

Article

Analysis of the Image of Global Glacier Tourism Destinations from the Perspective of Tourists

Fan Tang ^{1,2} , Jianping Yang ^{1,*}, Yanxia Wang ^{1,2} and Qiuling Ge ^{1,2}

¹ State Key Laboratory of Cryospheric Science, Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences, Lanzhou 730000, China

² The School of Resources and Environment, University of Chinese Academy of Sciences, Beijing 100049, China

* Correspondence: jianping@lzb.ac.cn

Abstract: Glaciers are attracting increasing attention in the context of climate change, and glacier tourism has also become a popular tourist product. However, few studies have been conducted concerning the image of glacier tourism destinations. To address this gap in the literature, in this study, we extracted destination images from 138,709 visitor reviews of 107 glacier tourism destinations on TripAdvisor using latent Dirichlet allocation (LDA) topic modeling, identified destination image characteristics using salience–valence analysis (SVA), and analyzed the differences in glacier tourism destination image characteristics across seasons and regions. According to the findings, the image of a glacier tourism destination consists of 14 dimensions and 53 attributes, with landscapes and specific activities representing the core image and viewing location and necessity representing the unique image. We identified significant seasonal and regional differences in the image of glacier tourism destinations. Finally, we discussed the unique image of glacier tourism destinations, the reasons for differences in the images, and the characteristics of different glacier tourism regions. This research could assist in the scientific management of their core images by glacier tourism destinations, as well as in the rational selection of destinations and travel timing by glacier tourists.

Keywords: glacier tourism; perceived destination image; destination image uniqueness; user-generated content; online reviews; TripAdvisor; latent Dirichlet allocation; salience–valence analysis; destination management



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1. Introduction

Mountains are among the most popular destinations for tourists, with their spectacular landscapes, majestic views, and unique and comfortable valleys [1]. Although nature, wilderness, topography, remoteness, and climate limit the development of mountain areas, these features also represent the strengths of mountain tourism [2]. Mountain tourism is growing at an unprecedented rate, playing an important role in the global tourism landscape as an obvious means of achieving sustainable development in mountain areas [3] and is considered an important tool for local economic development and environmental management [4].

Glacier tourism in general is a subcategory of mountain tourism and plays an important role in creating mountain landscapes and enhancing the connotation and visibility of mountain tourism [5]. Glacier tourism has become one of the most popular tourism projects worldwide, creating considerable value for tourists and local communities alike. The distinctive landscape and artistic features of glaciers are perceived to provide aesthetic value to tourists [6], and the evidence provided by glaciers with regard to climate change makes glacier tourism extremely valuable with respect environmental education and popular science [7]. The value of glacier tourism has drawn a sizable influx of visitors. The world's most famous glacier tourism destinations include the Alps [8], New Zealand's west coast [9], Canada's Columbia Icefields [10], China's Greater Shangri-La [11], and others,

with more than one million people visiting these locations each year. The arrival of tourists brings enormous economic value to local communities. More than USD 81 million each year is directly contributed to the economy by tourism associated with glaciers in New Zealand [12], and benefits with a value of more than USD 71 million were generated by tourism to China's Jade Dragon Snow Mountain in 2016 [13]. Furthermore, glacier tourism provides employment for local residents [14], and the building of related facilities may provide some indirect economic advantages to local communities [15].

However, today's mountain tourism is being hit by climate change and the COVID pandemic. Because mountain tourist infrastructure and activities rely on alpine temperature, topography, beauty, and seasonal cycles, climate change is having and will continue to have an impact on both current and future tourism growth in mountain regions, with consequences for residents in tourism-dependent mountain communities [16]. The booming glacier tourism industry has been negatively affected by the ongoing retreat of glaciers as the climate warms [17]. Melting glaciers will degrade the quality of the glacial scenery [11], increase the risk of rockfall during tourism activities [18], impair the tourist experience, and decrease the number of tourists visiting glaciers. Between 2003 and 2009, the number of visitors to Norway's Jostedalbreen National Park decreased by 38%. The primary causes of this reduction were changes in glacier morphology and accessibility [19]. Another group of academics believes that although climate change has accelerated the melting of glaciers, it has also increased new glacier tourism opportunities and visitor motivation to engage in "last chance tourism (LCT)" [20–22], which encourages tourists to experience this type of tourism before it is endangered [23], increasing the number of tourists. In addition, despite the considerable negative impact of the COVID pandemic on tourism, the therapeutic effects of natural landscapes could bring more opportunities for tourism in a post-COVID era [24]. Therefore, glacier tourism may remain popular over the coming decades or even reach a new peak of development.

In this context, glacier tourism destination management is particularly significant. The destination is the core of tourism [25], and the management of the destination is an important factor affecting the development of glacier tourism [26]. Scientific management of tourism destinations can assist with adaptation to the negative effects of climate change [27], increase visitor satisfaction, and promote regional economic development. However, the majority of existing research on glacier tourist destination management has focused on climate change adaptation [8,28,29], suggesting that glacier tourism destinations should adopt adaptive measures, such as management changes, developing new activities, enhancing educational activities, and changing the seasonality and spatiality of activities [5,27]. Such adaptive management measures represent a long-term strategy oriented toward climate change, with the goal of achieving sustainable development of glacier tourism. In contrast, the core image represents the main attraction of a glacier tourism destination and is the main factor influencing the glacier tourism experience of tourists. Targeting the needs of tourists and improving their satisfaction by improving the core image of the destination is perhaps more effective in the short term. Destination image is critical for destination management decisions and positioning [30]. Destination image creates brand value, is a crucial competitive asset [31], and is a powerful management tool for tourism [32]. Understanding the image of a destination helps tourism operators to attract more visitors and predict their behavioral intentions [33]. Therefore, identifying the image of glacier tourism destinations from the perspective of tourists is important for the management of glacier tourism destinations. However, few studies have been conducted concerning the experience of tourists at glacier tourist destinations and their perception of the image of the destination.

Currently, there are two main paradigms for tourism destination image research: structured and unstructured [34]. The structured paradigm refers to researchers' attempt to construct a framework for a destination image based on relevant theories, under which subimages can be divided, mainly by means of structured questionnaires. The unstructured paradigm involves distilling and summarizing the respondents' free descriptions of

destination image to capture the destination image. Early destination image studies relied mostly on structured questionnaire and interview data, but with the development of the Internet, user-generated content (UGC) has proliferated, causing not only a paradigm shift from structured to unstructured destination image studies, but also in traveler-generated content (TGC), the data sources for destination image studies experienced a shift from travel blogs to online travel reviews [35]. Thus, online travel reviews (OTR) based on social media has become an important data source for destination image research.

Therefore, in this study we extracted images of glacier tourism destination and analyzed the differences in their characteristics based on tourist reviews of glacier tourism locations on TripAdvisor. Specifically, we wanted to achieve the following research objectives (ROs):

1. The creation of an overall image of global glacier tourism destinations. Reviews of glacier tourism destinations were aggregated by country, and the potential image themes of glacier tourism locations in these countries were extracted separately and finally combined to form the overall image of global glacier tourism locations.
2. Core image recognition of tourist destinations with glaciers. Features of the glacier tourist destination's image were analyzed using the significance and positivity of the destination image as indicators.
3. An analysis of the image characteristics (indicating the degree of importance and positivity of the image) of glacier tourism destinations in various seasons. Reviews of glacier tourism destinations were gathered by season, and the destination images in different seasons were extracted.
4. An analysis of the image characteristics of glacier tourism destinations in various regions. The glacier tourist destinations were divided into six regions—North America, South America, Nordic, the Alps, the Qinghai–Tibet Plateau, and New Zealand—and the destination images were extracted for each region.

This study, on the one hand, closes a research gap concerning the image of glacier tourism destinations and, on the other hand, may assist agencies managing glacier tourism destinations to better understand the perceptions and experiences of visitors and therefore make better management decisions. In addition, the reported results may assist travelers in making trip decisions according to how closely their preferences match the image of glacial tourism destinations.

2. Key Concepts and Definitions

2.1. Glacier Tourism and the Glacier Tourism Destination

Glacier tourism arose with pilgrimage, expedition, and mountaineering in the 18th century; developed in the 20th century with mass tourism; and has been popular since the 1980s with leisure and experiential tourism activities. There is currently no accepted definition of glacier tourism due to the differing disciplinary backgrounds and research objectives of scholars engaged in research in this field. Pralong and Reynard describe glacier tourism as a synthesis of several types of tourism in glacier areas, such as geology tourism, mountain tourism, and adventure tourism [36]. Liu et al. define glacier tourism simply as tourism activities such as sightseeing, scientific research, exploration, and popular science education that take place in a glacier area [37]. According to Wang et al., glacier tourism refers to alpine tourist experiences or activities for which glacier resources or glacial relics represent the primary attraction [38]. Purdie expands the scope of glacier tourism by stating that in addition to activities that take place on a glacier, glacier tourism also includes activities that take place in adjacent areas, such as on glacial lakes, glacier inlets, or fjords [9]. Although a uniform understanding of glacier tourism has not yet been established, it is evident that it consists of glacier tourism resources and glacier tourism activities. A tourist destination is a location with unique natural or manmade features that attract non–native tourists to experience a variety of activities [39]. Therefore, unlike the concept of glacier tourism, the glacier tourism destination consists of glacier tourism resources, tourism infrastructure, service communities, transportation access, etc.

It is located close to the natural body of the glacier and within its surrounding extended area [40]. Glacier tourism destinations can be regarded as market-oriented multifunctional carriers based on glacier resources.

2.2. Tourism Destination Image

A tourism destination image is described as the totality of the impressions, feelings, and beliefs of tourists about a destination [41]. It starts to take shape before tourists arrive, and the visitor's experience will cause their image of the destination to evolve dynamically [35]. Echtner and Ritchie construct the destination image using three axes: functional-psychological, common-unique, and attribute-holistic, and propose a combination of standardized measures and open-ended questions to generate the destination image [34]. Gartner suggests that a destination image comprises three parts: cognitive, affective, and conative [42]; this definition has been widely accepted by tourism researchers [43,44]. The cognitive image is constructed in the tourist's mind based on facts about the destination and is the sum of what the individual knows or believes about the destination [45]. The affective image refers to the individual's emotional responses or appraisals, which reflect their feelings about the destination [46], and the identification of an emotional image helps tourists to pursue benefits that match the emotions associated with the destination, thus creating a more positive image of the destination [47]. Conative image is the motivation, preference, or behavioral intention of the visitor after being influenced by cognitive and emotional images [48]. Therefore, destination image theory proposes that cognitive and affective images represent an individual's subjective associations or impressions about the attributes of a destination [42], and the conative image depicts the individual's own idealized and desired future condition [49].

In summary, in this paper, we define the destination image of glacier tourism as the impressions, feelings, and behavioral intentions of tourists toward glacier tourism resources and activities, tourism infrastructure, and other elements. It includes cognitive images consisting of the glacier landscape, glacier activities, tourism transportation, tourism services, etc.; affective images consisting of excitement, enjoyment, worthiness, etc.; and conative images consisting of behaviors, such as willingness to recommend or revisit glacier tourism locations.

3. Data and Methodology

3.1. Data Sources

The data used in this study were derived from glacier visitor online review data from TripAdvisor. Depending on the source of information, the medium of destination image formation can be divided into induced (emanating from the destination promoters), organic (transmitted between individuals), and autonomous (produced independently of the previous categories) [42]. Organic agents include, along with the experience itself, the opinion of users and consumers that spreads through word-of-mouth marketing (WoM) in conversations with relatives, friends, colleagues, or acquaintances [35]. As a form of electronic word-of-mouth, online reviews contain a mixture of facts, opinions, impressions, emotions, etc., published and disseminated to others by travelers [50], which can influence the decision making of consumers and managers [51,52]. Consumers are more likely to trust online consumer evaluations than information provided by the operator because the former may contain important details that the latter is reluctant to make public [53]. Furthermore, TripAdvisor, as one of the world's top travel service platforms, is involved in travel marketplaces in a variety of nations and languages. In February 2022, the platform's official website reported that it had amassed one billion online comments and opinions. In addition, TripAdvisor protects its reputation by preventing bogus reviews via a regulatory system, has established a certain level of credibility and user trust in the sector, and has become a crucial database for researchers [54,55].

3.2. Data Collection

Some research has offered pertinent listings for locations worldwide that are popular for glacier tourism. We combined these listings and searched on the TripAdvisor website using the keywords “glacier” and “snow mountain.” Following the consolidation of some of the retrieved projects, such as “Mendenhall Glacier” and “Mendenhall Glacier Visitor Center,” a total of 107 glacier tourism destinations (Figure 1) from 16 countries (Table 1) were ultimately discovered. Using a Python crawler that we created, in June 2022, we automatically crawled 138,709 glacier visitor reviews. The fields that were crawled contained “username”, “hometown”, “comments”, “date”, and “score”. The earliest review in this set was posted in July 2003, and the most recent was posted in June 2022. Our dataset includes English, Spanish, Portuguese, Chinese, German, and other languages and was uniformly converted to English by calling the Google Translate API.

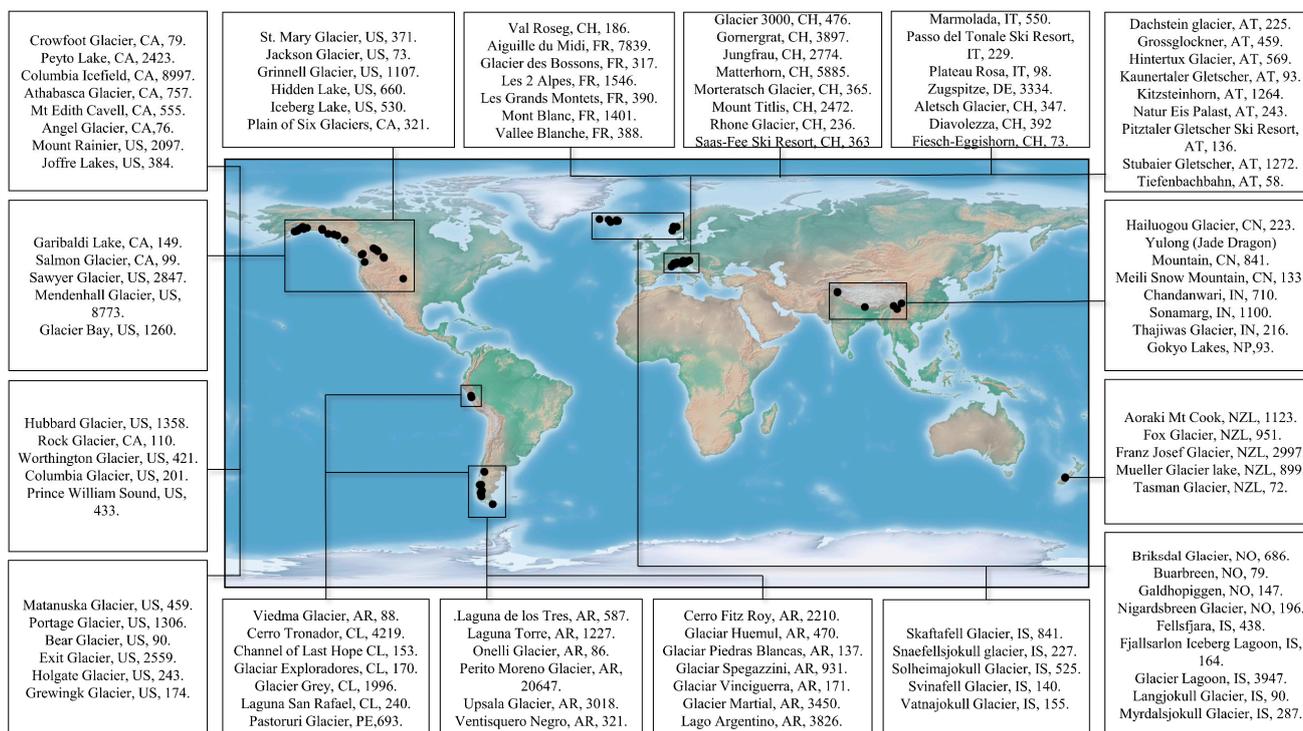


Figure 1. Location of the glacier tourist attractions. (The boxes indicate the name of the glacier, the abbreviation of the country, and the number of comments from visitors. Data from <https://www.tripadvisor.com/> (accessed on 12 June 2022)).

Table 1. Descriptive statistics of collected glacier travel reviews.

| Country | No. of Attractions | Reviews | Percentage | Country | No. of Attractions | Reviews | Percentage |
|-----------|--------------------|---------|------------|---------------|--------------------|---------|------------|
| Argentina | 14 | 37,169 | 26.80% | India | 3 | 2026 | 1.46% |
| Austria | 9 | 4319 | 3.11% | Italy | 3 | 877 | 0.63% |
| Canada | 10 | 13,566 | 9.78% | Nepal | 1 | 93 | 0.07% |
| Chile | 5 | 6778 | 4.89% | New Zealand | 5 | 6042 | 4.36% |
| China | 3 | 1197 | 0.86% | Norway | 4 | 1108 | 0.80% |
| France | 6 | 11,881 | 8.57% | Peru | 1 | 693 | 0.50% |
| Germany | 1 | 3334 | 2.40% | Switzerland | 12 | 17,466 | 12.59% |
| Iceland | 10 | 6814 | 4.91% | United States | 20 | 25,346 | 18.27% |

3.3. Data Preprocessing

The text data produced by user comments are unstructured and contain a lot of noisy information, which may seriously interfere with the results when used directly [56]. Therefore, data preprocessing has become a fundamental step in text data analysis [44,57,58]. In this study, the NLTK package in Python was selected for data preprocessing, comprising a set of text processing packages for classification, tokenization, stemming, parsing, and semantic reasoning. First, all text is converted to lowercase, and special punctuation is removed. Secondly, word splitting and loading of stop words were performed. Then, the text stop words were set, in addition to generic words such as “is”, “it”, “that”, etc. In addition, the names of some glacier tourist places, such as “Zugspitze”, “Mendenhall”, etc., were deactivated. Finally, POS filtering and word stemming were performed. Figure 2 shows the process for achieving the research objectives.

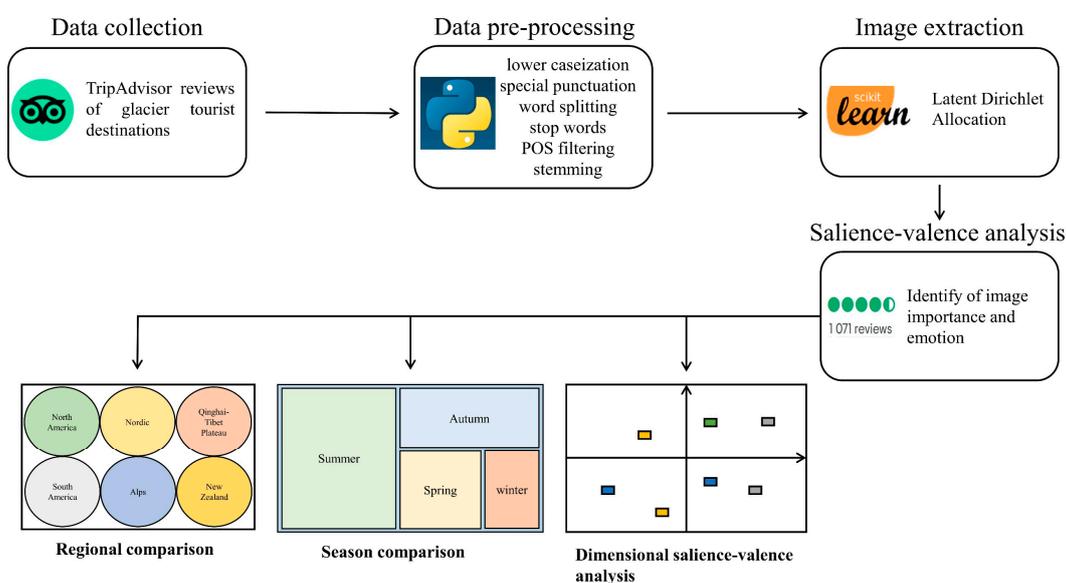


Figure 2. Research process.

3.4. LDA Topic Model

Latent Dirichlet allocation (LDA) is a generative probabilistic model used to process text data, representing text as a random mixture of potential topics in which each topic is characterized by a distribution of words [59]. The use of the LDA topic model can allow potential topics to be discovered from a large amount of unstructured textual big data [60], which helped us to construct an image of glacier tourism destinations in the world. These potential topics need to be named, usually with reference to the few words with the highest probability within the topic, as performed by one researcher and determined by another researcher. Figure 3 presents a graphical representation of LDA adapted from Blei et al. [59]. In the figure, α denotes the Dirichlet distribution of the first document topic, from which the topic distribution of document θ (polynomial distribution) is obtained, and from θ , a series of topics (z) can be derived. β denotes the topic–word Dirichlet distribution, and the word distribution (φ) (polynomial distribution) corresponding to topic z is generated by sampling from β . Finally, the words (w) are generated by combining z and φ . One word is extracted from each topic, and these words are connected to obtain a document. This is repeated several times, generating a large number of documents in the corpus. Finally, it is compared with the original document to determine the best way to distribute the points of the Dirichlet distribution.

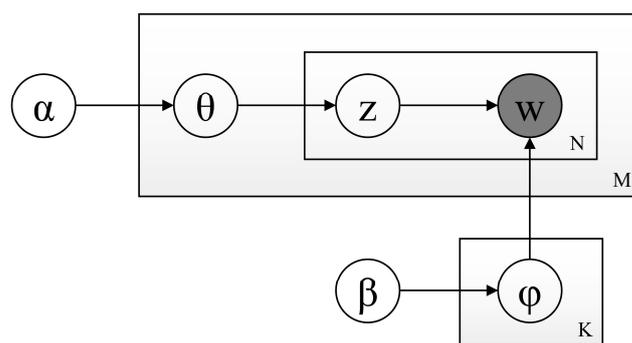


Figure 3. Graphical model representation of LDA.

The scikit-learn library in Python makes it easy to implement LDA modeling. However, it is first necessary to determine the values of the four main parameters: alpha, beta, n_topics , and n_iter (number of iterations). The corpus-level hyperparameters alpha (α) and beta (β) directly affect the LDA results, with smaller alpha values implying fewer dimensions per comment and smaller beta values resulting in fewer words per dimension [58]. Perplexity represents the uncertainty of the trained model with respect to which topic a document (d) belongs; the lower the perplexity, the more effective the model [52]. Therefore, in this study, perplexity was chosen as the basis for determining the values of the alpha, beta, and n_topic parameters. With reference to the experience of the Taecharungroj study, the alpha was set between 1 and 0.1, and the beta was set between 0.1, 0.01, and 0.001 [58]. When constructing the overall image of global glacier tourist locations (RO1) and determining the topic number, on the one hand, we required more theme numbers to ensure a more comprehensive extracted image, but on the other hand, we required a lower perplexity level. We ultimately set the number of topics to 5 when the visitor had posted fewer than 1000 comments. When the visitor had posted more than 1000 comments, the number of topics was set to 11. For the number of topics in RO3 and RO4, the number of topics with the lowest confusion was selected. In addition, alpha was set to 1, and beta was set to 0.1 for the lowest perplexity, and n_iter was taken to be 2000 to ensure convergence of results.

3.5. Saliency–Valence Analysis

To achieve RO2, in this study, we used the diagnostic tool saliency–valence analysis (SVA) developed by Taecharungroj et al. to identify the importance and emotional color (positive or negative) of each image [57], where saliency is expressed as the total number of visitor reviews for the image, and valence is expressed as:

$$\text{Image Valence} = (5 \text{ bubble reviews} - \text{Others bubble reviews}) / (\text{Total reviews of the image}) \quad (1)$$

Although TripAdvisor officially states that 5-bubble reviews from visitors indicate excellence and 3-bubble reviews are the average, the average score for all reviews in this study was 4.68. We observed that when tourists give a rating of fewer than 5-bubbles, it means that the tourist destination has at least some factors that make tourists feel dissatisfied. Therefore, in this study, we set reviews with 5-bubble ratings as “above average” reviews and all the other levels as “below average” reviews.

4. Findings

4.1. Overall Image of the Glacier Tourist Destination

Images of glacier tourism destinations (Appendix A, Table A1) in 16 countries were extracted using the LDA model and aggregated to obtain a global glacier tourism destination image system consisting of 14 dimensions and 53 attributes (Table 2). Among the 14 dimensions, the landscape dimension was dominated by attributes such as *mountain*,

landscape, glacier, ice, and glacial lake. The specific activities of glacier tourism included *hiking, skiing, cruising, and helicopter sightseeing*. The most important means of transportation for glacier tourism are *cable cars, boats, and trains*. *Whale, bear, and seal* were the main animals encountered during glacier tours. The most important infrastructure items were *roads and visitor centers*. Landscape features included *color and magnificence*. The price image was mainly described in terms of *tickets*. The tourism environment included *accessibility and weather/climate*. Viewing locations were specifically represented as *viewpoints and viewing platforms* where visitors could take photographs. *People and food* were used as separate dimensions and attributes, with *people* mainly indicating the atmosphere among visitors and the type of companions. The visitor experience was mainly expressed in terms of *worthwhile, enjoyable, and kindness*. Glacier tourism necessities included *water* and an *oxygen tank*. The *other* attributes were results that were difficult to interpret, had little relevance, or were modeled randomly or incorrectly. Appendix A Table A2 shows the image of glacier tourism destinations in the attribute dimension and their main topic words.

Table 2. Results of overall destination images.

| Dimension | Percentage | Attribute | Percentage | Dimension | Percentage | Attribute | Percentage | | |
|-------------------|------------|------------------------|------------|----------------------|------------|--------------------|------------|-----------------|-------|
| Landscapes | 30.83% | Ice | 3.70% | Local Infrastructure | 13.99% | Road | 6.26% | | |
| | | Ice Field | 1.19% | | | Piste | 0.13% | | |
| | | Glacier | 4.41% | | | Skywalk | 1.08% | | |
| | | Snow | 1.99% | | | Visitor Center | 5.02% | | |
| | | Mountain | 7.74% | | | Restaurant | 1.46% | | |
| | | Glacier Lake | 2.26% | | | Parking | 0.04% | | |
| | | Valley | 0.33% | | | Color | 1.98% | | |
| | | Waterfall | 2.40% | | | Sound | 0.36% | | |
| | | Landscape | 6.81% | | | Altitude | 0.17% | | |
| | | Hike | 8.81% | | | Slope | 0.53% | | |
| Specific Activity | 18.40% | Ski | 2.84% | Landscape Features | 4.37% | Magnificent | 1.33% | | |
| | | Self-Driving Tour | 0.91% | | | Price | 0.93% | Price | 0.09% |
| | | Climb | 0.83% | | | Ticket | 0.84% | Accessibility | 4.59% |
| | | Ride Horse | 0.15% | | | Travel Environment | 8.00% | Weather/Climate | 2.64% |
| | | Cruise | 2.17% | | | Viewing Location | 2.93% | Season | 0.55% |
| | | Helicopter Sightseeing | 1.90% | | | People | 2.23% | Crowdedness | 0.22% |
| | | Adventure | 0.79% | | | Experience | 0.71% | Viewpoint | 2.29% |
| Transportation | 10.05% | Cable Car | 3.64% | Necessity | 1.30% | Viewing Platform | 0.64% | | |
| | | Bus | 0.84% | | | People | 2.23% | | |
| | | Troll Car | 0.08% | | | Worthwhile | 0.45% | | |
| | | Train | 1.84% | | | Kindness | 0.10% | | |
| | | Boat | 3.54% | | | Enjoyable | 0.16% | | |
| | | Sledge | 0.11% | | | Water | 1.23% | | |
| | | Seal | 0.35% | | | Oxygen Tank | 0.07% | | |
| Animals | 3.37% | Whale | 2.01% | Other | 0.30% | Other | 0.30% | | |
| | | Bear | 1.01% | | | | | | |
| | | Food | 2.59% | | | | | | |

Figure 4 intuitively shows the salience–valence analysis at the dimension level of the glacier tourist destination image. Figure 4 shows that the landscape is the most salient (30.83%) and valent (0.63) image associated with glacier tourism locations, vastly outnumbering other images, showing that the landscape of glacier tourism destinations is the most popular factor for tourists. The salience of specific activities (18.4%), infrastructure (13.99%), transportation (10.05%), and tourism environment (8%) were also prominent and contained many types of secondary attributes, which have a significant impact on glacier tourism. Although the infrastructure salience was high, its valence (0.45) was lower than the overall average, and building and maintaining improved infrastructure is a common challenge for glacier tourism destinations. Among the other images in the dimension of glacier tourism, animal salience (3.37%) was not high, although its valence (0.73) was the highest, showing that it is a major highlight of glacier tourism. Conversely, price had a low salience (0.93%) and the lowest valence (0.31). As one Australian tourist commented on Zugspitze in March 2018: “The view from the gondola is fantastic, but unfortunately the price–performance ratio is not right at all”. Therefore, although the gorgeous landscape of glacier tourism can provide a high–efficiency valence to tourists, the negative feelings induced by expensive pricing must also be considered.

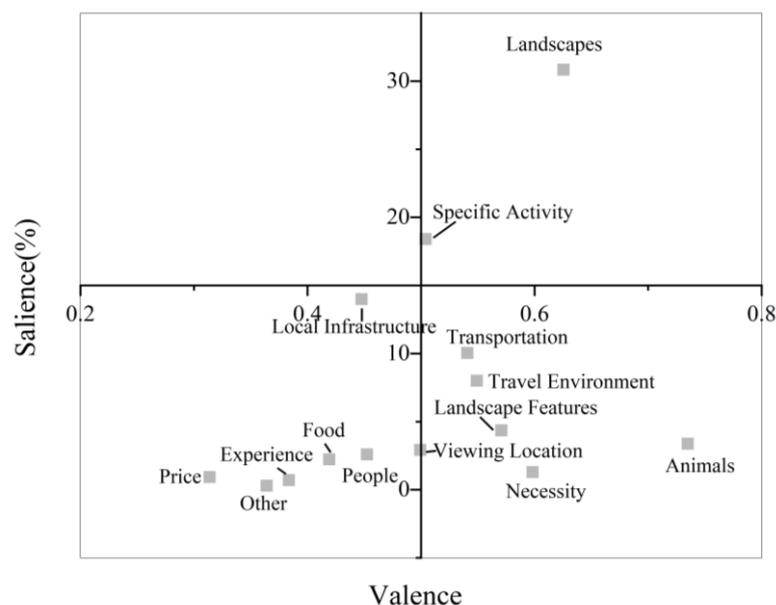


Figure 4. Dimensional salience–valence analysis.

Figure 5 shows the attribute–level valence of the image of glacier tourism destinations, with high attribute valence including *seal* (0.88), *ice* (0.77), *whale* (0.75), *glacier* (0.67), *cruising* (0.65), *color* (0.65), and *water* (0.62). On the other hand, the attributes of *price* (−0.38), *sledging* (−0.22), *skywalk* (−0.21), and *enjoyed* (0.02) had lower valence. Among the attributes, although the infrastructure valence at the dimensional level was low, the valence of *visitor center* (0.53) and *parking lot* (0.59) was high. Visitor centers are important in glacier tourism for provision of information on glacier mechanisms and glacier recession [61], thus deepening the experience of glacier tourism for tourists. For example, a visitor from Texas, USA, commented in August 2018 on the Exit Glacier visitor center: “The park visitor center is great and it is important to learn about the history and how our planet is changing”. Another visitor commented: “If you are in the area, spare a day to drive to the glacier and hike to the terminus. The visitor center at the beginning of the hike is small and throws light on how the glacier has been retreating over the past few decades. The initial hike path is paved and has signs that show where the glacier terminus was and how it moved back”. As a result, visitor centers play an important role in educating visitors about science and encouraging environmentally friendly behavior.

4.2. Seasonal Difference Analysis of GTD Image

Figure 6 shows the tree heat map of the image of glacier tourism destinations containing three types of information: season, dimensional image, and attribute image. The color indicates valence, and the block area indicates salience (i.e., the number of comments accounted for). As shown in Figure 6, the average valence of the four seasons did not differ significantly, with valence scores in the range of 0.52–0.56. However, summer (58,774) had a substantially higher importance score than autumn (35,952), spring (25,038), and winter (18,945), indicating that summer is still the peak season for glacier tourism locations, although glacier scenery is more impressive in the winter. Appendix A Table A3 shows the specific values of the seasonal image of glacier tourism destinations.

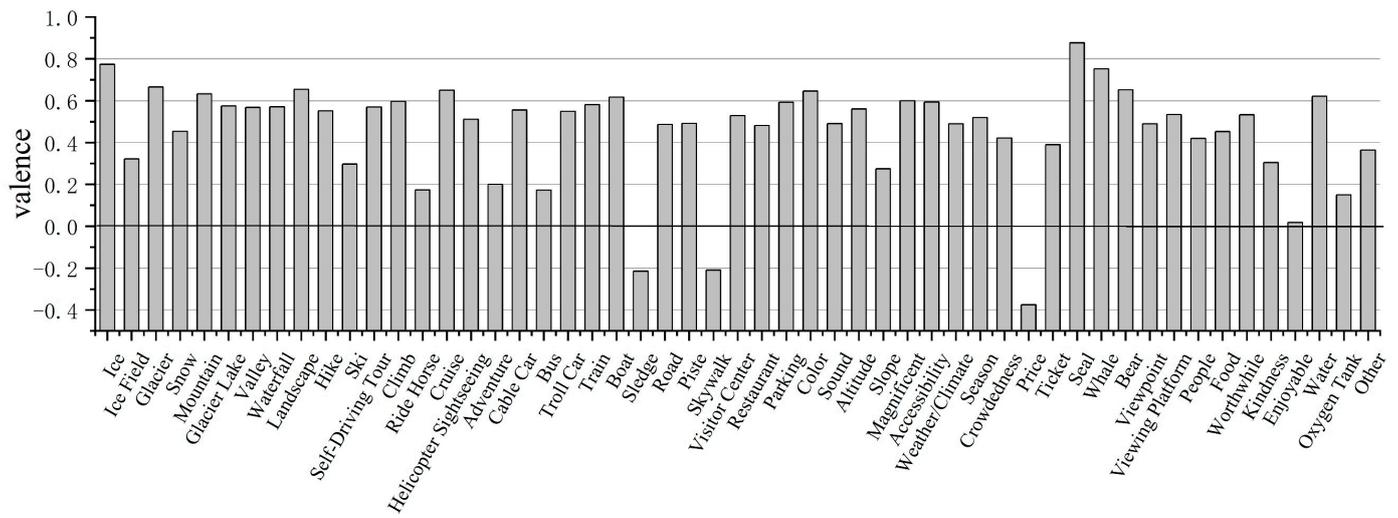


Figure 5. Attribute valence results.

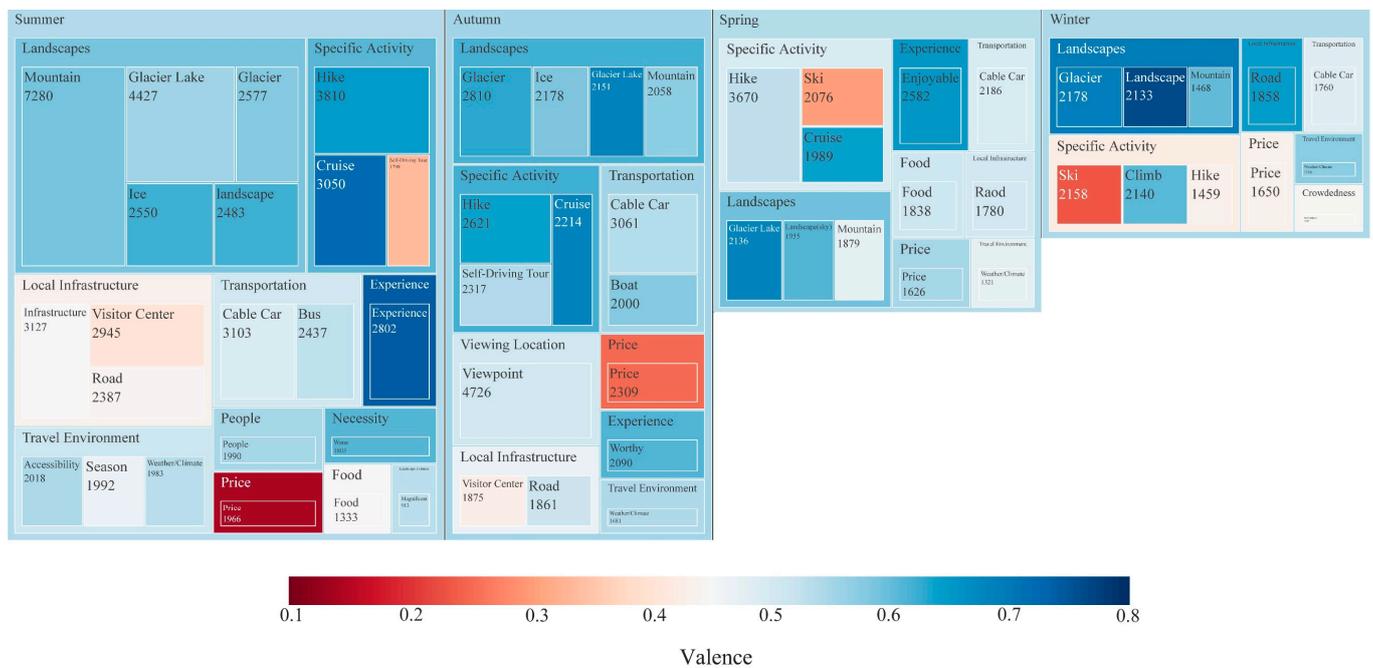


Figure 6. Seasonal differences in the image of glacier tourism destinations.

In terms of image categories, the landscape categories did not vary considerably and were mainly dominated by *mountains*, *glaciers*, and *glacial lakes*. Specific activities featured in each of the four seasons, with *self-driving* and *cruising* activities occurring primarily in the summer and fall, whereas *skiing* occurred only in the winter and spring, and *hiking* occurred in all four seasons as the core glacier tourism excursion. In addition, images such as *roads*, *cable cars*, *prices*, and *weather/climate* were also common to all seasons. Weather can have a direct impact on glacier tour operations, with overcast and foggy circumstances restricting visibility and accessibility to the glacier and affecting glacier tour activities, such as helicopter tours and hikes [62] and therefore valued by visitors regardless of the season. *Accessibility* is an image that was unique to summer. In the context of climate change, global glacier melting has accelerated, often forming large crevasses or producing disasters, such as ice avalanches and rockfalls, making glaciers difficult to access [63]. Rising temperatures in summer cause rapid melting of glaciers and increased tourism instability, which in turn

complicates tourist access to glaciers [64]; therefore, the image of accessibility occurred mainly in summer.

In terms of image valence, although there was little difference in the average valence of the four seasons, the valence characteristics of its internal dimensions and attributes were significant. The image of the winter *landscape* (0.69) had significantly higher validity than the other seasons, and winter and spring prices were more acceptable to visitors than those in the summer and fall. Although *skiing* activities are only present in winter and spring, visitors did not seem to be satisfied with them, in contrast to hiking and cruising, for which the valence was consistently higher. The *experience* of emotional image (0.74) was the highest—valence attribute in summer, indicating that tourists were highly satisfied with the overall experience of glacier tourism in summer.

4.3. Regional Difference Analysis of GTD Image

Figure 7 shows the regional image of the glacier tourism destination consisting of three types of information: region, dimensional image, and attribute image. The color indicates the valence, and the number indicates the salience (number of comments). In terms of the inner ring, which indicates the overall valence and salience of the image of the region, the three regions of North America, South America, and the Alps had the most reviews, accounting for roughly 87.5% of total reviews, showing that these three areas are the world’s top glacier tourism destinations. In terms of image valence, the Nordic (0.65) and South American (0.63) regions were the highest, followed by the North American (0.53) and Alpine (0.52) regions, whereas the New Zealand (0.31) and Tibetan Plateau (0.06) regions had the lowest valence. In terms of attribute image categories, North American (18 categories) and South American (17 categories) regions had the most attribute categories and were comprehensive glacier tourism destinations. In contrast, the New Zealand and Tibetan Plateau regions had only 11 categories of attributes, and their glacier tourism functions and elements were more singular. Appendix A Table A4 shows the specific values of the regional image of glacier tourism destinations.

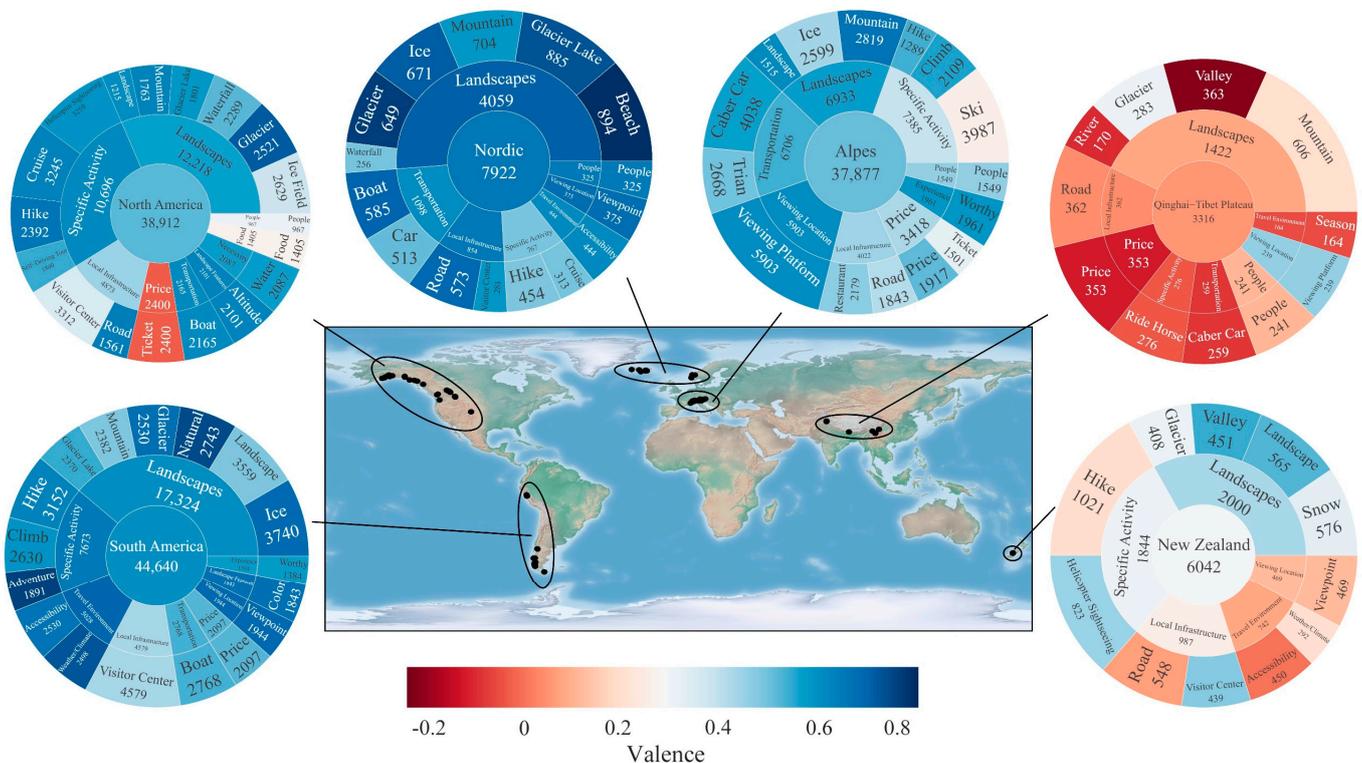


Figure 7. Regional differences in the image of glacier tourism destinations.

For the central ring, which reflects the dimension image of the region, the South American region was most popular for its travel environment, landscape features, and viewing locations, and its landscape and specific activities were most significant, although visitors had a relatively poor impression of its infrastructure. The strength of the image of the North American region lay in its specific activities and landscapes, which were the main image of its glacier tourism destinations and which were highly valued and widely recognized by tourists. Conversely, the high price of glacier tourism in North America was one of its few criticisms. The Nordic region won over visitors with its superb landscapes, and the viewing locations and infrastructure were equally popular with visitors, although they did not rate specific activities, which were relatively few and not easy to access. The Alpine region had the highest landscape, viewing location, and experience validity, as well as higher price satisfaction compared to other regions. The Qinghai–Tibet Plateau region had the lowest image valence of all the regions, with price (−0.11), tourism environment (−0.07), and transportation (−0.04) having the worst image and only the scenic location (0.47) having a slightly better image, whereas the rest of the image valence was negative or close to zero. The landscape and specific activities in the New Zealand region were relatively more popular with tourists but also had less valence than in other regions.

Finally, the outer ring reflects the image of a region's attributes. With regard to attributes under the *landscape* dimension, the naturalness of the *landscape* in the South American region (0.76) was the most prominent; North America was the most popular for *glaciers* (0.73); Northern Europe, as the region with the highest landscape valence, was highly praised by tourists for its *beaches* (0.81), *glaciers* (0.79), and *glacial lakes* (0.75); the Alpine region had the highest valence for *mountains* (0.68); the landscape of the Tibetan Plateau region seems to be unrecognized by tourists, and its highest valence was only 0.32 for *glaciers*; and although the *valley landscape* was the most criticized in the Tibetan Plateau Region, it was very different in New Zealand, reaching a valence of 0.56. In terms of specific activities, those that are unique to each region included *adventure* and *climbing* in South America, *cruising* and *hiking* in North America and Northern Europe, *climbing* and *skiing* in the Alps, *horseback riding* in the Tibetan Plateau, and *helicopter tours* in New Zealand. Although *skiing* was an image specific to the Alpine region, its satisfaction was not high, and the same applied to *horseback riding* in the Tibetan Plateau region. In terms of *price*, the valence of the regions was not low, with the exceptions of North America and the Tibetan Plateau. Notably, *accessibility* appears in the images of South America, Northern Europe, and New Zealand, suggesting that the approach and route to the glacier were important to them. The image of *viewing platforms* in the Alps and the Qinghai–Tibet Plateau was significant because glacier tourism in these two locations is mainly associated with sightseeing at the top of mountains, making the construction of viewing platforms particularly important.

5. Discussion and Conclusions

5.1. Discussion

The results of this study indicate that the image of glacier tourism locations consists of 14 dimensions. Compared to previous studies, the five most common categories were landscape, specific activities, transportation, infrastructure, and travel environment [34,43], and the image dimensions of animals, price, people, and food were also consistent with some previous research [45]. The difference is that the landscape features, viewing locations, and necessities (e.g., oxygen bottles and water) are unique images of glacier tourism. Glacial landscape features are an important reference for tourists, which produce the image of tourist destinations, and the evaluation of the glacier landscape by tourists is based on their perception and experience of glacier features, such as color, shape, texture, and sound [65]. Viewing location is also crucial to glacial landscape sightseeing. For example, tourists commented that the view of the golden mountain of sunshine (formed by sunlight hitting the top of the mountain and being reflected by the glacier) on China's Hailuoguo Glacier could only be seen from specific viewpoints. The image related to necessities

was also significant because glacier tourism activities mainly involve hiking, and the availability of water is indispensable; similarly, some glaciers are at high altitudes, and the air is relatively thin, so tourists participating in hiking and climbing activities may also need to carry oxygen tanks. In addition to the abovementioned cognitive images of tourism destinations, in this study, we also captured the affective image of an experience consisting of “worthwhile”, “kindness”, and “enjoyable”, a type of image that is often difficult to capture in unstructured tourism destination image constructs [44]. The conative image is more associated with the actions of the visitor after the trip, such as revisiting and recommending the destination [48,66]. Thus, although the conative image cannot be captured, the cognitive and affective images are sufficient to represent the overall image of the destination [42,67].

Among the images of glacier tourism destinations, landscapes and specific activities have high salience and high valence and are thus the core images of glacier tourism. Additionally, there is little of the human element to attract visitors to glacier tourism sites, in contrast to the image of mixed tourism sites (e.g., city tourism), where culture, entertainment, and experience are perhaps more important [44,45,58]. Similarly, the phenomenon of lower infrastructure valence is easy to explain. Glaciers are usually located in high-latitude or high-altitude mountains far from urban areas, with fragile natural environments that are prone to rockfall due to glacier recession [18], so the infrastructure construction and maintenance costs of glacier tourism sites are higher than those of the general tourism type, resulting in a lower valence of the image. The price image has the lowest valence, perhaps because tourists are required to pay extra for the protection of the glacier [68]. However, the high cost of travel is not unique to glacier tourism destinations, and tourist dissatisfaction with travel prices seems to be common across all types of travel [57,69,70].

The analysis of the seasonal image of glacier tourism destinations shows that glacier tourism sites have distinctive summer and winter characteristics. Visitors were significantly more satisfied with the winter landscape than the summer landscape, mainly because the summer is affected by high temperatures, leading to snow melting and glacier recession, whereas the low winter temperatures allow glaciers to be replenished by snowfall [71], and the combination of snow with mountains and forests can itself have a strong visual impact. Although tourist satisfaction with glacier skiing was not high, the number of glacier skiing visits was significantly higher in winter than in summer because of snowfall and microclimate fluctuations [72]; therefore, skiing is another feature of glacier tourism undertaken in winter. Glaciers are more stable in winter, so for glacier tourism, glacier-climbing activities are more appropriate in winter. Another advantage of winter glacier tourism is the price [68]. As it is the low season, tour operators usually attract tourists by lowering the prices of entrance fees and hotels [73], with the result that tourists are significantly more satisfied with the price in winter than in summer. On the other hand, summer glacier tourism is characterized by a diversity of landscapes, activities, and tourist service features; comfortable temperatures; and a climate more suitable for outdoor sports [74], hiking to experience the natural charm of the wilderness, or cruising the fjords to see glaciers and whales [75]. As a consequence, the experience image of the summer received the highest rating of the four seasons. The spring and fall seasons are not as distinctive as winter and summer, but they are still good times for glacier tourism.

Although the main attraction of glacier tourism is wholly based on the geographic environmental elements of the glacier destination [40], differences in regional characteristics can produce different characteristics at different glacier tourism sites. The South American and North American regions are well-developed and comprehensive glacier tourism destinations, with diverse and efficient landscape types and tourism services. However, the South American region is more prominent for adventure activities, such as hiking and climbing in glacier areas. The North American region is more diverse, and in addition to hiking, glacier tours by cruise ship, helicopter, or self-drive are also significant [76]. Northern Europe possesses the ultimate natural scenery, and cruises on glacial lakes are

a key feature [77]. The Alps are a typical mountain glacier tourism destination, with world-renowned glacier ski resorts featuring skiing, climbing, and sightseeing by cable car and train [29]. The Qinghai–Tibet Plateau region is also a mountainous glacier tourism area, but there is no skiing, and mountaintop sightseeing and horseback riding in the valley are its specialties [78]. Glacier tours in the New Zealand region feature wilderness hikes and glacier tours by helicopter [79].

5.2. Conclusions

In this study, we crawled 138,709 online reviews (text data) of 107 glacier tourism destinations on TripAdvisor and extracted images of glacier tourism destinations using the LDA theme model, with some interesting results. First, we found that the world glacier tourism destination image system consists of 14 dimensions and 53 attributes. Landscape and specific activities were the core elements of glacier tourism. Landscape features, viewing locations, and necessities had unique significance for glacier tourism, whereas infrastructure and prices were influenced by the environment of glacier tourism sites, resulting in low valence. Secondly, the image of glacier tourism destinations varied significantly on a seasonal basis, with summer glacier tourism sites having a variety of image types, tourism features, and a comfortable climate. Glacier tourism in winter was regarded as better in terms of landscape and price, and skiing activities were more appropriate in winter. Finally, the regional differences in the image of glacier tourism destinations were obvious. The world glacier tourism market is mainly concentrated in South America, North America, and the Alpine region, and each region has its own glacier tourism characteristics.

Our study has certain theoretical and practical implications. We extracted images of glacier tourism destinations based on tourist reviews of glacier tourism destinations worldwide, complementing research on glacier tourist experiences and destination image perceptions, as well as enriching unstructured research on destination images. In addition, the destination image analysis method based on the LDA theme model and SVA proposed in this study could help tourism managers to identify the key attributes of tourism destinations for scientific decision making and planning to enhance their attractiveness. Finally, the analysis of seasonal and regional variations in the image of glacier tourism destinations presented in this study could help tourists match their preferences when choosing glacier tourism destinations and the appropriate timing for their trips.

This study is subject several limitations that need to be addressed in future research. First, the study sample may be biased; we used data from TripAdvisor glacier traveler reviews, and glacier destinations and traveler reviews that did not appear on that platform were not taken into account. Secondly, the crawled visitor comments were written in multiple languages, and because of the large sample size, we converted them to English uniformly by calling the Google Translate API, a process that may lead to changes in the semantics of some words. In addition, for the image season analysis part of the destination, we used the visitor writing date for the season classification; however, this date may lag behind the visitor tour date, possibly biasing the results. Finally, traveler-generated content belongs to the organic information sources of destination image, and it is an interesting exercise to compare destination images derived from different information sources (induced, organic, and autonomous) [80]. In addition, with advances in machine learning and natural language processing capabilities, images and videos can serve as new sources of data in the study of destination images [81].

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Appendix A

Table A1. Results of national LDA topics.

| Argentina | Austria | Canada | Chile | China | France | Germany | Iceland |
|----------------|------------------|-------------------|----------------|------------------|---------------|------------------|----------------|
| Hike | Mountain | Adventure | Accessibility | Altitude | Cable Car | Snow | Accessibility |
| Accessibility | Slope | Ice Field | Worthy | Cable Car | Climb | Train | Glacier Lake |
| Ice | Crowdedness | Hike | Mountain | Kindness | Ticket | Mountain | Mountain |
| Glacier | Viewing Platform | Skywalk | Glacier Lake | Accessibility | People | Restaurant | Road |
| Boat | Restaurant | Glacier Lake | Road | Landscape | Train | Viewing platform | Seal |
| Mountain | Ice | Self-Driving Tour | Food | Ticket | Landscape | Cable Car | Boat |
| Food | Ski | Bus | Landscape | Landscape | Season | Weather | Glacier |
| Landscape | Accessibility | Mountain | Hike | Season | Ski | Road | Weather |
| Road | Other | Road | Sound | Oxygen Tank | Mountain | Ski | Hike |
| Visitor Center | Piste | Viewpoint | Viewpoint | Viewing Platform | Magnificent | Climb | Landscape |
| Color | Cable Car | Water | Boat | Weather | Weather | Ticket | Viewpoint |
| India | Italy | Nepal | New Zealand | Norway | Peru | Switzerland | United States |
| Ride Horse | Cable Car | Adventure | Hike | Waterfall | Landscape | Cable Car | Waterfall |
| Mountain | Slope | Mountain | Accessibility | Troll Car | Road | Road | Helicopter |
| Sledge | Ski | Hike | Landscape | Cruise | Viewpoint | Restaurant | Sightseeing |
| Viewpoint | Mountain | Glacier Lake | Viewpoint | Climb | Hike | Hike | Hike |
| Price | Altitude | Valley | Road | Accessibility | Accessibility | Mountain | Visitor Center |
| People | | | Glacier | Weather | | Snow | Cruise |
| Enjoyable | | | Weather | Parking | | Ski | Bear |
| Snow | | | Visitor Center | People | | Train | People |
| Accessibility | | | Snow | Mountain | | Weather | Mountain |
| Road | | | Helicopter | | | People | Water |
| Ice | | | Sightseeing | Hike | | Landscape | Glacier |
| | | | Valley | Road | | | Whale |

Table A2. Attribute dimensional glacier tourism destination image and its main topic words.

| Ice | Ice Field | Glacier | Snow | Mountain | Glacier Lake | Valley | Waterfall | Landscape | Hike | Ski | Self–Driving Tour | Climb | Ride Horse | |
|--|--|---|---|---|--|--|---|---|--|---|--|---|---|--|
| ice piece immense block nature | ice field explore wind cold | glacier iceberg sight beauty blue | snow ice winter view icy | mountain view summit cloudy level | lagoon lake water iceberg floe | valley scenery bridge track cross | waterfall lake river size view | landscape scenery mountain Lake snow | hike walk trail trek pace | ski slope piste snow lift | drive trip car hour road | climb rock summit glacier rope | ride horse rider valley access | |
| Cruise | Helicopter Sightseeing | Adventure | Cable Car | Bus | Troll Car | Train | Boat | Sledge | Seal | Whale | Bear | Road | Piste | |
| cruise ship board bay passage | helicopter access tour guide ride | adventure wild walk camp valley | car cable ride queue view | bus transport driver ride ticket | car troll access coach site | train journey station tunnel route | boat ride ship entrance guide | sledge transport snow experience ride | seal watch photograph water sea | whale saw wildlife trace sea | bear nature away trip point | road way path route access | piste ski variety route slope | |
| Skywalk | Visitor Center | Restaurant | Parking | Color | Sound | Altitude | Slope | Magnificent | Price | Ticket | Accessibility | Weather/Climate | Season | |
| skywalk platform attract scenery watch | visitor center information history service | restaurant food service staff place | parking car fee road transport | blue color water ice scenery | thunder sound noise silence moment | altitude level peak meter summit | slope condition area level variety | magnificent view superb height nature | price cost money fee expense | ticket buy price ropeway office | access walkway catwalk guide drive | weather rain sun cloudy temperature | season summer winter spring ice | |
| Crowdedness | Viewpoint | Viewing Platform | People | Food | Worthwhile | Kindness | Enjoyable | Water | Oxygen Tank | | | | | |
| crowd lot people queue wait | view viewpoint picture spot look | view platform height walk peak | people family couple group children | food lunch tea eat snack | worth trip price happy scenery | kind people help impress friend | enjoy experience beauty scenery comfort | water bring need bottle drink | oxygen tank breathe altitude sense | | | | | |

Table A3. Four seasons image statistics of glacier tourist destinations.

| Spring | Freq. | % | Summer | Freq. | % | Autumn | Freq. | % | Winter | Freq. | % |
|--|-------|--------|--|--------|--------|---|-------|--------|---|-------|-------|
| Landscapes (Glacier Lake, Mountain, Landscape) | 5970 | 23.84% | Landscapes (Glacier Lake, Glacier, Mountain, landscape, Ice) | 19,317 | 32.87% | Landscapes (Glacier, Ice, Glacier Lake, Mountain) | 9197 | 25.58% | Landscapes (Glacier, Mountain, Landscape) | 5779 | 30.50 |
| Specific Activity (Ski, Cruise, Hike) | 7735 | 30.89% | Specific Activity (Self–Driving Tour, Hike, Cruise) | 8658 | 14.73% | Specific Activity (Self–Driving Tour, Cruise, Hike) | 7152 | 19.89% | Specific Activity (Hike, Ski, Climb) | 5757 | 30.39 |
| Transportation (Cable Car) | 2186 | 8.73% | Transportation (Bus, Cable Car) | 5540 | 9.43% | Transportation (Boat, Cable Car) | 5061 | 14.08% | Transportation (Cable Car) | 1760 | 9.29 |
| Local Infrastructure (Road) | 1780 | 7.11% | Local Infrastructure (Infrastructure, Road, Visitor Center) | 8459 | 14.39% | Local Infrastructure (Road, Visitor Center) | 3736 | 10.39% | Local Infrastructure (Road) | 1858 | 9.81 |
| Landscape Features | 0 | 0% | Landscape Features (Magnificent) | 913 | 1.55% | Landscape Features | 0 | 0% | Landscape Features | 0 | 0 |
| Travel Environment (Weather/Climate) | 1321 | 5.28% | Travel Environment (Accessibility, Weather/Climate, Season) | 5993 | 10.20% | Travel Environment (Weather/Climate) | 1681 | 4.68% | Travel Environment (Weather/Climate, Crowdedness) | 2141 | 11.30 |
| Viewing Location | 0 | 0% | Viewing Location | 0 | 0% | Viewing Location (Viewpoint) | 4726 | 13.15% | Viewing Location | 0 | 0 |
| Price | 1626 | 6.49% | Price | 1966 | 3.35% | Price | 2309 | 6.42% | Price | 1650 | 8.71 |
| Experience (Enjoyable) | 2582 | 10.31% | Experience | 2802 | 4.77% | Experience (Worthwhile) | 2090 | 5.81% | Experience | 0 | 0 |
| People | 0 | 0% | People | 1990 | 3.39% | People | 0 | 0% | People | 0 | 0 |
| Food | 1838 | 7.34% | Food | 1333 | 2.27% | Food | 0 | 0% | Food | 0 | 0 |
| Necessity | 0 | 0% | Necessity (Water) | 1803 | 3.07% | Necessity | 0 | 0% | Necessity | 0 | 0 |

Table A4. Regional image of glacier tourism destinations.

| Alpes | Freq. | % | New Zealand | Freq. | % | Nordic | Freq. | % |
|---|--------|--------|---|-------|--------|---|--------|--------|
| Landscapes (Ice, Mountain, Landscape) | 6933 | 18.30% | Landscapes (Landscape, Glacier, Snow, Valley) | 2000 | 33.10% | Landscapes (Glacier, Waterfall, Mountain, Glacier Lake, Ice, Beach) | 4059 | 51.24% |
| Specific Activity (Climb, Hike, Ski) | 7385 | 19.50% | Specific Activity (Hike, Helicopter Sightseeing) | 1844 | 30.52% | Specific Activity (Cruise, Hike) | 767 | 9.68% |
| Transportation (Trian, Cable Car) | 6706 | 17.70% | Transportation | 0 | 0% | Transportation (Boat, Car) | 1098 | 13.86% |
| Local Infrastructure (Restaurant, Road) | 4022 | 10.62% | Local Infrastructure (Road, Visitor Center) | 987 | 16.34% | Local Infrastructure (Road, Visitor Center) | 854 | 10.78% |
| Travel Environment | 0 | 0% | Travel Environment (Accessibility, Weather/Climate) | 742 | 12.28% | Travel Environment (Accessibility) | 444 | 5.60% |
| Viewing Location | 5903 | 15.58% | Viewing Location (Viewpoint) | 469 | 7.76% | Viewing Location (Viewpoint) | 375 | 4.73% |
| Price (Price, Ticket) | 3418 | 9.02% | Price | 0 | 0% | Price | 0 | 0% |
| Experience (Worthwhile) | 1961 | 5.18% | Experience | 0 | 0% | Experience | 0 | 0% |
| People | 1549 | 4.09% | People | 0 | 0% | People | 325 | 4.10% |
| North America | Freq. | % | Qinghai–Tibet Plateau | Freq. | % | South America | Freq. | % |
| Landscapes (Landscape, Mountain, Waterfall, Glacier Lake, Ice Field, Glacier) | 12,218 | 31.40% | Landscapes (River, Mountain, Glacier, Valley) | 1422 | 42.88% | Landscapes (Landscape, Glacier Lake, Glacier, Ice, Mountain, Natural) | 17,324 | 38.81% |
| Specific Activity (Hike, Helicopter Sightseeing, Cruise, Self–Driving Tour) | 10,696 | 27.49% | Specific Activity (Ride Horse) | 276 | 8.32% | Specific Activity (Climb, Hike, Adventure) | 7673 | 17.19% |
| Transportation (Boat) | 2165 | 5.56% | Transportation (Cable Car) | 259 | 7.81% | Transportation (Boat) | 2768 | 6.20% |
| Local Infrastructure (Road, Visitor Center) | 4873 | 12.52% | Local Infrastructure (Road) | 362 | 10.92% | Local Infrastructure (Visitor Center) | 4579 | 10.26% |
| Landscape Features (Altitude) | 2101 | 5.40% | Landscape Features | 0 | 0% | Landscape Features (Color) | 1843 | 4.13% |
| Travel Environment (Weather/Climate) | 0 | 0% | Travel Environment (Season) | 164 | 4.95% | Travel Environment (Accessibility, Weather/Climate) | 5028 | 11.26% |
| Viewing Location | 0 | 0% | Viewing Location | 239 | 7.21% | Viewing Location (Viewpoint) | 1944 | 4.35% |
| Price (Ticket) | 2400 | 6.17% | Price (Price) | 353 | 10.65% | Price | 2097 | 4.70% |
| Experience | 0 | 0% | Experience | 0 | 0% | Experience (Worthwhile) | 1384 | 3.10% |
| People | 967 | 2.49% | People | 241 | 7.27% | People | 0 | 0% |
| Food | 1405 | 3.61% | Food | 0 | 0% | Food | 0 | 0% |
| Animals | 0 | 0% | Animals | 0 | 0% | Animals | 0 | 0% |
| Necessity (Water) | 2087 | 5.36% | Necessity (Water) | 0 | 0% | Necessity | 0 | 0% |
| Other | 0 | 0% | Other | 0 | 0% | Other | 0 | 0% |

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