Spatial distribution characteristics of cultural tourism in historical regions: a case of Shaoxing Ancient City based on POI data

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Abstract: As an important industry to achieve sustainable economic development, the role of cultural tourism has become increasingly prominent. The concentration and dispersion of various functions in the urban often reflect the distribution of different activities. It has become a crucial topic to consider how to respond to changes of urban function and balance the regional cultural protection and tourism economic development in historical areas for urban studies. In order to realize the comprehensive management and dynamic supervision, the article provides a method for analyzing cultural tourism in historical regions by using big data. In this work, we obtain the POI data of Shaoxing ancient city in China from Gaode map, combine them with GIS spatial analysis function and summarize the spatial distribution. In order to quantitatively identify the urban single and mixed functional area, the article also illustrates a way to reclassify the POI data and use the RGB color method to visualize the functional diversity index. The result shows that (1) With a tendency of decreasing from the road to the periphery, Shaoxing Ancient City function is relatively distributed in the marginal areas rather than in the central parts, especially in the traffic distribution square. (2) It is confirmed that the larger the functional density and diversity, the higher the public awareness of the historical blocks in Shaoxing Ancient City. (3) From the perspective of functional mixing, cultural function shows a high ability to be mixed with the tourism, but the spatial distribution of the two is still relatively discrete, which has not yet formed a good collaboration in Shaoxing Ancient City. (4) Compared with the network electronic map, the quantitative identification method provided by this study is more precise and accurate.

Keywords: cultural tourism, distribution characteristic, POI data, historical region

1 Introduction

Historical region is the birthplace and carrying heritage areas of special city's memories with a profound cultural background, also attaches great importance to residents' daily life. For many years, historical regions have always been a focus and difficulty in the protection of urban cultural heritage. Under the guidance of local government, most ancient cities are currently actively protected through developing cultural tourism, which seems to be a main trend to realize the regeneration of regional vitality and cultural revival. However,

as a dynamic cultural heritage, changes in urban functions brought about by tourism economic development cannot be avoided. Cultural tourism promotes urban economic development, but also brings a series of challenges including government's or resident's supervision, proportion of tourism and non-tourism economic, the choice of profitable subjects, urban development intensity norms and so on.

China, with thousands of years of history, has its own unique historical cities, regions and streets. Although local regional departments have tried to take various protective measures, that cannot avoid some embarrassing situations happening in these areas. We could easily find that some historical places are protected as a cold exhibition hall with no popularity and vitality, while others are urgent for "high-speed" economy developing without control. Excessive commercial development will accelerate a spread of "gentrification" or destroy truly historical landscape, regional context and genius loci. Eventually, it would probably be a biggest trigger of changes and differentiation in urban social communities (Zhang, 2017). How to search for a balance between protection and tourism development in accordance with changing functions in ancient cities? How to make history and culture live on through planning management? Apparently, finding a method to identify good ways of sustainable urban development has always been a crucial topic to consider in recent studies.

However, most of present traditional historical planning, relying on past statistical data and field investigation with high waste of labors, fees and times, are unable to quickly obtain the accurate spatial location or boundary information. With the deepening of the information network, many scholars have tried to explore the spatial distribution characteristics and laws of urban active points within the city through big data (Chi, Jiao, Dong, et al., 2016, Ning, 2016). In recent years, there have been more and more urban studies based on the data of POI (Point of Interest), which provides a new idea for functional identification for historical regions and spatial distributions analyzing between historical protection and tourism economy in the context of authenticity.

2 Data and methodology

2.1 Research area

This paper is based on the POI data from Gaode map in Shaoxing, China as an example. Shaoxing is one of the most ancient cities all over the world with a long history of more than 2,500 years. In 1982, Shaoxing was listed as one of the first state-list famous historical and culture cities in China with rich cultural heritages, which is called as "a natural museum without walls" until now. Suffering from several dynasties' expansion and evolution, there has been not much changes occurred in urban spatial patterns since Goujian City in King of Yue, even organization of modern cities has influenced traditional landscapes of Shaoxing(Figure 1). This research is focused on Shaoxing Ancient City (29°97′ to 30°03′N, 120°56′ to 120°60′E), with a total area of about 8 km^2.

2.2 POI data

The POI data of Shaoxing in December 2018 was obtained in the research. A total of 31,405 POIs were obtained, including 14 major categories, such as catering service, shopping service, science, education and culture service, scenic spots, public facilities, enterprises, etc. Each piece of POI data includes the information such as the name, category, address, latitude and longitude. From the perspective of urban management to be consistent with refined requirements, POI data in historical landscape sites can dynamically observe the city in time with its current description ability of facility locations at a microscopic scale. On the other hand, quantification and visualization of POI data can not only easily analyze quantitative functions of ancient sites, but also better reflect resource allocation characteristics of mixture areas to balance the relationship between urban historical protection and tourism economic utilization.

Figure1 Spatial patterns of Shaoxing Ancient City in dynasties

2.3 Methodology

The paper processed the POI data as follows: Firstly, according to the Gaode API platform, we obtained the all POI data of Shaoxing Ancient City in approximate latitude and longitude coordinate range, and then selected by Excel with polygon frame and using the ArcGIS 10.2 spatial analysis platform. Secondly, we tried to classify specific contents including name, type, address, latitude and longitude, etc. Referring to the definition of administration and public services (A) and commercial and business facilities (B) in "Code for urban land-use classes and Standards of planning construction use (GB50137-2011)", the POI points that are not related to the research were removed, after which we got a total of 6101 POI data in Shaoxing Ancient City. Finally, POIs were divided into six functions including catering business, enterprises, culture education, hotel accommodation, local-consumer places and leisure-oriented entertainment (Table 1).

Table1 Main information of a POI data coding B023F02NIB

item	*details*
POI code	*B023F02NIB*
Name	*Landscape Life Square*
Type code	*060101*
Type	*Buying service*
	Marketing
	Shopping mall
Reclassified function	*local-consumer places*
Address	*No. 6 Yuecheng Beach, Shaoxing City, Zhejiang Province, China*
Latitude and longitude	*120.581254, 30.02023*

In order to facilitate the mixing of statistical functions, the research region was divided into 797 100m*100m grids as a research unit because of the spatial intersection of POI data types. Referring to a nature recognition of each functional unit, the index frequency density and type ratio were constructed to identify the functional

properties according to relevant researches (Chi, Jiao, Dong, etc., 2016). The formula for calculating the degree of functional mixing is as follows: $F_i = n_i / N_i$, $Ci = Fi/(\sum_{i=h}^{6} Fi) \times 100\%$.

In this formula, taking POIs of type i as an example, we called it iPOI. n_i is a number of iPOI in a certain research unit. N_i is a total number of iPOI. F_i is a frequency density of iPOI in the total amount. C_i is a frequency density of iPOI, which is a percentage of the frequency density of all POIs in the research unit. To easily analyze the degree of mixture, taken the value of C_i in a research unit more than 50% as a criterion, after which the whole research units were divided into three categories as single-type, multi-type and no-data regions. If the value of C_i in a research unit was more than 50%, the unit could be evaluated as a single land property and determined by a type of POI. If the value of all C in the unit was less than or equal to 50% and larger than zero, the unit could be identified as a mixed property, which was determined by two mainly types of POIs with the largest proportion. If there is no POI in a research unit, the unit could be judged as a no-data region.

3 Spatial distribution characteristics of Shaoxing Ancient City

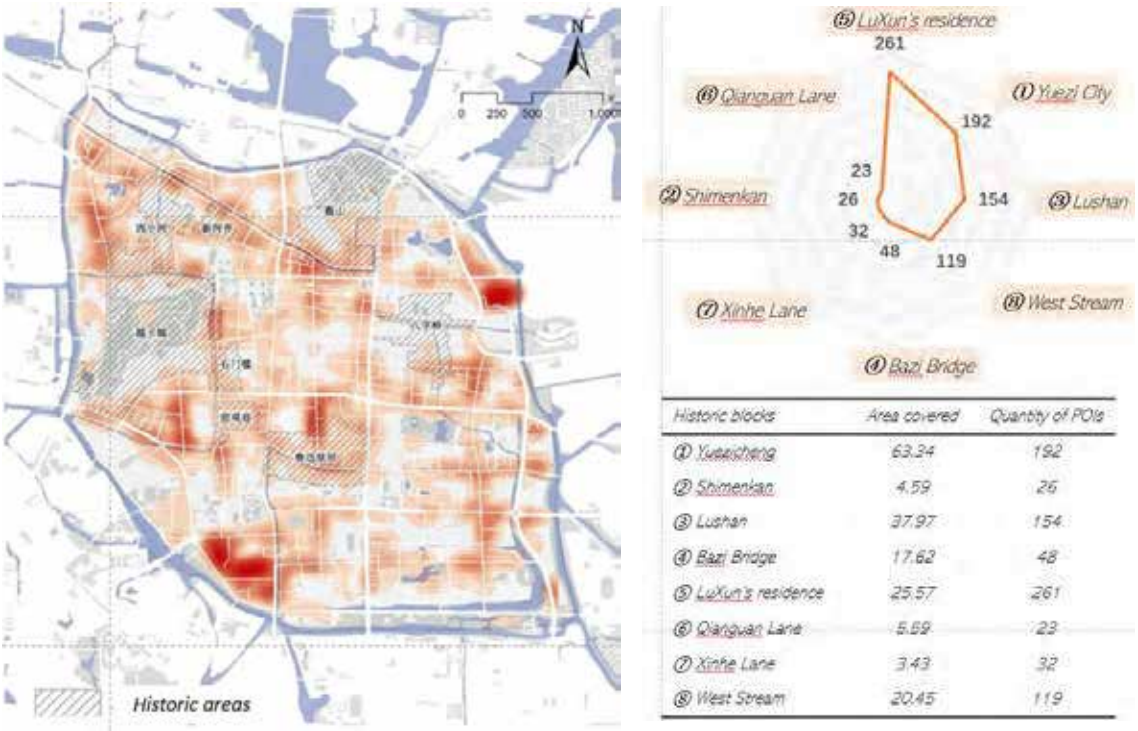
3.1 Overall functions

Based on the GIS platform, the POI point data is superimposed on the road network, water system, and mountain data to perform nuclear density analysis. It is found that the overall function of the ancient city mainly shows the following characteristics (Figure 2):

- the spatial agglomeration showed the characteristics of "large scattering and small concentration". It was obvious to find some structure patterns of scattering points in the center of the ancient city and agglomeration of edge areas. The peak of functional agglomeration density was located at the entrance and exit of the ancient city, such as the intersection of Jiefang Road and Huancheng Road on the south side, Huancheng Road and Shengli Road on the east side, Shengli Road and Huancheng Road on the west side. At the junction of the ancient city area and other areas, it is easy to attract commercial accumulation and different consumption by forming functional intensive regions.
- urban development in series was expanded and distributed along road axises. Density of functional agglomeration showed a gradient decline from roads to the periphery, while main city roads such as Jiefang Road radiate to the east-west was forming clusters around the edge. For example, Fushan Street and Xinjian South Street are clustered around newly built intersection blocks, radially connected by the edge of some historical streets.
- The historical block was surrounded by functional clusters. The higher the level of cognition, the more obvious function agglomeration and infiltration. According to the scope of the Year 2020 historical protection plan announced by Shaoxing Municipal Planning official website, there are eight historical blocks were officially confirmed, named as Yuezicheng, Shimenyu, Lushan, Baziqiao, Lu Xun's residence, Qianguanxiang, Xinhenong and Xixiaohe. As can be seen from Figure 3, every historical block covered a large number of cultural property by attracting accumulation of functions. However, due to the protection policy, the high-density function cluster was close to historical blocks without truly coincidence. Points of interest in a city mainly come from the network electronic map, so that each POI represents some degree of influence and attention. To some extent, the more POI data are gathered, the more intensive the economic, social and cultural activities in the region are and the more recognizable they are to the public. Through the spatial connection tool of GIS, the POI

data are linked withistorical blocks. It was found that a total POI data of Luxun's former resid ence, Yuezicheng and Jishan are ranked in the front with relatively high public notice, while relevant statistics of other historical districts were far apart. To add that, because Shimen occupies limited area, it was considered together with Yuezicheng due to geography.

Figure2 Overall spatial distribution characteristics of Shaoxing Ancient City

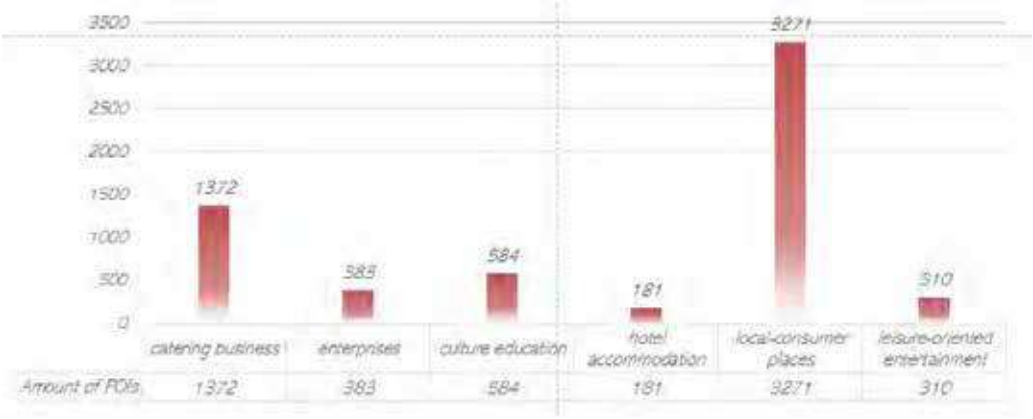


Historic blocks	Area covered	Quantity of POIs
① Yuezicheng	63.34	192
② Shimenkan	4.59	26
③ Lushan	37.97	154
④ Bazi Bridge	17.62	48
⑤ LuXun's residence	25.57	261
⑥ Qianguan Lane	5.69	23
⑦ Xinhe Lane	3.43	32
⑧ West Stream	20.45	119

3.2 Different functional types

Through nuclear density analysis of various functional areas, it was found that different functions was organized as different spatial distribution patterns(Figure 3).

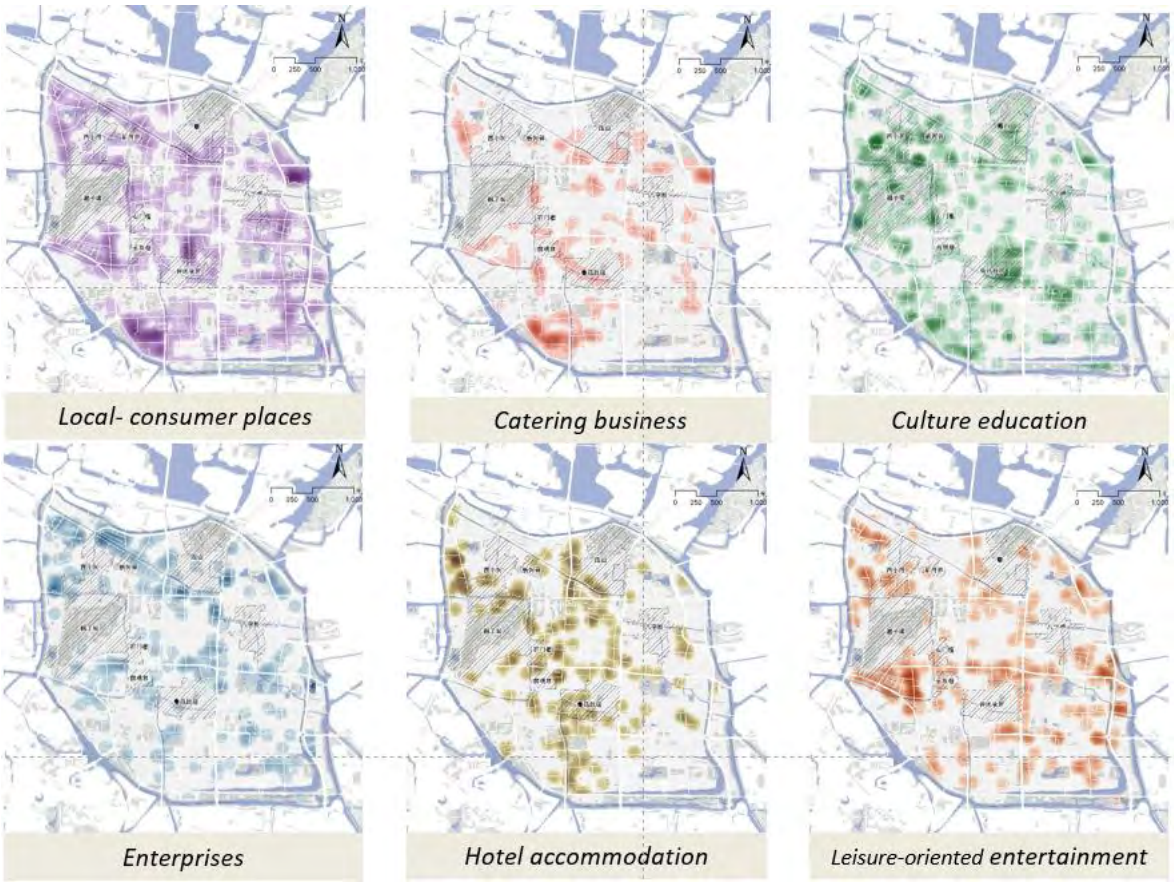
Table2 Quantities of different types of POIs in Shaoxing Ancient City



Catering business were mainly distributed in large shopping malls and characterized by point-like gathering. Catering varieties accounted for more than 60% of local non-local catering, teahouses, Jiangsu and Zhejiang cuisine accounted for about 23% of local restaurants, concentrated in historical districts or old streets. The cluster

was obvious at the junction of Xinhe Lane and Jiefang Road in the north of the company and pattern scattered in other places, which might be led to the reason about classification of logistics and transportation. Culture education includes social groups, education associations, schools, etc. Shaoxing has been prosperous in humanities for thousands of years and has a high degree of integration with historical blocks, but museums, exhibition centers and other functional facilities displayed to the public accounted for a relatively small proportion. Hotel accommodation was mainly located around Jiefang Road, indicating that tourists would more likely to choose main transport streets as a place to have a rest. Comparing with the current situation of land use, it was implied that hotel owners mainly relied on commercial facilities with low compatibility in residential areas. Entertainments for leisure and recreation show a typical characteristics of central distribution and peripheral concentration. Contrary to hotel accommodation, the spatial distribution of local-consumer place was widespread with better compatibility of multi-type land use, because it was mainly located near residential areas aimed at local people.

Figure3 Spatial distribution characteristics of different functions in Shaoxing Ancient City



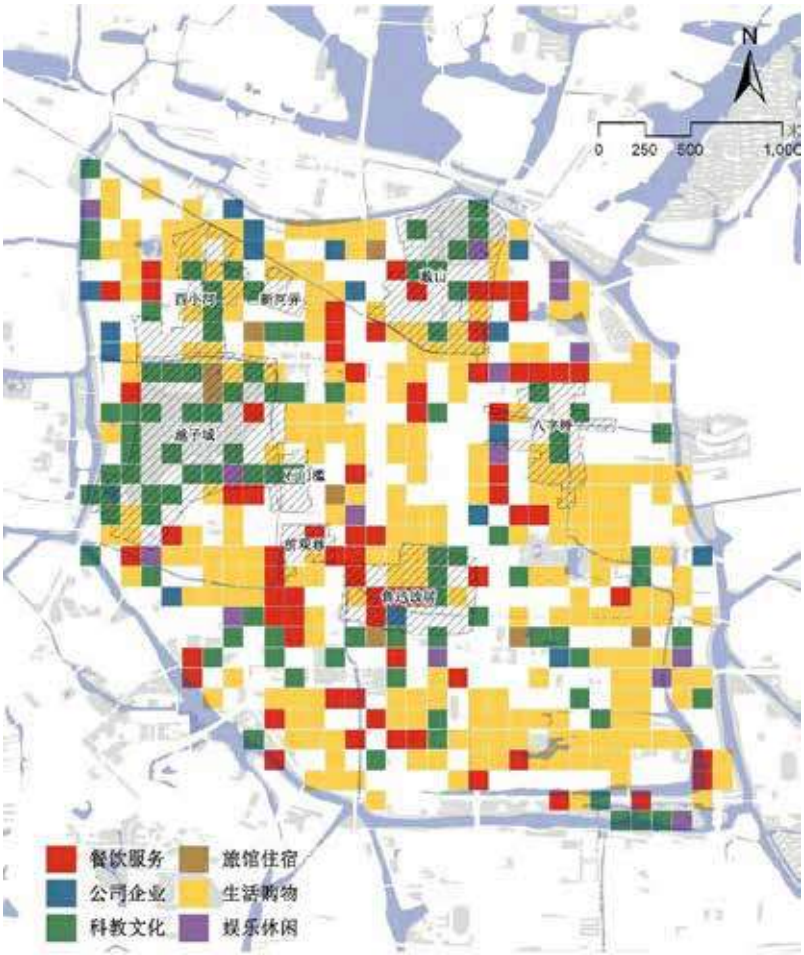
3.3 Units of functional mixing

According to statistics, there are 449 single-type functional units, 177 multi-type functional units and 171 non-type functional located in mountain or water sites. After further quantitative identification and visualization, the specific types of single functional area and mixed functional area can be distinguished.

- A single-type functional unit represents more than 50% of a certain POI type in a research unit, and its functional properties are determined by first-ranked type of POI data. In this paper, there were 6 single-type functional units, namely local-consumer place (54.8%), culture education (20.7%), catering business (15.8%), enterprises (3.6%), leisure-oriented entertainment (3.3%) and hotel accommodation (1.8%). Local-

consumer place was widely spread and randomly distributed in the inner part of the ancient city. Residents often spends time shopping along the street to transform original houses into various local functions, so that it takes up a larger proportion. The functions of science, education and culture were mainly clustering in historical and cultural blocks in the northwest, accounting for a relatively high proportion. Shaoxing has a lot of intangible cultural heritage, time-honored brands, characteristic towns and other high-quality cultural areas, but there are still a lot of valuable spotlights have not been fully utilized. Catering services were mainly distributed on the north-south axis, showing the longitudinal function gathering characteristics. Companies, entertainment for leisure and hotel accommodation accounted for a relatively small, mostly relied on other urban functions.

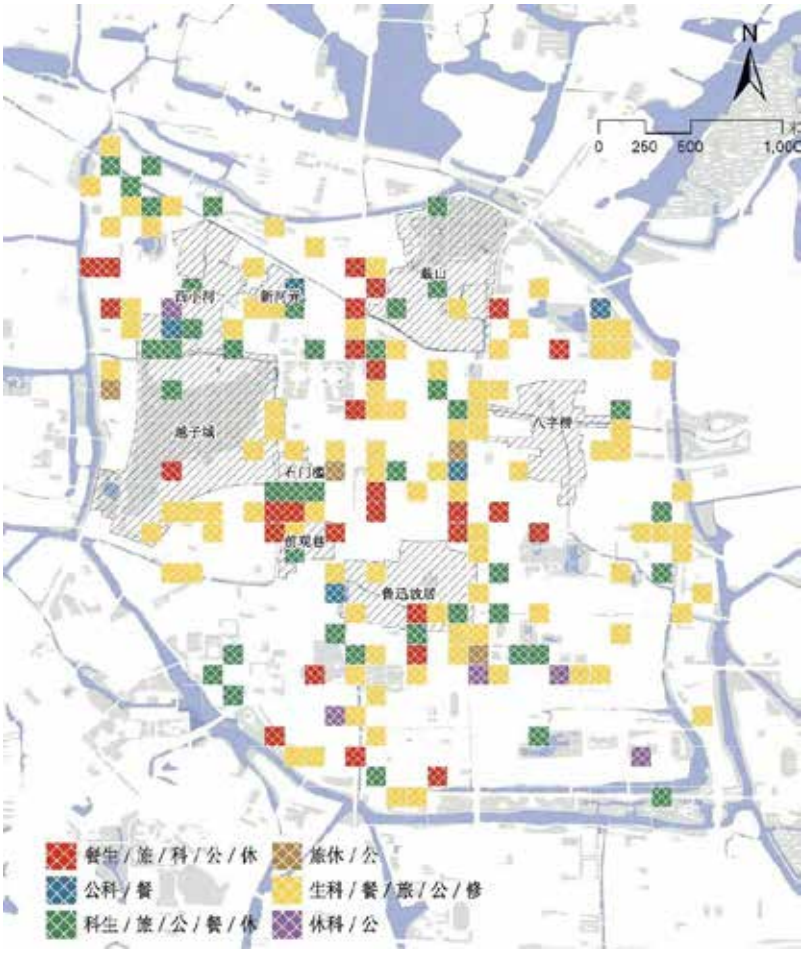
Figure4 Single-type functional units in Shaoxing Ancient City



- The multi-type functional units mean that the proportion of all types of POIs in the functional area does not exceed 50%, so that the top two POI types with the highest ratio are selected as properties. For example, the mixture of culture education and catering business is simply referred to as “culture & catering”, and the mixture of catering and local-consumer places is simply referred to as “catering-local”. According to the determined color of the first function, the distribution characteristics of multi-type functional units in Shaoxing Ancient City were as follows. As can be seen, there were 21 kinds of multi-type functional units in the research area. Among them, the multi-type units of catering business, culture education and local-consumer places accounted for a relatively high proportion, and the mixing degree of entertainment for leisure, corporate

enterprises, hotel accommodation and other functions is relatively low. It indicates that the former had a high compatibility, while the latter was relatively simple for the crowd.

Figure5 Multi-type functional units in Shaoxing Ancient City



4 Discussion

In recent years, the cultural development of Shaoxing Ancient City has entered a bottleneck period. According to the research report, residents and tourists are not aware of the historical environment of the ancient city as a whole, and the development, protection and display of cultural relics and historic sites are relatively simple (Zhu, Qian, 2018). In September 2018, the "Regulations on the Protection and Utilization of Shaoxing Ancient City" was approved by the Standing Committee of the Provincial People's Congress. The "Regulations" pointed out that there is a contradiction between the actual needs of the protection and utilization of Shaoxing ancient city and urban development, especially the problems of overall, physical state, activation protection and utilization. Therefore, it is imperative to re-examine the specific function use of Shaoxing Ancient City and analyze its protection and utilization.

- Generally speaking, Shaoxing Ancient City presented the spatial distribution characteristics of central distribution and functional agglomeration in marginal areas. Functional agglomeration density decreases from road to periphery gradient. It undertook the collection and distribution of external traffic at the junction of ancient and other areas, and was also a functional agglomeration area with emphasis on development and utilization.

- From the point of view of the protection of historical blocks, Shaoxing Ancient City paid attention to the original ecological protection, based on the living and shopping functions for residents, and there is no large-scale development and utilization. On the other hand, the public awareness of historical blocks is strongly related to the functional density and mixing degree. The public awareness hotspots of Lu Xun's former residence, Cangqiao Street and Shusheng's former residence are more obvious than other blocks, while the degree of functional expansion is low.
- The ancient city had abundant cultural tourism resources and high degree of mixability with other functions, but its development layout was scattered and shows obvious singularity, which had not yet formed the spatial layout of the whole city in series. In the context of the overall ancient city life, governments could try to take science and education culture as the guidance to promote the transformation and development of traditional residential space, and enhance the spatial penetration intensity of historical, landscape and cultural resources and external propaganda.

5 Conclusion

Existing research generally believes that the mixed use of urban functions can guide the orderly development and utilization of cities, increase interpersonal communication, improve regional vitality, and promote sustainable urban development. The complexity of cities and their internal structure make it more and more important to study the distribution of urban population density, and big data provide some new technical means for this theme. However, the traditional land use data is mostly planar and cannot accurately represent the actual situation of regional functional mixing. Based on the quantitative and visual analysis of the POI data of Shaoxing Ancient City, some conclusions could be drawn more easily.

The planning pattern and architectural art of the historical area have formed a unique regional cultural phenomenon (Ruan, Shao, Lin, 2002). Under the principle of urban authenticity, integrity and readability, the protection of historical ancient cities must be carried out. To carry out reasonable updating and utilization, it is also necessary to sort out the correct concept of understanding. Based on the objective data of POI, this paper needs to be further deepened and systematic, especially from the concrete empirical cases to analyze the relationship between social space and material culture involved in urban functional transformation. Only by linking the changes in historical space, cultural values and social consciousness can we truly show the “face”, “character” and “personality” of culture heritage through a good way of tourism economic developing.

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