RESEARCH ARTICLE

The network characteristics of classic red tourist attractions in Shaanxi province, China

Feng Yuxin[1,2], Tian Yunxia[1]*, Lv Xiaoyu[1]

1 College of Tourism, Northwest Normal University, Lanzhou, Gansu, China, 2 Gansu Great Wall and Long March National Cultural Park Construction and Development Research Center, Lanzhou, Gansu, China

* 2759182779@qq.com

🔓 OPEN ACCESS

Abstract

Red tourism is a distinctive form of tourism in China. Its network attention serves as a typical indicator to measure the level of promotion and publicity for red tourism, as well as an important reflection of its influence. Understanding the network structure of red tourism is of significant importance for optimizing the spatial pattern of tourism and promoting the development of the tourism industry. Based on this, this study takes the classic red tourism attractions in Shaanxi province, China as an example and constructs a multi-source data network attention evaluation index. Additionally, it employs social network theory to explore the network attention and tourist flow characteristics of the case study area. Research shows that: (1) Overall, the network attention to case-based destinations is relatively low, and there are significant differences in network attention among different attractions. Spatially, the distribution of network attention is uneven. This is manifested by higher network attention to attractions in Yan'an city and lower network attention to attractions in other regions. (2) There are differences in the network attention of different types of attractions. High-level attractions have a higher level of online attention, while low-level attractions have a lower level of network attention. Additionally, archaeological sites tend to receive a higher level of online attention. (3) The network density of tourist flow is low, and the tourism connections between nodes are not closely linked. The linkage between core nodes and edge nodes in tourism is poor. Developed tourism routes only exist in core nodes. (4) Nodes such as Zaoyuan revolution site, Yangjialing revolution site, and Wangjiaping revolution site have a significant influence in the network structure. In addition, the integration and development between red nodes and non-red nodes have been achieved. (5) There is a correlation between network attention and tourist flow, as well as a 'misplacement' feature. Based on the characteristics of attractions, they can be divided into four types: bright-star attractions, cash-cow attractions, thin-dog attractions, and question attractions. Based on the above conclusions, this study proposes targeted development recommendations.

Introduction

Under the guidance of the government, red tourism has rapidly developed, which has sparked scholarly research on red tourism. In China, red tourism generally refers to themed tourism

activities that revolve around revolutionary commemorative sites and landmarks, with a focus on the history, events, and spirit of the revolution [1]. Red tourism, unlike other types of tourism, serves as a significant avenue for promoting revolutionary culture. The Chinese government attaches great importance to the development of red tourism, resulting in a strong market demand and promising future prospects for red tourism in China. In recent years, red tourism has experienced rapid growth under the government's promotion. On March 23, 2021, People's Daily pointed out that from 2004 to 2019, China's red tourism resources have been continuously expanding, and the red tourism market has become increasingly active. The 'Report on the development of China's red tourism (2022)' states that in 2022, the cumulative number of tourists received in China's red tourism reached 3.478 billion, with a comprehensive income of 929.5 billion yuan. Red tourism has gradually become an important driving force for China's tourism development.

Literature review

Red tourism

Red tourism is an important component of the tourism industry. Currently, research on red tourism, both domestically and internationally, focuses on the value of red tourism, the spatial characteristics of red tourism, and its influencing factors.

In terms of the value of red tourism, scholars believe that it not only brings significant economic benefits, but also serves as an important form of disseminating advanced culture and conducting ideological education [2–4]. In the context of the new era, red tourism bears the historical mission of disseminating red culture and enhancing national identity [5, 6]. In addition, red tourism also possesses profound cultural connotations and contemporary values, serving as a significant driving force for enhancing cultural self-confidence [7]. In terms of spatial characteristics of red tourism, scholars often employ social network theory and spatial structure theory to investigate the spatial features of red tourism. For instance, Cong Li et al. (2021) conducted a study on the network structure of red tourism flow using online data [8]. Scholars have pointed out that important factors influencing red tourism include economic development, information technology, transportation conditions, and geographical distance [9]. Climate conditions and the holiday system also have a significant impact on the spatial distribution of red tourism [10]. Red resources and red culture form the foundation of red tourism. Promoting the integration of red culture and tourism is an important measure to facilitate the development of the tourism industry [11, 12].

Tourist flow

Tourist flow connect the origin and destination and serve as the foundation for the development of the tourism industry [13]. Its spatial pattern not only represents the movement of tourists but also reveals the diversity of tourism resources, making it an important tool for studying tourism phenomena. In recent years, with the rise of tourism big data, the academic community has conducted an increasing number of studies on tourist flow, with most of them focusing on the spatial characteristics of tourist flow, their influencing factors, and their correlations.

The spatial structure of tourism refers to the spatial scale and degree of aggregation formed by the interaction of tourism objects [14]. This spatial scale and degree of aggregation can reflect the spatial attributes and interrelationships of tourism activities, providing guidance for the spatial planning of tourist attractions. Based on this, scholars have conducted extensive research on the spatial characteristics of tourist flow. From the perspective of research methods, most studies utilize digital footprints of tourism, such as online texts and images, as data

[15]. Spatial analysis and social network analysis are employed to analyze the spatial characteristics of tourism flows. The scale of the research subject includes multiple levels, such as scenic spots [16, 17], cities [18], provinces [19], and city clusters [20]. Based on this, scholars have further analyzed the influencing factors of tourist flow, pointing out that the spatial structure of tourist flow is closely related to factors such as tourism resource endowment, transportation level, and distance [21–23]. In addition, Yang Li et al. (2023) found that the total volume of telecommunications services, the number of employees in the tourism industry, the number of accommodation enterprises, the number of corporate legal entities, and the total amount of government investment in the tourism industry are important factors influencing the flow of tourist information [24]. In terms of the correlation of tourism flow, most scholars have studied the coupling relationship between tourist flow and transportation based on the perspective of coupling [25]. Some scholars have also focused on other related studies of tourist flow [26], such as the relationship between tourist flow and the tourism environment [27], and the degree of coupling between tourism and the economy [28]. A few scholars have also investigated the impacts of haze [29], traffic [30], policies [31], language [32], natural disasters, and trade openness [33, 34] on tourist flow.

Network attention

The internet provides an important channel for tourists to obtain travel information. When tourists collect and browse travel information on the internet, they leave behind their browsing history, which is referred to as tourism network attention. Tourism network attention can reflect the level of public interest in tourist destinations, as well as reveal the characteristics of public needs and behavioral intentions [35]. Therefore, scholars have focused on studying network attention in the field of tourism.

Currently, there are two main methods for measuring network attention: one is based on Baidu index, and the other is based on constructing a network attention index using multiple sources of data. Reviewing relevant literature reveals that most studies use Baidu index as the platform and obtain raw data on tourism network attention through keyword searches. Additionally, many studies utilize spatial analysis methods to explore the spatiotemporal characteristics of different research subjects [36, 37]. For example, Shu Li et al. (2020) investigated the characteristics of online attention to sports tourism in China using Baidu Index as the dataset [38]. Subsequently, there has been an increasing number of studies focusing on online attention. However, when the research area includes multiple tourism resources, it is difficult to obtain comprehensive and effective data using Baidu index as an indicator [39]. Therefore, it is necessary to construct a network attention using multiple sources of data. For example, some scholars have used the network attention of websites such as Qunar, Ctrip, and Dianping as data to study the coupling between network attention and scenic attraction [40]. At the same time, scholars have also paid attention to the influencing factors of tourism online attention [41]. Research has found that important factors influencing online attention include economic level, population size, distance, climate, and transportation [42]. In addition, special events [43], negative information [44], policies [45], and other factors also have a significant impact on the online attention. Some scholars have also studied the correlation between online attention and tourist volume [46], as well as the correlation with tourism attractiveness [47]. This greatly enriches the research on online attention and provides a good reference for this study.

In addition, scholars have proposed methods for converting network attention into tourist flow from the perspective of measures and suggestions. As tourism network attention has predictive significance, most scholars believe that, on one hand, scenic areas should promptly pay attention to network attention information (such as online searches, browsing, ticket

purchases, etc.) and prepare for tourism reception in advance. On the other hand, scenic areas should attach importance to the dissemination and marketing role of the internet in order to attract tourists. Furthermore, Lan Xue et al. (2023) constructed an index for the conversion of network attention into tourist flow, and proposed a quantitative measurement method [48], further deepening the study of the relationship between network attention and tourist flow.

In summary, it can be concluded that the network attention reflects the overall perception of tourists towards a destination from a spatial perspective [49]. It serves as a mapping of the potential demands of the public and also has a predictive effect on actual tourist flow [50]. Therefore, there is a close relationship between network attention and tourist flow. In recent years, with the development of the digital economy, the 'internet +' model has played an important role in the development of red tourism, providing new impetus for its upgrading. Based on this, this study selects the classic red tourism attractions in Shaanxi province, China as a case study to explore the characteristics of network attention and tourist flow. This has important academic value for deepening the theoretical understanding of their relationship.

Research methods and data sources

Overview of the research area

Shaanxi possesses relatively abundant red tourism resources. In recent years, the 'Shaanxi-Gansu-Ningxia red tourism zone' and the 'Sichuan-Shaanxi-Chongqing red tourism zone' have been included among the 12 key red tourism zones cultivated in China. Shaanxi province has three routes included in the top 100 red tourism routes. The province has developed over 150 red tourism scenic areas, with 13 of them being listed in the '2016–2020 national red tourism development plan outline'. The red tourism development potential in Shaanxi is significant. According to the 'Big data report on red tourism consumption in China (2021)', Xi'an and Yan'an in Shaanxi province have been selected as the top 10 popular cities for red tourism in 2021. Based on the demand for the transformation and upgrading of the cultural and tourism industry, the province has currently developed a comprehensive and distinctive red tourism route covering the entire region, with Yan'an in northern Shaanxi as the leader, Xi'an as the key city, and the southern Shaanxi region as an extension [51].

Using Baidu coordinate picking tool, the longitude and latitude of the case study site were obtained to create a spatial distribution map of the red tourism classic attractions in Shaanxi province (Fig 1). (The Baidu coordinate system picking tool (http://api.map.baidu.com/lbsapi/getpoint/index.html) is a tool used for obtaining geographical location information of tourist destinations, including the latitude and longitude coordinates of scenic spots.)

Data source

Based on the previous analysis, there are primarily two research methods for studying network attention. The first method is based on Baidu index, while the second method involves constructing network attention using multiple sources of data. However, when the research area encompasses multiple tourism resources, it is difficult to obtain comprehensive and reliable data solely through Baidu index. Moreover, due to the multitude of tourism resources in this study, the reliability and accuracy of using a single data source are relatively low. Therefore, it is necessary to construct a network attention index for case studies. Based on the reference to previous research and considering the comprehensiveness, accuracy, and availability of data, this study selected five Chinese social platforms, namely Ctrip, WeChat, Baidu, 360, and Mafengwo, as the sources of network attention data (all data were collected until January 1, 2023.). The specific steps are as follows: firstly, data collection is conducted using range retrieval methods on various platforms to establish a retrieval database (Table 1). Finally, the
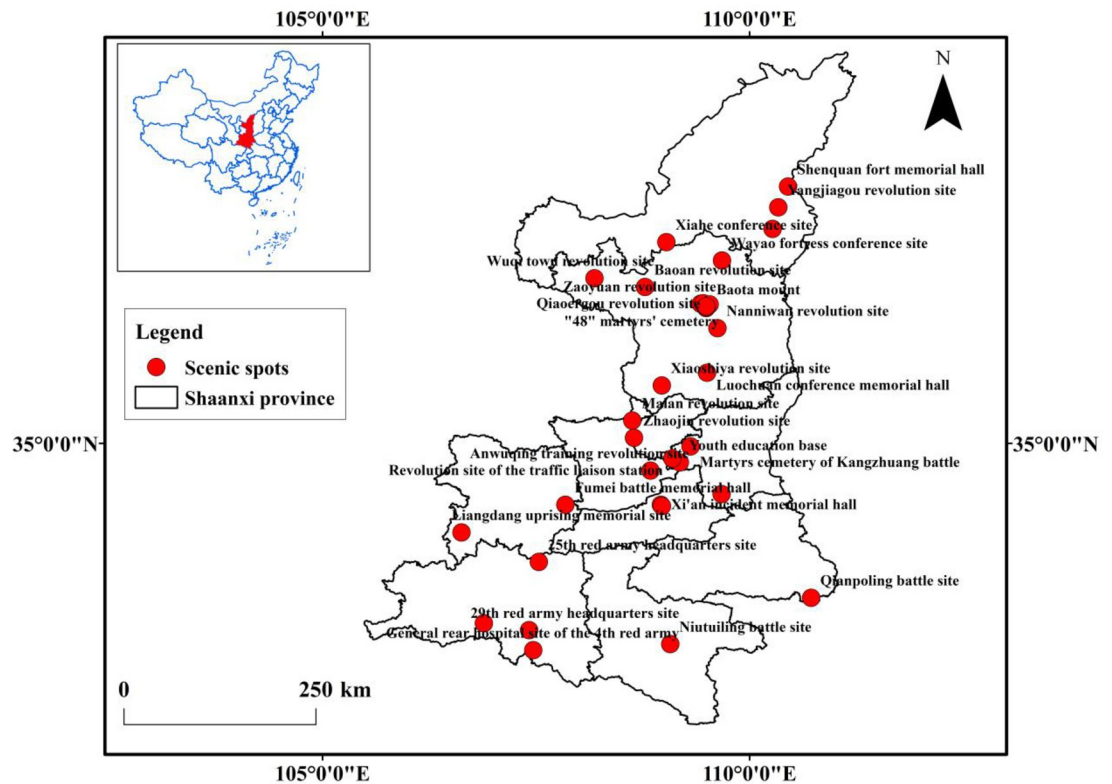
Fig 1. Distribution map of classic red tourism attractions in Shaanxi province. Note: This map is drawn based on the standard map of the ministry of natural resources of China (surveying and mapping approval No. GS(2019)1822), and the base map remains unaltered. The same applies to Fig 2.

https://doi.org/10.1371/journal.pone.0299286.g001

collected data is organized and categorized to obtain the raw data of network attention. The data on tourist flow is sourced from Mafengwo and Qunar platforms (all data retrieved as of January 1, 2023.). Building upon existing research [39], to ensure the integrity of the tourist

Table 1. Examples of the classic red tourism attractions in Shaanxi province.

Attractions	The number of attractions	Search example
Red tourism attractions in Xi'an city	2	Eighth route army's memorial hall, Xi'an incident memorial hall
Red tourism attractions in Yulin city	3	Yangjiagou revolution site, Shenquan fort memorial hall, Suide revolutionary history museum
Red tourism attractions in Fuping county	4	Youth education base, Anti-Japanese memorial site of the 120th red army, Revolution site of the traffic liaison station, Martyrs cemetery of Kangzhuang battle
Yan'an revolution memorial site scenic area in Yan'an city	17	Yan'an revolution memorial hall, Zaoyuan revolution site, Yangjialing revolution site, Wangjiaping revolution site, Phoenix mountain revolution site, Qingliang mountain revolution site,"48" martyrs' cemetery, Luochuan conference memorial hall, Wayao fortress conference site, Baota mount, Qiaoergou revolution site, Nanniwan revolution site, Revolution site of the northwest bureau, Shaanxi-Gansu-Ningxia region government site, Baoan revolution site, Wuqi town revolution site, Memorial hall of the Chinese people's anti-Japanese

https://doi.org/10.1371/journal.pone.0299286.t001

flow network structure, non-red attractions in the tourist flow routes were retained, and the aforementioned data was transformed into directed flow data between attractions. Ultimately, 468 valid origin-destination (O-D) data were obtained.

Research methods

Method of network attention.   First, the entropy method is used to calculate the weight of each indicator. Finally, using the model of network attention to calculate network attention of the attractions in the case, the specific steps are as follows:

First step, the data are processed in dimensionless. Due to the different magnitudes of each platform and index, to ensure the accuracy of the data, it is necessary to perform dimensionless processing on each data one by one. All indicators are positive and the calculation formula is as follows:

$$P'_{ij} = \frac{P_{ij} - min\{P_j\}}{max\{P_j\} - min\{P_j\}} + 0.0001 \tag{1}$$

Second step, calculating the proportion of the weight:

$$Q_{ij} = \frac{P'_{ij}}{\sum_{i=1}^{m} P'_{ij}} \tag{2}$$

Third step, the information entropy value of the j indicator is calculated:

$$e_j = -k \sum_{i=1}^{m} (Q_{ij} \times lnQ_{ij}) \tag{3}$$

Fourth step is to calculate the redundancy of the information entropy:

$$d_j = 1 - e_j \tag{4}$$

Fifth step is to calculate the weight value of the j indicator:

$$W_i = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

Sixth step is to calculate the single indicator:

$$S_{ij} = W_i \times P'_{ij} \tag{6}$$

Seventh step is to calculate the overall network attention:

$$D = S1 + S2 + S3 + S4 \tag{7}$$

In the formula: P_{ij} denotes the value of the j-th evaluation indicator for the i-th data, min $\{P_j\}$ and max$\{P_j\}$ are the minimum and maximum values of the j-th evaluation index in all data, k = 1/lnm, where m is the number of evaluation rows and n is the number of indicators, D is the network attention, S1 is the network review index, S2 is the network travel index, S3 is the social media index and S4 is the search engine index (Table 2). Index weights are calculated using the entropy method and retaining 6 digits of data after the decimal point.

Method of tourist flow.   Social network theory posits that social groups are interconnected networks in which actors (nodes) mutually influence each other. This theory assesses the importance of nodes in the network from a relational perspective and analyzes the significance of both individual nodes and the overall network based on the characteristics of the network structure [52]. It has been widely applied in tourism research. This study adopt indicators such

Table 2. Evaluation indicators of network attention.

Index	Weights	Data sources	Total number	Indicator processing
S1: network review index	0.251704	Ctrip	36296	Taking the total number of reviews as an index, processing the data dimensionless one by one.
		Mafengwo	4833	
S2: network travel index	0.245730	Mafengwo	8148544	Taking the total number of likes, comments, and views on each platform as the index, the data processing is the same as S1.
S3: social media index	0.250862	WeChat	7934362	Taking the total number of articles, videos, and the total number of readings as indicators, the data processing is the same as S1.
S4: search engine index	0.251704	Baidu	114830760	Taking the total number of searches on the platform as the index, and the data processing is the same as S1.
		360	3366518	

as size and density, core-edge, and node weighted degree to analyze the characteristics of tourist flow, drawing on this theory. Size and density represent the connections between nodes in the network. A larger value indicates closer connections between nodes, and vice versa. Node weighted degree reflects the diffusion and aggregation capacity of nodes. A higher value indicates greater capacity of the node. Core-edge is used to analyze the importance of individual nodes in the network.

Results analysis

Analysis of network attention

Spatial characteristics. The network attention is an important measurement indicator for attractions in terms of online promotion, marketing, and attractiveness, and it has significant implications for the construction of attraction platforms and precision marketing. According to Formula (7), the mean value of network attention is 0.340238677. This value is relatively small, indicating that the overall network attention of the case study site is low, and the promotion and publicity capabilities of the attractions' online platform need to be improved urgently. In addition, there are 8 attractions with a network attention degree ranging from 0.50000 to 1.00000, accounting for only 20% of the total number of attractions. On the other hand, there are 25 attractions with a network attention degree lower than the average, accounting for a high proportion of 62.5%. This indicates significant differences in network attention degree among the case study sites, with the majority of attractions having a relatively low network attention degree (Table 3). It is recommended that these types of attractions should focus on improving their network attention by increasing publicity and marketing efforts, in order to attract attention from visitors and cultivate potential tourists for the attractions.

Table 3. Network attention of attractions.

| Network attention	The number of attractions	Percentage (%)	Representative attractions
0.000000–0.100000	2	5	Wuqi town revolution site, Weihua uprising memorial hall
0.100001–0.200000	12	30	Memorial hall of the Chinese people's anti-Japanese, Zhaojin revolution site
0.200001–0.300000	5	12.5	Niutuiling battle site, Qingliang mountain revolution site
0.300001–0.400000	9	22.5	Phoenix mountain revolution site, Qianpoling battle site
0.400001–0.500000	4	10	Xi'an incident memorial hall, Malan revolution site
0.500001–0.600000	5	12.5	Xiahe conference site, Zaoyuan revolution site
0.600001–1.000000	3	7.5	Nanniwan revolution site, Yan'an revolution memorial hall
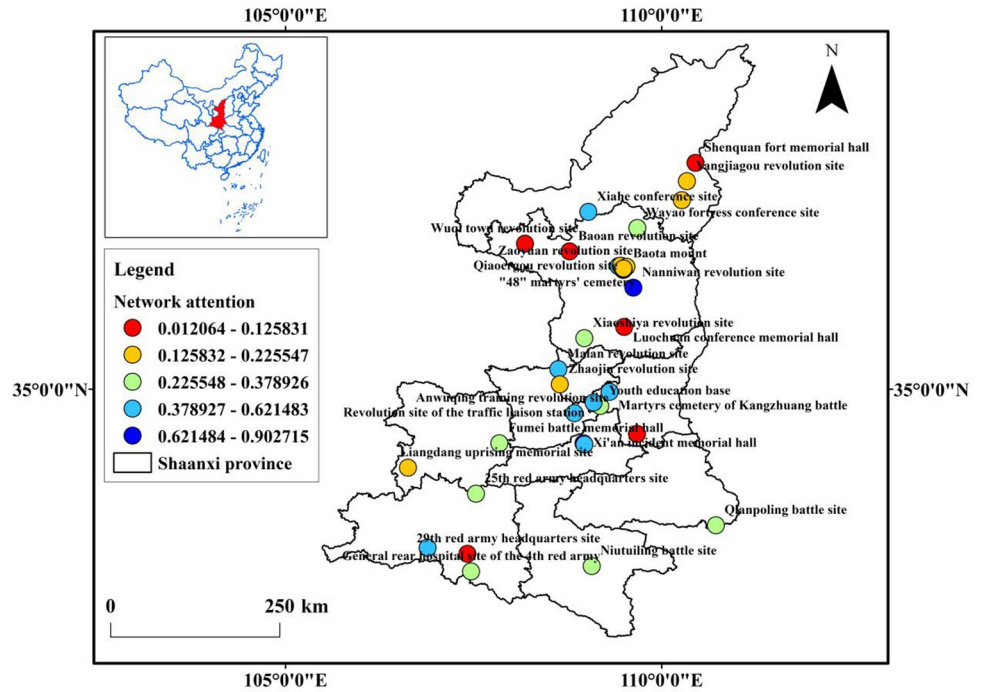
Fig 2. Distribution of network attention.

From the perspective of spatial distribution (Fig 2), tourist attractions in Yan'an city have a higher level of network attention, while attractions in other regions have a lower level of network attention. As shown in Table 3, the top three attractions are all located in Yan'an city. Among them, Nanniwan revolution site ranks first, and Yan'an revolution memorial hall ranks second. However, the network attention for attractions in Yulin and Baoji regions is relatively low, indicating a significant gap compared to Yan'an city. This also suggests, to some extent, that the abundance of resources, quality, and reputation of scenic areas are closely related to network attention.

Differences in types of attractions. The network attention of different types of attractions varies. In terms of attraction level, attractions with higher levels tend to receive more network attention. The main representative attraction is Yan'an revolution memorial hall, with a network attention score of 0.831570, ranking second (S1 Table). This attraction belongs to China's 5A-level tourist attractions, which are well-known and widely recognized by the public, leading to a higher level of attention. Additionally, some high-level attractions have relatively low network attention, such as Fumei battle memorial hall (4A). These types of attractions need to further leverage the Internet's utility to increase their exposure. In terms of attraction types, archaeological sites receive higher network attention. Among the top 20 attractions in terms of network attention, 15 of them are archaeological sites. This indicates that the public has differences in selecting attractions, and tourists' preferences have a certain influence on network attention.

Analysis of tourist flow

Size and density. By organizing and selecting data, a 93×93 attraction matrix is obtained, and a tourist flow network (Fig 3) is constructed. Overall, the network density of tourist flow is 0.023, indicating a low density in the network structure and a lack of close tourism
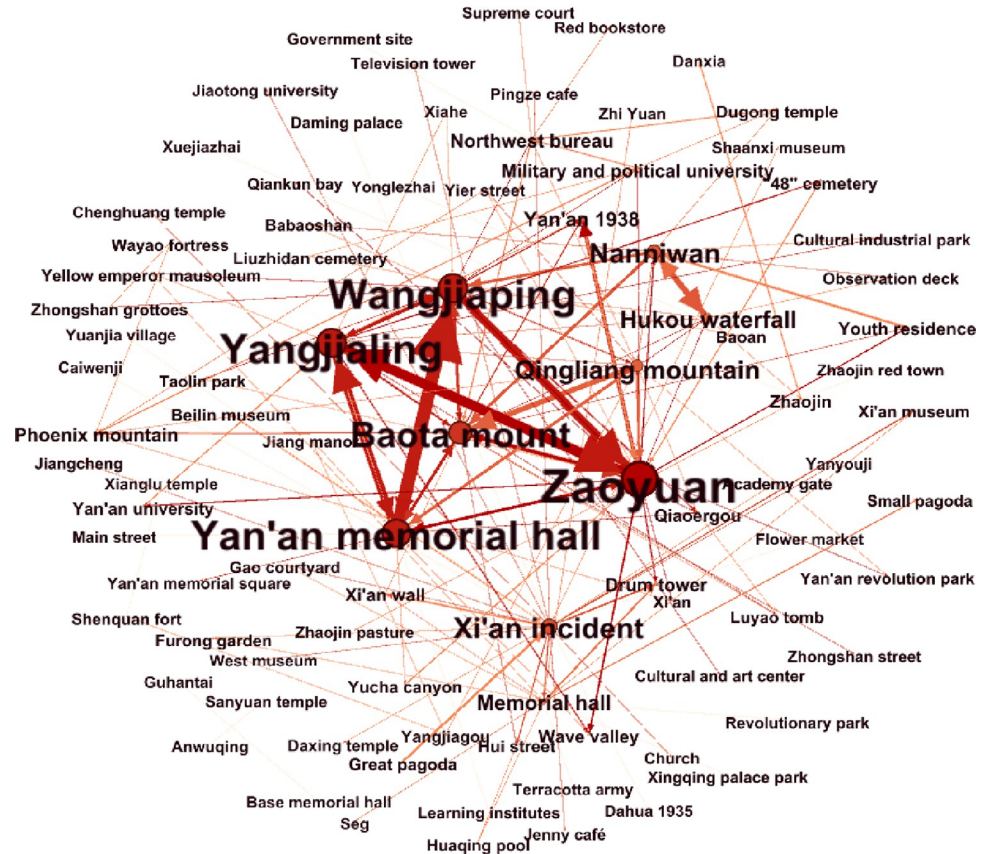
Fig 3. The network structure of tourism flow (S2 Table). (Note: Larger nodes in the graph indicate greater importance of the corresponding nodes. Thicker lines represent denser tourism flows between nodes).

connections between nodes. From the network structure, it can be inferred that there is a weak connection between core nodes and edge nodes, resulting in poor interconnectivity of tourism routes. Developed tourism routes only exist among core tourism nodes.

Core-edge. According to Table 4, Zaoyuan revolution site, Yan'an revolution memorial hall, Wangjiaping revolution site, Yangjialing revolution site, and Baota mount are located at the core positions of the network. This indicates that these nodes have strong aggregation and diffusion capabilities, making them core nodes. The density of the core nodes is 0.095, which is relatively small, indicating that the tourist flow between core nodes is not closely connected (Table 5). There are a large number of edge nodes in the network, scattered throughout Shaanxi province. Representative nodes include Anwuqing training revolution site. The density between edge nodes is 0.004, indicating a significant hierarchical differentiation in the structure of the tourist flow network. The density between the core and edge regions is 0.008,

Table 4. Example of core-edge results (N = 93).

	Core nodes	Edge nodes
Core nodes	Zaoyuan revolution site, Yan'an revolution memorial hall, Wangjiaping revolution site, Yangjialing revolution site, Baota mount, Xi'an incident memorial hall	Chenghuang temple , Yuanjia village , Zhi Yuan
Edge nodes	Qin terracotta army, Daming palace national park	Anwuqing training revolution site, Yonglezhai

Table 5. Density of core-edge.

	Density of core regions	Density of edge regions
Density of core regions	0.095	0.008
Density of edge regions	0.005	0.004

and the density between the edge and core regions is 0.005. This indicates that the core nodes hold an advantageous position in the exchange relationship with edge nodes, and the tourism development capacity of edge nodes needs to be improved.

Node weighted degree. The higher the weighted degree value of a node, the greater its influence in the tourist flow network. Based on this, this study summarizes the top 20 ranked nodes. According to Table 6, nodes such as Zaoyuan revolution site, Yangjialing revolution site, and Wangjiaping revolution site have high weighted degrees, indicating their significant influence in the network. The low weighted degree of nodes such as Qiaoergou revolution site, and Phoenix mountain revolution site indicates their relatively small influence in the network structure, suggesting that their tourism impact needs to be enhanced. Furthermore, among the top 20 nodes, 7 nodes are non-red nodes, accounting for 35% of the total. Examples include Hukou waterfall, and Drum tower. This suggests that non-red nodes play important roles in the network structure, and that red tourism often combines with non-red tourism resources for mutual development.

Analysis of network attention and tourist flow

The Boston matrix, also known as the market growth rate-relative market share matrix [53], suggests that under the interaction of market growth rate and relative market share, there are

Table 6. Example of node weighted degree (N = 93).

Number	Node	Node weighted degree	Whether it is a red node
1	Zaoyuan revolution site	107	yes
2	Yangjialing revolution site	87	yes
3	Wangjiaping revolution site	87	yes
4	Yan'an revolution memorial hall	85	yes
5	Baota mount	68	yes
6	Xi'an incident memorial hall	46	yes
7	Nanniwan revolution site	41	yes
8	Qingliang mountain revolution site	35	yes
9	Hukou waterfall	27	no
10	Eighth route army's memorial hall	18	yes
11	Yan'an 1938	15	no
12	Revolution site of the northwest bureau	12	yes
13	Phoenix mountain revolution site	11	yes
14	Memorial hall of the Chinese people's anti-Japanese	10	yes
15	Drum tower	9	no
16	Wave valley	7	no
17	Xi'an wall	7	no
18	Qiaoergou revolution site	6	yes
19	Yier street	3	no
20	Liuzhidan martyrs' cemetery	3	no

Table 7. Features of network attention and node weighted degree (example).

Bright-star attractions	Cash-cow attractions	Thin-dog attractions	Question attractions
Zaoyuan revolution site, Wangjiaping revolution site, Yan'an revolution memorial hall	Yangjialing revolution site, Baota mount	Xi'an incident memorial hall, Nanniwan revolution site	Qingliang mountain revolution site, Revolution site of the northwest bureau, Phoenix mountain revolution site, Qiaoergou revolution site

https://doi.org/10.1371/journal.pone.0299286.t007

four different types of products: bright-star products (high sales growth rate, high market share), thin-dog products (low sales growth rate, low market share), question products (high sales growth rate, low market share), and cash-cow products (low sales growth rate, high market share). Based on the Boston matrix, Li Jingyi et al. (2002) creatively constructed a model that reflects the tourism market [54], which has been widely applied in tourism research. Currently, this method has been extensively adopted by scholars in the field of tourism research. Based on the analysis in the previous section, it can be concluded that there is a correlation between network attention and tourist flow. Therefore, this study draws on the division method of the Boston matrix and relevant tourism research [55, 56] to determine the criteria for dividing tourist attractions based on network attention and node weighted degree. Similarly, tourist attractions are divided into bright-star attractions, cash-cow attractions, thin-dog attractions, and question attractions. The division of each type of attraction is shown in Table 7.

According to Table 7, it can be observed that there is a correlation between tourist flow and network attention, but they also exhibit a 'misplacement' characteristic. Specifically, in terms of bright-star attractions: this type of attraction has a high level of network attention and node weighted degree. The main representative attractions are Zaoyuan revolution site, Wangjiaping revolution site, and Yan'an revolution memorial hall. This category already possesses significant online influence and should be further leveraged to drive synergistic effects among these attractions in the future. Cash-cow attractions: this type of attraction is characterized by high network attention and low node weighted degree. The representative attractions are Yangjialing revolution site and Baota mount. This category attracts a considerable number of potential tourists, and therefore, it is necessary to enhance the tourism reception capacity of such attractions in the future. Thin-dog attractions: this type of attraction is characterized by low network attention and high node weighted degree. Representative attractions include Xi'an incident memorial hall and Nanniwan revolution site. In the future, innovative marketing and promotional methods need to be implemented to enhance their tourism influence. Question attractions: this type of attraction has both low network attention and node weighted degree, encompassing most of the attractions in the case study area. Representative attractions include Qingliang mountain revolution site, and Qiaoergou revolution site. It is urgent to develop multidimensional tourism development measures for these attractions.

Conclusion and discussion

Conclusion

This study investigates the characteristics of network attention and tourist flow in the classic red tourism attractions in Shaanxi province, China, using social network theory and other methods. The findings are as follows:

1. (1) The network attention to the case study sites is relatively low (with a mean value of 0.340238677), and there is a significant difference in network attention among different attractions. The promotional and advertising capabilities of attractions on the internet need

to be improved urgently. In terms of spatial distribution, the network attention is unevenly distributed. This is mainly reflected in the higher network attention of attractions in Yan'an city, while the network attention of attractions in other regions is relatively low. The abundance of tourism resources, level, and popularity of scenic areas are closely related to network attention. (2) There are variations in the network attention received by different types of attractions. Attractions with higher rankings tend to receive higher network attention, while those with lower rankings tend to receive lower network attention. Additionally, archaeological sites exhibit higher network attention, indicating that tourists' preferences have a certain influence on the network attention received. (3) The network density of tourist flow in the case study area is low (0.023), indicating a lack of close tourism connections between nodes. The interconnectivity between core and edge nodes is poor. Developed tourist routes are only present among the core tourism nodes. Edge nodes are in a disadvantaged position within the network structure, and their tourism capacity needs improvement. (4) Zaoyuan revolution site, Yangjialing revolution site, Wangjiaping revolution site, and other nodes have a significant influence in the network structure. The connection between non-red nodes and red nodes is relatively close, playing an important role in the network structure. (5) There is a correlation between network attention and tourist flow, as well as a 'misplacement' feature. Based on the Boston matrix, attractions can be divided into bright-star attractions, cash-cow attractions, thin-dog attractions, and question attractions.

Suggestions

Based on the above analysis, it can be concluded that the network attention to the classic red tourism attractions in Shaanxi province is relatively low, and there are significant differences in network attention among different types of attractions (Fig 2). Based on this, this study proposes the following suggestions from both macro and micro perspectives. On the macro level, on one hand, it is necessary to continuously increase investment and construction of high-level attractions, and continuously leverage the key role of red heritage sites. On the other hand, attention should be paid to the development of small and medium-sized attractions, with increased promotion to enhance their visibility and influence. At the micro level, based on the attributes of tourist flows such as network density, core-periphery structure, and node weighted degree, suitable development strategies are formulated for four types of tourist attractions, as follows:

1. (1) Bright-star attractions: leveraging synergies to create a tourism growth pole. This type of attraction has a strong appeal and significant market influence. In the future, it is necessary to further enhance the development level of these attractions and leverage their synergistic effects. On one hand, based on the traffic advantage of tourism resources, continue to innovate offline tourism products, and expand the market scale by combining online network advantages. On the other hand, leverage the radiating and driving effect of these attractions to create specialized and high-quality tourism routes that combine with red attractions (such as Zaoyuan revolution site and Yan'an revolution memorial hall) and non-red attractions (Yellow emperor mausoleum). (2) Cash-cow attractions: optimizing product supply and improving service quality. This type of attraction already has a considerable number of potential tourists. In the future, it should improve the basic tourism infrastructure of the attraction and strengthen the standardization of tourism services. For example, leveraging the network influence advantages of Yangjialing revolution site, Baota mount, and other attractions, based on the characteristics of these resources, interactive activities such as red

knowledge competitions and agricultural experiences should be carried out to further enhance tourism attractiveness and continue to enhance the reputation and visibility of the attractions. (3) Thin-dog attractions: innovative marketing and promotional methods to enhance tourism appeal. This type of attraction has relatively prominent characteristics in the tourist flow, but low network attention. In the future, marketing and promotional methods for this type of attraction should be improved, online tourism promotion should be strengthened, and network attention should be enhanced. For example, through platforms such as Douyin, Xiaohongshu, and Weibo, adopting O2O three-dimensional, live streaming, and other marketing methods, innovative marketing and promotional methods for Xi'an incident memorial hall, and other attractions should be implemented to enhance the online influence of the attractions and cultivate potential tourists. (4) Question attractions: enhancing the online visibility of tourist attractions to comprehensively improve the level of tourism products and services. The online visibility and level of tourism development of these attractions are relatively low, and it is necessary to comprehensively and multidimensionally enhance the development level of these attractions in the future. This can be achieved by increasing traditional media marketing such as television, radio, newspapers, and magazines, as well as actively engaging in new media marketing. At the same time, it is important to further improve the level of tourist services, enhance reception capacity, promote the integration of culture and tourism, and expand the scope of revolutionary education, red-themed festivals, educational tourism, and other content to create diversified tourism products.

Discussion

In the context of the internet, various social platforms have provided new channels for tourists to obtain travel information, which has also brought new opportunities and challenges to the development of red tourism scenic spots. Network attention, as an important indicator of the promotion and publicity capability of tourist attractions on the internet, should be given due attention. Currently, there are various channels for promoting tourist attractions, such as websites and software, which provide convenience for this purpose. The measurement of network attention should be conducted from multiple perspectives. Therefore, this study has constructed a dataset of network attention from multiple sources. Based on this background, this study analyzes the network attention and tourist flow characteristics of red tourism classic attractions in Shaanxi province, China, in order to promote the high-quality development of red tourism under the 'internet+' background.

Research has revealed significant variations in the development of network attention for red tourism destinations. Non-red tourism destinations exhibit a closer tourism connection with red tourism destinations, which brings forth new insights for the development of these destinations. The study also found that there is a certain relationship between network attention and tourist flow. This relationship is mainly manifested in scenic spots that are of high level, good quality, and high popularity, as they tend to attract more network attention. Although previous studies have shown a significant positive correlation between network attention and visitor traffic [57], there is also a distinct 'mismatch' characteristic between network attention and tourist flow. This study found that high network attention does not necessarily result in high tourist flow in scenic areas. Specifically, there are numerous factors influencing network attention. Red tourism receives significant attention from Chinese government departments, leading to extensive online promotion and a substantial impact on the network attention of scenic areas. On the other hand, tourist flow is influenced by various

factors such as resource endowment, transportation level, distance, and preferences [21–23]. Therefore, there is both correlation and dislocation between network attention and tourist flow. In the context of 'Internet+', scenic spots should not only focus on the effect of online promotion but also take into account the 'mismatch' of network attention, promoting the transformation and upgrading of tourist attractions comprehensively and from multiple perspectives.

In addition, due to objective constraints such as data availability and completeness, the author only obtained network data from six platforms. In the future, a quantitative model can be constructed to select comprehensive indicators. Additionally, the formation mechanism of network attention and the characteristics of tourist flow misplacement are also important research directions of concern.

Supporting information

S1 Table. Network attention of scenic spots.
(DOCX)

S2 Table. Data processing.
(DOCX)

S1 File.
(DOCX)

S2 File.
(DOCX)

S3 File.
(DOCX)

S4 File.
(DOCX)

S5 File.
(DOCX)

S6 File.
(DOCX)

S7 File.
(XLS)

Acknowledgments

Author Contributions

Conceptualization: Tian Yunxia.

Data curation: Tian Yunxia, Lv Xiaoyu.

Formal analysis: Tian Yunxia.

References

1. Xin Y, Wang LC, Liu HY. Centenary of the party: The temporal and spatial changes of national patriotic education bases. Journal of Arid Land Resources and Environment,2021, 35(12):177–187. https://doi.org/10.13448/j.cnki.jalre.2021.343

2. Hou HL, Zhang QR, Jiang YJ, Wang FY. Can red tourism lead to spiritual transformation? Evidence from tourists visiting the red army long march Xiangjiang battle memorial park. PloS one,2023, 18(7): e0280920. https://doi.org/10.1371/journal.pone.0280920 PMID: 37418357

3. Wang R. On the application of 'red culture' in urban parks. Open Journal of Applied Sciences,2023, 13 (07):1104–1110. https://doi.org/10.4236/OJAPPS.2023.137088

4. Ho JK. The effect of red tourism on the balanced development of the regional economy in China. Korean Journal of Hospitality Tourism,2018, 27(6):225–241. https://doi.org/10.24992/kjht.2018.08.27.06.225

5. Hung TC. Communist tradition and market forces: Red tourism and politics in contemporary China. Journal of Contemporary China,2018, 27(114):902–923. https://doi.org/10.1080/10670564.2018.1488105

6. Wall G, Zhao RN. China's red tourism: communist heritage, politics and identity in a party-state. International Journal of Tourism Cities,2017, 3(3):305–320. https://doi.org/10.1108/IJTC-03-2017-0017

7. Shao MH, Yang TT. Scene-empowered red culture tourism development: Theoretical logic and multidimensional paths. Journal of Lanzhou University(Social Sciences),2022, 50(06):95–104. https://doi.org/10.13885/j.issn.1000-2804.2022.06.009

8. Cong L, Li SY, Hong JX, Zhang WH. The spatial network structure of tourist flows for national red tourism attractions. Journal of Arid Land Resources and Environment,2021, 35(12):188–194. https://doi.org/10.13448/j.cnki.jalre.2021.344

9. Jiao SS, Li M, Tian FJ, Wu RL, Yang QQ. Distribution pattern and driving mechanism of network attention of Chinese red tourism classic scenic spots. Economic Geography, 2022, 42 (01):211–220. https://doi.org/10.15957/j.cnki.jjdl.2022.01.025

10. Xu JW, Wang W, Du J. Temporal-spatial characteristics of red tourism network attention and its influencing factors in six provinces of central China. Journal of Chongqing University(Social Science Edition),2023(2):82–96. https://doi.org/10.11835/j.issn.1008-5831.jg.2023.02.003

11. Zhao S, Timothy JD. Tourists' consumption and perceptions of red heritage. Annals of Tourism Research,2017,6397–111. https://doi.org/10.1016/j.annals.2017.01.003

12. Ren J. Research on the development of red tourism resources in Yan'an, China. Cross-Cultural Communication,2018, 14(3):22–27. https://doi.org/10.3968/10502

13. Liu HM, Hu J, Lv L, Zhang HH, Cao TT. Impact of COVID-19 on spatio-temporal pattern of tourism in Wuhan: A network attention based study. Journal of Arid Land Resources and Environment,2023, 37 (02):194–202. https://doi.org/10.13448/j.cnki.jalre.2023.052

14. Zhang YD, Li C, Chen Y, Guan SH. The community organization model and hierarchy in Xinjiang's tourism flow network. Scientia Geographica Sinica,2023, 43(9):1619–1628. https://doi.org/10.13249/j.cnki.sgs.2023.09.012

15. Qin XH, Li Xing M, Chen W, Tan HL, Luo L, Xu XH. Tourists' digital footprint: the spatial patterns and development models of rural tourism flows network in Guilin, China. Asia Pacific Journal of Tourism Research,2022, 27(12):1336–1354. https://doi.org/10.1080/10941665.2023.2166420

16. Ji XF, Huang HQ, Chen F, Li MJ. Spatial differentiation characteristics of regional self-driving tourism flow: A case study of central Yunnan urban agglomeration. Heliyon,2023, 9(11): e21814–e21814. https://doi.org/10.1016/j.heliyon.2023.e21814 PMID: 38027797

17. Xiao Y, Wang H, Miao SY, Xie B. A complex network analysis of local and non-local tourist flows in Beijing through mobile phone data. Transactions in Planning and Urban Research,2023, 2(2–3):217–235. https://doi.org/10.1177/27541223231183114

18. Hu MX, Xu FF, Wang JL, Zheng JM, Han B, Wang H. The communities detection of the tourist flow network using mobile signaling data in Nanjing, China. Applied Spatial Analysis and Policy,2023, 16 (4):1517–1540. https://doi.org/10.1007/S12061-023-09529-8

19. Ji XF, Ge YC, Chen F. Spatial and temporal differentiation characteristics of holiday tourism flow based on highway traffic flow big data: A case study of 7 holidays in 2017 in Yunnan province. Tourism Tribune,2019, 34(6),37–47. https://doi.org/10.19765/j.cnki.1002-5006.2019.06.009

20. Zhu HZ, Cao FD. Tourist flow network structure characteristics and its flow pattern based on geo-tagged photos: Taking the Yangtze river city group as an example. Resources and Environment in the Yangtze Basin, 2020, 29 (11): 2374–2383. https://doi.org/10.11870/cjlyzyyhj202011005

21. Li LN, Chen X, Zhang LY, Li Q, Yang Y, Chen J. Space-time tourist flow patterns in community-based tourism: an application of the empirical orthogonal function to Wi-Fi data. Current Issues in Tourism,2023, 26(18):3004–3022. https://doi.org/10.1080/13683500.2022.2106826

22. Wu LP, Zhang J. A study on the supply factors and mechanism of the inter-regional diffusion and transfer of inbound tourism flow. Current Issues in Tourism,2023, 26(3):392–406. https://doi.org/10.1080/13683500.2022.2128995

23. Xiao G, Li WM, Zhang C. Study on spatial structure and influencing factors of Jiangxi tourism route network. Areal Research and Development,2020, 39(05): 88–92. https://doi.org/10.3969/j.issn.1003-2363.2020.05.016

24. Yang L, Fu YH, Wang JJ. Spatiotemporal distribution patterns and driving factors of tourism information flow in Chinese provinces along the Belt and Road. Arid Land Geography,2023, 46(10):1714–1722. https://doi.org/10.12118/j.issn.1000-6060.2022.614

25. Liu TZ, Luo F, He JW. Evolution of Spatial Structure of Tourist Flows for a Domestic Destination: A Case Study of Zhangjiajie, China. Sustainability,2023, 15(4):3271–3271. https://doi.org/10.3390/SU15043271

26. Alexandre G, Samuel F, Sofia G, João R. The effect of virtual proximity and digital adoption on international tourism flows to Southern Europe. Tourism Economics,2023, 29(6):1643–1661. https://doi.org/10.1177/13548166221116704

27. Cheng Z, Jia TF. Study on the coupling and coordination relationship between the structure of tourism flow and tourism environment in Shanghai. Study of Modern Cities, 2020,(03): 106–112. https://doi.org/10.3969/j.issn.1009-6000.2020.02.016

28. Wang Z, Li T. Spatiotemporal coupling analysis of Chin's inbound tourism ditributive superiority and tourism economic efficiency. Human Geography,2021, 36(05):157–166. https://doi.org/10.13959/j.issn.1003-2398.2021.05.019

29. Xu D, Huang ZF, Huang R. The spatial effects of haze on tourism flows of Chinese cities: Empirical research based on the spatial panel econometric model. Acta Geographica Sinica, 2019, 74 (04): 814–830. https://doi.org/10.11821/dlxb201904014

30. Liu S, Zhang J, Liu PX, Xu YF, Xu L, Zhang HL. Discovering spatial patterns of tourist flow with multilayer transport networks. Tourism Geographies,2023, 25(1):113–135. https://doi.org/10.1080/14616688.2020.1850849

31. Usman K, Emeka L O, Katarzyna B. Do regional trade agreements enhance international tourism flows? Evidence from a cross-country analysis. Journal of Travel Research,2022, 61(6):1391–1408. https://doi.org/10.1177/00472875211028321

32. Usman K, Emeka L O, Idris OS. Exploring diverse sources of linguistic influence on international tourism flows. Journal of Travel Research,2022, 61(3):696–714. https://doi.org/10.1177/0047287520988909

33. Emeka LO, Ogechi A, Oludele F. Natural disasters, trade openness and international tourism: the role of income levels across countries. Tourism Recreation Research,2023, 48(1):60–78. https://doi.org/10.1080/02508281.2021.1891740

34. Ibitoye J O, Kleynhans P E. Influence of institutional quality, foreign direct investment and international trade on tourism inflow, South Africa[J]. Acta Commercii,2023, 23(1): e1–e12. https://doi.org/10.4102/AC.V23I1.1111

35. Wan TH, Zhang ZR, Li SL, Liang RQ. Research on the temporal and spatial distribution of the attention to rural tourism on domestic network. Journal of Southwest University (Natural Science Edition),2022, 44(06):138–149. https://doi.org/10.13718/j.cnki.xdzk.2022.06.015

36. Zhang Y, Jin X, Wang YW, Liu RT, Jing Y. Characterizing spatial-temporal variation of cultural tourism internet attention in western triangle economic zone, China. Land,2022, 11(12):2221–2221. https://doi.org/10.3390/LAND11122221

37. Zhang GH, Yuan HY. Spatio-temporal evolution characteristics and spatial differences in urban tourism network attention in China: Based on the Baidu index. Sustainability,2022, 14(20):13252–13252. https://doi.org/10.3390/SU142013252

38. Shu L, Zhang K, Wang XQ, Chen H, Tao YL. Network attention of China's sports tourism based on Baidu index. Journal of Beijing Sport University,2020, 43(06):110–122. https://doi.org/10.19582/j.cnki.11-3785/g8.2020.06.012

39. Li L, Tao ZM, Lai ZC, Li T, Ju SL. Analysis of the Internet attention and tourism flow network structure of red tourism resources in Long March National Cultural Park. Journal of Natural Resources,2021, 36 (07):1811–1824. https://doi.org/10.31497/zrzyxb.20210713

40. Ju SL, Tao ZM, Hang YL. Coupling coordination degree between rural scenic tourist network attention and gravity in Nanjing city. Economic Geography,2017, 37(11):220–228. https://doi.org/10.15957/j.cnki.jjdl.2017.11.027

41. Hou XS. Tourism network attention variation of Chinese cities under the COVID-19 pandemic. Sustainability,2022, 14(9):5131–5131. https://doi.org/10.3390/SU14095131

42. Ding X, Wang JQ, Li YQ. Study on characteristics and influencing factors of network attention degree of tourist destination based on Baidu index: A case of Xiamen city. Resource Development & Market,2018, 34(05):709–714. https://doi.org/10.3969/j.issn.1005-8141.2018.05.022

43. Chen JH, Hu YM. Online public opinion of cross-border tourism: A case study of the shipwreck in Phuket Island. Journal of Huaqiao University (Philosophy and Social Sciences Edition),2020,(03):68–79. https://doi.org/10.16067/j.cnki.35-1049/c.2020.03.007

44. Zhang M, Huang LY. Tourism development and public attention to negative online information: Based on the spatial correlations of tourism demand. Tourism Tribune,2021, 36(07):81–91. https://doi.org/10.19765/j.cnki.1002-5006.2021.07.011

45. Dai L, Bai CQ, Liang LW. Spatial spillover effect of the red tourism policy on public online attention in China: An empirical study based on semantic analysis and spatial econometric model. Journal of Natural Resources,2021, 36(11):2778–2796. https://doi.org/10.31497/zrzyxb.20211105

46. Fang YL, Cheng XL, Huang ZF, Guo BB. The dislocation characteristics and mechanism of network attention and tourists about Chinese national scenic spots. Economic Geography,2020, 40(04):204–213. https://doi.org/10.15957/j.cnki.jjdl.2020.04.023

47. Wang QL, Yang X, Fang Y. A Research on the spatial mismatch evolution and influencing factors of tourism resource abundance and tourism network attention in Sichuan province. Tourism Science,2023, 37(01):43–58. https://doi.org/10.16323/j.cnki.lykx.20220516.001

48. Lan X, Zhang H, Zhang XY, Zhou LH. Does 'heartbeat' mean 'actions'?-The construction and application of market conversion rate indicators for the network attention of tourist attractions. Tourism Science,2023, 37(05):37–60. https://doi.org/10.16323/j.cnki.lykx.2023.05.005

49. Lu LJ, Dai XY. Research on the tourist network attention and spatial pattern of tourist destination cities in Hunan based on the Baidu index. Resources and Environment in the Yangtze Basin,2020, 29 (04):836–849. https://doi.org/10.11870/cjlyzyyhj2020040 5

50. Liu HM, Hu J, Lv L, Zhang HH, Cao TT. Impact of COVID-19 on spatio-temporal pattern of tourism in Wuhan: A network attention based study. Journal of Arid Land Resources and Environment,2023, 37 (02):194–202. https://doi.org/10.13448/j.cnki.jalre.2023.052

51. Chen YY. The promotion of the tourist attraction of red learning tourism production in Shaanxi province. Journal of Shaanxi Xueqian Normal University,2019, 35(03):121–125. https://doi.org/10.11995/j.issn.2095-770X.2019.03.024

52. Yuan WY. Research on the spatiotemporal behavior characteristics of tourists in rural tourism destinations based on digital footprints -taking Wuyuan as an example. Central China Normal University,2023. https://doi.org/10.27159/d.cnki.ghzsu.2022.002465

53. Li CX, Jiang L, Deng Y, Zhang Y. The dynamic market competition state of inbound tourists in USA from 1990–2014. Journal of Shaanxi Normal University (Natural Science Edition),2020, 48(04):36–45. https://doi.org/10.15983/j.cnki.jsnu.2020.04.015

54. Li JY, Gan ZM, Xu CD. The analysis of the market competitive state and its transference of the entry tourism. Journal of Baoji College of Arts and Sciences (Natural Science Edition),2002(03):209–212. https://doi.org/10.13467/j.cnki.jbuns.2002.03.019

55. Sun GX. Inbound tourism market in Jilin province based on the tourism market competitive state. Scientia Geographica Sinica,2020, 40(6):973–979. https://doi.org/10.13249/j.cnki.sgs.2020.06.013

56. Kang L, Li ZT, Li WR. The Q-Q model analysis of China's provincial inbound tourism market structure. Journal of Shaanxi Normal University (Natural Science Edition),2020, 48(04):20–27. https://doi.org/10.15983/j.cnki.jsnu.2020.04.009

57. Wang LX, Yang M. Study on the relationship between tourism network attention and tourist flow in Chongqing based on Baidu index. Journal of Green Science and Technology,2023, 25(11):219–225. https://doi.org/10.16663/j.cnki.lskj.2023.11.003