzing the differences in tourist behaviors across diverse demographic and geographic contexts. Existing studies primarily focus on specific regions or demographic groups, limiting the generalizability of findings. For example, research often fails to adequately address variations in tourists' intention to revisit low-carbon destinations across urban versus rural areas or between culturally distinct regions. This creates a significant research gap, as such differences may stem from varying levels of environmental awareness, cultural attitudes toward sustainability, or access to eco-friendly infrastructure. Furthermore, while factors such as destination image and perceived value have been identified as influencing revisit intentions, insufficient attention has been paid to how these factors interact with psychological variables like emotional experience and eco-friendly engagement. This underscores the need for an integrated and multidimensional approach that incorporates behavioral, psychological, and contextual variables, enabling the development of more comprehensive and universally applicable models of low-carbon tourism.

2. Literature Review

2.1. Psychological Variables Selection

The psychological aspects of tourist behavior play a pivotal role in shaping the adoption of low-carbon tourism practices. Specifically, four key latent variables; low-carbon tourism, experience from low-carbon tourism, tourist satisfaction, and intention to revisit low-carbon tourism; provide a comprehensive framework for understanding these dynamics.

Low-carbon tourism encompasses practices aimed at minimizing carbon footprints through sustainable accommodations, eco-friendly activities, and waste management. Experience from low-carbon tourism reflects tourists' interactions and engagements with sustainable practices and their impact on emotional and cognitive perceptions. Tourist satisfaction is a critical variable, representing the fulfillment tourists derive from participating in low-carbon activities and experiencing high-quality services aligned with sustainability. Finally, intention to revisit low-carbon tourism captures the behavioral aspect, influenced by satisfaction and perceived value, which drives tourists to return to eco-friendly destinations and recommend them to others Together, these variables provide a holistic lens to explore how psychological factors translate into sustainable tourism behavior [6].

2.2. Low-Carbon Tourism Variable

Low-carbon tourism is a multifaceted concept that emphasizes reducing the environmental footprint of travel through sustainable practices. Tourists who actively participate in eco-friendly behaviors, such as staying in energy-efficient accommodations and engaging in waste management programs, contribute directly to the goals of low-carbon tourism. This variable reflects the integration of environmental consciousness with tourism activities, highlighting the role of sustainable mobility, renewable energy, and eco-friendly consumption in shaping travel decisions.

Studies suggest that tourists are more likely to engage in low-carbon tourism when they perceive tangible environmental benefits and social responsibility from their actions [7]. By participating in low-carbon activities, travelers not only reduce their environmental impact but also experience personal fulfillment and emotional satisfaction. Research also indicates that incorporating low-carbon tourism elements into destinations enhances their appeal and drives higher tourist satisfaction and repeat visits. For instance, programs that educate tourists about sustainable practices, coupled with visible ecological benefits, strengthen commitment to low-carbon travel. These elements create a comprehensive approach to fostering eco-friendly behaviors, building loyalty among environmentally conscious tourists.

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2.3. Experience From Low Carbon Tourism

Experience from low-carbon tourism captures the range of interactions and engagements tourists have with sustainable practices during their travel. This variable reflects the emotional, cognitive, and environmental dimensions of a tourist's journey in a low-carbon context. Emotional experiences, such as the sense of fulfillment derived from engaging in eco-friendly activities, play a pivotal role in shaping perceptions of value and satisfaction. Cognitive aspects include the learning opportunities gained through exposure to sustainable practices, such as understanding the importance of waste management or renewable energy use [8].

For example, tourists participating in conservation efforts or purchasing local, organic products often report heightened satisfaction and a stronger connection to the destination [9]. The environmental experience further enhances their overall perception, as engaging directly with preserved natural landscapes or eco-conscious initiatives fosters positive attitudes and reinforces the desire to contribute to sustainability. Research indicates that experiences rooted in low-carbon tourism not only elevate immediate satisfaction but also promote long-term loyalty and advocacy for such destinations. These experiences collectively enrich tourists' perspectives and motivate them to revisit and recommend low-carbon destinations.

3. Research Hypothesis

H_1: Low-carbon tourism practices positively influence tourist experiences

The concept of low-carbon tourism has gained increasing attention in academic discourse as a sustainable approach that not only mitigates environmental impact but also enhances tourists' overall experience. Several studies highlight that adopting low-carbon practices in tourism can lead to more meaningful and immersive experiences, aligning with the growing environmental consciousness of travelers [10]. Empirical research suggests that engaging in low-carbon tourism positively influences tourist satisfaction, as travelers often seek authenticity and deeper connections with local cultures and natural environments [11]. Sustainable tourism activities such as eco-friendly accommodations, low-impact transportation, and responsible travel behaviors contribute to a more enriching and fulfilling travel experience [12].

H_2: Low-carbon tourism practices positively influence tourist satisfaction

Sustainable tourism, particularly low-carbon tourism, has gained significant attention due to its positive impact on environmental conservation and visitor experiences. Numerous studies indicate that low-carbon tourism initiatives not only reduce ecological footprints but also enhance tourists' overall satisfaction by providing immersive and responsible travel experiences [13]. The relationship between low-carbon tourism and tourist satisfaction is both substantial and favorable. Research highlights that eco-friendly travel options, including green accommodations, sustainable transport, and nature-based tourism, contribute to an enriched tourist experience by fostering a sense of environmental responsibility and engagement [14]. Destinations that adopt comprehensive carbon reduction strategies—such as promoting local culture, reducing waste, and implementing energy-efficient tourism facilities—often experience higher rates of repeat visits and positive word-of-mouth recommendations [15].

H_3: Low-carbon tourism practices positively influence the intention to revisit low-carbon tourism destinations.

Sustainable tourism has gained increasing attention in recent years due to the growing concerns over climate change and environmental degradation. In this context, low-carbon tourism, which emphasizes reducing carbon emissions through environmentally friendly travel behaviors and sustainable tourism development, has been identified as a crucial approach to promoting sustainable tourism practices. Recent studies suggest that low-carbon tourism experiences play a significant role in shaping tourists' behavioral intentions, particularly their likelihood of revisiting a destination that aligns with sustainable principles [16]. Given the increasing demand for sustainable tourism options, destinations that prioritize low-carbon tourism initiatives are more likely to build long-term relationships with environmentally conscious tourists. Thus, the relationship between low-carbon

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tourism experiences and revisit intentions is not only significant but also essential for promoting sustainable tourism development [17].

H_4: The experience of low-carbon tourism positively influences the intention to revisit low-carbon tourism destinations

The relationship between tourist experiences in low-carbon tourism and their intention to revisit has been widely examined in recent academic research. Scholars consistently find that experiences within low-carbon tourism environments have a positive and significant impact on tourists' intentions to return. This suggests that the sustainable and environmentally responsible nature of such tourism offerings enhances overall visitor satisfaction and fosters loyalty [18]. Recent studies highlight that the immersive and sustainable attributes of low-carbon tourism, such as eco-friendly accommodations, green transportation, and community-based initiatives, contribute to a more fulfilling tourist experience. These positive experiences strengthen emotional connections and reinforce tourists' willingness to engage in repeat visits [19].

H_5: Tourist satisfaction with low-carbon tourism positively influences the intention to revisit low-carbon tourism destinations

Rahmawati and Kusumawati [20] conducted a systematic literature review exploring the connection between memorable tourism experiences, satisfaction, and revisit intention. Their findings highlight that positive experiences significantly enhance tourists' likelihood of returning to a destination [20]. The effect of memorable tourism experiences on revisit intention in community-based tourism destinations in Vietnam. The study confirmed that various aspects of a tourism experience, including cultural engagement and environmental awareness, contribute positively to the likelihood of repeat visits [21]. The low-carbon tourism experiences and developed a multidimensional scale to measure their impact. Their findings revealed that different elements of low-carbon tourism, such as sensory engagement, learning experiences, and behavioral changes, significantly enhance visitor satisfaction and ultimately influence their intention to revisit [22].

H_6: The experiences involving low-carbon tourism positively influence tourist satisfaction.

The role of government policies and business strategies in promoting low-carbon tourism experiences is evident. Well-managed low-carbon tourism destinations that provide an immersive and comfortable experience without compromising environmental sustainability tend to yield higher tourist satisfaction [23]. In addition, environmental and climate satisfaction have been found to impact tourists' awareness and satisfaction in low-carbon destinations. This study highlights that tourists are increasingly valuing destinations that integrate sustainable practices, such as clean energy usage and eco-friendly infrastructure, into their tourism offerings [24].

H_7: The tourist experience from low-carbon tourism mediates the relationship between low-carbon tourism practices and the intention to revisit low-carbon tourism destinations.

Tourist experiences play a pivotal role in bridging sustainable practices with desired behavioral outcomes. By delivering engaging, educational, and emotionally resonant experiences, destinations can translate the abstract principles of sustainability into tangible and meaningful benefits for visitors. Destinations that successfully incorporate sustainable development principles into the design of tourist experiences are more likely to encourage repeat visitation and foster long-term tourist loyalty [25, 26].

H_8: Tourist satisfaction with low-carbon tourism mediates the relationship between low-carbon tourism practices and the intention to revisit low-carbon tourism destinations.

Satisfaction serves as a critical mediating variable in the relationship between sustainable tourism practices and tourists' future behavioral intentions. Tourists who are satisfied with their green tourism experiences are more likely to support, revisit, and advocate for environmentally responsible destinations [27, 28]. This mediating role highlights the significance of perceived value and emotional satisfaction in shaping tourists' intentions to return and fostering loyalty toward sustainable tourism offerings.

Figure 1 shows the conceptual model of the causal relationships between low-carbon tourism, tourist experiences, satisfaction, and intention to revisit low-carbon tourism destinations. In the

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proposed model, the symbol "H" denotes the research hypotheses that examine the relationships among the key variables.

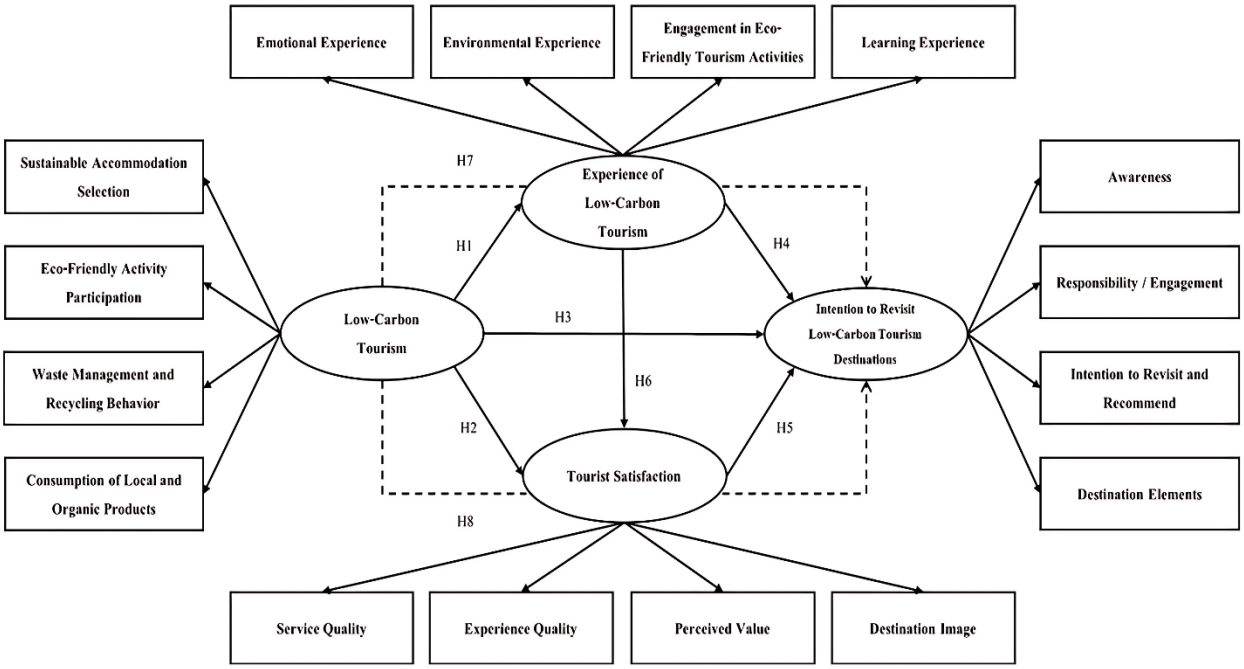

Figure 1.
Proposed structural equation model of the causal relationships between low-carbon tourism, tourist experiences, satisfaction, and intention to revisit low-carbon tourism destinations.

3. Materials and Methods

3.1. Research Design

This study employs structural equation modeling (SEM) to examine the causal relationships between low-carbon tourism, tourist experiences, satisfaction, and intention to revisit low carbon tourist destinations. SEM is an advanced statistical technique that allows for the estimation of complex relationships between latent variables, enabling a robust assessment of the direct and indirect effects [29]. Given the multidimensional nature of low-carbon tourism behavior, SEM provides an effective means of validating theoretical constructs and exploring interrelationships between observed and latent variables.

3.2. Measurement Model and Constructs

The Structural Equation Modeling (SEM) framework was developed based on four core latent constructs:

1. Low-Carbon Tourism: This construct was measured using observed variables that reflect key dimensions of sustainable tourism practices, including the use of environmentally friendly accommodations, participation in eco-conscious activities, waste management and recycling behaviors, and the consumption of local and organic products.
2. Tourist Experience: This construct captures multiple facets of the tourist's interaction with low-carbon tourism activities. It comprises emotional experiences, environmental experiences, engagement in eco-friendly tourism practices, and learning outcomes derived from participation.

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3. Tourist Satisfaction: This construct represents tourists' overall evaluation of their experience. It includes perceptions of service quality, experience quality, perceived value, and the image of the destination.
4. Intention to Revisit Low-Carbon Tourism Destinations: This construct reflects future behavioral intentions related to low-carbon tourism. It encompasses awareness of low-carbon tourism, personal responsibility and engagement in sustainable practices, as well as the intention to revisit and recommend such destinations to others.

Each construct was measured using multiple observed indicators. Validity and reliability of the measurement model were confirmed through Confirmatory Factor Analysis (CFA), ensuring that all constructs met the required psychometric standards before proceeding to structural model analysis.

3.3. Research Instrument

The research instrument employed in this study was a structured questionnaire developed to investigate the causal relationships among low-carbon tourism, tourist experiences, tourist satisfaction, and the intention to revisit low-carbon tourism destinations. The questionnaire was constructed based on well-established measurement scales from existing literature and was adapted to align with the specific context of low-carbon tourism.

The development of the questionnaire followed a systematic and rigorous process to ensure its validity and reliability. This process included an extensive literature review, expert validation, and pilot testing.

The questionnaire consisted of five sections, with Sections 2 through 5 utilizing a five-point Likert scale (ranging from 1 = Strongly Disagree to 5 = Strongly Agree). The content of each section is outlined below:

1. Demographic Information: This section collected general background data on respondents, including gender, age, education level, occupation, and previous experience with low-carbon tourism.
2. Low-Carbon Tourism: This section measured respondents' engagement with environmentally responsible practices, such as eco-friendly accommodations, the use of sustainable transportation, and efforts in waste reduction.
3. Tourist Experiences: This section assessed various aspects of the tourism experience, including emotional engagement, environmental interaction, and learning gained from low-carbon tourism activities.
4. Tourist Satisfaction: This section evaluated respondents' perceptions of service quality and their overall satisfaction with the tourism experience.
5. Intention to Revisit Low-Carbon Tourism Destinations: This section measured future behavioral intentions, focusing on awareness of low-carbon tourism, a sense of personal responsibility and engagement, intention to revisit, and the perceived image of the destination.

To assess the reliability and validity of the questionnaire, a pilot study was conducted involving a sample of 50 participants. The collected data were subjected to reliability testing using Cronbach's Alpha and construct validity analysis through the use of factor analysis. Items with factor loadings below 0.40 were carefully examined and, subsequently, removed to enhance the instrument's reliability, resulting in the elimination of two items. Following these modifications, all the constructs demonstrated strong internal consistency, with Cronbach's Alpha coefficients exceeding the commonly accepted threshold of 0.70. As a result, the revised questionnaire was deemed valid and reliable for full-scale data collection and subsequent structural equation modeling (SEM) analysis (Nunnally and Bernstein, 1994).

This rigorous development and testing process ensured that the research instrument demonstrated high reliability and validity, making it a robust tool for measuring the causal relationships in low-carbon tourism research [30].

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3.4. Data Collection, Sample Size, and Sampling Strategy

This study targeted Thai tourists visiting Khao Yai National Park, a prominent nature-based tourism destination in Thailand. The park's rich biodiversity, eco-tourism initiatives, and sustainable tourism infrastructure provide an ideal setting for investigating how low-carbon tourism practices influence tourist experiences and, subsequent, behavioral intentions. Given its status as a leading eco-tourism site, Khao Yai attracts a diverse range of domestic tourists, making it a strategic location for analyzing sustainability-driven travel behavior.

Survey data were collected from 510 respondents, ensuring a statistically robust sample for the structural equation modeling (SEM). Following Hair., et al. [31] who recommend a minimum sample size of 200–500 for SEM, this dataset provides reliable and generalizable results in regard to examining the causal relationships between the studied variables. Face-to-face surveys were conducted at key areas within Khao Yai National Park, such as visitor centers, camping grounds, and canteens, ensuring data collection from tourists with varied travel motivations and experiences. Participation was voluntary, and informed consent was obtained from all the respondents. Confidentiality and anonymity were strictly maintained, in alignment with ethical research standards.

A purposive sampling approach was employed to ensure that the respondents had prior experience with low-carbon tourism activities, allowing for an accurate assessment of their experiences, satisfaction, and future travel intentions. The sampling criteria included: tourists who engaged in low-carbon tourism activities at Khao Yai National Park, such as using eco-friendly transportation, staying in green accommodation, and participating in conservation efforts. Individuals participated voluntarily, ensuring ethical compliance.

3.5. Data Analysis

Ensuring data accuracy and validity is a critical step in confirming the appropriateness of the dataset for rigorous research analysis. The data validation process involved multiple stages aimed at identifying and addressing potential anomalies prior to statistical analysis. Initially, the dataset was examined for missing values, which were managed using appropriate imputation techniques such as mean substitution and deviation adjustment, depending on the nature and extent of the missing data. This phase was conducted using SPSS software, which offers robust capabilities for handling multivariate data.

Outlier detection was performed using Mahalanobis Distance to identify extreme cases that could distort the results of the analysis. A significance level of $p < 0.001$ was set as the threshold for identifying outliers. Each flagged case was individually reviewed to determine whether it represented a legitimate data point or an error. As a result, 10 outliers were removed from the initial sample of 400 respondents. This systematic data-cleaning process improved the reliability and integrity of the final dataset, laying a solid foundation for subsequent statistical analyses.

Confirmatory Factor Analysis (CFA) was then employed to assess the measurement model and to ensure that the latent constructs were accurately represented by their respective observed variables. The Maximum Likelihood Estimation (MLE) method, known for its effectiveness in analyzing multivariate data, was used to evaluate model fit within the Structural Equation Modeling (SEM) framework. Following the outlier removal process, the dataset was further assessed for construct validity and reliability. Factor loadings above 0.70 were considered acceptable, supporting the convergent validity of the constructs. In addition, Cronbach's Alpha coefficients were calculated to evaluate internal consistency, with values of 0.70 or higher indicating satisfactory reliability [30].

This comprehensive approach to data cleaning and validation was essential for minimizing potential biases or errors, thereby enhancing the robustness and accuracy of the findings. The use of SEM provided a powerful analytical tool to examine the complex relationships among the variables, contributing to the theoretical and empirical advancement of low-carbon tourism research.

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4. Results

4.1. Demographic Characteristics of the Respondents

As detailed in Table 1, the study sample comprised 510 participants, with a nearly balanced gender distribution, namely 47.65% male, 51.57% female, and 0.78% preferring not to specify their gender. In terms of age distribution, the largest group of respondents (34.31%) was aged 20 years or younger, followed by those aged 21–30 years (27.84%). The remaining participants included those aged 31–40 years (17.84%), 41–50 years (11.37%), 51–60 years (4.90%), and over 60 years (3.73%). Notably, the sample shows a disproportionate representation among the age groups, with individuals under 30 years comprising over 60% of the total study sample. This imbalance may be attributed to the on-site data collection conducted at Khao Yai National Park, a destination that attracts a high volume of students and youth travelers, particularly during weekends and holidays. Younger visitors tend to be more active in regard to outdoor recreational activities and may be more willing to participate in surveys related to environmental or sustainable tourism topics, contributing to their overrepresentation in the sample.

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Table 1.
Demographic profile of the respondents.

Participants	Frequency (LSPS)	Percentage (%)
Gender		
Male	243	47.65
Female	263	51.57
Prefer not to specify	4	0.78
Age		
≤20 years	175	34.31
21–30 years	142	27.84
31–40 years	91	17.84
41–50 years	58	11.37
51–60 years	25	4.90
>60 years	19	3.73
Education level		
Below bachelor's degree	261	51.18
Bachelor's degree	217	42.55
Above bachelor's degree	32	6.27
Occupation		
Government officer/state enterprise employee	76	14.90
Private sector employee	128	25.10
Business owner	44	8.63
Freelancer/self-employed	25	4.90
Student	219	42.94
Retired	6	1.18
Unemployed	12	2.35
Income (Monthly)		
THB ≤ 15,000	259	50.78
THB 15,001–30,000	139	27.25
THB 30,001–45,000	59	11.57
THB 45,001–60,000	29	5.69
THB 60,001–75,000	9	1.76
THB 75,001–90,000	7	1.37
THB 90,001–105,000	5	0.98
THB >105,000	3	0.59
Low-carbon tourism experience		
Stay in eco-friendly accommodation (e.g., green hotels, eco-lodges, camping)	272	17.30
Participate in nature conservation activities (e.g., tree planting, litter collection)	302	19.20
Engage in carbon offset programs (e.g., contributing to offset carbon emissions)	40	2.50
Use public transportation during travel	110	7.00
Explore destinations by cycling	166	10.60
Go hiking or trekking	265	16.90
Reduce waste, separate trash, reuse items, and support recycled products	250	15.90
Conserve energy and use clean or renewable energy sources	167	10.60

Regarding educational attainment, more than half (51.18%) of the respondents had qualifications below a bachelor's degree, while 42.55% held a bachelor's degree, and only 6.27% had participated in postgraduate education. The occupational distribution revealed that 42.94% were students, 25.10% were private sector employees, 14.90% were government officers or state enterprise employees, 8.63% were business owners, 4.90% were freelancers or self-employed, 2.35% were unemployed, and 1.18% were retired.

The majority of respondents (50.78%) reported a monthly income of THB ≤ 15,000, while 27.25% earned between THB 15,001–30,000. The remaining income groups comprised 11.57% of respondents earning THB 30,001–45,000, 5.69% earning THB 45,001–60,000, and progressively lower proportions in higher income brackets.

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In terms of Low-Carbon Tourism Experience, the participants engaged in various low-carbon tourism activities, with the most common being participation in nature conservation activities (19.20%) and staying in eco-friendly accommodation (17.30%). Other notable activities included hiking or trekking (16.90%), waste reduction and recycling (15.90%), and cycling for exploration (10.60%). Engagement in carbon offset programs was the least practiced behavior (2.50%).

These demographic insights provide a foundation for understanding tourist behavior and preferences in the context of low-carbon tourism, contributing to the broader discourse on sustainable tourism development.

4.2. Reliability and Validity Testing

As detailed in Table 2, the results of the convergent and discriminant validity analysis indicate that the measurement constructs used in this study are statistically reliable and valid. The factor loadings for all the observed variables exceed the recommended threshold of 0.5, demonstrating strong relationships between the indicators and their respective latent variables.

For the low-carbon tourism (LCT) construct, the factor loadings range from 0.566 (eco-friendly activity participation) to 0.855 (waste management and recycling behavior), indicating acceptable levels of construct validity. The composite reliability (CR) of this construct is 0.841, and the average variance extracted (AVE) is 0.575, suggesting adequate internal consistency.

Table 2.
Convergent validity and discriminant validity results.

Constructs	Items	Factor Loading	S.E.	CR	Cronbach's Alpha	AVE	r^2	MSV	ASV
Low-Carbon Tourism	Sustainable Accommodation Selection	0.799	0.048	0.841	0.823	0.575	0.639	0.480	0.447
	Eco-Friendly Activity Participation	0.566	0.058				0.321		
	Waste Management and Recycling Behavior	0.855	-				0.730		
	Consumption of Local and Organic Products	0.782	0.045				0.611		
Experience of Low-Carbon Tourism	Emotional Experience	0.718	0.037	0.899	0.901	0.691	0.515		
	Environmental Experience	0.817	0.033				0.667		
	Engagement in Eco-Friendly Tourism Activities	0.874	-				0.764		
	Learning Experience	0.903	0.034				0.816		
Tourist Satisfaction	Service Quality	0.748	0.039	0.915	0.919	0.730	0.560		
	Experience Quality	0.852	0.032				0.726		
	Perceived Value	0.897	-				0.805		
	Destination Image	0.910	0.032				0.828		
Intention to Revisit Low-Carbon Tourism Destination	Awareness	0.889	0.03	0.936	0.935	0.786	0.790		
	Responsibility/Engagement	0.892	-				0.796		
	Intention to Revisit and Recommend	0.890	0.031				0.792		
	Destination Elements	0.874	0.033				0.764		

The experience of low-carbon tourism construct shows factor loadings between 0.718 (emotional experience) and 0.903 (learning experience), with a CR of 0.899 and an AVE of 0.691. These values confirm the construct's reliability and the appropriate-ness of the selected measurement items.

For the tourist satisfaction construct, the factor loadings range from 0.748 (service quality) to 0.910 (destination image), with a CR of 0.915 and an AVE of 0.730. This indicates a high level of construct validity and reliability.

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The intention to revisit the low-carbon tourism destination construct exhibits the highest reliability and validity, with factor loadings between 0.874 (destination elements) and 0.892 (responsibility/engagement). The CR value is 0.936, and the AVE is 0.786, reflecting strong construct measurement validity and reliability.

The discriminant validity assessment confirms that the maximum shared variance (MSV) values do not exceed the AVE values, and the constructs are distinct from one another. Overall, the results validate the robustness of the measurement model, ensuring its appropriateness for further hypothesis testing.

Discriminant validity was also established. As presented in Table 3, the square roots of the AVE for each construct are greater than their corresponding inter-construct correlations. Specifically, the AVE square roots are 0.758 for low-carbon tourism, 0.831 for the experience of low-carbon tourism, 0.854 for tourist satisfaction, and 0.887 for the intention to revisit the low-carbon tourism destination. All the inter-construct correlations are significant at the 0.01 level, ranging from 0.553 to 0.636, indicating moderate-to-strong, but distinct, relationships between the constructs. Collectively, these results confirm that the measurement model possesses adequate convergent and discriminant validity, supporting its suitability for further structural model analysis.

Table 3.
Discriminant validity of the constructs.

Construct	Low-Carbon Tourism	Experience of Low-Carbon Tourism	Tourist Satisfaction	Intention to Revisit Low-Carbon Tourism Destination
Low-Carbon Tourism	0.758			
Experience of Low-Carbon Tourism	0.606 **	0.831		
Tourist Satisfaction	0.553 **	0.621 **	0.854	
Intention to Revisit Low-Carbon Tourism Destination	0.583 **	0.605 **	0.636 **	0.887

Note: ** Correlation is significant at the 0.01 level (2-tailed test).

4.3. Structural Equation Modeling Analysis (SEM Analysis)

Structural equation modeling (SEM) was employed to test the proposed hypotheses and examine the underlying structure of tourists' responses to key factors associated with the intention to revisit low-carbon tourism destinations. Despite the methodological complexities involved in assessing indirect relationships, SEM remains a widely utilized approach in empirical research, due to its ability to model complex interactions between latent and observed variables. The integration of quantitative research is essential for ensuring the effective application and accuracy of SEM in hypothesis testing.

This section focuses on the path analysis and hypothesis testing conducted to evaluate the proposed model, identifying the key variables influencing the intention to revisit low-carbon tourism destinations, as illustrated in Figure 2. Specifically, SEM was applied to investigate the structural relationships within the framework of customer experiences. While analyzing indirect relationships presents certain challenges, SEM continues to be a valuable and extensively used method in tourism and consumer behavior studies. The incorporation of robust quantitative methodologies enhances the reliability and validity of the SEM approach, facilitating a deeper understanding of the factors shaping tourists' intentions to revisit low-carbon tourism destinations.

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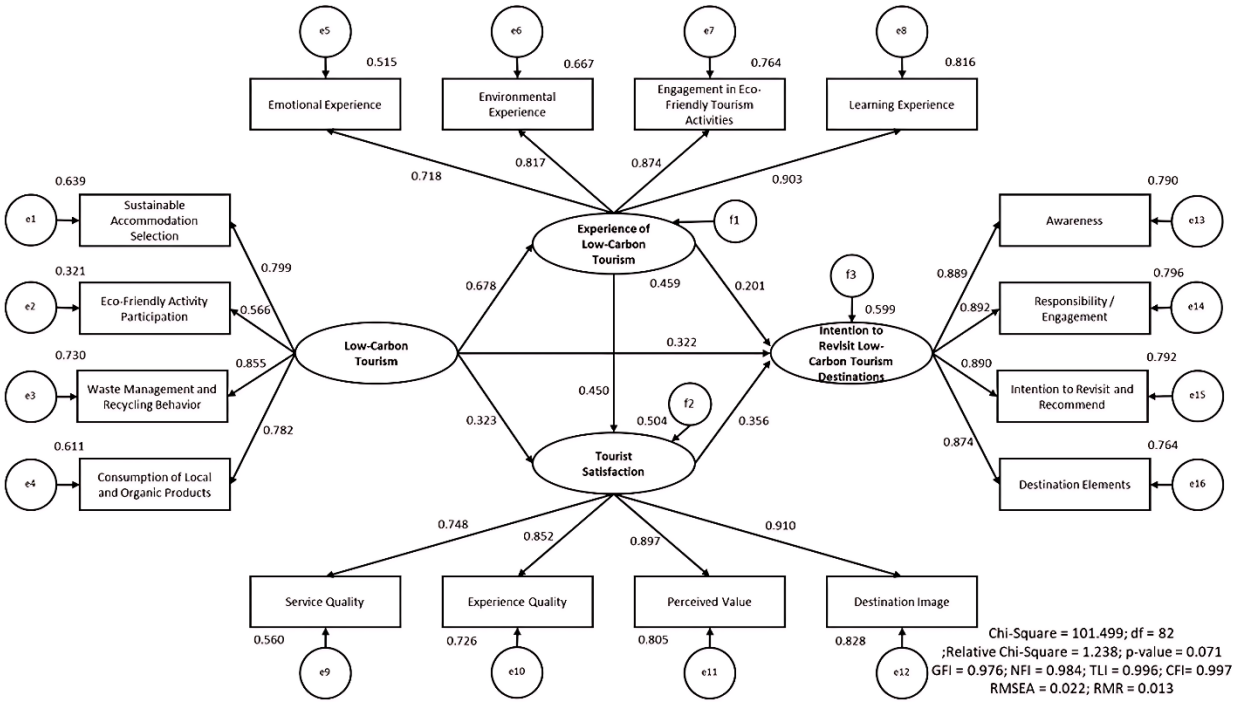

Figure 2.
Structural equation modelling of low-carbon tourism, tourist experiences, satisfaction, and intention to revisit low-carbon tourism destinations.

The results of the structural equation modelling (SEM) analysis, as depicted in Figure 2, indicate a well-fitted model with robust statistical indices. The model fit indices suggest a strong alignment with the empirical data: Chi-Square (χ^2) = 101.499, degrees of freedom (df) = 82, relative Chi-Square = 1.238, and a *p*-value of 0.071. Additional fit indices further confirm the model's adequacy, with a Goodness-of-Fit Index (GFI) of 0.976, a Normed Fit Index (NFI) of 0.984, a Tucker–Lewis Index (TLI) of 0.996, and a Comparative Fit Index (CFI) of 0.997. The Root Mean Square Error of Approximation (RMSEA) is 0.022, and the Root Mean Square Residual (RMR) is 0.013, both indicating an excellent fit.

The path analysis demonstrates significant relationships among the key constructs related to low-carbon tourism. The intention to revisit low-carbon tourism destinations is positively influenced by tourists' prior experiences, including emotional, environmental, and learning experiences. The analysis reveals a strong relationship between experience quality and perceived value, which in turn impacts tourist satisfaction. Destination image also plays a crucial role in shaping perceived value and overall satisfaction.

Furthermore, engagement in eco-friendly tourism activities, such as sustainable accommodation selection, waste management, and the consumption of local and organic products, significantly contributes to tourists' awareness and responsible behavior. These factors collectively enhance their intention to revisit and recommend low-carbon tourism destinations.

The standardized path coefficients highlight the strength of these relationships, with values ranging from moderate to strong associations. The high reliability of the observed variables, with loadings exceeding 0.7 in most cases, further supports the validity of the constructs.

Overall, the SEM results validate the proposed model, emphasizing the importance of sustainable tourism experiences, engagement in eco-friendly activities, and perceived service quality in shaping tourists' future behavioral intentions.

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The path analysis results, as presented in Table 4, reveal significant relationships between low-carbon tourism, tourist experiences, satisfaction, and revisit intentions. All the hypothesized relationships were supported with a high level of statistical significance ($p < 0.001$).

Table 4.
Path analysis results.

Hypothesis	Paths	Path Coefficient	*p*-Value	Relationship
H1	Low-Carbon Tourism → Experience of Low-Carbon Tourism	0.678 ***	<0.001	Supported
H2	Low-Carbon Tourism → Tourist Satisfaction	0.323 ***	<0.001	Supported
H3	Low-Carbon Tourism → Intention to Revisit Low-Carbon Tourism Destination	0.322 ***	<0.001	Supported
H4	Experience of Low-Carbon Tourism → Intention to Revisit Low-Carbon Tourism Destination	0.201 ***	<0.001	Supported
H5	Tourist Satisfaction → Intention to Revisit Low-Carbon Tourism Destination	0.356 ***	<0.001	Supported
H6	Experience of Low-Carbon Tourism → Tourist Satisfaction	0.450 ***	<0.001	Supported

Note: Remark: *** significant at 0.001 level.

First, the findings indicate that low-carbon tourism significantly enhances tourists' experiences (H1: $\beta = 0.678$, $p < 0.001$), suggesting that sustainable tourism initiatives contribute positively to travelers' engagement and perceptions. Additionally, low-carbon tourism has a substantial impact on tourist satisfaction (H2: $\beta = 0.323$, $p < 0.001$), underscoring the role of environmentally conscious travel in shaping positive tourism experiences.

Furthermore, low-carbon tourism directly influences tourists' intentions to revisit sustainable destinations (H3: $\beta = 0.322$, $p < 0.001$). This finding highlights the growing appeal of low-carbon tourism, which fosters long-term behavioral commitments among travelers.

This study also confirms the importance of tourism experiences and satisfaction in shaping revisit intentions. Specifically, the experience gained from low-carbon tourism significantly affects revisit intentions (H4: $\beta = 0.201$, $p < 0.001$), indicating that memorable, eco-friendly travel experiences encourage return visits. Moreover, tourist satisfaction strongly predicts revisit intentions (H5: $\beta = 0.356$, $p < 0.001$), reinforcing the importance of delivering high-quality services in regard to sustainable tourism to enhance tourist loyalty.

Finally, the analysis confirms a significant positive relationship between tourist experiences and satisfaction in the context of low-carbon tourism (H6: $\beta = 0.450$, $p < 0.001$). This indicates that tourists who have meaningful and enjoyable low-carbon travel experiences are more likely to report higher levels of satisfaction. Engaging in eco-friendly tourism activities appears to enhance overall travel satisfaction, reinforcing the importance of delivering positive and immersive low-carbon experiences.

Overall, these results emphasize the interconnected nature of low-carbon tourism, tourist experiences, satisfaction, and revisit intentions, providing critical insights for policymakers and industry stakeholders, aiming to promote sustainable tourism development.

4.4. Results from the Mediation Analysis

The mediation analysis, the results of which are detailed in Table 5, was used to examine the indirect effects of low-carbon tourism on the intention to revisit low-carbon tourism destinations through two mediating variables: the experience of low-carbon tourism and tourist satisfaction.

The direct effect of low-carbon tourism on the intention to revisit was found to be significant ($\beta = 0.322$, $p < 0.001$), confirming that engaging in low-carbon tourism directly influences tourists' willingness to return.

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Furthermore, the indirect pathways were analyzed to assess the partial mediation effects. First, the mediating role of the experience of low-carbon tourism was tested (H7). The results indicate a significant indirect effect ($\beta = 0.138$, $p = 0.001$), suggesting that the experiences gained from low-carbon tourism partially mediate the relationship between low-carbon tourism participation and revisit intention. This implies that when tourists have enriching and memorable experiences as a result of low-carbon tourism activities, they are more likely to return.

Second, tourist satisfaction was examined as a mediator (H8), yielding a significant indirect effect ($\beta = 0.117$, $p < 0.001$). This finding confirms that tourist satisfaction partially mediates the relationship between low-carbon tourism and revisit intention, highlighting the importance of service quality, experience quality, perceived value, and destination image in reinforcing tourists' likelihood of revisiting.

Overall, both mediation hypotheses (H7 and H8) were supported, confirming that while low-carbon tourism has a direct effect on revisit intention, the experiential and satisfaction-related aspects significantly enhance this relationship. These findings underscore the necessity for tourism providers to focus on delivering high-quality experiences and ensuring customer satisfaction to promote sustainable tourism behaviors.

Table 5.
Meditation analysis results.

Hypothesis	Paths	Direct Effect	Indirect Effect	*p*-Value	Mediation	Relationship
	Low-Carbon Tourism → Intention to Revisit Low-Carbon Tourism Destination	0.322 ***		<0.001		Supported
H7	Low-Carbon Tourism → Experience of Low-Carbon Tourism → Intention to Revisit Low-Carbon Tourism Destination		0.138 ***	0.001	Partial	Supported
H8	Low-Carbon Tourism → Tourist Satisfaction → Intention to Revisit Low-Carbon Tourism Destination		0.117 ***	0.000	Partial	Supported

Note: Remark: *** significant at 0.001 level.

The path analysis results, as presented in Table 6, reveal the direct, indirect, and total effects among the key constructs assessed in this study. Low-carbon tourism (LCT) has a significant direct effect on the experience of low-carbon tourism ($\beta = 0.678$, $p < 0.001$), tourist satisfaction ($\beta = 0.323$, $p < 0.001$), and the intention to revisit low-carbon tourism destinations (direct effect: $\beta = 0.322$; indirect effect: $\beta = 0.360$; total effect: $\beta = 0.682$).

The experience of low-carbon tourism significantly influences tourist satisfaction ($\beta = 0.450$, $p < 0.001$) and also has a direct effect on the intention to revisit ($\beta = 0.201$, $p < 0.001$), with an additional indirect effect via satisfaction ($\beta = 0.160$), resulting in a total effect of $\beta = 0.361$. Tourist satisfaction, in turn, has a strong direct effect on the intention to revisit low-carbon tourism destinations ($\beta = 0.356$, $p < 0.001$).

The model demonstrates good explanatory power, with R^2 values of 0.459 for the low-carbon tourism experience, 0.504 for tourist satisfaction, and 0.599 for the intention to revisit. The overall model fit is robust, as indicated by a Chi-Square value of 101.499 (df = 82), a relative Chi-Square value of 1.238, $p = 0.071$, RMSEA = 0.022, RMR = 0.013, GFI = 0.976, NFI = 0.984, TLI = 0.996, and CFI = 0.997.

These results underscore the importance of creating meaningful low-carbon tourism experiences and enhancing tourist satisfaction, both of which significantly influence the intention to revisit. This highlights the value of sustainable tourism practices in fostering long-term visitor engagement.

Table 6.
Path analysis (direct and indirect effects) results.

Dependent Variable / Causal Variable	Experience of Low-Carbon Tourism			Tourist Satisfaction			Intention to Revisit Low-Carbon Tourism Destinations		
	DE	IE	TE	DE	IE	TE	DE	IE	TE
Low-Carbon Tourism	0.678	-	0.678	0.323	0.305	0.628	0.322	0.360	0.682
Experience of Low-Carbon Tourism	-	-	-	0.450	-	0.450	0.201	0.160	0.361
Tourist Satisfaction	-	-	-	-	-	-	0.356	-	0.356
R-square (R^2)	0.459			0.504			0.599		

Note: "DE" = Direct Effect, "IE" = Indirect Effect, "TE" = Total Effect. A hyphen (–) indicates that no direct path was modeled or the direct effect is statistically insignificant and thus not reported.

4.5. Data Analysis Summary

1. The variables Low Carbon Tourism, Experience from Low Carbon Tourism, and Tourist Satisfaction collectively explain 59.9% of the variance in tourists' Intention to Revisit Low Carbon Tourism Destinations.
2. All three variables—Low Carbon Tourism, Experience from Low Carbon Tourism, and Tourist Satisfaction—have a positive and statistically significant effect on the Intention to Revisit Low Carbon Tourism at the 0.05 significance level.
3. Low Carbon Tourism exerts both direct and indirect positive influences on the Intention to Revisit Low Carbon Tourism Destinations, mediated through Experience from Low Carbon Tourism and Tourist Satisfaction. The total effect size is 0.682, comprising a direct effect of 0.322 and an indirect effect of 0.360.
4. Experience from Low Carbon Tourism has a direct positive effect on the Intention to Revisit Low Carbon Tourism, as well as an indirect effect mediated by Tourist Satisfaction. The total influence is 0.361, consisting of a direct effect of 0.201 and an indirect effect of 0.160.
5. Tourist Satisfaction demonstrates a direct positive influence on the Intention to Revisit Low Carbon Tourism, with an effect size of 0.356.
6. Among the three variables, Low Carbon Tourism exerts the strongest influence on the Intention to Revisit, followed by Experience from Low Carbon Tourism, and then Tourist Satisfaction.

5. Discussion

The present study aimed to examine the causal relationships among Low Carbon Tourism, Tourist Experience, Tourist Satisfaction, and the Intention to Revisit Low Carbon Tourism Destinations. The findings offer empirical support for the proposed model and make meaningful contributions to the literature on sustainable and responsible tourism. The results are interpreted in relation to previous studies and the original working hypotheses.

The analysis revealed that low-carbon tourism activities, tourist experiences, and tourist satisfaction were collectively responsible for explaining 59.9% of the variance in tourists' intention to revisit low-carbon tourism destinations. This finding supports the initial hypothesis, which posited that engagement in low-carbon tourism activities significantly influences tourist experiences and satisfaction, thereby shaping their intention to revisit such destinations in the future. These results align with prior research indicating that green perceived value has a significant positive effect on tourists' intention to participate in low-carbon tourism and fully mediates the relationship between environmental cognition and revisit intention [32]. Furthermore, the tourist experience—comprising emotional engagement, service quality, destination attributes, cultural authenticity, and overall image of

destination— is a key factor influencing tourist satisfaction and subsequent behavioral intentions. As highlighted in previous studies, memorable and emotionally resonant experiences are strong predictors of satisfaction and loyalty [33].

The findings of this study indicate that low-carbon tourism exerts both direct and indirect effects on tourists' intention to revisit low-carbon destinations, with a total effect size of 0.682. This suggests that tourists' engagement in environmentally sustainable practices—such as selecting sustainable accommodations, participating eco-friendly activities, supporting local products, and minimizing waste—has a substantial impact on their future travel intentions. The significant indirect effects, mediated through tourist experience and satisfaction, highlight that responsible travel behaviors are most influential when coupled with positive and memorable experiences. This result aligns with prior research emphasizing the role of emotional and experiential dimensions in shaping sustainable travel intentions. For instance, in the context of national parks, environmentally responsible behaviors have been shown to positively influence tourist satisfaction, with memorable nature-based experiences serving as mediators of repeat visitation and recommendation [34]. Similarly, Hosseini, et al. [35] found that memorable travel experiences strongly shape tourists' behavioral intentions, including the desire to revisit and engage in the same activities. Additionally, emotional experiences contribute significantly to overall satisfaction, which in turn positively influences tourists' intentions to recommend the destination to others [36, 37]. These findings underscore the importance of designing low-carbon tourism experiences that are not only environmentally responsible but also emotionally engaging and memorable.

Tourist satisfaction remains a significant predictor of revisit intention, as evidenced by its direct effect size of 0.356 in this study. This finding aligns with prior research emphasizing the critical role of satisfaction in fostering tourist loyalty. For example, [38] reported a strong direct relationship between tourist satisfaction and revisit intention, with a path coefficient of 0.608 ($p < 0.001$), highlighting satisfaction as a major contributor to return visits in ecotourism contexts. Similarly, Panca and Wihardi [39] found that among Generation Z tourists, satisfaction mediates the relationship between experiential quality and revisit intention, suggesting that positive travel experiences enhance satisfaction, which in turn increases the likelihood of revisiting. In a related study, Morshed, et al. [28] confirmed that satisfaction significantly influences revisit intention through the mediating role of loyalty, further reinforcing its importance in repeat visitation behavior. These findings collectively underscore that tourist satisfaction is a crucial antecedent of behavioral loyalty across diverse tourism contexts. In the domain of low-carbon tourism, ensuring high levels of satisfaction is essential not only for encouraging repeat visits but also for supporting the long-term sustainability and success of environmentally responsible tourism initiatives.

The study identified low-carbon tourism as the most influential factor affecting revisit intention, followed by tourist experience and satisfaction. This order of influence reflects a shift in tourist motivations, with environmental responsibility emerging as a core value in travel decision-making. The findings suggest that environmentally conscious practices not only enhance tourists' experiences and satisfaction but also significantly increase the likelihood of repeat visitation.

This result aligns with recent empirical research. Zainordin, et al. [40] found that ecological sustainability initiatives in Langkawi significantly improved tourist satisfaction, which in turn positively impacted revisit intention. Similarly, Sahabuddin, et al. [41] demonstrated that environmental values and service quality in the Sundarbans played as a significant factor contributing to tourist satisfaction, loyalty, and environmentally responsible behavior. Furthermore, Li, et al. [42] reported that tourists' perceptions of low-carbon value and social responsibility in Zhangjiajie National Forest Park were strong predictors of their future engagement in low-carbon tourism. Collectively, these studies underscore the central role of low-carbon tourism in fostering tourist loyalty and advancing sustainable tourism development.

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6. Conclusion and Implications

This study offers robust empirical evidence that low-carbon tourism significantly influences tourists' revisit intentions, both directly and indirectly, through tourist experience and satisfaction. Among the variables examined, low-carbon tourism emerged as the most influential predictor, underscoring a fundamental shift in tourist motivations—where environmental responsibility is a central value in travel decision-making.

From a theoretical perspective, the findings contribute to a deeper understanding of the interplay between environmental, experiential, and emotional dimensions in shaping sustainable tourist behavior. The results affirm that environmentally responsible practices, when embedded in engaging and high-quality travel experiences, foster not only immediate satisfaction but also long-term loyalty.

In terms of practical implications, the study emphasizes the strategic importance for destination managers and policymakers to incorporate low-carbon principles across all facets of tourism—ranging from activities and transportation to accommodation, local product consumption, and waste management. Such integration not only enhances the overall tourist experience but also aligns with broader goals of environmental and tourism sustainability.

In conclusion, this research underscores the pivotal role of low-carbon tourism in shaping tourist behavioral intentions and provides a foundation for destination strategies that simultaneously promote responsible travel, enhance environmental awareness, and support both sustainable and economic development.

6.1. Limitations

Although this study yielded valuable contribution into the dynamics of low-carbon tourism certain limitations should be noted. First, the reliance on self-reported questionnaires may have introduced social desirability bias and inaccuracies in respondents' recall. Second, the sample was confined to tourists visiting selected low-carbon destinations, which may constrain the generalizability of the findings to other types of tourism contexts or broader demographic groups. Third, the cross-sectional design used in this study may limits the ability to draw conclusions about causal relationships over time.

6.2. Future Research Directions

Although this study advances the understanding of low-carbon tourism, several directions for future research are recommended. First, as approximately 40% of the variance in revisit intentions remains unexplained, it is important to investigate additional variables such as place attachment, personal norms, and perceived behavioral control. Second, the sample comprised tourists who were already familiar with or supportive of low-carbon tourism. Future studies should consider stratifying participants based on their level of environmental engagement to better understand how to motivate less environmentally conscious tourists. Finally, adopting a longitudinal design or incorporating behavioral tracking methods could provide deeper insights into the long-term stability of revisit intentions. These research directions may contribute to a more comprehensive understanding of sustainable tourism and the factors influencing responsible tourist behavior.

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Author Contributions:

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Institutional Review Board Statement:

This study was conducted in accordance with the Declaration of Helsinki and gained the approval of the Ethics Committee at Suranaree University of Technology (Protocol code COE no.164/2567 and date of approval 6 November 2024).

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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