Macau Street Network Form and Commercial Density Distribution

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Abstract: The evolution of urban spatial structure will dominate the generation and change of urban centers to a large extent; the urban center that is, the commercial center, its function transformation, rise and fall is largely reflected in the degree of commercial concentration.

1. Introduction

Based on the above conclusions, this paper will quantitatively study the layout of commercial density in Macau, and clearly express the relationship between street network form and commercial aggregation through data analysis and visual expression. The data collection of Macau's commercial layout is mainly realized by the author's on-site investigation of Macau in 2015-2018. After the data collection is completed, the data is entered into a form by computer input, and then the shop address information is marked on the map. In the analysis of street network form, the analysis method of space syntax will still be used. On the basis of the global integration degree and local integration analysis chart of Macau city, the "selection degree" parameter is added as an important reference index for analysis.

2. Characteristics of commercial density distribution in the Macau Peninsula

The address of the Macau commercial network is marked with a red dot on the map to create a commercial density map. See Figure 1. From the visual analysis of the commercial density distribution map of the Macau Peninsula, the distribution of commercial density in various regions of Macau is significantly different. Among them, the central area is the largest and densest area of Macau's commercial density distribution; the new port and reclamation area have the lowest commercial density; the commercial density distribution near the North Gate and the Gaoshide Dema Road is relatively concentrated, and other areas are scattered; The commercial density is high, and the distribution is decreasing from north to south.

Figure 1 Macau Commercial Network Layout

The Macau global integration map, the 500m partial integration map, and the 500m selectivity map are compared and compared with the commercial layout map to observe the commercial distribution characteristics at different scales. See Figure 2. First, from the comparison between Macau's global integration degree (2b) and the business layout map (2a), the global integration degree map reflects the overall trend of Macau's commercial layout; it shows the results of the city-wide integration analysis and Macau. The commercial distribution of the peninsula is basically the same, with the highest integration area and the highest commercial density area pointing to the central area; the high integration value of the vicinity of the North District Guanzha, the Gaoshide Da Ma Road area, the southwest area and the new port area is also related to commercial The distribution is consistent. Secondly, the comparison of the local integration degree (2c) from the radius of 500m with the commercial layout shows that the results of the local integration analysis based on the radius of 500m reflect the correspondence between the walking range and the commercial distribution. The commercial streets that are not prominent in the global map, such as Camp Street, October Fifth Street, and the Ruins of St. Paul, have been captured and revealed; the street network displayed near the North Gate is more specific and detailed than the global map. The 500-meter selectivity analysis chart (2d) further highlights some streets in the southwestern district and the new port area that are not shown in the partial map.

The values of global integration, local integration and selectivity are recorded. According to the business aggregation, they are divided into high-density and low-density regions. See Table 1 and observe their spatial morphological characteristics. (There are less than 30 commercial outlets per square kilometer as low density zones, and more than 30 are high density zones). It can be seen from Table 1 that the streets with high-density commercial outlets have higher connectivity than the low-density regions; from the perspective of integration and selectivity, they are also higher than the low-density regions. This shows that the degree of connectivity, integration, and selectivity in the urban area have a positive impact on the generation of business activities. Easily accessible, convenient transportation, and crossing high-potential roads are more likely to attract business activities.
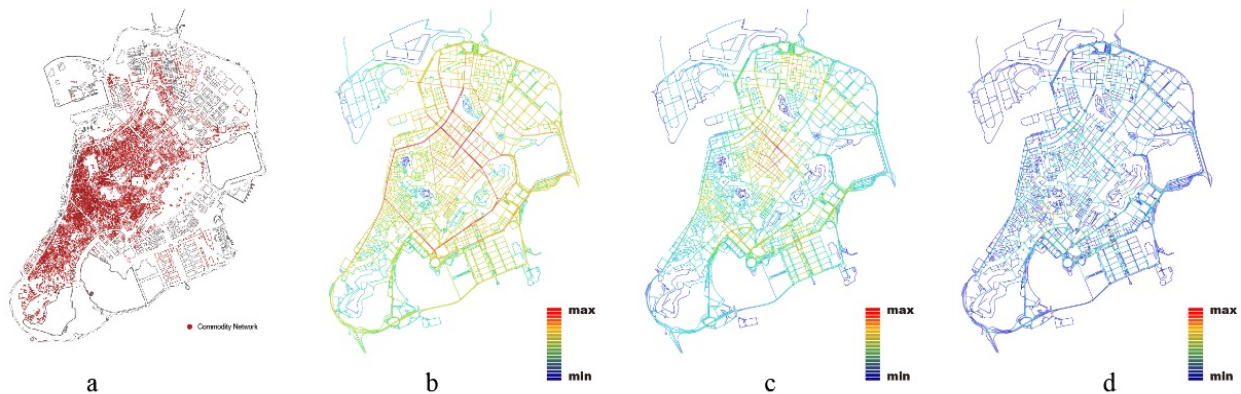

Figure 2 Commercial distribution characteristics at different scales

Table 1 Two types of regional morphology data

classification	Street connectivity	Street length	Integration			Choice		
			R=500m	R=1250m	Global scope	R=500m	R=1250m	Global scope
Low density zone	3.3	34.9	142.1	481.4	1287.3	2387657	2638031	217520751
High density zone	6.8	51.3	200.1	725.5	1889.2	6210872	6541983	629850153

Table 2 Average increase in spatial morphology data for low-density areas in high-density areas

classification	Street connectivity	Street length	Integration			Choice		
			R=500m	R=1250m				R=500m
City overall	23.56%	19.23%	28.26%	21.43%	15.56%	112.57%	146.48%	171.15%
central area	22.78%	29.45%	26.91%	17.75%	17.32%	131.42%	191.71%	286.82%
Southwest District	24.91%	12.12%	41.56%	31.98%	19.93%	161.61%	231.63%	378.95%
North District	9.34%	1.67%	22.38%	12.16%	8.51%	49.36%	53.84%	40.63%
New port area	13.56%	10.32%	-5.73%	-6.47%	-3.70%	-7.16%	-13.39%	-31.18%

The values of global integration, local integration and selectivity of the four regions of the peninsula are recorded, as shown in Table 2 for further analysis. In addition to the new port and the three areas outside the new reclamation area, the degree of integration, local integration, and selectivity are directly proportional to the commercial density. The new port and the new reclamation area of the outer port showed some abnormalities. Although its commercial density is proportional to the connectivity value, its integration and selectivity are inversely proportional to the commercial density distribution. The regional commercial density of the degree of integration and high selectivity is reduced. This phenomenon reflects the particularity of the spatial structure of the new port area. The distribution of road patterns and commercial density in the area does not follow the patterns shared by other regions.

Second, the spatial aggregation characteristics of commercial outlets

Adding the global integration and selection of Macau cities to the business distribution map of Macau, you can visually see the spatial aggregation characteristics of its commercial outlets, as shown in Figure 3. Extract spatial syntactic data of the city and four regions, sort the integration value and the selection value in descending order, select the street corresponding to the top 20% of the total number, and count the number of commercial outlets in these streets, statistical results and regional total outlets. The quantity is calculated by the ratio, and the proportion is taken.

Figure 3 Spatial aggregation characteristics of commercial outlets

From the perspective of the overall city of Macau, the value of integration and selectivity of the street is proportional to the number of commercial outlets in the street. The higher the degree of integration and selectivity, the more commercial outlets in the street. From the analysis of different radii, the data ratio peaks within the radius of 1000m and 1400m. This reflects the impact of the range of people's walking activities on the business layout.

After analyzing the charts of the four independent regions, it is found that the analysis map of the southwest region shows the opposite trend to the other three regions. The percentage of commercial outlets in the region decreased significantly as the distance of the selection radius increased. The other three-zone selectivity radius is proportional to the percentage of commercial outlets. From the global integration analysis chart, it can be seen that the integration degree of the southwestern region is relatively low. Compared with the other three districts, the road network structure is relatively closed. It is the main residential area of the Macau Peninsula, and its commercial

activities mainly serve the interior of the region.

3. The calculation of distribution density of commercial outlets

A total of 950 streets in the Macau Peninsula have been recorded. According to the statistics of the number of each street, the distribution density of commercial outlets in different regions can be calculated. First, count the number of house numbers in each street, sorted by number from large to small and divided into 17 categories. Type 1 streets contain a house number, type 2 streets contain two, and so on. According to the distribution data of commercial outlets, the number of commercial outlets included in each type of street is counted, and the ratio of the number of outlets to the number of each type of street number is calculated, and the distribution density of commercial outlets can be obtained. Figure 4.
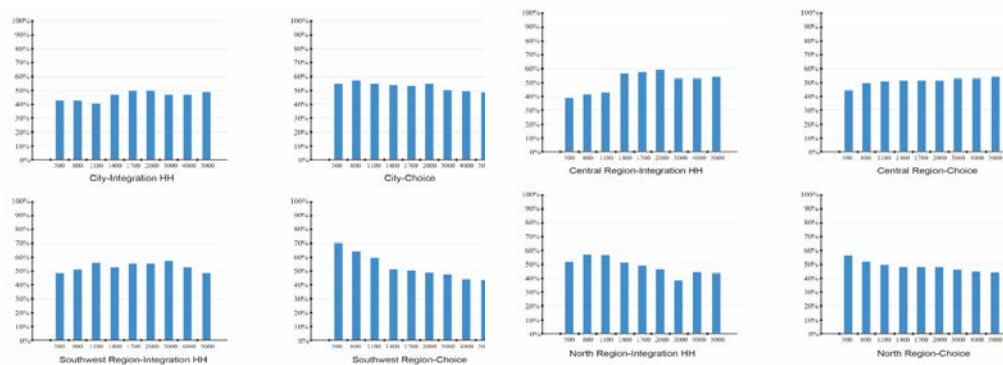

Figure 4 Statistics of different analysis radius data

According to the same calculation method, each area of the city is calculated separately. The calculation results are shown in the figure. The graph shows the different trends in the distribution of commercial density in the four regions. The commercial density of the central area increased significantly with the increase of the number of addresses, showing a strong carrying capacity for commercial activities; the trend of the north line and the new port area is basically the same, and the density value shows a downward trend after the number of house numbers reaches the eighth category. Its commercial carrying capacity is strong. The trend map in the southwest region is more complicated, and its numerical value fluctuates greatly, and its commercial carrying capacity is weak.

4. Distribution of commercial density at different scales in each region

As can be seen from the previous section, the southwestern region and the central district show a huge difference in commercial carrying capacity. This section will further study these two typical areas and analyze the distribution of commercial density at different scales in the two regions. See Table 3.

Table 3 Analysis of the degree of integration, selectivity and commercial density of different radii in each region (R2)

Radius (m)	Angle integration			Angle selection		
	central area	Southwest Old Town	City overall	central area	Southwest Old Town	City overall
500	0.58	0.72	0.64	0.62	0.78	0.68
750	0.78	0.61	0.72	0.69	0.63	0.64
1000	0.81	0.57	0.65	0.73	0.45	0.58
1250	0.79	0.51	0.59	0.71	0.31	0.47
1500	0.80	0.53	0.51	0.66	0.25	0.37
1750	0.71	0.51	0.44	0.62	0.27	0.31
2000	0.73	0.52	0.46	0.68	0.27	0.27
2500	0.75	0.49	0.47	0.61	0.28	0.23
3000	0.72	0.51	0.55	0.52	0.27	0.22
4000	0.71	0.41	0.57	0.54	0.26	0.18
5000	0.71	0.37	0.53	0.56	0.22	0.14
n	0.73	0.32	0.53	0.57	0.21	0.13

Converting the values in Table 3 into a line graph can visually see the correlation between integration, selectivity, and commercial density at different radii in the two regions. It can be seen from the trend of the red line segment that when the local integration radius reaches 800 meters, the ratio of commercial density to integration degree reaches the highest value. The minimum value is reached at a radius of 2000m as the radius distance increases. After 2000m, the radius increased slightly, but did not return to the high peak. The correlation between the degree of selection and the density of commercial outlets is shown in blue lines, and the degree of selection shows a downward trend in commercial density as the radius of choice increases. Among them, the 500-meter radius selectivity has the highest commercial density correlation value.
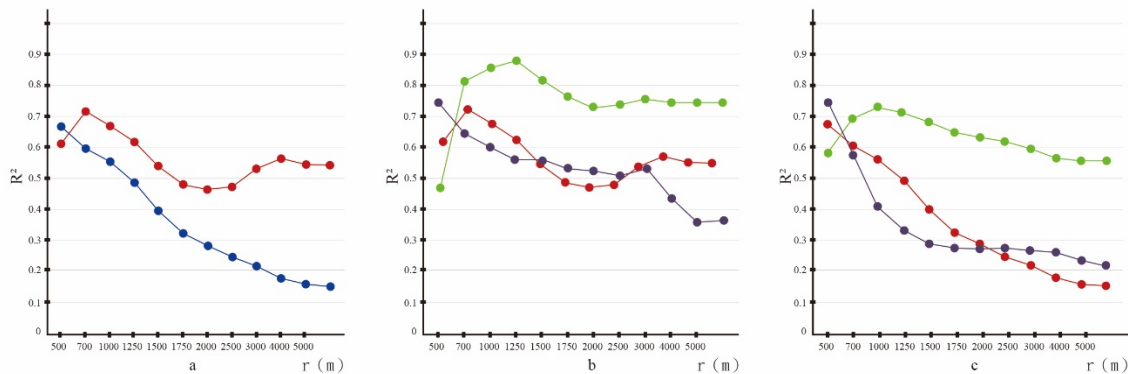

Figure 5 Analysis of integration degree, selection degree and commercial network density data in urban context

According to the Table data, the correlation line graphs of the integration degree, selection degree and commercial dot density of the southwest region and the central region are respectively generated, and they are superimposed with the global line graph. Figure 5b shows that the central region average coefficient value is much higher than the global average coefficient, highlighting the status of its urban center. The highest value of the fold line appears at a radius of 1,250 meters, and then falls back at 2000 meters, but the overall value is in the high value area. Its selection trend chart shows the same trend. The high value of the central zone at different radii shows its strong commercial appeal. The radius of 500m-1500m basically covers the distance that people walk, and the distance between 1500m-5000m covers the distance between vehicles. At different distances, it still has a much higher than the urban average, which is why it has become the most important city and commercial center in Macau.

Compared with the central area, the highest value of integration and selectivity in the southwest region appears at a radius of 500m and decreases significantly as the radius distance increases. Figure 5b, Figure 5c. This shows that the commercial services in the southwestern old city are mainly residents in the area, and the service radius is mostly pedestrian-accessible. Most business gatherings occur within a small scale that is accessible to people.

5. Conclusion

From the perspective of global integration and selectivity analysis of Macau cities, the degree of density of commercial network aggregation is obviously related to urban spatial structure. There are significant differences in the form of street networks between densely populated streets and sparsely populated streets. Commercial outlets tend to be concentrated in streets with high integration and high selectivity. These streets have higher accessibility and traffic potential than other streets, and are easy to attract people to gather and better carry out commercial activities.

From the aggregation characteristics of commercial outlets, the street with the integration degree and selectivity accounting for the top 20% of the global value contains more than 50% of the commercial outlets on the peninsula. This further embodies the force exerted by the prevailing

streets in the urban spatial structure on commercial agglomeration. The commercial carrying capacity at different radius scales reflects the functions of each region.

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