Public Perception Characteristics and Differentiation Analysis of the Ecological Development of Ice and Snow Sports in Daqing City

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Abstract

To accurately grasp the public foundation and perceptual differences in the ecological development of ice and snow sports in resource-based cities, this study takes 412 residents of Daqing City as the research object. Using the literature method, questionnaire survey method and mathematical statistics method, it conducts quantitative analysis from three dimensions: core cognition, current situation evaluation and participation willingness, and adds in-depth analysis perspectives such as mean ranking, coefficient of variation and dimensional correlation. The results show that residents of Daqing City have a good overall cognition of the ecological development of ice and snow sports. However, there are intra-dimensional differences in the depth of their cognition. Specifically, their understanding of ecological impacts and development risks is relatively weak. The overall evaluation of the current development situation of ice and snow sports by residents is at a moderate level, and there are significant individual differences in the evaluation of government investment, showing a disconnection characteristic of "cognition level being higher than actual evaluation". Residents' willingness to participate is generally positive, with a significant preference for ecological research and study and characteristic integration projects. The willingness to pay an ecological consumption premium is higher than the willingness to participate in basic sports, and the participation degree is positively correlated with the cognition level. Based on the perception characteristics and differentiated performance, targeted promotion strategies are proposed to provide refined references for the high-quality ecological development of ice and snow sports in Daqing City.

Keywords

Daqing City, Ice and snow sports, Ecological development, Public perception, Differentiation analysis

Introduction

The concept that "ice and snow are also gold and silver mountains" has driven the transformation of China's ice and snow sports into a stage of high-quality and sustainable development. The ecological transformation of ice and snow sports has become an important practice for the integrated development of ecological civilization construction and the sports industry [1]. As a core development area for ice and snow sports, Heilongjiang Province's exploration of the ecological development of ice and snow sports in its resource-based cities has the dual value of industrial transformation and ecological protection. As a typical petroleum resource-based city, Daqing has incorporated the development of ice and snow sports into the ecological priority framework in promoting diversified economic transformation. The public's cognition, evaluation and willingness to participate are the core social foundation for the ecological development of ice and snow sports [2].

Existing studies have initially explored the public foundation for the ecological development of ice and snow sports in Daqing City, but lack in-depth excavation of the intra-dimensional differences, discrete characteristics and cross-dimensional correlations of public perception. Based on the original survey data, this study uses mathematical analysis methods such as mean ranking and coefficient of variation to analyze the perceptual laws and differentiated performance of the public in the ecological development of ice and snow sports. It accurately identifies the advantages and

shortcomings in development and provides data support and practical paths for the refined policymaking of the ecological development of ice and snow sports in resource-based cities.

Research objects and methods

Research objects

The research objectives are residents of Daqing City who participate in or understand ice and snow sports, covering groups of different ages, occupations and levels of participation in ice and snow sports.

Research methods

(1) Literature method: By systematically combing and summarizing relevant domestic and foreign literature on the ecologicalization of ice and snow sports, public perception, and industrial transformation of resource-based cities, this paper sorts out the research context and theoretical basis, so as to provide solid theoretical support for the research design, analysis and discussion of this study.

(2) Questionnaire survey method: A structured questionnaire with a Likert 5-point scale was designed, covering three dimensions: core cognition, current situation evaluation and participation willingness (1 point = completely unaware/ completely dissatisfied/ completely unwilling, 5 points = very aware/ very satisfied/ very willing). A total of 440 questionnaires were distributed through a combination of online and offline approaches, among which 412 valid questionnaires were collected, with an effective recovery rate of 93.630%.

(3) Mathematical statistics method: On the basis of the original descriptive statistics and one-sample t-test, mean ranking was added to analyze the public's attention and preference characteristics of perception. The coefficient of variation was used to analyze the discrete degree and individual differences of perception. Cross-dimensional correlation analysis was conducted to explore the internal relationship among cognition, evaluation and willingness. All data were processed by SPSS 26.0.

(4) Logical analysis method: Combining the results of mathematical analysis, the public perception characteristics of the ecological development of ice and snow sports in Daqing City were summarized, and the differentiated development strategies were deduced.

Reliability and validity test

Reliability test showed that the Cronbach's Alpha coefficient and split-half reliability of the three dimensions (core cognition, current situation evaluation and participation willingness) were all between 0.884 and 0.908, indicating good questionnaire reliability. In the validity test, the KMO values were all greater than 0.900, the Bartlett test $p<0.05$, and the cumulative variance explanation rate was 55.304%-66.096%, indicating good structural validity of the questionnaire and scientificity and validity of the survey data (Table 1 and Table 2).

Table 1. Reliability test.

Scale	Number of items	Cronbach's Alpha	Split-half reliability
Core cognition	10	0.910	0.908
Current situation	6	0.897	0.884
Participation willingness	6	0.884	0.887

Table 2. Validity test.

Scale	KMO value	Bartlett's test p value	Cumulative variance explanation rate (%)
Core cognition	0.947	0.000	55.304
Current situation	0.908	0.001	66.096
Participation willingness	0.907	0.001	63.330

Research results and in-depth analysis

Basic characteristics of residents' participation in ice and snow sports in Daqing City

The survey shows that the participation rate of ice and snow sports among Daqing residents reaches 85.000%, of which 55.600% participate in sports on a regular basis, 29.400% participate occasionally, and 15.000% have never participated in such activities. Further cross-analysis found that the average score of residents who regularly participate in ice and snow sports in the core cognition dimension is 3.89, which is statistically significantly higher than that of occasional participants (3.72) and non-participants (3.25). This indicates that the degree of actual participation in ice and snow sports is positively correlated with residents' cognitive level of

ecologicalization, and the lack of participation experience is an important reason for the weak ecological cognition of some residents.

Characteristic and differentiation analysis of residents' core cognition of the ecologicalization of ice and snow sports

The core cognition dimension includes 10 items. The one-sample t-test shows that the difference for all items is statistically significant ($p<0.01$), which are all significantly higher than the neutral value of 3.00 points, indicating that residents' overall cognition toward ecologicalization is positive. In-depth analysis was conducted through mean ranking and coefficient of variation to further explore the differential characteristics within the cognition dimension (Table 3).

Table 3. Residents' understanding of the core cognition of the ecologicalization of ice and snow sports and in-depth analysis.

Item	Valid sample (N)	Mean ± standard deviation	t value	p value	Mean ranking	Coefficient of variation (CV)
Ecological concept of the 9th Asian Winter Games in Harbin	412	3.88±1.136	15.706	<0.01	1	0.293
Unique advantages of developing ecological ice and snow sports	412	3.83±1.006	16.745	<0.01	2	0.263
Importance of learning from the ecological experience of the Harbin Asian Winter Games	412	3.82±1.053	15.774	<0.01	3	0.276
Connotation of the ecological development of ice and snow sports	412	3.81±1.042	15.751	<0.01	4	0.273
Low-impact development as the core criterion for project planning	412	3.81±1.078	15.215	<0.01	4	0.283
Experience value of the integrated model of "ice and snow + wetland ecology"	412	3.77±1.087	14.452	<0.01	5	0.288
Concept of the ecological development of ice and snow sports	412	3.76±1.131	13.716	<0.01	6	0.301
Brand potential of the integrated model of "ice and snow + industrial heritage"	412	3.76±1.075	14.341	<0.01	6	0.286
Degree of ecological environmental impact of ice and snow sports	412	3.74±1.085	13.806	<0.01	7	0.290
Risk of wetland ecological damage caused by over-development	412	3.74±1.039	14.415	<0.01	7	0.278

From the perspective of mean ranking, residents' cognition has obvious characteristics of prominent key points and significant shortcomings:

(1) The cognition score of the ecological concept of the 9th Asian Winter Games in Harbin is the highest (3.88), indicating that the ecological concept communication of large-scale ice and snow events has strong public penetration. Events have become an important carrier for the popularization of ecological ice and snow concepts.

(2) The cognition scores of the degree of ecological environmental impact of ice and snow sports and the risk of wetland ecological damage caused by over-development are the lowest (both 3.74). This reflects that residents' understanding of the risk cognition and underlying logic of the ecological

development of ice and snow sports is relatively weak. Their understanding of "ecologicalization" mostly stays at the positive conceptual level rather than the practical level of "low impact and risk prevention" [3].

(3) The cognition scores of the local characteristic integrated models of "ice and snow + industrial heritage" and "ice and snow + wetland ecology" are at a moderate level (3.76-3.77). This indicates that the publicity and promotion of Daqing's local characteristic ecological ice and snow models have not formed sufficient public awareness.

From the perspective of the coefficient of variation, there are differences in the discrete degree of residents' cognition:

(1) The coefficient of variation of the concept of the ecological development of ice and snow sports is the highest (0.301), indicating that there are the greatest differences in residents' understanding of this core concept. Some residents only stay at the literal cognition, while others form an in-depth understanding.

(2) The coefficient of variation of the unique advantages of developing ecological ice and snow sports is the lowest (0.263). This indicates that Daqing residents have formed a relatively consistent cognition of the local resource advantages (ice and snow resources, wetland resources, industrial heritage resources) for developing ecological ice and snow sports. It is a natural advantage for the ecological development of ice and snow sports.

Characteristic and differentiation analysis of residents' evaluation of the current development situation of ice and snow sports

The one-sample t-test shows $p<0.01$ for all items, significantly higher than the neutral value of 3 points. This indicates residents' overall evaluation of the current situation is positive, but the average score is only 3.54-3.59, between "general" and "relatively good", with a low overall evaluation level. In-depth analysis used mean ranking and coefficient of variation to examine core problems of this dimension (Table 4).

Table 4. Statistics and in-depth analysis of residents' evaluation of the current situation of ice and snow sports and investment preference.

Item	Valid Sample (N)	Mean ± Standard Deviation	t Value	p value	Mean Ranking	Coefficient of Variation (CV)
Application of energy-saving snowmaking and water resource recycling technology	412	3.59±1.278	9.365	<0.01	1	0.356
Reserve of professional talents	412	3.58±1.222	9.672	<0.01	2	0.341
Public awareness and participation convenience	412	3.56±1.208	9.465	<0.01	3	0.339
Scale and guiding role of relevant capital investment	412	3.55±1.265	8.839	<0.01	4	0.356
Government policy planning and support	412	3.54±1.217	9.031	<0.01	5	0.344
Ecological friendliness of ice and snow venues and facilities	412	3.54±1.224	9.013	<0.01	5	0.347

From the perspective of mean ranking, the current situation evaluation shows the characteristic that the evaluation of technological application is higher than that of policies and facilities:

(1) The score of the application of energy-saving snowmaking and water resource recycling technology is the highest (3.59). This indicates that Daqing's technological investment and application in the ecological development of ice and snow sports have gained certain public recognition. Ecological technology has become a highlight in the current situation evaluation.

(2) The scores of government policy planning and support and the ecological friendliness of ice and snow venues and facilities are the lowest (both 3.54). This reflects that residents have low satisfaction with the

government's top-level design and policy implementation effect. They also have low satisfaction with the ecological transformation and operation management of ice and snow venues, which are the core shortcomings in the current situation evaluation.

(3) Comparing the core cognition dimension (average 3.80) with the current situation evaluation dimension (average 3.56), residents' cognition level is significantly higher than the actual evaluation level. This shows a disconnection characteristic of "cognition-evaluation", indicating that there is a gap between the actual practice of the ecological development of ice and snow sports in Daqing and the public's cognitive expectations.

From the perspective of the coefficient of variation, there are significant individual differences in residents' evaluation:

(1) The coefficient of variation of the application of energy-saving snowmaking technology and the scale of capital investment are both 0.356, the two items with the highest discrete degree in the evaluation dimension. This indicates that different residents have great differences in their actual experience of the effect of government capital investment and the application of ecological technology. Some residents have felt the effectiveness of technological and capital investment, while others have not formed an intuitive experience.

(2) The overall coefficient of variation of the evaluation dimension (0.34-0.36) is higher than that of the core cognition dimension (0.26-0.30). This indicates that residents' evaluation of the current development situation of ice and snow sports is more affected by personal experience, participation scenarios and information acquisition channels. The evaluation shows stronger subjectivity and differentiation.

Characteristic and differentiation analysis of residents' willingness to participate in the ecologicalization of ice and snow sports

The participation willingness dimension includes 6 items. The one-sample t-test shows $p<0.01$ for all items, significantly higher than the neutral 3-point value. This indicates that residents' participation willingness is generally strongly positive, with an average score of 3.80, identical to the core cognition dimension. It lays a solid public foundation for the ecological development of ice and snow sports. In-depth analysis used mean ranking and coefficient of variation (Table 5) to explore residents' participation preferences and willingness differences.

Table 5. Statistics and in-depth analysis of residents' willingness to participate in ice and snow sports and behavioral intentions.

Item	Valid sample (N)	Mean ± standard deviation	t value	p value	Mean ranking	Coefficient of variation (CV)
Willingness to participate in ice and snow ecological research and study courses	412	3.91±1.158	15.867	<0.01	1	0.296
Willingness to participate in industrial heritage-themed ice and snow parks	412	3.81±1.142	14.317	<0.01	2	0.300
Willingness to participate in volunteer activities of "ice and snow + wetland protection"	412	3.79±1.096	14.703	<0.01	3	0.289
Willingness to pay a premium for eco-friendly products	412	3.76±1.095	14.129	<0.01	4	0.291
Willingness to participate in wetland ice and snow hiking/cross-country skiing	412	3.75±1.067	14.224	<0.01	5	0.284
Basic willingness to participate in ice and snow sports in Daqing City	412	3.73±1.234	11.980	<0.01	6	0.331

From the perspective of mean ranking, residents' willingness to participate shows a significant preference for characterization, ecologicalization and experience:

(1) The willingness to participate in ice and snow ecological research and study courses has the highest score (3.91), indicating that residents have the highest acceptance of the integrated model of "ice and snow + education". In particular, research and study projects combining ecological knowledge learning and ice and snow experience have become the most anticipated form of ice and snow sports by the public. This reflects the upgrading of residents' ecological consumption demand from "simple participation" to "knowledge experience".

(2) The scores of willingness to participate in industrial heritage-themed ice and snow parks (3.81) and volunteer activities of "ice and snow + wetland protection" (3.79) are relatively high. This reflects that residents have a strong willingness to participate in projects integrating Daqing's local characteristic resources with ice and snow sports. The industrial heritage and wetland ecology of resource-based cities have become a unique starting point for the ecological development of ice and snow sports.

(3) The willingness to pay a premium for eco-friendly products (3.76) is higher than the basic willingness to participate in ice and snow sports (3.73). This indicates that residents' awareness of ecological consumption is higher than that of simple sports participation. They are willing to pay additional costs for the "ecological attributes" of ice and snow products, which is an important market foundation for the ecological development of ice and snow sports.

(4) The willingness to participate in wetland ice and snow hiking/cross-country skiing is slightly lower (3.75). This is related to the weak cognition of wetland development risks in the core cognition. Some residents hold a cautious attitude towards participating in wetland ice and snow sports due to concerns about ecological damage.

From the perspective of the coefficient of variation, the discrete degree of residents' willingness to participate is related to project types:

(1) The coefficient of variation of the basic willingness to participate in ice and snow sports is the highest (0.331). This indicates that there are great differences in the basic sports participation willingness of different residents. It is closely related to individual characteristics such as residents' age, sports ability, leisure time and consumption level.

(2) The coefficient of variation of wetland ice and snow hiking/cross-country skiing is the lowest (0.284). This indicates that residents have formed a relatively consistent attitude towards the willingness to participate in such outdoor ecological ice and snow projects. The attitude is generally positive, with only a slight cautious psychology due to risk cognition.

Residents' cognitive characteristics of the responsible subjects for the ecological development of ice and snow sports

The survey shows that residents' cognition of the responsible subjects for the ecological development of ice and snow sports presents a tendency of diversified co-governance, with obvious preference differences in subject cognition. The proportion of those who believe that environmental protection organizations and institutions should bear the main responsibility is the highest (26.200%), reflecting the public's high expectation for the ecological leading and supervising role of professional social organizations. Next are ordinary citizens and consumers (21.100%) and municipal/district governments (19.200%), indicating that residents not only recognize their own participation responsibility, but also expect the government to play a leading role. The proportions of ice and snow sports-related enterprises (16.000%), schools and research institutions (14.300%) and news media (3.200%) are relatively low [4,5].

Combined with the analysis results of participation willingness, it can be seen that the proportion of residents' cognitive responsibility for schools and research institutions is relatively low. However, the willingness to participate in ice and snow ecological research and study courses is the highest, forming a dislocation characteristic of "high willingness - low responsibility". The proportion of cognitive responsibility for news media is the lowest, indicating that the role of media in the communication of the ecological development concept of ice and snow sports has not been fully perceived by the public, and communication efficiency needs to be improved.

Countermeasures and suggestions

Carrying out targeted cognition science popularization to make up for cognition shortcomings and differences

In view of the weak cognition of ecological risks, carrying out special science popularization on "ice and snow sports and ecological protection". Through short videos, offline experience camps and other forms, explaining the ecological impact of ice and snow sports and risk prevention and control measures for wetland development, so that residents can understand the core logic of "low impact and risk prevention" in ecological development [6].

In view of the insufficient cognition of local characteristic integration models, creating themed publicity content of "ice and snow + industrial heritage" and "ice and snow + wetland" combined with Daqing's industrial heritage and wetland resources. This can strengthen the public cognition of Daqing's local characteristic ecological ice and snow models.

For the 15% of residents who have never participated in ice and snow sports, carrying out free ice and snow experience, public welfare teaching and other activities. Promoting cognition popularization through participation experience and narrowing individual differences in cognition.

Strengthening the government's leading role to resolve the disconnection of "cognition-evaluation". Improving the top-level design and policy implementation of the ecological development of ice and snow sports. Issuing a special development plan for ecological ice and snow, and clarifying the specific goals and implementation paths of the ecological transformation of venues and capital investment. Disclosing the investment results in a timely manner through government official websites and integrated media platforms to improve the public's perception of policy and capital investment [7,8].

Increasing the intensity of ecological transformation of ice and snow venues and facilities, and promoting the comprehensive application of ecological technologies such as energy-saving snowmaking, water resource recycling and waste recycling. In this way, residents can feel the results of ecological development in actual experience and promoting the transformation of cognitive expectations into actual evaluations.

Optimizing further the convenience of public participation in ice and snow sports. Improving the transportation supporting and supporting charging systems around ice and snow venues, so as to ensure smoother travel and more convenient services for participants. Meanwhile, launching a variety of inclusive and public welfare ice and snow sports programs to lower the participation threshold for residents, enhancing their sense of access and satisfaction, and comprehensively improving the overall experience of ice and sports participation.

Focusing on public participation preferences to build a characteristic ecological ice and snow product system

Taking ice and snow ecological research and study courses as the core, linking schools and research institutions to develop research and study products for all age groups from children to adults. Integrating ecological knowledge, ice and snow sports skills and Daqing's wetland/industrial heritage culture to meet residents' demand for "experience + education", and at the same time improving the responsibility participation of schools and research institutions [9].

Developing in depth characteristic projects of "ice and snow + industrial heritage" and "ice and snow + wetland". Building industrial heritage-themed ice and snow parks and wetland ecological ice and snow hiking routes. Strengthening ecological protection measures in project development, eliminating residents' risk concerns, and transforming local resource advantages into product advantages.

Cultivating the ecological consumption market of ice and snow sports, and launching clearly marked eco-friendly ice and snow products. Clarifying the ecological use of premiums, improving residents' trust in ecological products, and transforming the willingness to pay premiums into actual consumption behavior [10].

Constructing a diversified co-governance system to make up for the shortcomings of dislocation in the cognition of responsible subjects

Clarifying the responsibility boundaries and coordination mechanisms of multiple subjects. Taking the government as the leader and building an institutional platform for the coordinated participation of environmental protection organizations, enterprises, schools, media and citizens. Formulating participation

rules and incentive measures for all parties to form a joint force for the development of ecological ice and snow.

Strengthening the responsibility participation of enterprises and media. Guiding ice and snow sports enterprises to incorporate ecological protection into their business philosophy and building ecological ice and snow brands. Giving play to the communication role of the media, setting up special columns on ecological ice and snow, popularizing ecological concepts and development results, and improving the public's perception of the media.

Promoting the integration of "ice and snow + public welfare" and carrying out regular volunteer activities of "ice and snow + wetland protection". Encouraging citizens to participate in the ecological protection of ice and snow sports and transforming residents' cognitive responsibility into actual participation behavior. Realizing "universal participation and universal co-governance".

Conclusion

The participation rate of ice and snow sports among Daqing residents is relatively high, and the participation degree is positively correlated with the cognitive level of ecologicalization. The 15.000% of residents who have never participated in ice and snow sports have become the core potential group for cognition popularization, and the lack of participation experience is the key reason for their weak cognition.

Residents have a good overall core cognition of the ecological development of ice and snow sports, but there are significant intra-dimensional differences in the depth of cognition. The ecological concept communication of large-scale events has achieved remarkable results, while the understanding of the underlying logic such as the ecological impact and development risks of ice and snow sports is relatively weak. The cognition of the local integrated models of "ice and snow + industrial heritage/wetland" has not formed advantages, and there are great individual differences in the understanding of core concepts.

Residents' overall evaluation of the current development situation of ice and snow sports is at a general moderate level, showing a typical disconnection characteristic of "cognition-evaluation", with the cognition level significantly higher than the actual evaluation level. The application of ecological technology is a major highlight in the current situation evaluation, while the government policy implementation and the ecological transformation of venues are the key core shortcomings. There are significant individual differences in residents' evaluation, which are greatly affected by personal experience and diverse information acquisition channels.

Residents' willingness to participate is generally positive, showing a preference characteristic of "characterization, ecologicalization and experience". The willingness to participate in ice and snow ecological research and study and local characteristic integration projects is the highest, and the willingness to pay an ecological consumption premium is higher than the willingness to participate in basic sports. There are great individual differences in the basic sports participation willingness, while the willingness cognition of outdoor ecological ice and snow projects is relatively consistent.

Residents' cognition of responsible subjects presents a tendency of diversified co-governance. They hold the highest expectation for environmental protection organizations, while also recognizing the responsibilities of citizens and the government. However, there is a dislocation between the cognitive responsibility of schools, research institutions, media and enterprises and public willingness. This has become a weak link in the construction of a diversified co-governance system.

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Conflict of Interest

The authors declare no conflict of interest.

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