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A COMPARATIVE STUDY ON TEMPORAL AND SPATIAL CHARACTERISTICS OF TOURISM FLOW IN DALIAN AND QINGDAO BASED ON ONLINE TRAVEL NOTES

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Abstract. *Python was used to capture the text information of online travel notes on the Qunar website, and compare the temporal and spatial characteristics of tourism flows between Dalian and Qingdao. The research findings are as follows: 1) Both cities have low and peak tourism seasons, especially in Dalian; 2) The top 20 tourism nodes in the two cities are distributed in a six core network, forming a low density of social networks, both of which are 0.2658; 3) The centralities of the tourism nodes' network structure of the two cities are similar; 4) The geographical distribution of tourism nodes in the two cities is extremely uneven, and the geographical distribution of the top 20 tourist attractions in Qingdao is more concentrated.*

Keywords: Online travel notes, Tourism flow, Temporal and spatial characteristics, Social network structure

1. **Introduction.** With the popularity of the Internet, digital footprint came into being. Digital footprint refers to the massive electronic traces left by users on the network. Active digital footprint refers to the information independently generated or uploaded by users, which gives people "consciousness weight". As an integral part of active digital footprint, online travel notes, which have the characteristics of high information authenticity and reflecting tourists' preferences, have become an important source of information for urban tourism research [1], bringing a new perspective to tourism research. This study discusses the characteristics of regional tourism flow according to the information generated by online travel notes.

Tourism flow is one of the key issues in tourism geography. It refers to the collective spatial movement of tourists caused by the similarity of tourism demand in a specific region, which has two basic characteristics of time distribution and spatial structure [2,3]. Foreign scholars' research on tourism flow can be traced back to the 1960s, and the research focuses on flow statistics and forecasting, and spatial structure. The domestic research on tourism flow started relatively late, and the research focuses on temporal and spatial evolution, network structure characteristics, and temporal and spatial distribution. The research objects are mostly countries and provinces, with large scales.

This study selects Dalian and Qingdao for comparative study. There are three reasons: 1) Both of them are coastal cities around the Bohai Sea, with similar types of tourism resources, and are famous for coastal tourism; 2) They are the tourism core cities of Liaoning Province and Shandong Province respectively, with similar status in the province; 3) The tourism revenues of the two countries in 2021 are 165.7 billion yuan and 195.6 billion yuan respectively, accounting for 23.67% and 16.66% respectively [4]. Based on the above three points, it can be considered that the tourism industry of the two cities is comparable.

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This study compares the tourism flow information of the two cities reflected in the online travel notes of the two cities, and puts forward optimization suggestions for the tourism industry of the two cities on the basis of the research.

2. **Data Sources and Research Methods.** Using Python to capture the text information of online, 877 travel notes about Dalian and 690 travel notes about Qingdao were crawled on Qunar website, respectively. After eliminating invalid data such as no travel information, obvious advertisement implantation, inconsistency between title and travel notes and repetition, 624 and 593 complete and effective data were obtained, respectively.

During the study, SPSS software was used to count and process travel data; Netdraw was used to visualize the social network structure of the tourism nodes; Ucinet was used to analyze the centrality of tourism nodes; at the same time, the geographical data of the two cities are introduced, and ArcGIS is used to visualize the distribution of tourist attractions.

3. Comparison of Time Characteristics of Tourism Flow.

3.1. **Visit time.** Summarize and count the visit dates in the online travel notes, and get the visit time of tourists in Dalian and Qingdao, as shown in Figure 1.

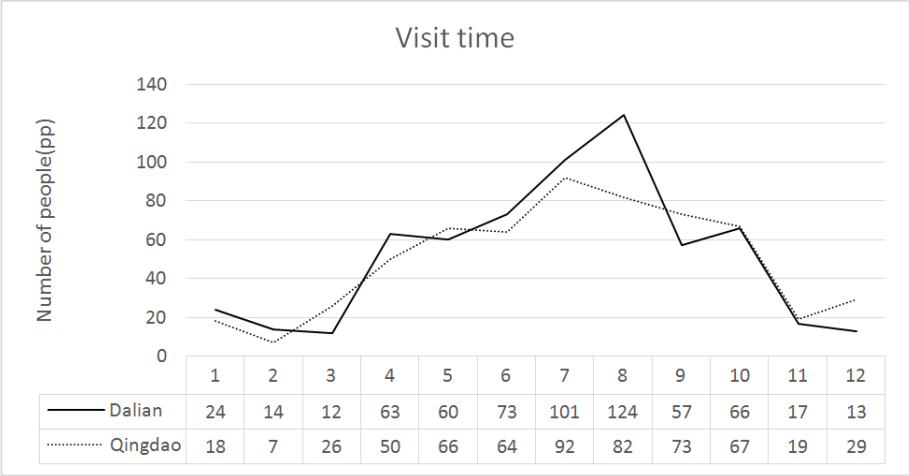

FIGURE 1. Distribution of visitors' visit time in Dalian and Qingdao

As can be seen from Figure 1, the peak tourist seasons of the two cities are between April and October. The peak tourist visits of Dalian are in August and Qingdao are in July. The standard deviation of the visiting time of tourists in the two cities is 35.362 and 27.241 respectively, that is, there are problems of low and peak tourism seasons in both cities. Among them, Dalian is more obvious [5,6].

3.2. **Stay time.** The number of tourists staying in Dalian is concentrated in 1-5 days, accounting for 89% in total, and the number of tourists staying for more than 5 days only accounts for 11%; the number of stay days of tourists in Qingdao is concentrated in 1-5 days, accounting for 87% in total, and the number of tourists staying for 5 days or more accounts for only 13%. The distribution of stay days of tourists in the two cities is similar.

4. Comparison of Spatial Characteristics of Tourism Flow.

4.1. **Selection of tourism nodes.** This study follows the principle of objectivity and does not choose the traditional scenic spots as tourism nodes [7], but uses ROST_CM6 to make word frequency statistics on the row column in the data, and takes the POI data of the first 20 frequencies as the tourism node. Due to the different expressions of the same tourism node, they are merged and summarized [8].

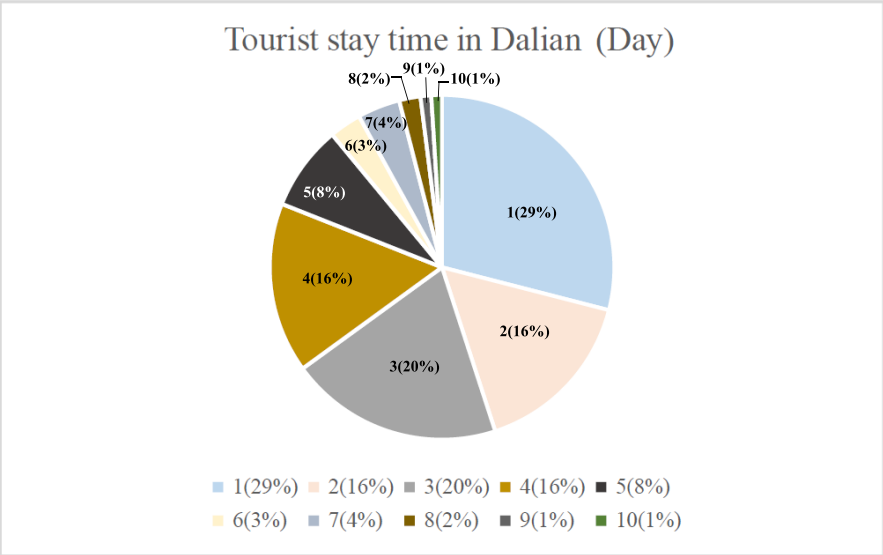

FIGURE 2. Tourist stay time in Dalian

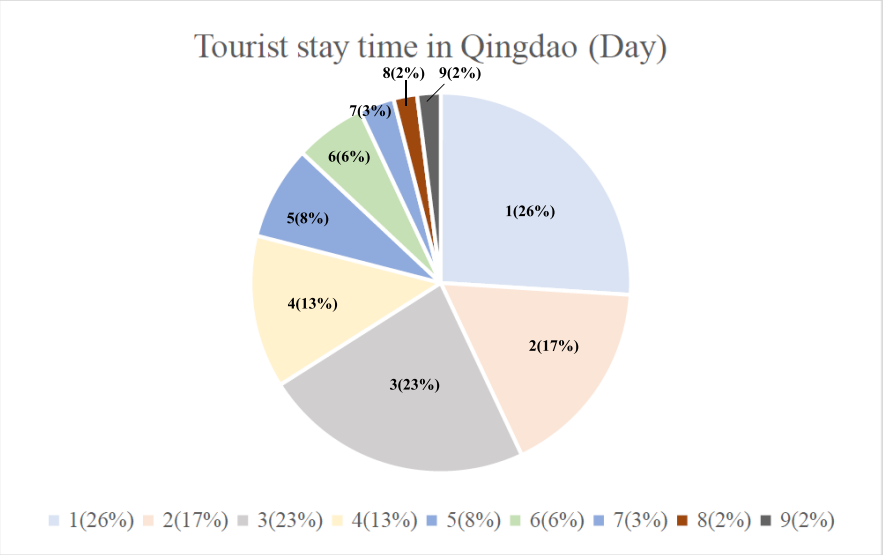

FIGURE 3. Tourist stay time in Qingdao

According to Table 1 and Table 2, the most popular tourist nodes in the two cities are Xinghai Square and Zhanqiao. The visiting frequency of the top 20 tourism nodes in Dalian is generally less than that in Qingdao.

4.2. **Social network structure.** Carry out binary processing on the travel data of tourists in the online travel notes. For example, there is travel record in Xinghai Park → Bangchui Island, which is recorded as 1, and there is no travel record, which is recorded as 0. Visualize the binary data with Netdraw, and export the network structure of tourism flow of the top 20 travel nodes of the two cities (see Figure 4 and Figure 5).

It can be seen from Figure 4 and Figure 5 that the tourism networks of the two cities are multi-core radial.

The network composed of 20 tourism nodes has the maximum possible number of connections of 380, and there are actually 101 in both cities. According to the calculation formula of social network density: $D = \sum_{i=1}^{k} \sum_{j=1}^{k} d(ni, nj)/k(k-1)$, the network density of the two cities is 0.2658, and the network density of the top 20 tourism nodes with the

TABLE 1. Top 20 tourism nodes of visit frequency in Dalian

No.	Name	Times	Freq.	No.	Name	Times	Freq.
1	Xinghai Square	192	30.77%	11	Bangchui Island	57	9.13%
2	Tiger Beach Ocean Park	150	24.04%	12	Russian Style Street	52	8.33%
3	Jinshitan Resort	128	20.51%	13	Oriental Venice Water City	31	4.97%
4	Dalian Shengya Ocean World	96	15.38%	14	Fujiazhuang	29	4.65%
5	Binhai Road	91	14.58%	15	Tianjin Street	27	4.33%
6	Xinghai Park	75	12.02%	16	Black Rock Reef	26	4.17%
7	Dalian Haichang Discovery Kingdom Theme Park	66	10.58%	17	Friendship Square	24	3.85%
8	Fisherman's Wharf	66	10.58%	18	Harbour Square	23	3.69%
9	Zhongshan Square	61	9.78%	19	Yanwo Ridge	22	3.53%
10	Dalian Forest Zoo	61	9.78%	20	Sea Crossing Bridge	20	3.21%

TABLE 2. Top 20 tourism nodes of visit frequency in Qingdao

No.	Name	Times	Freq.	No.	Name	Times	Freq.
1	Zhanqiao	230	38.79%	11	Little Qingdao	66	11.13%
2	Eight Great Passes	147	24.79%	12	Lu Hsun Park	61	10.29%
3	Qingdao Olympic Sailing Center	145	24.45%	13	Huangdao Golden Beach	54	9.11%
4	May Fourth Square	137	23.10%	14	Taiping Cape	53	8.94%
5	Laoshan Mountain	122	20.57%	15	Qingdao Beer Museum	51	8.60%
6	Firewood Yard – Zhongshan Road Characteristic Snack Street	78	13.15%	16	Taidong 3rd Road Pedestrian Street	41	6.91%
7	Qingdao Railway Station	76	12.82%	17	Qingdao Underwater World	27	4.55%
8	First Bathing Beach	68	11.47%	18	Huashi Building	26	4.38%
9	Zhejiang Road Catholic Church	68	11.47%	19	Shilaoren Bathing Beach	25	4.22%
10	Qingdao Haichang Polar Ocean Park	67	11.30%	20	Zhongshan Park	22	3.71%

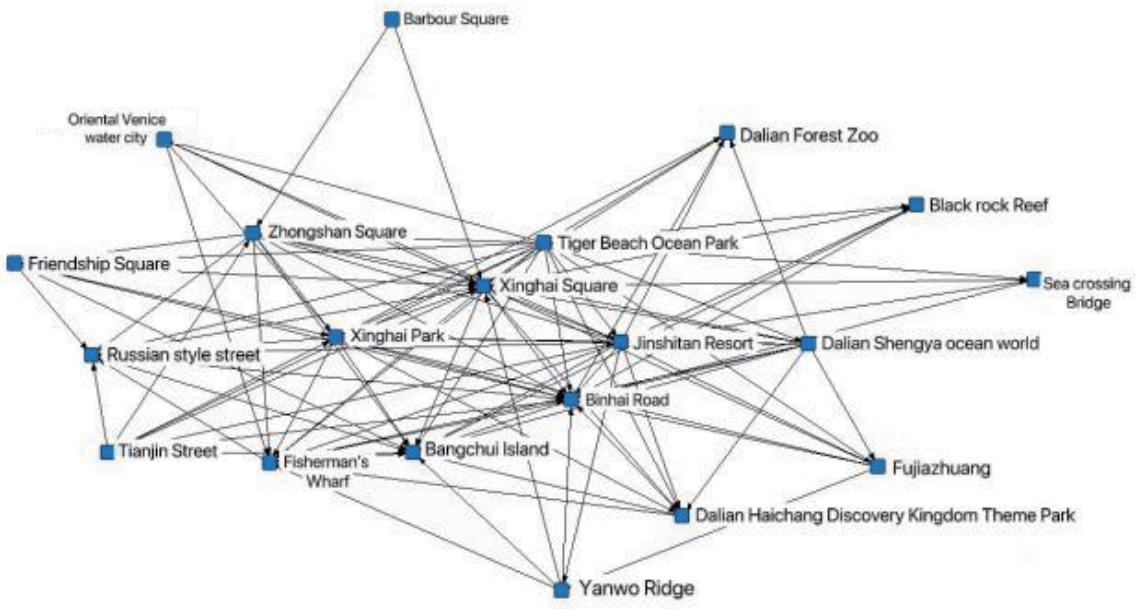

FIGURE 4. Visualization of tourism flow network structure in Dalian

same visit frequency is low, indicating that there is mutual connection between the scenic spots of the two cities, but there is a lack of connection exceeding a certain strength.

4.3. **Analysis of tourism node centrality.** The importance of tourism nodes in tourism flow network can be evaluated by centrality. Social network scholars have put forward many different indicators, among which the commonly used ones are degree centrality,

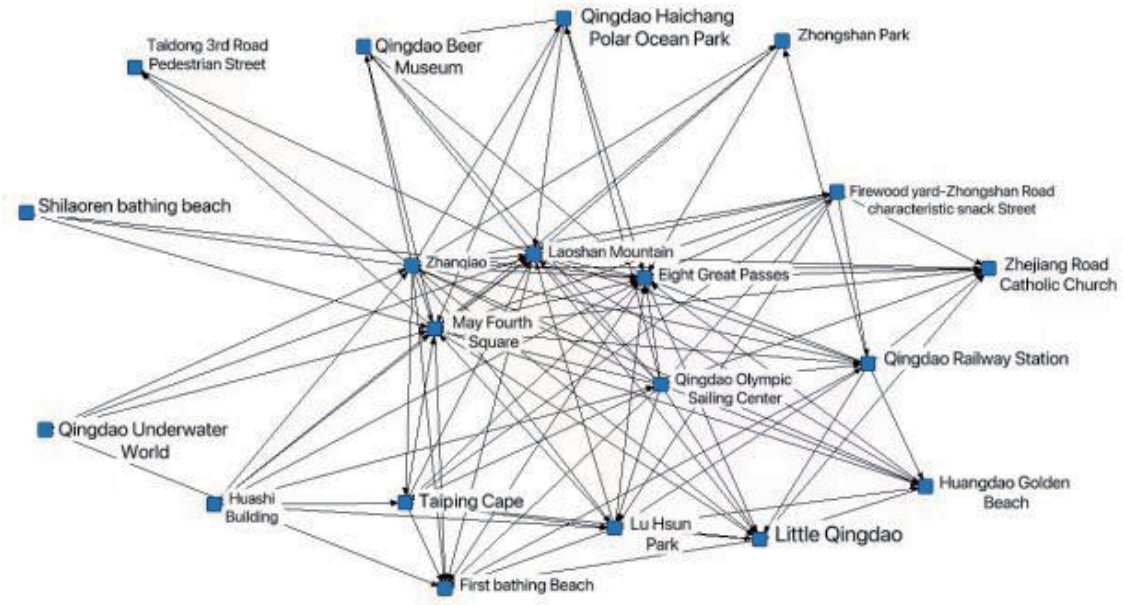

FIGURE 5. Visualization of tourism flow network structure in Qingdao

closeness centrality and betweenness centrality [9,10], which respectively reflect the direct communication ability, spatial accessibility and the ability to control network communication of nodes in the network. In this study, the centrality based on geographical location is introduced into the tight centrality analysis to observe the relationship between the geographical location of each tourism node and its ability in the social network.

4.3.1. *Degree centrality.* The number of nodes directly connected between a tourism node and other tourism nodes. The higher the degree, the wider the connection between the tourism node and other tourism nodes. Outdegree: the number of relationships between this tourism node and other tourism nodes; Indegree: the number of relationships that other tourism nodes point to this node.

4.3.2. *Closeness centrality.* In the calculation of tight centrality, this study introduces two sub indicators, one is the centrality of social network, and the other is the centrality of geographical location. The closeness centrality of the traditional social network refers to the closeness of the relationship between any tourism node and all other nodes in the social network. The closeness centrality of geographical location refers to the difficulty of a tourism node to reach other tourism nodes, which is used to evaluate whether the tourism node has advantages in spatial location. The calculation formula is $d_i = \frac{1}{n-1}\sum_{j\neq i} d_{ij}$, $CC(i) = \frac{1}{d_i} = \frac{n-1}{\sum_{j\neq i} d_{ij}}$ (The "d" is the straight-line distance between two tourism nodes.) [10].

4.3.3. *Betweenness centrality.* The number of times a tourism node acts as the bridge of the shortest path between any two other tourism nodes. The higher the intermediary centrality, the stronger the ability of the tourism node as a medium.

Ucinet was used to analyze the centrality of the network structure of tourism nodes in the two cities, and use the formula to calculate the close centrality of tourism nodes in the two cities based on geographical location (Table 3 and Table 4).

It can be seen from Table 3, 1) Tiger Beach Ocean Park, Jinshitan Resort and Dalian Shengya Ocean World have the highest point outdegree and low point indegree. It can be seen that these three nodes play a radiating role in the network structure; Binhai Road and Bangchui Island have high penetration and low exit, which play a focusing role in the network structure; Xinghai Square has a high degree of point in and point out, which not

Table 3. Centrality of tourism nodes in Dalian

No.	Name	Degree centrality		Closeness centrality		Betweenness centrality
		Outdegree	Indegree	Network structure	Geographical position	
1	Xinghai Square	7	12	0.053	0.084	27.492
2	Tiger Beach Ocean Park	17	0	0.048	0.092	12.558
3	Jinshitan Resort	12	5	0.048	0.024	12.946
4	Dalian Shengya Ocean World	10	1	0.037	0.075	1.577
5	Binhai Road	2	15	0.048	0.082	12.208
6	Xinghai Park	7	8	0.043	0.072	6.658
7	Dalian Haichang Discovery Kingdom Theme Park	3	5	0.033	0.023	0
8	Fisherman's Wharf	3	9	0.038	0.090	3.026
9	Zhongshan Square	7	5	0.038	0.100	5.988
10	Dalian Forest Zoo	0	6	0.031	0.095	0
11	Bangchui Island	0	14	0.042	0.076	5.206
12	Russian Style Street	2	8	0.036	0.096	0.554
13	Oriental Venice Water City	4	1	0.030	0.087	0
14	Fujiazhuang	5	2	0.032	0.092	0.500
15	Tianjin Street	7	1	0.033	0.099	0
16	Black Rock Reef	2	3	0.030	0.068	0
17	Friendship Square	5	2	0.032	0.100	0
18	Harbour Square	2	0	0.028	0.096	0
19	Yanwo Ridge	4	2	0.031	0.093	0.286
20	Sea Crossing Bridge	2	2	0.029	0.090	0
Mean		5.050	5.050	0.037	0.082	4.450
Max		17	15	0.053	0.100	27.492
Min		0	0	0.028	0.023	0
Std Dev		4.117	4.489	0.008	0.022	6.905

only plays a great role in focusing, but also plays a great role in radiation. 2) The closeness centrality of Xinghai Square is the highest, which means its accessibility is the strongest; The closeness centrality of Harbor Square is the lowest, which means it is difficult to connect with other tourist attractions. Friendship Square and Zhongshan Square have an excellent geographical location; Dalian Haichang Discovery Kingdom Theme Park is partial to a corner. 3) The betweenness centrality of Xinghai Square is the highest and is an important tourism node hub.

Make the above analysis on the centrality of tourism nodes in Qingdao according to Table 4, which will not be repeated here.

Through Table 3 and Table 4, an interesting phenomenon is founded. Because the actual number of network connections and network density of tourism nodes in the two cities are the same, their degree centrality, tight centrality and intermediary centrality based on social network are very similar, but the distribution of tourism nodes in Qingdao is more dense. This can be obtained from the data of geographical compactness centrality. The tourism nodes in the two cities can be visualized by using ArcGIS. You can also intuitively see the distribution of scenic spots in the two cities (see Figure 6 and Figure 7).

The top 20 tourism nodes of Dalian are concentrated in the coastal area of Zhongshan District, and the top 20 tourism nodes of Qingdao are concentrated in the coastal area of Shinan District. The coastal nature of scenic spots is obvious, and the distribution in the city is extremely uneven. In contrast, the distribution of tourism nodes in Qingdao is more concentrated.

Table 4. Centrality of tourism nodes in Qingdao

No.	Name	Degree centrality		Closeness centrality		Betweenness centrality
		Outdegree	Indegree	Network structure	Geographical position	
1	Zhanqiao	16	3	0.053	0.146	22.773
2	Eight Great Passes	4	13	0.048	0.163	12.940
3	Qingdao Olympic Sailing Center	14	1	0.043	0.121	5.873
4	May Fourth Square	8	11	0.053	0.134	22.773
5	Laoshan Mountain	7	11	0.050	0.031	17.107
6	Firewood Yard – Zhongshan Road Characteristic Snack Street	7	2	0.034	0.141	0.379
7	Qingdao Railway Station	8	4	0.038	0.135	2.315
8	First Bathing Beach	0	10	0.036	0.168	1.611
9	Zhejiang Road Catholic Church	0	8	0.033	0.147	0.111
10	Qingdao Haichang Polar Ocean Park	4	2	0.031	0.083	0
11	Little Qingdao	2	9	0.037	0.150	0.933
12	Lu Hsun Park	7	5	0.038	0.161	1.520
13	Huangdao Golden Beach	2	6	0.033	0.054	0
14	Taiping Cape	6	4	0.036	0.146	0.665
15	Qingdao Beer Museum	0	6	0.031	0.154	0
16	Taidong 3rd Road Pedestrian Street	0	3	0.029	0.147	0
17	Qingdao Underwater World	4	0	0.029	0.165	0
18	Huashi Building	7	0	0.032	0.162	0
19	Shilaoren Bathing Beach	2	1	0.029	0.067	0
20	Zhongshan Park	3	2	0.030	0.167	0
Mean		5.050	5.050	0.037	0.132	4.450
Max		16	13	0.053	0.168	22.773
Min		0	0	0.029	0.031	0
Std Dev		4.307	3.918	0.008	0.040	7.575

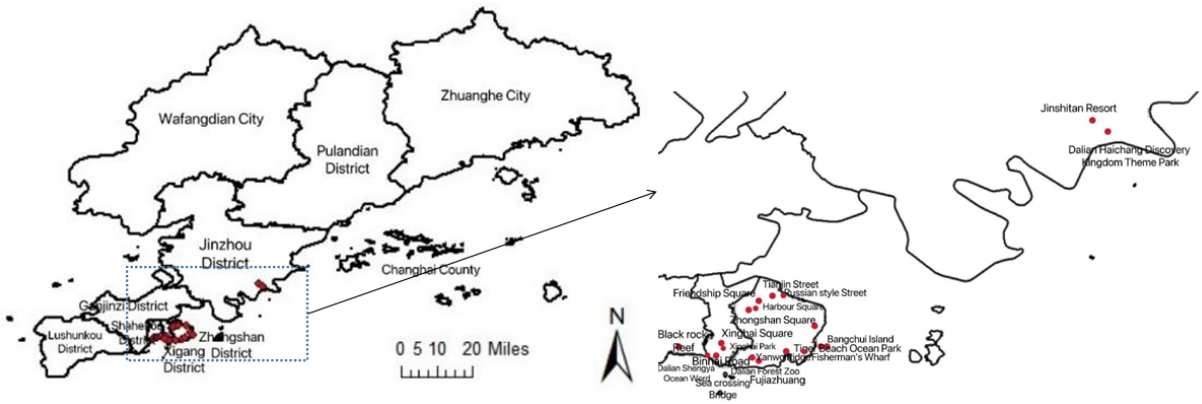

Figure 6. Distribution of tourist attractions in Dalian

Looking back at Table 1 and Table 2, we can see that the visit frequency of each tourism node in Qingdao is significantly higher than that in Dalian. Therefore, it can be concluded that the denser geographical distribution of tourism nodes, the higher possibility of tourists visiting similar scenic spots.

5. **Conclusions and Suggestions.**

5.1. **Conclusions.** 1) Time distribution: due to climate, landscape type and other factors, the two cities have the problem of low and peak tourism seasons, especially in Dalian; the tourism days in the two cities are concentrated in 1-5, lacking in-depth tourists. 2) Social network structure of tourism nodes: the network density of the top 20 tourism

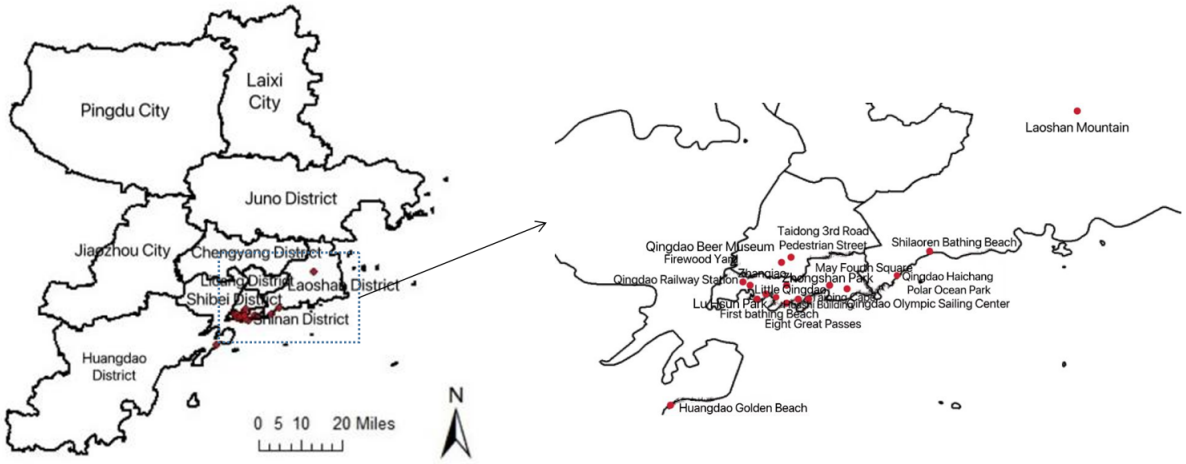

FIGURE 7. Distribution of tourist attractions in Qingdao

nodes in the two cities is 0.2658; the network structure of tourism nodes is similar, with multiple nodes as the core; the three network centers of the two cities are similar, and the direct communication ability, spatial accessibility and control network communication ability of each tourism node are quite different. 3) Spatial distribution of tourism nodes: the geographical distribution of tourism nodes in the top 20 of the frequency of tourists' visits in the two cities is relatively concentrated, and the distribution in the city is extremely uneven. The geographical concentration of tourism nodes in Qingdao is higher.

5.2. **Suggestions.** The following suggestions are put forward for the optimization of tourism in Dalian and Qingdao. 1) Alleviate the off-season tourism: The two cities need to use their own characteristics to create winter tourism projects to alleviate the difficulties in the off-season [11,12]. 2) Develop high-quality tourism products. The "14th Five-Year Plan" proposes to "form a strong domestic market and build a new development pattern" [13]. The two cities should seize the growth opportunity of tourism consumption under the strategy of expanding domestic demand, grasp the industry changes of "cross-border tourism return" under the epidemic, focus on mid-to-high-end tourism products, and create high-quality in-depth tours, niche tours, and customized tours. 3) Launching package tickets for tourist attractions. Through the analysis of the social network structure of tourism nodes, it can be seen that tourists in the two cities do not have obvious single-destination tourism directional behaviors, and packages for diversified attractions can be launched. 4) Coordinated development of regional tourism. Solve the uneven distribution of popular attractions, and ease the reception pressure of popular attractions during the peak tourist season. 5) Breaking the dilemma of the homogenization of coastal tourism. There are 17 coastal cities in the Bohai Rim region, and the degree of homogeneity of tourism resources is serious. The two cities need to increase the integration of cultural and tourism industries to create national-level cultural tourism festivals and cultural tourism performances [14]. 6) The degree of homogeneity is serious, and if it only features "Binhai", it will be too replaceable. Dalian needs to increase the integration of cultural and tourism industries, and create national-level cultural tourism festivals and cultural tourism performances [14].

5.3. **Limitations of the study.** 1) This study only collects the data on a single website of Qunar, which has limitations. The multi-source data generated by users is worthy of further mining, sorting and research. 2) This study does not distinguish between self-help travel, group travel, local travel and remote travel in data processing. In the analysis of online travel notes, it is worth classifying tourists first and then refining them.

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