

The Reach of Shopping Center Layout Form on Subway - Based On Kernel Density Estimate

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Abstract—With the rapid progress of modern cities, the railway construction must be developing quickly in China. As a typical high-density country, shopping center on the subway should be one important factor during the process of urban development. The paper discusses the influence of the layout of shopping center on the subway, and put it in the time and space's axis of Shanghai urban development. We use the digital technology to establish the database of relevant information. And then get the change role about shopping center on subway in Shanghai by the Kernel density estimate. The result shows the development of shopping center on subway has a relationship with local economic strength, population size, policy support, and city construction. And the suburbanization trend of shopping center would be increasingly significant. By this case research, we could see the Kernel density estimate is an efficient analysis method on the spatial layout. It could reveal the characters of layout form of shopping center on subway in essence. And it can also be applied to the other research of space form.

Keywords—Shanghai, Shopping center on the subway, Layout form, The Kernel density estimate.

I. RESEARCH BACKGROUND

UNDER the influence of economic globalization, the speed of China's urbanization process is going faster and faster. By the end of 2012, there are 127 cities have more than 1 million population. And the number is about three times more than that in 1995 [1]-[4]. At the same time, the modern urban expansion and the traffic pressure have a strong impact on people's life quality. Subway as the primary choice for traffic problem, presents a kind of high speed development. From 2007 to 2013, the average annual growth rate of rail transit is 22.7% [1]-[4]. At the end of 2013, 17 cities have the subway lines in China (excluding Hong Kong and Macao), and its total mileage comes to 2074 kilometers. Shanghai becomes the No. 1 because of the 567 kilometers subway mileage. During the process of reducing traffic pressure, the subway construction not only reduces the traffic pressure, but also brings the big commercial potential because of its stable huge passenger flow. Take Shanghai as an example which is most developed in financial business. There are 11 shopping centers above the subway opening among 2010-2013. This number accounts for 42.3% of total amount, and the area comes to about 64.1%. It seems that the shopping center above the subway has been a new trend, and it also takes more and more influence on the layout of city [1]-[4].

This paper would focus on the macro perspective of urban development. We put the forming process of shopping center

above the subway into the space-time coordinates of urbanization. On the basis of the collecting data and digital analysis, we try to find the change role of spatial distribution, and give advice to the future urban planning for Shanghai.

II. RESEARCH FOUNDATION

A. Research Range

The planning of this research is a new definition of Shanghai planning in 2012, including Jing'an District, Huangpu District, Xuhui District, Changning District, Hongkou District, Yangpu District, Putuo District, Zhabei District, Pudong New Area (Fig. 1). In this article, the first shopping center above the subway is Shanghai new world city, which is opened in 1995 and connects with the People's Square Station. Therefore, the research range is defined as from 1995 to 2013.

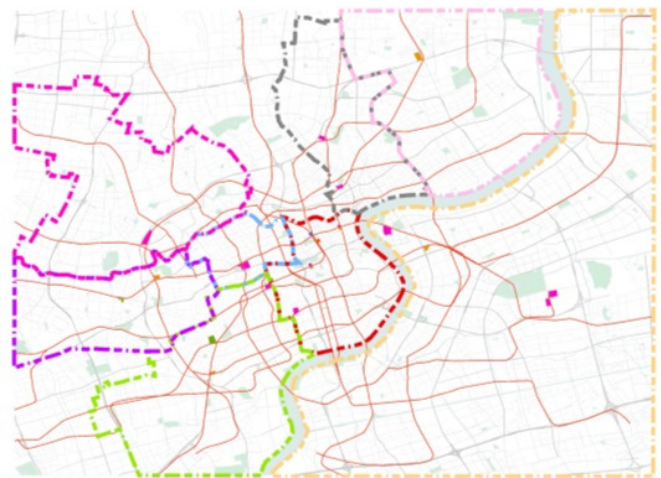


Fig. 1 The shopping center above the subway in Shanghai

B. Research Object

The object of this research is the shopping center above the subway which opened in 1995 in Shanghai. The total number is 26. The information about shopping center in 2013 is derived from "Shanghai Council of Shopping Centers" [8], and we get the date of shopping center above the subway through field investigation.

Shopping center information contains name, creation time, subway station, district, regional distribution and area. The district refers to the position of shopping center above the subway; the regional distribution means the division of urban spatial pattern. Take the following as an example:

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TABLE I
INFORMATION ABOUT THE SHOPPING CENTER ABOVE THE SUBWAY

Name	Shanghai IFC	Hongyi Plaza	Grand Gateway	Cloud Nine Shopping Mall
Creation Time	2010	2006	1999	2005
Subway Station	Lujia Zui	East Nanjing Road	Xujiahui	Zhongshan Park
District	Pudong New District	Huangpu District	Xuhui District	Changning District
Regional Distribution Area	Suburb	City Center	City Center	City Center
	37.0	6.5	34.9	31.6

Name= shopping center above the subway in Shanghai, Creation Time= the completion of the building, Subway Station= which station connection with the building, District= location, Regional Distribution= the significance of building in city, Area= building's area.

We import the information into Arcmap software after finishing the date, and make the position link with the vector diagram of Shanghai land property in 2012. As a result, we could make data information and spatial information together to create the database for "shopping center above the subway in Shanghai". As shown in Fig. 2, the colored figures are research objects which carry the corresponding information about shopping center above the subway. Take the red one as an example, from the identify window, we could get the information about Shanghai IFC's creation time, district, regional distribution, area and etc.

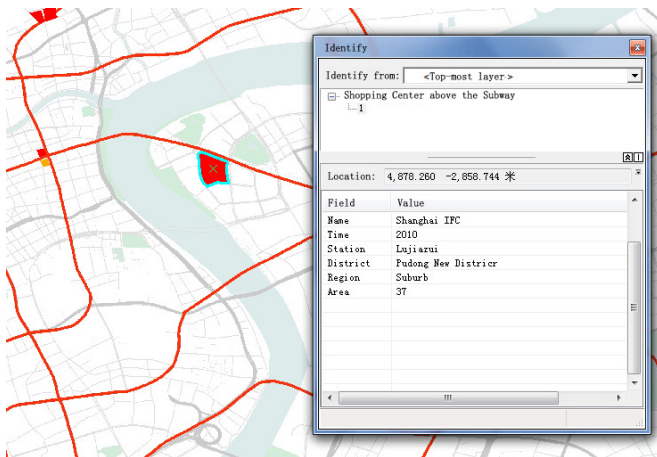


Fig. 2 The database of shopping center above the subway in Shanghai

C. Research Stage

According to the development of shopping center and the construction of subway, this paper divides the spatial development of Shanghai shopping center into four stages, including from 1995 to 2000, from 2001 to 2004, from 2005 to 2009, from 2010 to 2013. Through the establishment of "the data about Shanghai shopping center above the subway", we could get the number and distribution of shopping center in every stage. (Fig. 3)

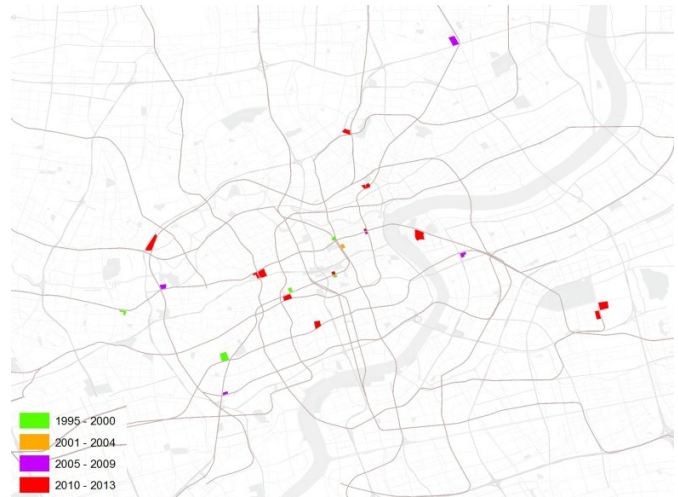


Fig. 3 The distribution of research objects in Shanghai

III. THE ANALYSIS ABOUT SPACE CONSTRUCTION OF SHOPPING CENTER ABOVE SUBWAY BASED ON THE KERNEL DENSITY ESTIMATION

This article would establish the database on the basis of "Shanghai shopping center above the subway", and use the kernel density estimation to study the spatial distribution for construction of urban commercial space density above the subway.

A. Kernel Density Estimation

Kernel density estimation is used to estimate the unknown density function in Probability theory. It belongs to one of the nonparametric test method. The kernel function is based on the kernel quadratic equation which is founded by Silverman.

Japanese police science institute calculate the crime point distribution by kernel density estimation and get the picture about crime probability distribution area in Tokyo [6]. The red color means the higher crime probability. It provides the scientific basis for daily security management (Fig. 4).

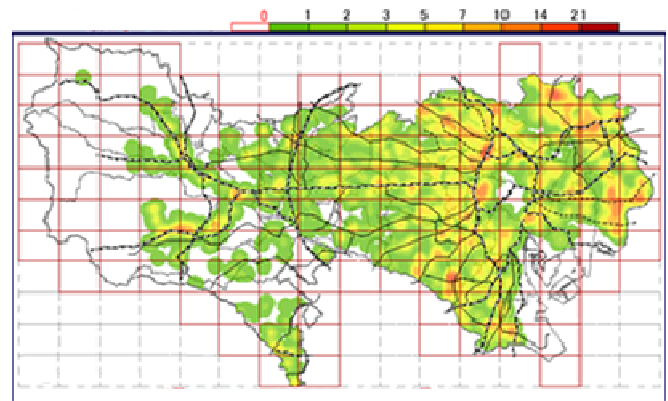


Fig. 4 The research of crime probability distribution in Tokyo

B. The Analysis about Space Construction of Shopping Center above Subway

In order to recognize the space construction of shopping center above subway directly, this paper use kernel density

estimation to analyze the spatial distribution for each stage. According to the definition and computing method of kernel density estimation, we could turn the distribution map of Shanghai shopping center above subway into the space construction map in Arcmap. Take the stage from 1995 to 2000 as an example, and the conversion process as follow:

- Step 1.** Turn the polygon graphics into the point graphics. Every point is the polygon geometric focus point. In the process of transformation, keep the area data of each graphic as the weighting factors.
- Step 2.** We choose the “Density” command under the “Spatial Analysis” toolbar, and calculate the density distribution basis on the point graphic. In the dialog box of density command, we need to set up the main parameters: (Fig. 5).

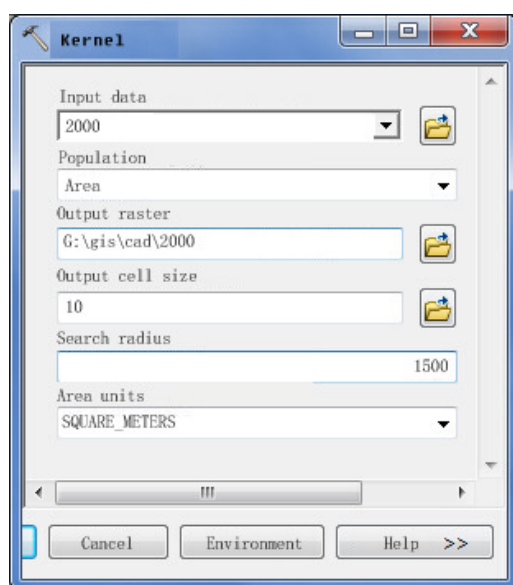


Fig. 5 The command window of Kernel density

Input data– Refers to the layer which the point should be calculated, example shows 2000 points.

Population field– Refers to the weight value column. In the example, the point represents the commercial area.

Search radius– Refers to the influence of the point. In this paper, it refers to the area density influence of shopping center above the subway. Considering the obverse degree of the graphic trend and the particularity of subway, we set the radius as 1500 meters.

Area units– The unit is meter in this paper, the unit of area is square meter.

Output cell size– Refers to the size of each unit in density distribution, which is associated with the smoothness of the final output image. It is set to 10 meters in example.

- Step 3.** We could get the density distribution through the software operation. The darker one means the higher density and the more important influence. Then observe the result picture and adjust the parameter settings according to the drawing requirements.

IV. THE CHANGE RULE OF SPACE DISTRIBUTION OF SHANGHAI SHOPPING CENTER ABOVE THE SUBWAY

A. The Development Stage of Shanghai Shopping Center above the Subway

According to the information from International Council of Shopping Centers, the development of shopping center has a close relationship with the per capita GDP and the car ownership ratio. In this article, we can think that the development of shopping center above the subway has a close relationship with the per capita GDP and the subway construction. The first shopping center above subway in Shanghai is built in 1995, at the same time the subway line just completed and the per capita GDP reached 1200 dollars. In the next 10 years, the per capita GDP keeps 10% growth rate. Especially in 2004, the GDP annual growth in Shanghai first broke 100 billion yuan, and per capita GDP reached 6688 dollars. With the completion of the preliminary planning of metro lines, the year of 2004 should be the important turning point in development history of Shanghai shopping center above the subway.

From pictures about four stages between 1995 and 2013 (Fig. 6), it can be seen that in 1995-2004 decade [1]-[4], at the early stage of shopping center above the subway, the connection between original shopping center and subway didn't get enough attention because of the metro planning problems and technology limitation. From 2005 to 2009, with the improvement of subway line, the convenient transportation and the stable and dense passenger flow produce great market capacity and gathering economic benefit. The shopping center above the subway begins to start the high-speed development stage. Since 2010, due to excessive competition and population suburbanization, the shopping center above the subway presents the suburbanization development. However, the central city still is hot place because of its advantage of traffic, population and purchasing power. The shopping center above subway is clustered together in Nanjing road commercial circle, Huaihai road commercial circle, Lujiazui district as well as the municipal business center and presents the typical cluster state. In addition, the new shopping center gradually appeared in Wujiao commercial circle and Zhongshan Park commercial circle with huge development potential.



Fig. 6 Four stages about the development of shopping center above the subway

B. The Influence Factor of Shanghai Shopping Center above the Subway

The rapid development of shopping center above the subway has a relationship with the comprehensive development in Shanghai. It could be divided into hardware and soft environment [5], [7]. In this paper, the hardware means the economic development, the subway construction, planning and landscape. And soft environment refers to the industrial environment, management environment, population density, consumption habit and etc. Historically, emerging retail formats always develop in the excellent conditions of city at first. Shanghai is the most important economic center and the opening up the frontier known city in China. With the support of the Yangtze River Delta, it has been the highly treasure land of the people stream, business flow and logistics. Shanghai, with its superior comprehensive conditions, naturally becomes the major base of shopping center above the subway. Here in 2009 and 2013, we compare the data at the population, per capita GDP and macro economy.

We put the macro economy picture and the spatial distribution density together. (Fig. 7) And put the per capita GDP and spatial distribution density together as well [1]-[4]. (Fig. 8) We can see: the growth of shopping center above the subway is related with the economic development, and its growing trend begins to change from the traditional business district to the new commercial district. The healthy and rapid development of economic development and the overall income

increase provide a huge market potential for shopping center above the subway. At the same time, it turns the traditional residents' consumption to the enjoy type. Urban residents' consumption is still the dominant force. On the other hand, the level of purchasing power at the outskirts are growing fast, it brings a perfect opportunity for shopping center construction.

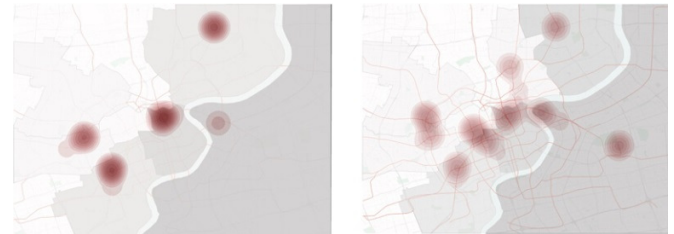


Fig. 7 The economy picture with the spatial distribution density

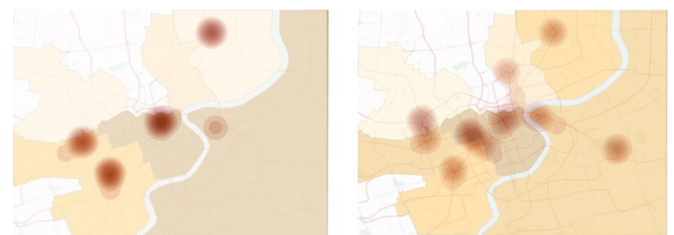


Fig. 8 The per capita GDP with the spatial distribution density

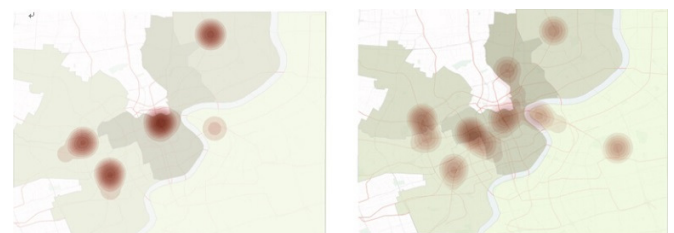


Fig. 9 The population with the spatial distribution density

Area population influence the space distribution of shopping center above the subway is another important factor. As shown in Fig. 9, although the macro economy and per capita GDP in Putuo and Changning district are not as well as it in another [1]-[4], the population of two districts provides the important support for shopping center operation. Therefore, the suburban areas would be the highlight of commercial facilities, and create a new space for shopping center construction.

In addition, convenient public transportation system provides the fundamental supporting role for shopping center. Because of the crowded ground transportation in city center, the subway planning would be the key factor for the stream of people. On the other side, the high value of leisure shopping is another important driving force for development of shopping center above the subway.

V. CONCLUSION

Above all, in the past 20 years, the shopping center above the subway has a great development in Shanghai, no meter its enormous growth of total amount or huge expansion of spatial distribution. Compared with the rapid development of

commercial space, the selection and planning of shopping center in China are short of strong decision theory, and rely heavily on the commercial behavior and developers will.

Today, the development of shopping center above the subway has a closely relationship with the urban economy, population, transportation and consumer behavior. Thus, the construction of shopping center in Shanghai should match its hardware and soft environment, and should be coordinated with the urban construction, layout and structure. At the same time, it could not only be beneficial to enhance the overall efficiency of retail enterprise, but also could promote the harmonious development of the city.

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