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Low-Carbon Behaviour Performance of Scenic Spots in a World Heritage Site

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Abstract: A low-carbon behaviour performance evaluation index system is designed by using a Delphi method in this study. The analytic hierarchy process (AHP) is applied to systematically measure the low-carbon behaviour performance of 32 scenic spots in Zhangjiajie, a world heritage site. The key driving factors that can significantly influence the low-carbon behaviour performance of the scenic spot are extracted by combining redundancy analysis (RDA). The results show that the scenic spots of Zhangjiajie performance well regarding low-carbon behaviour, however, there are still a great deal of room for improvement and promotion. Pressure from investors, the administration committees, tourists and local governments is the main driving factor for the low-carbon behaviour of scenic spot.

Keywords: low-carbon tourism; low-carbon behaviour performance; world heritage site; Zhangjiajie

1. Introduction

In the 21st century, humankind is facing the great challenge of global environmental change and global sustainable development. Human activities are affecting the Earth's system with unprecedented magnitude and speed, which, in turn, affects the quality of human life and the level of sustainable development. Tourism is closely linked to the environment and climate and is considered to be a vulnerable and highly climate-sensitive sector of the economy [1,2]. According to the research report of the World Tourism Organization, the carbon dioxide generated by global tourism development reached 1.3 billion tons, which accounted for 4.9% of the total anthropogenic carbon dioxide, while the contribution rate of anthropogenic global warming by the tourism sector accounted for 5–14% [3,4]. Moreover, carbon dioxide from world tourism is expected to increase by an average of 2.5% per year until 2035. In 2018, 12.10 billion trips were made worldwide (Source: World Travel and Tourism Council (https://www.wttc.org/)). Such a large scale of long-distance human activities inevitably causes severe energy consumption and environmental pollution [5]. Therefore, how to promote the energy conservation and emissions reduction of the tourism industry achieve a low-carbon tourism industry is an important issue that academic circles should pay close attention to and that governments of various countries urgently need to solve.

The concept of low-carbon tourism originates from the World Economy Forum "Towards Low-Carbon Travel and Tourism" [6], whose target is to reduce greenhouse gas emissions and minimize the negative impact on the ecological environment [7]. At present, there has been many published papers on the low carbon tourism. The research of the these studies mainly focuses on the accounting of carbon emissions from tourism, such as tourism destinations of different scales [1,4,8,9], individual tourism departments [10–13], and different types of tourism activities [5,14,15]. In recent years, based on the accounting of tourism carbon emissions, some scholars have begun to explore the key factors that affect tourism carbon emissions [16–18], the relationship between tourism carbon emissions and regional economic development [19–21], and the evaluation of regional tourism low-carbon strategy and policy [7,22].

Scenic spots shoulder the responsibility of attracting tourism consumption and radiating the whole tourism sector, which is one of the important sources of carbon emissions from tourism [8,23]. In the extant studies on the low-carbon development of scenic spots, researchers devote more attention to the measurement of the tourism carbon footprint for scenic spots and on the discussion about the low-carbon development strategy of scenic spots [24–26]. A few scholars have established an evaluation index system of low-carbon scenic spots to evaluate whether the scenic spots meet the standards of low-carbon scenic spots [6,27,28]. The low-carbon behaviour of scenic spots refers to the general term of measures and means taken by tourist attractions to have a positive impact on the environment based on their own conditions and development strategies in the face of pressure from the government, public and consumers. Under the constraints of different environmental policies and the tourism market demand, scenic spots have a different value orientation and behaviour choices, and the low-carbon behaviour of scenic spot enterprises will directly affect or even determine their environmental performance and then affect the environmental quality of the destination [29]. However, scholars have seldom evaluated the low-carbon behaviour performance (LCBP) of scenic spots from the perspective of "bottom-up" and behavioural subjects to explore the driving factors.

This study aims to overcome this omission in the literature. Delphi method is used to construct LCBP indicators of tourism scenic spots from the five dimensions of low-carbon design, daily energy saving, water-saving management, waste reduction and low-carbon awareness, and this study evaluates the LCBP of 32 scenic spots in Zhangjiajie, a world heritage site by using AHP. Based on stakeholder theory, an index system of the driving factors of the low-carbon performance of scenic spots is established based on the interests of tourists, local governments and investors. The key driving factors that significantly affect the low-carbon behaviour performance are extracted through RDA to analyse the influence of subjects with different interests on the LCBP of scenic spots.

Our research has strong implication for the low-carbon development of scenic spots in world heritage sites. On the one hand, through a field investigation, the implementation of low-carbon behaviours in 32 scenic spots of different grades in Zhangjiajie is evaluated and compared. Combining and discussing the key factors that influence the low-carbon behaviour of Zhangjiajie scenic spots is conducive to further optimize low-carbon management decisions, improve the LCBP, and accelerate the low-carbon tourism process of Zhangjiajie. On the other hand, world heritage site is a special type of tourist destination, and environmental protection and ecological construction is the lifeline of the coordination and sustainable development of the human and terrestrial systems [30]. This study can also provide a reference for other world heritage sites to evaluate the low-carbon behaviour performance, regulate the low-carbon behaviour and optimize the low-carbon development policy of scenic spots to achieve the sustainable development of world heritage sites.

The following chapters of this study are arranged as follows: The related literature is reviewed in Section 2; Section 3 is an overview of the study area. This section describes the geographical location of Zhangjiajie and the low carbon tourism management. We specify the research methodology in Section 4, in which the empirical methods and data collection are introduced. The empirical result is presented in Section 5, in which we analyze the low-carbon behaviour performance and its influencing factors of the world heritage site, Zhangjiajie. Section 6 discusses the empirical results and Section 7 presents the important conclusions of the whole research.

2. Literature Review

2.1. Low-Carbon Tourism

The research report of the World Economic Forum proposed the specific target of tourism carbon emissions reduction when it published the tourism carbon emissions, namely, in the next 15–20 years, the total tourism carbon emissions, including related transportation, shall be controlled within 2.7%, and the industry will eventually move towards a low-carbon direction [7,31]. Therefore, the focus of low-carbon tourism is to control and reduce greenhouse gas emissions in the process of tourism development [32]. In the study of low-carbon tourism, the energy consumption and carbon emissions level of tourism destinations are the first areas that have attracted academic attention. For example, Gossling [33] expanded the research scale to the tourism industry by using a global scope. With CO_2 emissions used as the evaluation index, it is estimated that the total carbon emissions of global tourism reached 1400 million tons in 2001. The analysis also shows that due to the differences in tourism resources, destination culture and tourist characteristics, the benefits of tourism carbon emissions in different countries and destinations vary greatly [34]. Wang et al. [35] assessed that the average annual growth rate of carbon emissions from China's tourism industry was as high as 9.91%, and the low-carbon development path has become an inevitable requirement for the sustainable development of China's tourism industry. Konan et al. [36] measured the carbon emissions of tourism in Hawaii by analysing the carbon footprint of tourists. Nepal [37] turned its perspective to rural tourism destinations and analysed the leading factors that affect the tourism energy consumption pattern in Annapurna, Nepal. The results showed that the altitude, level of industry reception, diversity of energy prices and structures, energy consumption habits and acquisition of energy-saving technologies could significantly affect the tourism energy consumption in this region. The above scholars calculated the carbon emissions of tourism destinations by using different scales, and some of them calculated the carbon emissions of specific tourism departments or tourism activities. For instance, Wu et al. [38] calculated the energy consumption and carbon emissions of 29 star-rated hotels in Singapore by using the regression model and following the standard procedures of enterprise greenhouse gas emissions accounting. The study found that the nightly carbon emissions of a single room in a different star-rated hotel were significantly different than the carbon emissions measured by the amount of carbon dioxide produced per square metre. Macintosh et al. [39] believed that international air travel emissions would increase by at least 110% between 2005 and 2025. Becken et al. [24] divided tourism activities in New Zealand into attraction activities, entertainment activities and tourism experience activities. Through research, it was found that the energy consumption of experience activities was the highest, followed by entertainment activities, and the energy consumption of attraction activities was the lowest, with only 6 MJ/ time.

Tourism has become a key area of global greenhouse gas emissions, energy conservation and carbon emissions reduction. Therefore, the low-carbon transformation of tourism is a crucial part of realizing a low-carbon economy. How to increase the energy conservation and reduce tourism emissions to promote the sustainable development of tourism are the main goals of the low-carbon construction of tourism destinations. Some scholars advance a series of countermeasures and recommendation from the perspectives of new energy utilization, tourism supply chain management, tourism service model update, and low-carbon tourism profit model innovation to reduce tourism carbon emissions, boost tourism environmental quality and promote tourism's low-carbon transformation. For example, Liu et al. [40] augured the feasibility of the construction of Kinmen Island's renewable energy system from the two aspects of the economic environment and social conditions and concluded that the development of renewable energy would help to build a super-clean habitat with energy self-sufficiency and to construct a positive international image to enhance international competitiveness. Ma et al. [41] found that innovating the profit model of low-carbon tourism enterprises and helping them to gain benefits from the development of low-carbon tourism are principal supports to promote the sustainable development of low-carbon tourism. Zhang [7] considers that Tibet can promote the development of regional low-carbon tourism by reducing the carbon emissions intensity of tourism, improving the tourism transportation system, popularizing low-carbon tourism knowledge, and increasing the proportion of carbon sink. Meng et al. [42] found that Australia's carbon tax has a significant effect on reducing the carbon emissions of tourism.

2.2. Low-Carbon Tourism Attraction

Scenic spot is the core link of the tourism industry chain, one of the considerable sources of the carbon emissions of tourism destinations, and one of the primary subjects of tourism destination ecological environment protection [29]. Therefore, the low-carbon transformation and upgrading of scenic spot is directly related to the coordinated development of the human and earth systems of tourism destinations. Scientific assessments of the carbon emissions of scenic spots are the basis of the low-carbon transformation of scenic spots. Scholars have calculated the carbon emissions of different areas and different types of scenic spots. Bhuiyan et al. [43] accounted for carbon emissions from 42 forest recreation sites in Malaysia. Bakhat et al. [44] found that the energy consumption of the Ali Islands in Spain was relatively small by measuring the power consumption. Zhou et al. [26] appraised China's Lushan Mountain carbon emissions in 10 years and concluded that tourism makes Lushan a vital source of carbon emissions. As the core sector of tourism, scenic spots not only have great advantages in developing a low-carbon economy but also become the leader of the low-carbon transformation of tourism [23]. In light of the large carbon emissions in scenic spots, some scholars began to explore the planning of low-carbon scenic spots. Based on the Driving-Forces-State-Response Model, Li et al. [31] constructed the concept model of a low-carbon scenic spot and proposed a potential low-carbon development evaluation system from the five dimensions of a "low-carbon economic index, environmental index, operation index, technical index and management index". Ma et al. [41] constructed a comprehensive evaluation index system of low-carbon tourism destinations with the expert consulting method and assigned the index weight through the AHP. When selecting the method to confirm the weight of the indicators, Zhao [28] compared the advantages and disadvantages of an analytic network process (ANP) and AHP from the aspects of the problem structure, structure hierarchy, analysis steps and decision theory and finally chose the problem structure to establish the evaluation model of low-carbon scenic spots. However, the scholars mentioned above stopped at the construction of a low-carbon scenic spot index system, and empirical research is limited in tourism literature. Only a few scholars have carried out empirical analyses. Based on the theory of management entropy increase and the management dissipation structure, Luo et al. [45] proposed a multi-dimensional comprehensive evaluation system for low-carbonization scenic spots and applied it to the Jiuzhaigou in China, thus, reveal the systematic order and development trend of low-carbonization construction in scenic spots. Cheng et al. [6] take the cities of Xixi Wetlands in China as cases studies and the Delphi method is constructed the low-carbon evaluation index system to evaluate the low-carbon development level of the Xixi Wetlands.

3. Study Area and the Development of Low-Carbon Tourism

Zhangjiajie (28°52′~29°48′ N, 109°40′~111°20′ E) is located in the upstream of the Lishui River in northwest Hunan Province, China (Figure 1). Zhangjiajie is seated in the hinterland of Wuling Mountain and is one of the most crucial tourist cities in China. Zhangjiajie is home to tourism resources. Zhangjiajie not only represents China's first National Forest Park, World Natural Heritage, World Geopark, National Key Scenic Area, AAAAA tourist attraction and other top tourism brands, but also has won many special honours such as "China's excellent tourist city", "National Civilized Scenic Spot", etc. 2018 year saw the Zhangjiajie 85.217 million tourists visits and reap income of 75.86 billion Yuan. (Source: Hunan Province Department of Culture and Tourism (http://lfw.hunan.gov.cn/)). Tourism has become a real strategic pillar industry of Zhangjiajie. As one of the first four pilot cities of comprehensive tourism reform in China, Zhangjiajie proposed to strive to build a green, low-carbon, liveable and travelable world tourism destination and seize the strategic highland of low-carbon tourism city development. Scenic spots are the space where tourists complete tourism activities, and they are also the driving force that attracts tourists to make tourism decisions. Low-carbon scenic spots are considerable parts of creating low-carbon tourism destinations.

Figure 1. Location of the study area.

In recent years, Zhangjiajie has implemented a series of low-carbon measures, such as "Century Demolition", a "Low-Carbon Travel Ticket" and upgrading environmental protection vehicles, in scenic spots to alleviate the environmental pressure of scenic spots caused by the sharp increase of tourism activity intensity under the traditional quantitative expansion growth mode. Whereas, the energy conservation and consumption reduction in tourism scenic spots are still in the state of independent enterprise management overall and have not been promoted to the level of policy guidance and promotion. The low-carbon construction and development of scenic spots in Zhangjiajie still has a long way to go [46].

4. Research Methodology

4.1. Low-Carbon Behaviour Performance of Scenic Spots

4.1.1. Delphi Method and Analytic Hierarchy Process (AHP)

Delphi method refers to repeated back-to-back correspondence consultations according to a certain procedure to consult the opinions of the members of an expert group. After several rounds of consultation and feedback, different opinions gradually converge [47]. By summarizing and combining with other mathematical statistics methods, a consistent and reliable recommendation or prediction evaluation result is achieved. Delphi method has the advantages of anonymity, feedback and statistics and is now widely used in policy making, business forecasting, programme evaluation and other aspects [48–50]. The analytic hierarchy process is a multi-criteria decision-making method that combines qualitative and quantitative analyses and was proposed by American operations research scientist Saaty in the early 1970s. AHP is simple and practical and is especially suitable for qualitative judgment, especially for the problem that the decision result is difficult to measure directly and accurately [51]. At present, the analytic hierarchy process is widely used in the fields of economics, management and marketing decision-making and evaluation [52,53].

4.1.2. Construction of an Indicator System

Based on the actual construction of a low-carbon tourism demonstration area in Zhangjiajie, a world heritage site, we examine the related literature of index design regarding low-carbon scenic spots from the concept of a low-carbon economy, low-carbon tourism and low-carbon scenic spots [6,28,31,41,45,54–56]. The initial 54 indicators are determined by screening the high-frequency indicators and referring to the related policies and systems of pollution prevention and the control of tourism in China (Table 1).

Table 1. The initial indicators of scenic spots' LCBP.

No.	Index Content	No.	Index Content
1	Localization of building materials, environmental nature, recycling of building materials	28	Keep as much soil as possible on the ground
2	Reasonable design of building structure	29	Set up a garbage collection station in scenic spots
3	Building with a long service life	30	Increase the permeable pavement of the scenic spot
4	Building site without damaging the terrain	31	Distribution density of sorting trash cans
5	Building site selection to minimize the destruction of the original ecosystem	32	Trash can for ecological materials
6	Increase the green coverage rate	33	Classification and recycling of wastes
7	Building external insulation, warm in winter and cool in summer	34	Harmless disposal of unrecoverable waste
8	Ecological walking trail construction	35	Buffets are available in quantity, eliminating waste
9	Green rate of road in scenic area	36	Green recycling equipment is provided in accommodation facilities
10	Guide signs that use ecological materials	37	Use of environmentally friendly bags
11	Built ecological parking	38	Use degradable plastic to pack tourist souvenirs
12	Good indoor lighting	39	Buy local products and souvenirs to benefit the community
13	Many outdoor tourism activities, reducing equipment and energy consumption	40	Activities of "carbon offset" in scenic spots
14	Energy-saving lamps (indoor lights and outdoor streetlights)	41	Extent to which low-carbon technologies are used
15	Hotels use elevators less, leave the room power, etc.	42	Recruit and solicit feedback from tourists on the low-carbon management of scenic spots
16	Try to adopt the new energy resources of solar and wind energy	43	Tour guides remind low-carbon knowledge and provide low-carbon related services
17	Monitor and manage energy-consuming equipment	44	Low-carbon environmental education for local residents
18	Provide low-energy accommodations such as tents	45	Scientific planning of low-carbon scenic spot construction
19	Local ingredients, green food, reduce the proportion of meat	46	Monthly training of low-carbon tourism knowledge for employees
20	Promote low-carbon green power vehicles (cars)	47	Promote the construction of low-carbon scenic spots through WeChat, Weibo, etc.
21	Encourage guests to take public transportation	48	Percentage of the revenue from scenic spots used for low-carbon maintenance
22	Provide personalized energy-saving vehicles such as skids and sedan chairs	49	Low-carbon environment monitoring mechanism in scenic spots
23	Use water-saving recycling technology	50	Low carbonization inspection organization
24	Adopt an intelligent inductive water-saving system	51	The utilization rate of energy-saving facilities in scenic spots
25	Set up a rainwater centralized treatment system	52	The utilization rate of renewable energy in scenic spots
26	Control the discharge of harmful sewage	53	Tourist feedback and complaint mechanism
27	Reception facilities with water-saving cleaning technology	54	Investment in low-carbon scenic spot construction

Based on the original index system that contains 54 indices, 10 professors in the field of ecotourism and tourism environments and 10 postgraduate students who are majoring in tourism geography are selected as the expert advisory group through the Delphi method. Questionnaires that confirm the indices are issued by the above expert group members for two rounds of consultation and 20 questionnaires are issued in each round, all of which are collected and valid.

After the first round of expert opinion consultation, a total of 18 indicators are counted and excluded due to reasons of repeatability, measurement difficulty, a low correlation with this study and inconsistency with the actual situation in Zhangjiajie. In addition, according to the experts' opinions, two indices are added: "equipped with a circulating water flushing ecological toilet" and "adjust room temperature by building ventilation system".

In the second round of the expert consultation, each expert was invited to distinguish the degree of importance of the index system formed after the adjustment. The importance of the indicators is divided into five grades, specifically "very unimportant", "less important", "important", "more important", and "very important", which are given a score of 1, 3, 5, 7 and 9, respectively. The arithmetic mean value and variation coefficient value are used to correct the index system. The arithmetic mean value represents the concentration degree of expert opinions, that is, the tendency of expert collective opinions to be reflected in the importance degree of the indicators. When the arithmetic mean value is higher, the concentration degree of expert opinions is higher, and the indicators are more important. The variation coefficient value represents the degree of coordination of the expert opinions. When its value is smaller, the index is less controversial. Finally, the evaluation index system of low-carbon behaviour in scenic spots as shown in Table 2 is determined, which is divided into five categories and has a total of thirty eight questions.

4.1.3. Index Weight of LCBP in Scenic Spots

Based on the construction of the low-carbon behaviour evaluation index system, this paper adopts the AHP to determine the weight of each index. To ensure the reliability of the index weight, we sent questionnaires to the 20 experts in the expert group again and asked them to make judgments on the importance of the same level of secondary and tertiary indicators. The specific steps are as follows:

(1) A pair wise comparison of the importance degree between the factors was implemented based on the interaction between various factors, and it was scored on a scale from 1–9 to establish a judgment matrix of hierarchical factors and to obtain the correlation weight system value and weight value of the various factors.

(2) To ensure the rationality of the AHP results, it is also necessary to ensure the general consistency of the constructed judgment matrix, that is, the consistency coefficient $CR \leq 0.1$; otherwise, it is necessary to readjust the judgment matrix.

(3) A total of 20 questionnaires were issued, and 17 were recovered, with a recovery rate of 85%. After averaging the statistical data of the questionnaire, the weight of the low-carbon performance indicators are presented in Table 2.

Table 2. The indicators and weights of scenic spots' LCBP.

First-Level	Second-Level	Weight	Third-Level	Weight
Low-carbon behaviour evaluation index system for scenic spot	Low-carbon design CR = 0.0032	0.149	Localization of building materials, environmental nature, recycling of building materials	0.263
			Reasonable design of building structure	0.086
			Building site without damaging the terrain	0.023
			Building site selection to minimize the destruction of the original ecosystem	0.084
			Increase the green coverage rate	0.041
			Building external insulation, warm in winter and cool in summer	0.154
			Ecological walking trail construction	0.263
			Guide signs that use ecological materials	0.042
			Built ecological parking	0.041
	Daily energy conservation CR = 0.0025	0.256	Many outdoor tourism activities, reducing equipment and energy consumption	0.027
			Energy-saving lamps (indoor lights and outdoor streetlights)	0.249
			Try to adopt new energy resources of solar and wind energy	0.029
			Monitor and manage energy-consuming equipment	0.223
			Use the building ventilation system to adjust the room temperature	0.099
			Provide low-energy accommodations such as tents	0.055
			Promote low-carbon green power vehicles (cars)	0.261
			Provide personalized energy-saving vehicles such as skids and sedan chairs	0.053
	Water saving management CR = 0.0062	0.087	Equipped with a circulating water flushing ecological toilet	0.210
			Adopt an intelligent inductive water-saving system	0.210
			Use of water-saving recycling technology	0.115
			Set up of a rainwater centralized treatment system	0.043
			Control the discharge of harmful sewage	0.349
			Reception facilities with water-saving cleaning technology	0.043
			Increase the permeable pavement of the scenic spot	0.026
	Waste reduction CR = 0.0035	0.457	Set up the garbage collection station in the scenic spot	0.261
			Trash can for ecological materials	0.032
			Distribution density of sorting trash cans	0.098
			Classification and recycling of wastes	0.158
			Harmless disposal of unrecoverable waste	0.093
			Green recycling equipment is provided in accommodation facilities	0.287
			Use environmentally friendly bags	0.034
			Use degradable plastic to pack tourist souvenirs	0.032
	Low-carbon awareness CR = 0.0022	0.048	Activities of "carbon offset" in scenic spot	0.125
			Promote the construction of low-carbon scenic spots through WeChat, Weibo, etc.	0.062
			Scientific planning of low-carbon scenic spot construction	0.357
			Monthly training in low-carbon tourism knowledge for employees	0.357
			Recruit and solicit feedback from tourists on the low-carbon management of scenic spots	0.034
			Investment in low-carbon scenic spot construction	0.062

4.1.4. Measurement of the LCBP in Scenic Spots

The total value of the low-carbon behaviour evaluation index in scenic spots was set as *LCBP*. The score of the five primary indices of low-carbon design, daily energy saving, water-saving management, waste reduction and the scenic area of low-carbon awareness was L_1, L_2, L_3, L_4 and L_5, respectively, the actual evaluation score of each secondary index is P_{ij}, and the weights of the first and second indices are W_i and W_{ij}, respectively.

$$LCBP = \sum_{i=1}^{5} L_i,\ L_i = W_i \cdot \sum P_{ij} \cdot W_{ij} \tag{1}$$

When $i = 1$ then $j = 9$, when $i = 2$ then $j = 8$, when $i = 3$ then $j = 7$, when $i = 4$ then $j = 8$, and when $i = 5$ then $j = 6$.

4.2. Influencing Factors of LCBP in Scenic Spots

4.2.1. Construction of an Indicator System

In China, local governments, as the substantive representatives of government departments in exercising scenic spot power, are not only the managers and supervisors in the operation process of scenic spots but also the economic subjects of scenic spots. The administration committee is a management organization directly appointed by the local government, which is the final executor of scenic spot decision-making and one of the two major business subjects. Its low-carbon consciousness and behavioural motivation will affect the choice of low-carbon behaviour. As another business entity of the scenic spot, investors have legitimacy and power over the scenic spot and are also in a strong position for low-carbon behaviour decision-making. At the same time, the scenic spot is subject to multiple pressures from other scenic spots, tourists, community residents and other core stakeholders, and the LCBP also faces different degrees of interest demands. Based on the internal motivation and external pressure in the implementation of low-carbon behaviours in Zhangjiajie scenic spots, this study develops scale factors that influence the low-carbon behaviour performance of scenic spots based on the tourism stakeholder theory [6,57–61] that can significantly influence the LCBP (Table 3).

Table 3. The driving indicators of scenic spots' LCBP.

Stakeholders	Code	Indicators
Local government	G_1	Restrictions from the Tourism Law
	G_2	Cyclic supervision of the environment in scenic spots
	G_3	Increasing support for demonstrating low-carbon scenic spots
Administration committee	M_1	Multiple requirements on enterprises from the detailed environmental regulations
	M_2	Frequent and strict environmental regulation
Investors of scenic spots	I_1	Reduce the cost of environmental governance
	I_2	The application of financial loans to comprehensive environmental governance
	I_3	Establishment of friendly relations with the government
	I_4	Establishment of an enterprise's brand image
	I_5	Fulfilment of enterprises' environmental responsibility
Surrounding scenic spots	O	Low-carbon construction of surrounding scenic spots
Tourists	TO	Zeal of tourists for low-carbon tourism products
Residents	D	Willingness of original residents to protect the environment

4.2.2. Research Methods and Data Processing

Redundancy analysis (RDA) is a linear analysis method based on sorting techniques. RDA can statistically evaluate the relationship between one or a set of variables and another, and it is a very effective means and method to eliminate collinearity among variables; its greatest advantage that it independently maintains the contribution rate of each explanatory variable to the response variable [62]. Thus, RDA has been successfully applied in the ecological environment field [63–66].

Through in-depth interviews, the degree of the effect of each factor on the low-carbon behaviour selection in the scenic spot was scored according to the five-level scoring standard. Specifically, "1" expresses the degree of the weakest role, and "5" is the strongest. Furthermore, explore the indicators that can significantly affect the low-carbon behaviour and clarify the order of scenic spots and the driving factors. First, divide trend correspondence analysis (DCA) was carried out. Since the gradient of the sorting axis was less than 3, the selection model (PCA, RDA) was more applicable [65]. Followed by the effective evaluation of different driving factors in the interaction between the relationships, collinearity was eliminated between the impact factors to maintain the contribution rate of the explained variables to the corresponding variable. RDA was adopted in this study for the sorting analysis, which mainly consists of two kinds of RDA analysis. First, all the impact factors were selected for comprehensive analysis and for characterizing the corresponding relation of LCBP, scenic spot and the impact factors. Second, manual selection was adopted to explore the key factors that can significantly affect the low-carbon behaviour performance ($p < 0.05$), and the redundant variables with weak action intensity were removed.

4.3. Survey Objects and Data Collection

The research objects in this paper mainly include nine AAAAA scenic spots, eleven AAAA and four AAA scenic spots and eight non-A-level scenic spots in Zhangjiajie, which are divided into group A, group B and group C, respectively, according to the level of scenic spots (Table 4). Before the members of the research team began, they received relevant training. The members of the research team not only understood the relevant information of the 32 scenic spots under investigation but also had a clear interpretation of each measurement index of the low-carbon behaviour index system, and they were able to make a quick and appropriate evaluation of the various low-carbon behaviours of scenic spots. Meanwhile, through in-depth interviews with the management of the scenic spot management committee, we can grasp the factors that affect the low-carbon behaviour of the scenic spot.

Table 4. The classification of the scenic spots in Zhangjiajie (Source: Ministry of Culture and Tourism of the People's Republic of China (https://www.mct.gov.cn/; and Hunan Province Department of Culture and Tourism: http://lfw.hunan.gov.cn/)).

Group	Rank	Name	Group	Rank	Name
Group A (9)	AAAAA	Tianzi Mountain	Group B (15)	AAAA	Helong Memorial Hall
	AAAAA	Huangshi Village		AAAA	Jiangya Hot Springs
	AAAAA	Tianmen Mountain		AAAA	Kuzhu Village
	AAAAA	Yuanjiajie		AAAA	Dayong Town
	AAAAA	Suoxiyu		AAA	Zixia Temple
	AAAAA	Jinbianxi		AAA	Green Land Sightseeing Garden
	AAAAA	Bailong Elevator		AAA	Science and Technology Hall of Giant Slamander
	AAAAA	Yangjiajie		AAA	Junsheng Gallery
	AAAAA	Ten-mile Natural Gallery	Group C (8)	Non-A	Zhangjiajie Grand Gorge
Group B (15)	AAAA	Huanglong Cave		Non-A	Puguang Temple
	AAAA	Baofeng Lake		Non-A	Martyrs' Cemetery
	AAAA	Wanfu Hot Springs		Non-A	Wulei Mountain
	AAAA	Longwang Cave		Non-A	Badagongshan Natural Reserve
	AAAA	Tujia Folk Garden		Non-A	Jade Emperor Grottoes
	AAAA	Jiutian Cave		Non-A	The Old Yard
	AAAA	Maoyan River		Non-A	He Long's Former Residence

The questionnaire consists of three sections. Section 1 is the basic information of the scenic spot, which includes the level and geographical location of the scenic spot. Section 2 is the low-carbon behaviour evaluation index system of the scenic spot, which includes 38 measurement indices in five categories. Section 3 is the influencing factors of the low-carbon behaviour performance in scenic spots, which includes 13 items. From 5–25 October 2018, the research team went to each scenic spot for on-site investigating, recording and scoring. A total of 600 questionnaires were distributed in the field with 200 each in groups A, B and C. Forty-seven questionnaires with incomplete answers, incomplete completion and obvious logic errors were eliminated, and 553 valid questionnaires were obtained, which accounts for 92.2% of the total questionnaires distributed.

5. Findings

5.1. Reliability and Validity

In this study, the Cronbach's alpha coefficient is used to test the reliability of the questionnaire. The results show that the total reliability of the questionnaire is 0.895. In Section 2 of the questionnaire, the Cronbach's coefficient of the five major indicators of the low-carbon behaviour group is greater than or close to 0.75. The reliability of the index group of the low-carbon behaviour driving factors in the third part of scenic spots is 0.835, which indicates that the indicators of each project have good reliability. The qualitative evaluation method of expert subjective judgment is used to test the validity of the questionnaire, which is assessed by the 20 experts to be of high validity. The results show that the factor load of each measurement index on the measurement variable is highly significant and that the average extraction variance (AVE) value of all variables is greater than 0.5. At the same time, the square root of the AVE is larger than the correlation coefficient among the variables, which fully shows that the questionnaire convergence and discrimination have good validity.

5.2. Evaluation of LCBP in Scenic Spots

5.2.1. Low-Carbon Design

Low-carbon design is the key link and important foundation of the low-carbon planning and construction of scenic spots [28]. As seen from Table 5, among the nine indicators of low-carbon design, the overall mean scores of the three indicators of "building site selection to minimize the destruction of the original ecosystem", "reasonable design of building structure", and "building site without damaging the terrain" are listed in the top three (4.07, 4.06, and 4.05, respectively), which indicates that the site selection and layout of most scenic spots (points) in Zhangjiajie have fully considered the integration with regional geological landforms and the ecological environment. In the selection of building materials, many scenic spots actively respond to the call of "localization of building materials, environmental nature, recycling of building materials" (3.06), and the mountainous scenic spots represented by the Wulingyuan-Tianzi Mountain scenic spot adapt measures according to local conditions, use local materials and integrate into nature to build fences with rattan and wood strips as raw materials. However, the environmental protection of the building materials for the scenic spots dominated by leisure and entertainment, such as Wanfu Hot Springs and Jiangya Hot Springs, is inferior. In terms of energy conservation and emissions reduction, only a few scenic spots save energy and reduce consumption by increasing the green coverage rate and using thermal insulation to build external walls (2.48, 2.92). The walking path is a multi-functional regional corridor that integrates leisure, sightseeing and cultural displays. Many scenic spots are natural and original in their ecological construction (3.76). Groups B and Group C still have a long way to go in "guide signs that use ecological materials" (2.64 and 2.47, respectively). As one of the most important components of infrastructure in the scenic spots, the penetration rate of ecological parking lots in Zhangjiajie scenic spots is low (1.92). This is an urgent need that requires attention from the relevant departments.

Table 5. Mean distribution of the scenic spots' LCBP indicators in Zhangjiajie.

Low-Carbon Behaviour Indicator	Group A Mean	Group B Mean	Group C Mean	Total Mean	Scenic Spot of Single Index Highest Score	
Low-carbon design					Scenic Spot	Score
Localization of building materials, environmental nature, recycling of building materials	3.09	2.99	3.10	3.06	Tianzi Mountain	4.05
Reasonable design of building structure	4.15	3.97	4.11	4.06	Suoxiyu	4.75
Building site without damaging the terrain	3.89	4.13	4.10	4.05	Yangjiajie	4.81
Building site selection to minimize the destruction of the original ecosystem	4.19	4.03	4.02	4.07	Tianzi Mountain	4.71
Increase the green coverage rate	2.32	2.78	2.35	2.48	Dayong Town	3.80
Building external insulation, warm in winter and cool in summer	2.50	3.24	2.86	2.92	Huanglong Cave	4.33
Ecological walking trail construction	4.07	3.71	3.52	3.76	Huanglong Cave	4.89
Guide signs that use ecological materials	3.50	2.64	2.47	2.87	Longwang Cave	4.80
Built ecological parking	2.05	2.02	1.68	1.92	Huanglong Cave	3.40
Group means	3.31	3.28	3.13	3.24		
L_1	0.51	0.50	0.48	0.49		
Daily energy conservation						
Many outdoor tourism activities, reducing equipment and energy consumption	3.95	2.79	3.21	3.24	Maoyan River	4.78
Energy-saving lamps (indoor lights and outdoor streetlights)	3.77	3.63	2.99	3.49	Junsheng Gallery	4.89
Try to adopt new energy resources of solar and wind energy	1.31	1.30	1.36	1.32	Baofeng Lake	3.15
Monitor and manage energy-consuming equipment	2.55	2.64	1.68	2.34	Longwang Cave	3.65
Use the building ventilation system to adjust the room temperature	3.08	2.73	2.80	2.85	Yuanjiajie	4.25
Provide low-energy accommodations such as tents	3.50	2.60	2.30	2.80	Maoyan River	4.69
Promote low-carbon green power vehicles (cars)	4.12	2.26	3.27	3.07	Huanglong Cave	4.68
Provide personalized energy-saving vehicles such as skids and sedan chairs	3.64	1.60	1.78	2.22	Jinbianxi	4.36
Group means	3.24	2.44	2.42	2.67		
L_2	0.88	0.70	0.67	0.74		
Water-saving management						
Equipped with a circulating water flushing ecological toilet	2.84	2.63	2.53	2.66	Zhangjiajie Grand Gorge	4.88
Adopt an intelligent inductive water-saving system	2.80	3.07	2.49	2.83	Huangshi Village	4.57
Use water-saving recycling technology	2.14	2.05	1.91	2.03	Huangshi Village	3.21
Set up the rainwater centralized treatment system	1.39	1.51	1.76	1.55	Huangshi Village	3.59
Control the discharge of harmful sewage	3.50	3.00	2.60	3.03	Huanglong Cave	4.20
Reception facilities with water-saving cleaning technology	2.08	2.38	2.05	2.21	Jiangya Hot Springs	3.26
Increase the permeable pavement of the scenic spot	4.20	3.60	4.05	3.95	Huanglong Cave	4.98
Group means	2.71	2.60	2.48	2.61		
L_3	0.25	0.24	0.21	0.24		

Table 5. *Cont.*

Low-Carbon Behaviour Indicator	Group A Mean	Group B Mean	Group C Mean	Total Mean	Scenic Spot of Single Index Highest Score	
Waste reduction						
Set up a garbage collection station in a scenic spot	4.15	3.28	2.51	3.31	Tianzi Mountain	4.95
Trash can for ecological materials	3.80	3.30	2.60	3.23	Huanglong Cave	4.90
Distribution density of sorting trash cans	3.44	3.04	2.61	3.03	Huanglong Cave	5.00
Classification and recycling of wastes	2.41	2.21	1.97	2.20	Huanglong Cave	3.31
Harmless disposal of unrecoverable waste	3.75	3.45	3.35	3.51	Jinbianxi	3.75
Green recycling equipment is provided in accommodation facilities	4.08	3.99	4.04	4.03	Junsheng Gallery	4.45
Use environment-friendly bags	2.00	1.50	1.30	1.60	Wanfu Hot Springs	2.25
Use degradable plastic to pack tourist souvenirs	4.45	3.85	4.00	4.10	Ten-mile Natural Gallery	4.77
Group means	3.51	3.08	2.80	3.13		
L_4	1.68	1.49	1.36	1.51		
Low-carbon awareness						
Activities of "carbon offset" in a scenic spot	2.19	1.65	1.57	1.80	Yangjiajie	3.50
Promote the construction of low-carbon scenic spots through WeChat, Weibo, etc.	2.25	1.45	1.87	1.86	Zhangjiajie Grand Gorge	4.30
Scientific planning of low-carbon scenic spot construction	3.55	2.80	2.77	3.04	Baofeng Lake	4.00
Monthly training of employees in low-carbon tourism knowledge	2.24	1.30	1.23	1.55	Longwang Cave	2.51
Recruit and solicit feedback from tourists' on the low -carbon management of scenic spots	2.40	1.69	1.55	1.85	Tianmen Mountain	3.11
Investment in low-carbon scenic spot construction	2.80	1.67	1.60	2.02	Ten-mile Natural Gallery	2.58
Group means	2.57	1.76	1.77	2.02		
L_5	0.13	0.09	0.09	0.11		
LCBP	3.45	3.02	2.81	3.10		

5.2.2. Daily Energy Conservation

Table 5 shows that the scenic spots of group A actively carry out experiential and interesting outdoor tourism activities, slow the speed of construction material and energy consumption (3.95), such as the Science and Technology Hall of Giant Slamander, Huanglong Cave, and actively develop experience and outdoor leisure projects. All of these measures can improve tourist scenic attractions and disperse crowds, which reduces the carbon footprint of the scenic spot to a certain extent [67]. Most scenic spots in Zhangjiajie adopt building ventilation systems and energy-saving lights, and the overall mean score of the two indices reaches 2.85 and 3.49, respectively. Except for a few scenic spots, such as Baofeng Lake and Huangshi Village, new energy sources, such as bio-energy, wind energy and solar energy are rarely fully utilized in the Zhangjiajie scenic spots (1.32), and the penetration rate of the monitoring system of energy-consuming devices is relatively low (2.34). In addition, the AAAAA scenic spot actively promotes low-carbon green power vehicles (cars) and strives to reduce or even eliminate exhaust emissions (4.12). To meet the personalized and diversified travel and transportation needs of tourists, personalized energy-saving transportation tools, such as slides and sedan chairs, are provided for tourists (3.64). Limited by their own conditions, only a few scenic spots provide tents and other low-energy accommodation facilities (2.80).

5.2.3. Water-Saving Management

Among the seven low-carbon behavioural indicators of “water-saving management”, the overall mean score of “increase permeable pavement of scenic spots” is the highest (3.95). With the increase in government environmental supervision, most scenic spots have begun to strictly control the discharge of harmful sewage (3.03) and actively use an intelligent induction water-saving system (2.83). Nevertheless, the terminal treatment of water resources in the three groups of scenic spots is slightly inadequate, and water-saving recycling technology has not been popularized (2.14, 2.05, 1.91). The climate of Zhangjiajie is a subtropical mountain prototypical monsoon humid climate, with an annual precipitation of up to 1400 mm (Source: Baike. Baidu (https://baike.baidu.com/item/Zhangjiajie/370496#reference-[9]-19051-wrap)) but only a few scenic spots, such as Huangshizhai, use a rainwater centralized treatment system (1.55). In addition, due to the difficulties in financing, slow financing, expensive financing and from expensive equipment, it is difficult for most scenic spots to adopt water-saving cleaning technology (2.21). Tourist toilets are a necessary facility for tourists and are also a prior symbol to show the tourism public service level. It was found that using recycled water for flushing toilets is not widely adopted in the Zhangjiajie District (2.66). Zhangjiajie Grand Gorge has actively responded to the “toilet revolution” by building smart and eco-friendly toilets and ecologically foaming toilets (4.88), but the traditional flushing toilets are still more common in other scenic spots. A few scenic spots, such as and Yangjiajie, still retain the old dry toilets, which are incompatible with the overall environment and atmosphere of the scenic spot and are extremely low in energy conservation and environmental protection.

5.2.4. Waste Reduction

Zhangjiajie actively responds to the call of “ecological civilization” construction and fully mobilizes enterprises, community residents, tourists and other subjects in the scenic spot to reduce waste in an all-round way [23]. Except for the low score of “using environment-friendly bags”, other practical links in the dimension of “waste reduction” all perform well. Residents in and outside the scenic spots reached a consensus to send household garbage to centralized garbage collection points, which is then sent to the garbage disposal station in Yongding District for green treatment by special garbage collection vehicles. Most of the AAAAA scenic spots in Zhangjiajie have established garbage collection stations (4.15). For example, the Tianzi Mountain scientifically planned and constructed a centralized garbage recycling station to facilitate the centralized treatment of garbage in the scenic spot according to the density of tourists in the low and peak tourist seasons (4.95). Whereas, some of the centralized garbage recycling stations with lower levels are far away from one another and have insufficient garbage throughput. Garbage bin design is an important reflection of the cultural connotation and public service level of the scenic spots. A sorting trash can with environmental protection quality was selected in Huanglong Cave, which fully integrates into the overall environment of the scenic spot and emphasizes the cultural connotation of the scenic spot and the large distribution density. In Zixiaguan, Tianmen Mountain and other scenic spots, garbage sorting identification is unclear, and it is, therefore, easy to mislead tourists to input garbage and, thus, lose the sorting function. The three groups of scenic spots (A, B and C) performed well in "use biodegradable plastic to pack tourist souvenirs" (4.45, 3.85 and 4.00, respectively), which curbs the production of waste at the source.

5.2.5. Low-Carbon Awareness

Table 5 shows that the group mean of low-carbon awareness is only 2.02, which is the lowest score in the five categories of indicators, except that the score of the "scientific planning of low-carbon scenic spot construction" is slightly higher (3.04); however, other indicators all score at a low level. The visits find that the Zhangjiajie low-carbon attractions construction investment is insufficient (2.02), Zhangjiajie rarely carry out "carbon offset" and other environmental protection and public welfare activities (1.80), and even the staff of the Wulingyuan-Tianmen Mountain scenic spot almost all agree that the scenic spot has a good ecological environment, high green coverage rate, and high carbon neutral intensity so that there is no need to add a low-carbon practice link of carbon offset. According to the survey, out of the 32 scenic spots, only a few such as Zhangjiajie Grand Gorge are consistent with the trend of a low-carbon economy and promote low-carbon knowledge through new media, such as its WeChat official account, Headline News and Weibo (4.30). Most scenic spots indicate that they did not organize monthly staff training on low-carbon tourism knowledge (1.55), and even some scenic spots have never organized such training activities so that employees are indifferent to the construction of low-carbon scenic spots. With the help of various network information platforms, the Tianmen Mountain scenic spot actively maintains a benign interaction with tourists, collects suggestions and opinions from tourists on the low-carbon management of the scenic spot, and gives different forms of rewards to tourists who provide their opinions to promote the low-carbon construction of the scenic spot (3.11).

5.2.6. The Score of LCBP for 32 Scenic Spots

It can be seen from Table 6 that the Huanglong Cave (AAAA) vigorously promotes its low-carbon construction, and its low-carbon behaviour performance ranks first place, which makes it the best model to establish the concept of ecological environmental protection and the construction of a low-carbon scenic spot. Zhangjiajie Grand Gorge (non-A) integrates the low-carbon concept into its planning, construction, operation and management, and has become a dark horse in the practice of low-carbon tourism. It is worth noting that with AAAA Karst landscape, the Longwang Cave and Jiutian Cave are numbers 14 and 18, respectively, which may relate to the stage of the life cycle of tourism scenic spots, and their LCBP is far from Huanglong Cave. Both Longwang Cave and Jiutian Cave are in the "in phase" stage. In these scenic spots, tourists increase gradually and form a certain proportion of the tourism market, but the limited funds are often used to improve tourism infrastructure in the scenic spot; therefore, low-carbon construction investment is stretched, whereas Huanglong Cave is in the "development" stage. The tourism market was rapidly formed and is constantly expanding, and the scenic spot continues to increase the capital investment in low-carbon construction; thus, its low-carbon behaviour performance is far ahead. Constrained by an insufficient abundance of tourism resources, it is difficult for He Long's Former Residence to play its role in the construction of low-carbon scenic spots, and its LCBP ranks last among the 32 scenic spots.

Table 6. LCBP and ranking of 32 scenic spots in Zhangjiajie.

Ranking	Scenic Area/Spot	LCBP	Ranking	Scenic Area/Spot	LCBP
1	Huanglong Cave	4.19	17	Martyrs' Cemetery	3.22
2	Tianzi Mountain	4.18	18	Jiutian Cave	3.17
3	Huangshi Village	4.10	19	Maoyan River	3.10
4	Tianmen Mountain	3.82	20	Wulei Mountain	3.09
5	Yuanjiajie	3.80	21	Science & Technology Hall of Giant Salamander	3.08
6	Suoxiyu	3.74	22	Jiangya Hot Springs	3.04
7	Zhangjiajie Grand Gorge	3.67	23	Dayong Town	3.02
8	Jinbianxi	3.66	24	Junsheng Gallery	2.97
9	Bailong Elevator	3.54	25	Zixia Temple	2.96
10	Yangjiajie	3.53	26	Badagongshan Natural Reserve	2.95
11	Ten-mile Natural Gallery	3.47	27	Green Land Sightseeing Garden	2.91
12	Baofeng Lake	3.46	28	Jade Emperor Grottoes	2.86
13	Wanfu Hot Springs	3.29	29	The Old Yard	2.71
14	Longwang Cave	3.29	30	Kuzhu Village	2.70
15	Helong Memorial Hall	3.27	31	Puguang Temple	2.59
16	Tujia Folk Garden	3.22	32	He Long's Former Residence	2.39

5.3. The Driving Factors of LCBP in Scenic Spots

The RDA_1 results of the driving factors and LCBP showed that all ranking axes are significant ($P = 0.004$), the sorting result is ideal, and the total eigenvalue interpretation proportion is 78.3%. The cumulative explanation information of the first ranking axis is as high as 67.8%, whereas those of the second sort axis are only 8.7% (Table 7). Thus, the first ranking axis can fully express the change of LCBP.

Table 7. RDA ranking results between LCBP and the driving forces.

Parameter	RDA_1		RDA_2	
Sum of all canonical eigenvalues	0.783		0.726	
Axis	Axis 1	Axis 2	Axis 1	Axis 2
Eigenvalues	0.678	0.087	0.653	0.074
LCBP-driving force correlations	0.914	0.916	0.888	0.837
Cumulative percentage variance of LCBP	67.8%	76.5%	65.3%	72.7%
Cumulative percentage variance of LCBP-driving force relations	86.4%	97.8%	88.6%	98.7%

To explain all the driving factors of LCBP, according to the significance and importance of each factor (Table 8), the factors express the scenic area according to investors, such as to "reduce the cost of environmental governance", "the application of financial loans to comprehensive environmental governance", and "establishment of friendly relations with the government", according to the scenic area management office, such as "multiple requirements on enterprises from the detailed environmental regulations", "frequent and strict environmental monitoring", according to the local government, "increasing support for demonstrating low-carbon scenic spots", and according to tourists' "zeal of tourists for low-carbon tourism products". All have 95% confidence, which can significantly affect the performance of the scenic spot to engage in low-carbon behaviours.

Table 8. Importance and significance test results of the driving factors' interpretation.

Driving Factor	*P*	Importance	Driving Factor	*P*	Importance
I_1	0.002	0.525	I_4	0.074	0.100
I_2	0.002	0.473	I_5	0.066	0.097
I_3	0.002	0.370	G_1	0.110	0.075
M_2	0.002	0.281	T	0.138	0.073
G_3	0.010	0.198	G_2	0.114	0.067
M_1	0.040	0.134	O	0.350	0.033
TO	0.028	0.130			

RDA analysis (RDA_2) is conducted on the seven key drivers that can significantly affect the LCBP of scenic spots, and the results show that the correlation coefficient between the LCBP and the drivers is 0.888, which indicates that the correlation between the LCBP and the drivers is very obvious on the first ranking axis. The two major sorting axes can cumulatively explain 72.7% of the LCBP data information and 98.7% of the LCBP-and driving factor-related information, which fully indicates that the above 7 indicators can be used as the key indicators to characterize the relationship between the LCBP and the drivers.

The shift cumulative percentage and LCBP in the first and second axes can be found by contrasting and analysing RDA_1 and RDA_2. The cumulative percentage difference of the changes in the driving factors' relationship is rather small, and the second sort shaft provides little information, which proves that the different dynamic conditions of the LCBP reified and were expressed in the first shaft again.

It can be observed that the cluster tendency of the low-carbon behavioural performance of the explained variables is significant along the first ranking axis by interpreting the RDA results of the seven driving factors. In view of the explanatory variables, the correlations between "reduce the cost of environmental governance", "the application of financial loan on the comprehensive environmental governance", "establishment of friendly relations with the government", "multiple requirements on the enterprises from the detailed environmental regulations", "increasing support for demonstrating low-carbon scenic spots" and the first sorting shaft are higher than their correlations with the second sorting shaft. However, compared with the "reduce the cost of environmental governance" and "the application of financial loan on the comprehensive environmental governance", the degree of the role in "establishment of friendly relations with the government", "multiple requirements on the enterprises from the detailed environmental regulations" and "increasing support for demonstrating low-carbon scenic spots" is slightly weak. "zeal of tourists for low-carbon tourism products" and "frequent and strict environmental supervision" fall into the second ranking axis, but "frequent and strict environmental supervision" is closely related to the two ranking axes (Figure 2). The information interpretation amount of the two axes and the connecting length of each driving factor in the figure indicate that the pressure from the scenic spot management office, scenic spot investors, local governments and tourists is the key driving factor that affects the LCBP of Zhangjiajie scenic spots. Only 10 scenic spots are obviously affected by the independent driving factors, which accounts for 31% of the total sample of scenic spots, including the four scenic spots with the best LCBP, namely, Huanglong Cave (rank 1), Tianzi Mountain (rank 2), Huangshi Village (rank 3) and Tianmen Mountain (rank 4), and the four scenic spots ranked low in LCBP, namely, Junsheng Gallery (rank 24), Yuhuang Grottoes (rank 28), The Old Yard (rank 29) and He Long's Former Residence (rank 32). The other 22 scenic spots are affected by multiple driving factors.

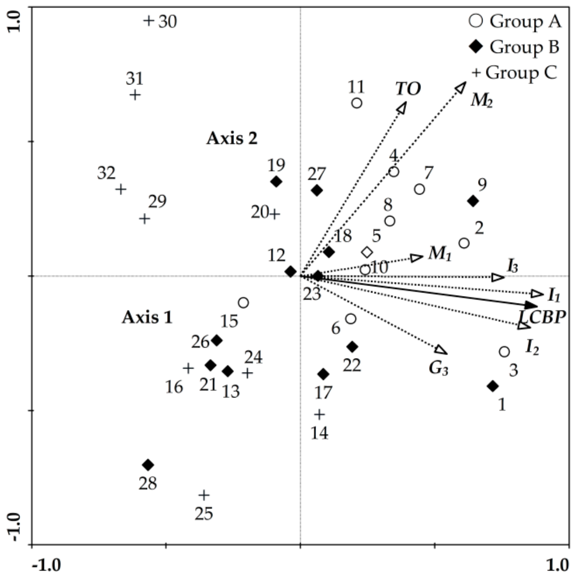

Figure 2. RDA results of the LCBP of scenic spots in Zhangjiajie and the seven driving factors.

6. Discussion

Thus far, although the initiative to build low-carbon scenic spots has been widely acclaimed around the world, China has provided neither a strict definition of low-carbon scenic spots nor a more scientific and accurate system to consider whether the LCBP meets high standards [28,45]. Therefore, the literature available on the LCBP in and the driving factors for scenic spots is limited. Our research takes this deficiency as an opportunity to conduct a tentative study. The Delphi method and AHP were taken to quantitatively evaluate the LCBP of 32 scenic spots in Zhangjiajie. At the same time, this article clarifies the key factors influencing LCBP in the scenic spot, which is an important idea and practical instruction significance in making effective environmental policy by using RDA.

Overall, the low-carbon behaviour in Zhangjiajie performs well. The weighted LCBP group averaged 3.10, nevertheless there is still a lot of room for improvement and promotion. The average score of the performance group in low-carbon design, the management of daily energy saving, water saving, waste reduction and low-carbon awareness was 0.49, 0.74, 0.24, 1.51 and 0.11, respectively. Among the five low-carbon behaviour measurement projects, the score of waste reduction was the highest, and the low-carbon awareness performance was the most deficient in scenic spots. Currently, the concept of low carbon has become an irresistible social phenomenon, and environmental and energy issues have entered the common sense of the public. The low-carbon awareness is still the obstacle to scenic spots enhance low-carbon behaviour. This observation also reflects that the current market environment for cultivating scenic spots with good low-carbon behaviours is far from mature, which requires the joint efforts of all stakeholders in tourist attraction, a conclusion that is similar to the studies conducted by Zhang [7].

The LCBP in scenic spots is because of the dynamic game of balancing multiple interests among multiple interest subjects [27]. According to the RDA, pressures from investors, administration committee, tourists and local government are main driving factors for low-carbon behaviours in scenic spots. In the low-carbon construction, local governments play a leading role in resource allocation and interest division, and interest pursuit and value orientation are the key factors that affect the low-carbon behaviour of scenic spots, which is also consistent with the research conclusion of Cheng et al. [6] The landscape management office is the accredited institution for the local government supervision of scenic spots, which can directly use its authority to exert more powerful positive guidance on the low-carbon behaviour; thus, it is an momentous factor to promote the low-carbon governance of scenic spots. As one of the most important market subjects, investors have power and legitimacy over scenic spots. The low-carbon awareness and investment of these investors in low-carbon construction directly affect the LCBP [55,68]. Tourists are the basis of the survival of scenic spots, and their low-carbon value identification and behaviour choice affect to some extent the low-carbon construction level of scenic spots, which is similar to the finding from the study conducted by Becken et al [60].

There are three major contributions of this study as follows. First, this study discusses the trend of low-carbon behaviour of scenic spots, the influencing factors and mechanism from the perspective of micro dynamics in Zhangjiajie. This "bottom-up" consideration provides a new idea for the environmental management and sustainable development of all scenic spots at Zhangjiajie world heritage site in theory, which will help deepen and develop the basic theoretical research on tourism. Second, this study defines the research variables from the operating level. Accordingly, a measurement scale of low-carbon behaviour and the influencing factors in scenic spots is developed. In addition, the interaction mechanism between the low-carbon behaviour and various influencing factors is analysed to realize the transformation of the research on the low-carbon behaviour of scenic spots from a single factor to comprehensive factors. This approach can also provide the possibility of promoting the transformation of scenic spots from passive feedback behaviour under environmental regulation to active decision-making behaviour under comprehensive factors. Third, 32 scenic spots at Zhangjiajie world heritage sites are taken as the research objects, and the comparative analysis is conducted by classification, which covers a wide range of areas and is highly representative. The data analysis method of plant community-RDA is introduced to study the influencing factors of low-carbon behaviour, and the theoretical framework of the influencing factors of low-carbon behaviour in scenic spots is more clearly and reasonably interpreted.

7. Conclusions

By using the Delphi method, AHP and RDA, this paper systematically evaluates the LCBP and reveals the key variables that affect the low-carbon behaviour in scenic spots. Research shows that the low-carbon behaviour of Zhangjiajie performs well. However, there is still a certain gap between this performance and Zhangjiajie's goal of building a low-carbon tourism demonstration zone. Most scenic spots have low average scores in the "low-carbon consciousness" item, and the weak low-carbon awareness has become the largest weakness that restricts the low-carbon construction. The LCBP in scenic spots is because of a dynamic game among multiple interest subjects. In the low-carbon construction, the pressure from local governments, the administrative committee, investors and tourists are the most important driving force that affect the low-carbon behaviour performance. This driving force is the resulting force of environmental regulation and the profit motive. The low-carbon development trend of the surrounding scenic spots and the environmental interests of the original residents have not had a significant impact on the low-carbon construction.

Based on the findings, this study proposes countermeasures to improve the low-carbon behaviour of Zhangjiajie scenic spots. Recommendations from the local governments and administration committees are mainly based on the improvement of low-carbon tourism laws and the establishment of a low-carbon scenic spot evaluation and certification system. Effective policy guidance should be well implemented, and rewards and punishment should be conducted simultaneously to advocate for low-carbon tourism scenic spot construction. The implementation of low-carbon policies needs to begin with details, government publicity and low-carbon environmental education should be strengthened, and a strong supervision mechanism should be established to urge scenic spots to accelerate the low-carbon tourism demonstration zone. The countermeasures at the investor-level mainly include raising the awareness of social responsibility, introducing low-carbon technology and strengthening the communication and cooperation among scenic spots. Based on the level of tourists, "tourists and scenic spots should be responsible for the effective supervision of low-carbon behaviour" [59].

Low-carbon behaviour in tourist attractions is a forward-looking and strategic proposition of the times. However, there are still the following deficiencies in this study. First, since few scholars systematically measure the LCBP of scenic spots, this study lacks standards for reference in the construction of the index system; thus, further improvement of the index system is needed in follow-up studies. Second, this study only measures LCBP of scenic spots in the same timeframe. Subsequent studies can compare the LCBP in different timeframes vertically to comprehensively understand the evolution of regulations of LCBP of scenic spots. Third, based on the analysis of low-carbon behaviours, a linkage analysis needs to be conducted to determine whether the spatial distribution pattern of carbon emissions is consistent with that of scenic spots to make carbon emissions reduction more targeted.

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