Research on Popular Science Tourism Based on SWOT-AHP Model: A Case Study of Koktokay World Geopark in China

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Abstract: A geopark is the best place for scientific knowledge dissemination, recreation and regional economic development. However, research on science tourism in China’s national geoparks is still in its infancy and the theory is lagging behind practical development needs. For the purpose of exploring the shortcomings and optimization paths of geoparks in science tourism development, here, we used Koktokay World Geopark as the research object and examined the internal advantages, internal disadvantages, external opportunities, and external challenges. Then, using 17 indicators, such as natural resource endowment, a SWOT-AHP model was constructed to systematically analyze the advantages, disadvantages, opportunities, and threats. The analysis found that advantages > disadvantages > opportunities > threats. The SWOT four-quadrant strategy was positioned at the first quadrant, and the advantage-opportunity strategy should be based on its internal advantages and make full use of the external opportunity conditions. Based on the results, suggestions were made to maintain resource advantages, obtain policy opportunities and improve the transportation conditions and the interpretation system; hence, in this study, a reasonable path for the development of science tourism in Koktokay World Geopark was explored and theoretical references for the science tourism and sustainable development of other geoparks were provided.

Keywords: popular science tourism; Koktokay World Geopark; SWOT-AHP model

1. Introduction

With the development of the economy and society, improvements to materials and an increase in spare time, travelers’ demands have changed. They are no longer satisfied with traditional tourism; rather, tourists now hope to gain knowledge through tourism activities. For this reason, popular science tourism emerged, which is also called “spiritual sufficing tourism”. It is in this background that China’s domestic popular science tourism rose quietly and presented a good state of vigorous development. With China possessing the world’s largest domestic tourism market and with the continuous progress of building a well-off society in an all-round way, tourism in China has become a cardinal part of people’s daily lives, and China’s tourism industry has entered an era of mass tourism. The mass tourism boom has resulted in the popularization of science gaining in power across a wider range, in an imperceptible way through the process of education and entertainment. At present, after 80 years of development, popular science tourism has gradually matured in developed countries and has become an important part of tourism [1]. Although China’s popular science tourism started late, the current development trend is good, and it has become an important component of the construction of national parks as a way to explore the national sharing mechanism in China [2]. In China’s national parks and natural protected land system, geoparks had earlier been proposed to carry out popular science tourism and this became one of the three purposes of establishing a geopark [3]. The popularization of science is the main goal; science tourism popularizes scientific knowledge in the process of tourism, combines education with fun, combines
learning together with tourism and integrates entertainment, participation, knowledge and education.

**Literature Review**

Science tourism initially originated in museums. It performed functions, such as family education and social interaction, and the learning mechanisms for science popularization in museums have also provoked thought. Jasen further confirmed this view in his study on museum visitors’ motivation and named museums as science tourism attractions [4]. With an increasing awareness of science popularization, science tourism developed in other fields and research in this field has gradually expanded to industrial sites [5], geoparks [6,7], agriculture [8], forestry [9] and other fields [10,11]. In this regard, the value of the science provided by geoparks cannot be underestimated.

Geoparks are the best places for providing scientific knowledge, recreation and regional economic development [12]. The world’s first national park, Yellowstone National Park, was established in the United States in 1872. It set a precedent for the protection of geological sites in foreign countries and Yellowstone National Park is still demonstrating its value to this day. Geological tourism resources are the object of geotourism activities, and geological relics are the material basis for the development of science tourism.

Geological sites not only have scientific research and popularization value, but they also have unique natural beauty and other aesthetic appreciation value, as well as historical value, archaeological value, cultural value, etc. Geotourists are usually willing to pay a certain amount of money for the management and protection of geoparks [13].

It is of great significance to develop science tourism in geoparks. This helps to protect geological relic resources, while also providing more employment opportunities for the local area, broadening the income sources of local residents and improving the quality of life [14,15]. Science tourism can not only stimulate local socio-economic and cultural development but also enhance the awareness of local residents while strengthening their cultural identity and pride [16]. It can also reduce the negative impact of tourism on traditional culture by encouraging the protection and inheritance of traditional culture [17]. As an unconventional form of tourism, it can enhance the visibility of tourist destinations to a greater extent [18], increase the number of tourists that visit a destination [19] and accelerate improvements in infrastructure. In ecological terms, science tourism is a kind of sustainable tourism; it helps to maintain geographic diversity [20] and reduce the environmental pressure on cities.

China’s science tourism is in a rising period and its geology-based popular science tourism faces many problems. For example, an emphasis on the economy rather than conservation causes geological sites to suffer from destruction [21], leading to the content of the interpretation system becoming singular and overly specialized [22] and preventing tourists from fully understanding the scientific knowledge it contains. This results in improper management, unreasonable development [23] and weak marketing [24], leading to some locations becoming little-known science tourism destinations, with fewer science routes and other problems. While scientifically designed interpretation systems satisfy the knowledge reconstruction and science tourism activities of tourists, with fewer science routes and other problems. While scientifically designed interpretation systems satisfy the knowledge reconstruction and science tourism activities of tourists, with fewer science routes and other problems. 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Geopark as the research object, systematically analyzes its science tourism development with a SWOT-AHP model on the basis of the existing achievements and puts forward localized and appropriate suggestions. The proposals put forward for the interpretation system and transportation system of Koktokay are of great practical significance and practical value for Koktokay's development. The results of the study make up for the deficiencies in the existing research to a certain extent, further enrich and improve the theoretical system of geopark science tourism and provide theoretical guidance for the sustainable development of geoparks.

2. Overview of the Study Area

The Koktokay World Geopark is located at the source of the Irtysh River in northern Xinjiang, North East of Fuyun County, Altai Region; Geographic coordinates are 89°41′33″ E~90°02′41″ E, 46°56′52″ N~47°19′31″ N (Figure 1) [33]. The area is 562.50 square kilometers. It is the first world Geopark in China with typical mineral deposits and mining relics, both natural tourism resources and cultural tourism resources. Natural tourism resources include the “No.3” mineral vein, 1938 earthquake fault, the Arctic Ocean water system Irtysh River source scenery and ice-snow tourism resources in winter; cultural and tourism resources include Tiemak rock paintings, Kazakh ancient tombs, Kazakh yurt houses, Haizikou Power Station, Soviet-style architecture, etc. In 2017, Koktokay World Geopark was approved for inclusion in the World Geopark Network List by UNESCO [34]. In 2016, the Chinese National Development and Reform Commission awarded Koktokay town as the first batch of towns with Chinese characteristics. The administrative area of Koktokay town covers an area of 1,710 hectares, with a registered population of 4870. There are four township industrial enterprises. In 2019, the Koktokay scenic area received 692,500 tourists [35].

Figure 1. Koktokay World Geopark’s Location.

3. Method and Data Source

3.1. SWOT Analysis

SWOT, an abbreviation for strength, weakness, opportunity and threat, is an analytical method proposed in the early 1980s by Wyrick [36], a professor of management at the University of San Francisco. SWOT is an intuitive and simple method, which matches
various internal strengths and weaknesses closely related to the research object with external opportunities and challenges and analyzes them with each other. The SWOT analysis of geopark is a comprehensive, systematic and accurate study of the strengths, weaknesses, opportunities and challenges in comparison with each other and a comprehensive analysis combined with the AHP analysis method to derive the corresponding development strategy, which provides certain basic theoretical support for the development of science tourism in geoparks.

3.2. SWOT-AHP Model

SWOT-AHP analysis is a method of combining qualitative and quantitative research, the research method combines the methods and concepts of SWOT model and the scientific nature of element quantification, making the SWOT model more objective; with the hierarchical analysis process, the data science is clearer and the analyses results are easy to accept and convincing. Utilizing AHP inside a SWOT framework aims to systematically assess SWOT variables and proportionate their intensity. This is a reasonable starting point for studying the current, anticipated situation or a potential course of action in a more detailed way. This method has been applied to the research of strategy making [37,38], ecotourism [39] and sustainability [40,41]. This paper continues to use this algorithm to further study the Koktokay World Geopark and test the scientificity of the SWOT-AHP model.

3.3. Calculation and Consistency of the Weight of the Evaluation Index Test

(1) Judgment matrix construction and its empowerment. Using the 1–9 scale method of AHP level analysis [42], usually 5–15 experts [43–45] were invited to score the importance of each factor and combine the actual situation of the research area to compare and assign the two indicators one by one, then establish a judgment matrix through the affiliation between adjacent levels and calculate the relative weight Wi of each index.

(2) Calculate the eigenvalue. In the AHP decision analysis method, the most fundamental computational task is to solve the maximum feature root of the judgment matrix and the corresponding feature vector. The eigenvalue is now calculated by using the square root method.

1. calculates the product of the element in each row of the judgment matrix (Equation (1))

\[ M_i = \prod_{j=1}^{n} b_{ij} (i = 1, 2, \ldots, n) \]  

(1)

2. calculates the n-th root of \( M_i \) (Equation (2))

\[ \overline{W}_i = \sqrt[n]{M_i} (i = 1, 2, \ldots, n) \]  

(2)

3. normalizes the vector \( \overline{W} = [\overline{W}_1, \overline{W}_2, \ldots, \overline{W}_n]^T \) (Equation (3)), i.e.:

\[ W_i = \frac{\overline{W}_i}{\sum_{k=1}^{n} \overline{W}_k} (i = 1, 2, \ldots, n) \]  

(3)

Then \( W = [W_1, W_2, \ldots, W_n]^T \) is the desired eigenvector.

4. calculates the maximum feature root (Equation (4))

\[ \lambda_{\text{max}} = \sum_{i=1}^{n} \frac{(AW)_i}{nW_i} \]  

(4)

In formula: \( (AW)_i \) Denote the i-th component of the vector \( AW \).
Index ranking and index consistency test. A consistency test is required to evaluate the consistency of the hierarchical ranking results. To effectively measure the consistency of the index, its consistency index \( CI \) (Equation (5)) and the consistency ratio \( CR \) should be calculated.

\[
CI = \frac{\lambda_{\text{max}} - n}{n - 1}
\]  

(5)

In the above formula, when \( CI = 0 \), the judgment matrix has complete consistency; otherwise, the larger the \( CI \) is, the worse the consistency of the judgment matrix is. In order to test whether the judgment behavior is satisfactorily consistent, the random consistency proportion index \( CR \) of the judgment matrix (Equation (6)) is introduced.

\[
CR = \frac{CI}{RI}
\]  

(6)

Generally, the judgment matrix is considered satisfactorily consistent at \( CR < 0.10 \); otherwise, when \( CR 0.1 \), the judgment matrix needs to be adjusted until satisfied.

3.4. Data Source

The data involved in the article were obtained from the National Statistical Yearbook, the National Tourism Statistical Yearbook, the National Tourism Administration, the Department of Culture and Tourism of the autonomous region and the official website of the Fuyun government. The scoring tables of the 10 experts consulted in the hierarchical analysis are from three teachers with deputy high or above, three graduate students in tourism and geography, and two Koktokay World Geopark executives and two officers.

4. Evaluation Index

In total, 17 indicators were selected based on four levels: internal advantage S (5), internal disadvantage W (4), external advantage based on O (4) and external threat T (4), respectively. We take Kokotokay world science tourism development as the target layer, its internal advantages, internal disadvantages, external opportunities, and external threat as standard layer and 17 indicators (including geomorphological resources, commentary system, etc.) as index layer, to establish Kokotokay geopark’s science tourism development hierarchical analysis model (Table 1).

Table 1. Hierarchical analysis model of popular science tourism development.
Table 1. Cont.

<table>
<thead>
<tr>
<th>Target Layer</th>
<th>The Standard Layer</th>
<th>Indicator Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>External opportunities (O)</td>
<td>Policy support O1</td>
<td>Good brand promotion opportunity O2</td>
</tr>
<tr>
<td></td>
<td>Listed in the World Geopark List O3</td>
<td>Superior large domestic market consumption environment O4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Superior large domestic market consumption environment O4</td>
</tr>
<tr>
<td>External threat (T)</td>
<td>Domestic competition of the same type of world geopark T1</td>
<td>Park resource protection pressure is huge T2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>The development of popular science tourism in China is in the initial stage T3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>People’s awareness of popular science and tourism still needs to be strengthened T4</td>
</tr>
</tbody>
</table>

4.1. Four-Aspect Respective SWOT Analysis

4.1.1. S-Analysis of the Internal Advantage Index

In the precedent relevant research, scholars had natural resources [46], cultural resources [47], the excellent ecological environment [48], popular science tourism facilities [49] and a popular science tourism transportation system [50] as the advantages evaluation index. Based on this, our research evaluates the internal advantages of science tourism development from the aspects of geological and geomorphological resources, cultural resources, traffic conditions, popular science tourism facilities and ecological environment.

(1) Geological and geomorphological resource endowment

Koktokay is a unique geological park in China, in that it mainly features earthquake relics. The scenic area incorporates unique mountain landscapes with water features, grasslands, pictographs, hot springs and other wonders of the Altai Mountains; the large rare metal deposits and Altai granite are particularly prominent. This scenic area, with large scale, dense distribution, high quality and unique resources, has good tourism appreciation and scientific popularization value. Although it is the same natural landscape, its natural features and highlights are more obvious and more competitive than the adjacent Class 5A Kanas Scenic.

(2) Rich in cultural resources

This is mainly reflected in ethnic customs, Soviet-style architecture and revolutionary tourism resources. The main ethnic Kazakh of the Koktokay, using the Kazakh language, created unique housing, named yurts, a temporary structure, light, easy to support and easy to dismantle. Kazakhs are good at singing, dancing and embroidering, with unique ethnic customs. In Koktokay, the ancient buildings teem with Soviet characteristics. The building itself is solemn and generous and has become a priceless tourism resource. Moreover, China owed an astronomical foreign debt to the Soviet Union after the Korean War, but little is known that the secluded town had made great contributions to China, repaying nearly half of the huge foreign debt, which has a strong patriotic education value.

(3) Continuous improvement in transportation supporting facilities

Koktokay World Geopark formed a comprehensive transportation system based on road traffic and supplemented by aviation and railway traffic. Kokyokay is 50 km northeast from Mongolia, 33 km west from Fuyun County, 6 h from 580 km of Urumqi, 300 km of Altay City and 30 km away from National Highway 216. Travel time for tourists has significantly decreased since the Fuyun Airport was formally opened to traffic in August.
2015. In December 2019, Fuyun Railway Station was formally opened and integrated into the national rail network, giving travelers more alternatives and significantly advancing the growth of tourism.

(4) Commissioning of science tourism facilities

The Koktokay geological museum, highlighting the value of popular science, has been opened. In the interior, through the overall landscape design and paving, lamp basin, pots and metope curve shape, the integration of small buildings, such as the ticket office and the ticketing office into the main atmosphere of the building, makes the site environment fit with the science theme. To demonstrate the style of Koktokay to science visitors, esoteric knowledge of earth science is popularized in conjunction with the welcome and leisure square at the entrance of the museum and the office area. The use of science tourism facilities makes Koktokay increasingly abundant in research achievements and experiences. From 2017 to 2020, more than 30,000 educational tourism students were received [51].

(5) Great regional ecological environment

According to the “Code for Construction and Operation of National Eco-Tourism Demonstration Zone” (GB/T26362-2010), a document from the Department of Culture and Environment of the Department of the Autonomous Region (12 November 2019), the Koktokay Scenic Spot in Fuyun County, Altay area, is to be an “Autonomous Region-level Ecotourism Demonstration Zone”.

4.1.2. W-Analysis of the Internal Disadvantage Index

In the precedent relevant research, scholars faced the low transformation of geological science achievements [2,52], seasonal limitation [53], high transportation cost [54] and strong professionalism of systematic explanation [55] as the disadvantage evaluation index. Based on this, our research evaluates the internal disadvantages of science tourism development from the transformation of science popularization achievements, tourism seasonality, transportation cost and interpretation system professionalism.

(1) Modest degree of popular science transformation

Koktokay’s science tourism products are all singular and there are a lot of popular science tourism resources that still need to be produced. Its display methods are, likewise, rather simple. Presently, the publicity facilities of earth science popularization in the park basically only exist in the geological exhibition hall, the park’s museum and the main monument square. The overall conversion of the value of earth science is low. How to transform the esoteric scientific value into easy-to-understand knowledge has become an unsolved problem in the park.

(2) Tourism seasonality is obvious

Koktokay World Geopark is located in the Altai Mountains, which is a continental climate with pronounced seasonal changes. In summer, the scenic area’s climate is pleasant, the mountain is sublime, but the winters are bitterly cold here—the area is known as China’s second cold pole—with icy roads, subzero temperatures in September and October and other conditions that are not favorable for the growth of science tourism.

(3) The transportation cost of tourist popular science tourism is high

Koktokay town is located in Fuyun County, Altay Region. The majority of visitors to Koktokay generally first arrive in Urumqi by plane or train and then transfer to the bus or Urumqi–Fuyun County flights, travel at least 6.7 h and from June to September, when travel is at its most suitability, air tickets are more expensive, so the time and space cost of tourists to participate is high.

(4) The commentary system is highly professional

This primarily pertains to the granite landform and mine-relic-related landscape in Koktokay. The popular science explanations in its tourism explanation system, such as
the Huaxi, Indian and Yanshan rocks, and the Triassic, Cretaceous and Jurassic describing paleontological fossil resources, are too professionalized and obscure for tourists.

4.1.3. O-Analysis of the External Opportunity Index

In the precedent relevant research, scholars had the policy conditions [56], brand publicity opportunity [57], including in the world Geopark list [58], and superior market environment [59] as the external evaluation index. Based on this, our research evaluates the external opportunities of popular science tourism development in terms of policy conditions, brand publicity, inclusion in the World Geopark List and large market environment.

(1) Support of policy conditions

With the Belt and Road initiative, Western Development Strategy and Xinjiang policy, China increased the tourism westward, especially in Xinjiang. The State Council issued Xinjiang to participate in the Russia Economic Corridor Construction Implementation Plan, and the National Tourism Administration issued guidelines on further promoting the tourism of Xinjiang work, improving Xinjiang science tourism facilities, cultivating the related science staff; this will greatly promote the development of science tourism in Xinjiang. The Eco-tourism Demonstration Area Plan of Koktokay Scenic Area (2018–2026), undertaken by Fuyun County’s Cultural Tourism Bureau, clearly defines the Koktokay World Geopark as a new Koktokay tourism style with local characteristics of folk culture and red culture as connotations, integration and enhancement of landscape resources, popularization of scientific and cultural knowledge and full creation of “ecology, technology and culture”.

(2) Good brand promotion opportunities

Wang Qi’s song “Koktokay Shepherd”, which burst onto the Internet at the end of October 2020, resulted in an increased search volume about Koktokay, promoting the brand of Koktokay; the brand is close to the Kanas scenic spot, which is also located in Altay. Koktokay is currently in the stage of diverting Kanas scenic spot’s tourists. Under the publicity of “Koktokay Shepherd”, the brand building of Koktokay World Geopark is promoted and transformed into tourist diversion from Kanas scenic spot.

(3) Listed in the UNESCO World Geopark list

On 5 May 2017, the Executive Board of UNESCO decided to officially approve the inclusion of A’er Mountain in Inner Mongolia and Koktokay National Geopark in Xinjiang in the World Geopark Network List [34]. This brought benefit to the Koktokay World Geopark in terms of raising the international visibility of the geological area, providing a high-level publicity platform for the park and, at the same time, promoting the protection of geological relics, science education, tourism and driving the local economic development of Fuyun County.

(4) Superior domestic market consumption environment

China’s GDP exceeded CNY 100 trillion in 2020 [60]. In completing the building of a well-off society in all respects, the economic level of residents improved, so they are no longer satisfied with material demand; the scientific demand of the public at the spiritual level also increased. Good domestic market demand conditions will be conducive to the development of science tourism.

4.1.4. T-Analysis of the External Threat Index

In the precedent relevant research, scholars had the same type of geological park [61], resource protection pressure [62], popular science tourism development at an early stage [63] and people’s weak popular science tourism consciousness [64] as the threat evaluation index. Based on this, our research evaluates the external threat of science tourism development in Koktokay World Geopark from similar competition, resource protection pressure, science tourism development stage and science tourism awareness.
(1) Competition of the same type of domestic geological parks

The construction of Koktokay World Geopark started late and was remote from the tourism market. Competition from the surrounding national parks is mainly from Kanas National Geopark, which was developed early and has mature product development.

(2) The protection pressure of park resources is huge

Activities, such as scientific research and educational research practice, have put a lot of pressure on the carrying capacity of geological parks, as well as the capacity to manage and protect ecological parks, as tourism in Xinjiang has grown and scientific popularization activities have become more frequent. As Koktokay World Geopark develops further, more tourists and researchers will come to the area to participate in its activities. Even a science tourism destination with favorable natural ecological conditions and unique geological landscape will be degraded due to excessive tourists, lack of management and poor maintenance, especially the lack of proper education and supervision [65]. This will put its original ecological and geological resources in danger, putting an unheard-of strain on resource protection.

(3) The development of science tourism in China is in the initial stage

At present, the majority of visitors to geological parks, forest parks and other popular science scenic spots neglect the scientific popularization value of the scenic spots and instead concentrate on the aesthetic ethics of the natural and cultural landscape and other ornamental values. A study investigated the behavior targets of more than 300 enterprises participating in the science expo and related to the science industry, and the result shows that fewer enterprises are engaged in related work in the field of science tourism [3,66]. The overall development of popular science tourism in China is still in the initial stage.

(4) People’s awareness of science tourism still needs to be strengthened

The majority of people commute between their homes and office in roughly two points and one line each day. They are unaware of many popular and underutilized picturesque locations relevant to popular science tourism and they also lack the motivation to research and expand these locations’ relevance to popular science. The cultivation of scientific and cultural literacy of employees has not received sufficient attention from all units, which ignores the social benefits of scientific popularization and its contribution to the nation and the masses. Popular scientific tourism currently has a fairly limited domestic tourist source market in China.

5. Results

The calculation results are shown in Table 2, the maximum feature roots of both the target layer and the four criterion layers were in the interval 4–5.5, and the index CR of all levels is <0.10, indicating that the judgment matrix passed the consistency test.

Table 2. Judgment of the matrix feature values and consistency test.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>( \lambda_{\text{max}} )</th>
<th>( n )</th>
<th>CR</th>
<th>Consistency</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>4.1927</td>
<td>4</td>
<td>0.0722</td>
<td>accord with</td>
</tr>
<tr>
<td>S</td>
<td>5.3875</td>
<td>5</td>
<td>0.0865</td>
<td>accord with</td>
</tr>
<tr>
<td>W</td>
<td>4.2640</td>
<td>4</td>
<td>0.0989</td>
<td>accord with</td>
</tr>
<tr>
<td>O</td>
<td>4.2542</td>
<td>4</td>
<td>0.0952</td>
<td>accord with</td>
</tr>
<tr>
<td>T</td>
<td>4.0000</td>
<td>4</td>
<td>0.0000</td>
<td>accord with</td>
</tr>
</tbody>
</table>

All index weights are then ranked and an expert scored them by \(-4, -3, -2, -1, 1, 2, 3, 4\) according to the Delphi method by positive score for advantage and opportunity, and negative score, as shown in Table 3; the greater the absolute value of the final weighted score, the greater the strength.
<table>
<thead>
<tr>
<th>The Standard Layer</th>
<th>Weight between Groups</th>
<th>Indicator Layer</th>
<th>Within-Group Weights</th>
<th>Comprehensive Weight</th>
<th>Factor Score</th>
<th>Weighted Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td>0.4337</td>
<td>S1</td>
<td>0.27</td>
<td>0.117</td>
<td>4</td>
<td>0.468</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S2</td>
<td>0.3354</td>
<td>0.1455</td>
<td>3</td>
<td>0.4365</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S3</td>
<td>0.0777</td>
<td>0.0337</td>
<td>3</td>
<td>0.1011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S4</td>
<td>0.0359</td>
<td>0.0156</td>
<td>2</td>
<td>0.0312</td>
</tr>
<tr>
<td></td>
<td></td>
<td>S5</td>
<td>0.281</td>
<td>0.12197</td>
<td>2</td>
<td>0.24394</td>
</tr>
<tr>
<td>W</td>
<td>0.3699</td>
<td>W1</td>
<td>0.0771</td>
<td>0.1285</td>
<td>3</td>
<td>-0.0855</td>
</tr>
<tr>
<td></td>
<td></td>
<td>W2</td>
<td>0.1201</td>
<td>0.0444</td>
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<tr>
<td></td>
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<td>W3</td>
<td>0.3833</td>
<td>0.1418</td>
<td>4</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>W4</td>
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<td>0.1552</td>
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<td>0.0213</td>
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</table>

**SWOT Four-Quadrant Strategy Selection**

Below are the calculation formulas for total advantage strength, total weakness strength, total opportunity strength and total threat strength (Equations (7)–(10)):

\[
\text{Total Strength Index } S_a = \sum \frac{s_i}{n_i} = 1.2807 \tag{7}
\]

\[
\text{Total Weakness Index } W_a = \sum \frac{w_i}{n_i} = -1.2515 \tag{8}
\]

\[
\text{Total Opportunity Index } O_a = \sum \frac{o_i}{n_i} = 0.3631 \tag{9}
\]

\[
\text{Total Threat Index } T_a = \sum \frac{t_i}{n_i} = -0.2059 \tag{10}
\]

That is, the total strength index of popular science tourism development is 1.2807, the total weakness index is −1.2515, the total opportunity index is 0.3631 and the total threat index is −0.2059. With the total strength index, total weakness index, total opportunity index and total threat index as coordinates, connect the \( S_a, W_a, O_a, T_a \) to get the popular science tourism development strategy quadrangle and draw the strategic quadrilateral center of gravity point according to the quadrant center of gravity formula (Equation (11)) (Figure 2):

\[
P(X, Y) = P \left( \sum \frac{X_i}{4}, \sum \frac{Y_i}{4} \right) = (0.0393, 0.0073) \tag{11}
\]

Through quantitative analysis of SWOT-AHP for the Koktokay World Geopark, we observe that its advantages > disadvantages > opportunities > threats, and the influence of the factors in the standard layer on their advantages, disadvantages, opportunities and threats is not completely consistent. The major benefit of Koktokay’s development of science tourism is its rich cultural resources (0.1455). The Koktokay World Geopark is endowed with geological and geomorphic resources (0.1171) and a healthy regional ecological environment (0.1219), giving it dazzling highlights and a competitive edge. The major flaw in the growth of popular science tourism is the overly professionalized commentary system (0.1552). The development of science tourism is further hampered by
the high transportation cost (0.1418). The support of policy conditions (0.0631) and the superior domestic market consumption environment (0.0275) are major opportunities for the development of science tourism in Koktokay. However, it is also necessary to judiciously address the threat posed by China’s initial growth of popular science (0.0213) and the great pressure associated with resource protection (0.0213). Overall, Koktokay’s science tourism development strategy is located in the first quadrant; it should take an advantage–opportunity strategy, in accordance with its own rich geological resources, distinctive cultural resources and good regional ecological environment advantage, in the central and Xinjiang Uyghur autonomous region government’s policy support and guidance, increase investment in popular science tourism facilities, strengthen popular science achievement conversion and realize the value of Koktokay’s popular science tourism.

Figure 2. Strategic selection of SWOT four quadrants for popular science tourism development in Koktokay World Geopark.

6. Discussion, Limitations and Future Research
6.1. Discussion

Through the qualitative analysis of SWOT and SWOT-AHP quantitative analysis of the development, the research results show that Koktokay World Geopark’s advantages > disadvantages > opportunity > threat, and the influence of the factors in the standard layer on its advantages, disadvantages, opportunities and threat is not wholly consistent. Rich cultural resources are the largest advantage of science tourism development. Koktokay has brilliant highlights and a strong competitiveness due to its endowment in geological and geomorphic resources and the favorable regional ecological environment. A too-professionalized commentary system is the biggest weakness in the development of science tourism. Additionally impeding the growth of popular science tourism is the high transportation costs incurred by travelers. The support of policy conditions and the ideal domestic market consumption environment are major opportunities for developing popular science tourism in the Koktokay World Geopark. However, it is also necessary to reasonably deal equitably with the threat posed by China’s early growth of popular science and significant strain placed on the preservation of park resources.

Geoparks are unique regional complexes that integrate multiple functions, such as ecological protection, scientific research, education, tourism and community development, which make it the best place for scientific knowledge dissemination, recreation and regional economic development. To further improve science tourism in Koktokay Geopark, it is necessary to face up to its problems in terms of transportation, interpretation system and re-
source conservation. There is a strong link between improvements in the transport network and the development of the tourism industry. During the Roman Empire, the construction of a system of roads along the Mediterranean Sea allowed the inhabitants of Rome to travel to Pompeii and Hercules to escape the summer heat [67], yet the transportation system in Koktokay Geopark needs to be improved. In addition, while developing transportation, it is also important to consider environmental sustainability and to choose a comprehensive approach with lower overall carbon emissions [68]. Whereas tourism development and resource conservation have been hot topics since the 1990s [69–71], science tourism development is no exception, and an overly narrow tourism-centered paradigm can lead to unsustainable tourism. In terms of a tourism interpretation system, science tourism is different from the interpretation system of general scenic spots, which is an important heritage conservation strategy. Since the interpretation system of geoparks contains obscure geological knowledge [72], it needs to be transformed so that tourists can easily understand it. Based on the analysis results, we propose the following three recommendations:

1. Both development and protection should be given equal priority based on resource advantages. Rich geological resources are the primary benefit of Koktokay and the premise of science tourism development, but in some places, such as Sayi Henbrak’s ecology being very fragile, the geological landscape is susceptible to man-made damage. Koktokay should protect its resources as a precondition for any type of development in order to achieve sustainable development. The Koktokay World Geopark integrates natural and cultural tourism resources. We must adhere to the principle that development and protection are equally important during the development process and fully utilize cultural and natural resources, including seismic remnants, locations of deposits of extremely rare metals, Altai granite, as well as cultural resources, such as Kazakh ethnic customs, Soviet-style architecture and patriotic education. It will be built into a rare metal “natural exhibition hall” town, integrating science, education, leisure and business. To strengthen the participation of the local residents, the Iranian government has led the indigenous people of Gershham Island Geopark to participate in the establishment of the hawksbill turtle hatchery, which not only protects sea turtles, but also provides seasonal employment opportunities for the locals [14]. The local government of Koktokay should also take the initiative to encourage the community’s residents to get involved in the development of the park, so that they can reap real material and spiritual benefits, as well as mobilize their positive energy to get involved in the town’s efforts to protect its geological resources.

2. Improve the tourism transportation system. The growth of tourism is significantly impacted by transportation. In order to create popular science tourism in Koktokay World Geopark, there are still a lot of transportation-related issues that need to be resolved. The standard of tourist transportation, amenities and gear is primarily at issue. The year before last, Fuyun railway station was officially opened, marking the official inclusion of Fuyun County in China’s national railway transportation network. Despite being formally opened, Fuyun Railway Station only has one train per day going to Urumqi. In general, the accessibility of Koktokay World Geopark scenic spots is relatively poor, especially in summer and some holidays, and the actual demand for tourism and transportation cannot be met. Tourists from other provinces generally first arrive in Urumqi by plane or train and then transfer to bus or Urumqi–Fuyun County flights, which takes at least 6 or 7 h, and in the high season, from June to September, air tickets are most expensive and the time and travel expenses are relatively high. In addition, there are only one or two flights a day at present and the road and air transport carrying capacity is insufficient in summer. In the peak season, the Urumqi–Fuyun flight should be encrypted and a flight from Fuyun County to the first-tier cities (i.e., Beijing, Shanghai and Guangzhou) should be appropriately opened.

3. Encourage multidimensional interpretation instead of the conventional mode. Compared with the guide content of general parks and other scenic spots, the explanation
content of geological parks has a systematic, professional and profound connotation. Therefore, the Koktokay World Geopark commentator needs to pay attention to how well the material of the interpretation process is grasped by popular science audiences. The content also needs to be simple to understand so that visitors can understand it in a short time. In order to have a deeper impression on the visitors and increase their understanding of popular science in the geopark, the popular science content must be closely tied to the topic over the course of the tour. In addition to the common forms in general parks, such as pictures, videos and audio equipment, etc., to provide the most basic service information for tourists, geoparks can also consider unique facilities, such as geological museums, geological and geomorphology signs, popular science bulletin boards and other related facilities and equipment services for tourists. Additionally, the use of VR and other technologies can be introduced to make the scientific connotation of geology and landform more vivid. These technologies can also be used to transform the obscure professional terms into common parlance, plan and design popular science education activities related to geoparks and attract more visitors by giving them an immersive interest experience.

6.2. Limitations and Future Lines of Research

This paper tries to explore the reasonable path of developing science tourism in geoparks with the SWOT-AHP model. However, there are certain limitations. Firstly, due to the availability of data and the subjectivity of experts’ opinions, the construction of the index system will differ among different scholars, which will make the research results biased to some extent. In addition, when conducting the AHP analysis, only 10 expert opinions were taken due to the limited number of experts, which is in line with the methodological requirements, but the number of invited experts can be expanded to make the results more scientific, given the allowed objective conditions. Finally, the case site of this study, Koktokay, is located in the inland hyper-arid region, and its evaluation indexes and research results have limited significance for other humid regions, which could be extended to the study of geoparks in North Africa and the Middle East.

The overly professionalized interpretation system and the contradiction between conservation and development, embodied in the science tourism development of Koktokay, represent, to a certain extent, the common problems encountered by other geoparks. The primary issues that need to be resolved in order to promote science tourism in each science location are the sustainable development ideas of science tourism, transit circumstances and interpretation system. However, the development of science tourism as a systematic project is not an overnight matter and the problems that need to be solved are not limited to the above three aspects. It is only with the participation of all walks of life that we can more effectively promote the protection of geological relic resources and realize the sustainable development of science tourism in geoparks and the function of serving the local social economy. Current research based on science tourism is still focused on the individual meso-micro scale. Future research can focus on the comparative study of science tourism in different geographic regions and extend the index system constructed in this paper to the study of geoparks in arid regions, such as North Africa and the Middle East, to verify the scientficity of the model and enrich the research results of popular science tourism.

7. Conclusions

The development of science tourism is influenced by various factors, including resource endowment, transportation, interpretation system, seasonality and policy. In this research, based on combing previous studies, we analyzed the development of science tourism in Koktokay World Geopark with the SWOT-AHP model and found that:

1. Koktokay World Geopark’s advantages > disadvantages > opportunity > threat. The SWOT four-quadrant strategy is positioned in the first quadrant and the advantage–opportunity strategy should be based on its own internal advantages and make full use of the external opportunity conditions.
2. Transportation is a substantial factor in developing tourism and the flowering of science tourism in the Koktokay Geopark is severely hampered by being in an arid region with inland transportation. For unconventional tourism, such as science tourism, tourists pay more attention to the immersive experience in the field and the transportation factor becomes more important. This serves as a reference for subsequent spatial planning and transportation planning.

3. The interpretation system of the geopark should be human-oriented. Unlike the interpretation system of general scenic spots, the interpretation system of geoparks is rich in obscure geological knowledge, such as Triassic, Cretaceous and Jurassic, for describing biological fossil resources and Middle Varisian magmatic rocks and Indochinese magmatism rocks for describing granite. It needs to be transformed into easy-to-understand text for visitors and future studies should focus more on how to best optimize the interpretation system.

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