Received: 19 July 2022 | Revised: 30 July 2022 | Accepted: 26 August 2022 | Published online: 15 September 2022

RESEARCH ARTICLE

Journal of Global Humanities and Social Sciences
2022, Vol.3(3)76-79
DOI: 10.47852/bonviewGHSS2022030311

Research on Zhanjiang Urban Spatial Structure and Functional Area Characteristics from POI Perspective

BON VIEW PUBLISHING

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Abstract: With the development of information technology and big data technology, the rise of geospatial big data represented by Point of Interest (POI) has driven the innovation of urban spatial structure research. Taking Zhanjiang as the research area, this paper divides Zhanjiang into six functional areas, and uses more than 119,900 pieces of POI industry classification big data to analyze the internal spatial structure types of Zhanjiang from the perspective of functional area distribution and regional cluster distribution, so as to provide scientific reference for the sustainable development and optimization of Zhanjiang urban space.

Keywords: POI; Zhanjiang; Functional area

1. Introduction

The urban spatial structure has always been a hot issue in geography research, which mainly studies the socio-economic attributes of urban space and the spatial distribution of urban functional areas. On this basis, three basic models of urban spatial structure-concentric circle model, sector model and multi-core model （Shao et al. 2020） have emerged. With the advancement of China's urbanization and industrial revolution, the internal spatial structure of modern cities is constantly evolving, developing and becoming increasingly complex. It is necessary to identify the spatial allocation and differentiation of industrial functional areas more precisely and clarify the spatial distribution characteristics and evolution laws of urban functions, which is conducive to promoting the healthy development of urban systems and making scientific and effective plans （Shi &Song et al. 2018）.

All along, traditional urban functional space research is mainly based on qualitative data such as land surveys, demographic statistics and remote sensing monitoring data（Li et al. 2019）. With the development of information technology and big data technology, geospatial big data represented by Point of Interest (POI) provides a new research idea for quantitative research of urban space. It can explore the development law and trend of urban space, explore and excavate spatial information at a deeper level and scale, and put forward a reasonable and healthy planning structure for urban planning.

Guangdong province is a strong economic province in China, but the shortcoming of its economic development lies in its unbalanced development, showing a dual spatial economic structure of core and edge. Zhanjiang, as a sub-central city in Guangdong Province, plays an important economic and strategic role in the overall development of the whole province. However, Zhanjiang City is located in the west of Guangdong Province, which belongs to the underdeveloped area of Guangdong Province. It has some problems, such as a small economic aggregate, insignificant industrial agglomeration effect and insufficient development imbalance (Tang et al., 2021), which restrict the further development of Zhanjiang's economy and society. Taking Zhanjiang City as the research object, this paper uses POI industry classification big data to summarize the evolution characteristics of urban internal spatial structure and functional areas from the perspective of industry cluster distribution, in order to supplement the theoretical and empirical research of urban spatial structure driven by development spatial big data, and provide scientific reference for sustainable development and optimization of urban space in Zhanjiang City.

2. Regional overview, data sources and research methods

2.1 Regional overview and data sources

Zhanjiang City is located in the south of the Chinese mainland and the southwest of Guangdong Province, with a total land area of 13263km^2. In 2021, the resident population of Zhanjiang was 6,981,200, and the annual gross domestic product (GDP) was 355.99 billion yuan. In this paper, five counties and four districts in Zhanjiang city are the main research areas, and POI data are collected from the map of Gaode in July 2022. After data preprocessing, about 119,900 valid POI data of Zhanjiang

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city are obtained. This information data content basically covers all the physical elements of urban economic geography, with high accuracy, and meets the requirements of realistic reliability and accuracy of the spatial location of physical elements in sub-functional areas.

Figure 1 Location of each district and county in Zhanjiang City

2.2 Research methods

This paper mainly uses the following research methods to analyze the evolution of Zhanjiang's urban functional areas.

(1) The Nearest Distance Index (NNI) is used to identify the distribution pattern and aggregation degree of POI data in Zhanjiang. If NNI is less than 1, it means that the observation patterns tend to converge, and the smaller the NNI value, the higher the aggregation degree. On the contrary, NNI greater than 1 indicates that the observed pattern tends to be discrete.

(2) Heat map analysis. Classify POI data into the above categories, realize data visualization through urban POI heat map distribution, explore the agglomeration distribution and development direction of each functional area, further analyze the formation mechanism of Zhanjiang industry distribution, and explore the rationality of urban spatial structure distribution.

3. Analysis of urban spatial structure and functional area characteristics of Zhanjiang City

3.1 Identification of urban functional areas in Zhanjiang City

Based on the law of urban development in the world, when the urbanization rate is between 30% and 70%, the city develops rapidly, showing rapid urbanization. The urbanization rate of Zhanjiang is 43.9% in 2020 and 46.46% in 2021, an increase of 2.56%, which indicates that Zhanjiang is in the youth period of rapid and vigorous development.

According to other scholars' reference to the classification of urban comprehensive functional areas and the law of modern urban development, all types of POI data in Zhanjiang are reorganized and classified into six types of functional area data, as shown in Table 1.

Table 1 POI Classification of Space Facilities in Zhanjiang Functional Area

Functional area category	Functional area space facilities	Number of POI (pieces)	Space function
Residential functional area	Commercial residence, community and villa	3225	habitable area
Public service functional area	Government agencies, social organizations, science, education, culture and health, medical insurance	23662	Public service space
Commercial functional area	Company, financial insurance	12402	Commercial financial space
Recreational functional area	Shopping, life service, catering, leisure sports	73569	Recreation space
Green space functional area	Parks, green spaces, squares, scenic spots	1798	Green land and square space
Transportation functional area	Parking lot, bus station, bus station, service area, gas station	5309	Road and traffic facilities space

According to the statistics of all types of POI data in Zhanjiang City, it can be seen from Figure 1 that the total POI data in Potou is the least, only more than 0.5 thousand pieces. Xiashan has the largest number of POIs, reaching more than 22,000, which is 4.2 times that of Shantou. As the main urban area of Zhanjiang City, Xiashan Mountain covers an area of 114km2 and Chikan Mountain covers an area of 62km2. The total area of the two districts only accounts for 1.33% of the total area of Zhanjiang City, but the number of POIs accounts for 32.82%. It can be preliminarily seen that POIs in Zhanjiang City have an obvious central area aggregation

phenomenon.

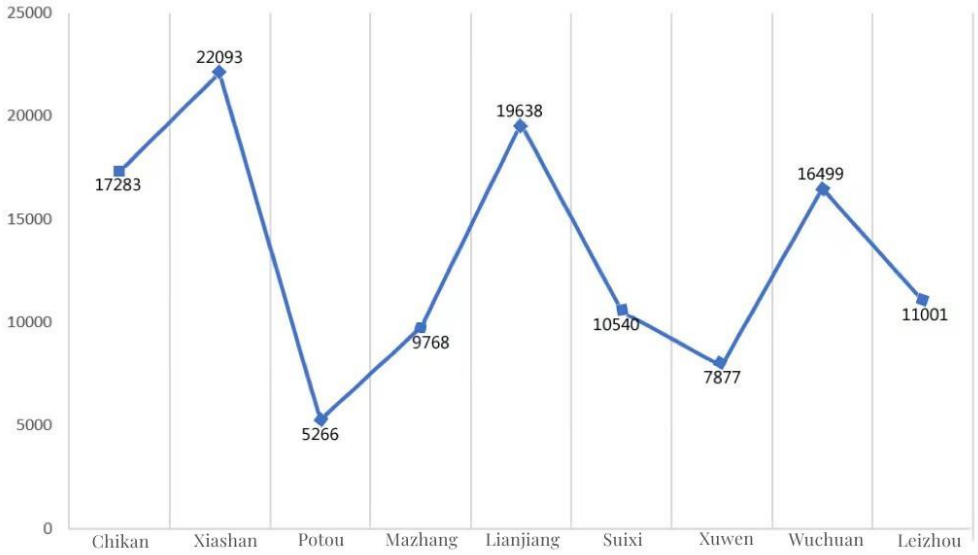

Figure 2: POI data of districts and counties in Zhanjiang city

3.2 Identification of POI data aggregation degree

Whether the POI data is gathered in space or not, and the degree of gathering is the premise of judging the urban spatial structure, and it also restricts the future development of the urban spatial structure. The NNI of Zhanjiang POI data is in the range of 0.167~0.235, and the Z score is lower than -62.03. Through the 99% significance test, it shows that Zhanjiang POI data has a very high clustering distribution in urban space. There is a strong correlation between NNI value and GDP value at the confidence level of 0.01, which indicates that the POI data of Zhanjiang is basically consistent with the level of urban economic development.

3.3 Industrial composition characteristics of urban spatial structure

Zhanjiang is characterized by plains and terraces, a long coastline, numerous islands, a wide beach area, many inland rivers and abundant aquatic resources. According to the above-mentioned division of urban functional areas and the analysis of urban elements aggregation, the POI data of six functional areas in Zhanjiang are analyzed by heat map to explore the agglomeration and distribution characteristics and development direction of economic activities in functional areas, so as to further analyze the formation mechanism of urban spatial structure in Zhanjiang, as shown in Figure 3.

From the POI heat map analysis of different functional areas in Zhanjiang City, it can be seen that all functional areas in Zhanjiang City are characterized by strong centre aggregation, which belongs to a concentrated mass urban structure. Most of these urban structures appear in coastal plain cities, forming an urban spatial structure of main centre-sub-centre-main node-secondary node.

As can be seen from Figure 3, Zhanjiang City takes Chikan and Xiashan as the central areas and radiates to the periphery to form point and sheet-shaped functional area clusters, forming the urban spatial structure of Wuchuan sub-center and Lianjiang, Suixi and Xuwen main nodes. Residential functional areas are mainly distributed in Chikan, Xiashan and other counties and districts, which conform to the development law of urbanization. The aggregation effect of commercial functional areas is obvious, concentrated in the centre and southeast of the city, pointing to the axis of the Guangzhou-Zhanjiang urban Unicom road. It is found that there are two obvious central areas except for green space and square functional areas, and the spatial distribution of residential, commercial, leisure and entertainment functional areas shows strong central aggregation. It can be seen that the main centres of the six functional areas are highly complex in the central city.

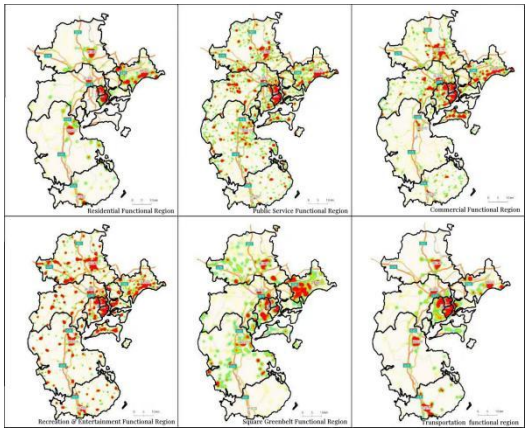

Figure 3: Spatial heat map of Zhanjiang's functional area division

4. Conclusion

In this paper, the mapping system from POI big data to functional area data in Zhanjiang is established, and the characteristics of urban spatial structure in Zhanjiang are discussed from the perspectives of functional zoning and functional aggregation. Statistics, the average nearest

neighbour index and the heat map method are mainly used to analyze the spatial distribution of six functional areas in Zhanjiang, and the main conclusions are as follows.

4.1 Zhanjiang's urban elements are characterized by significant agglomeration, which is a concentrated and lumpy urban spatial structure, and the degree of agglomeration is basically consistent with the level of urban economic development. It belongs to the classic urban spatial structure model of "main centre-sub-centre-main node-sub-node". The urban spatial structure is influenced by landform, road traffic, geographical location and other factors, showing a diversified spatial structure.

4.2 With the development of the economy and the advancement of industrial transformation, due to the strong spatial correlation between residential functional areas and other functional areas, the suburbanization of the real estate industry has a certain impact on urban spatial structure; Most of the commercial and traffic functional areas are highly concentrated in the central city due to the influence of agglomeration interests; The development direction of each regional space is closely related to the road axis of Guangzhou-Zhanjiang City Unicom.

5. Suggestions and discussions

Based on the above research, Zhanjiang is currently in the development stage of industrial transformation and upgrading, and the urban spatial structure needs to be improved. It is necessary to strengthen the linkage between the central city and other counties, promote the integrated development of cities, coordinate the construction of cross-regional infrastructure, and promote the integration of functional spaces.

This study focuses on the spatial aggregation degree of POI data by region but does not involve other factors such as urban population, social space, traffic network, etc. Limited by the POI data of a single time phase, this paper only studies the present characteristics of regional spatial structure in Zhanjiang but fails to cover the dynamic evolution process of urban spatial structure.

Acknowledgement

This research was funded by social science fund subject of Zhanjiang philosophy of 2022,. ZJ22YB08.

Conflict of Interest

The authors declare that they have no conflicts of interest to this work.

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How to Cite: Wu, X. (2022). Research on Zhanjiang Urban Spatial Structure and Functional Area Characteristics from POI Perspective. *Journal of Global Humanities and Social Sciences*, *3*(3), 75–78.
https://doi.org/10.47852/bonviewGHSS2022030311