Study on the control method of the form of street buildings based on the classification via space syntax configuration

Yu Wenshuang¹; Pan Bo²; Zhu Lingyun³; Yu Qinman⁴; Tang Lian⁵

ABSTRACT

As an important part of urban space, street space has become the urban living place where multifunctional activities happen with the development of history. Based on the role and position of the street space in cities, it is important for urban designers to set up the principles for the setback, form and function of the buildings along the street, thus take optimization control of the spatial form. However, in China, the control of the street building forms can mainly meet the basic needs of traffic and safety. The methods and principles for controlling for perception or suitability for activities have hardly been established, especially according to different functions or different locations of the streets. Space syntax, known as a scientific and mature approach, can be used to describing the relationship between street space and the whole or local city configuration. Thus this paper takes the calculated value of space syntax as a classification standard, then analyzes the morphological characteristics of street buildings, the distribution of activities alongside the streets of different types. Estimation methods are created and optimization strategy is put forward. Firstly, street space is classified according to the connectivity value of the road network in Nanjing core urban areas based on space syntax. Then four typical streets are selected as a sample. They are investigated and portrayed in detail with respect to the location, height and function of the buildings alongside them, also including people’s activities on the urban ground floor and so on. Thirdly, the visual perception of street samples (streetscape), the use and distribution of street space, the frequency and density of human activities are evaluated based on existing methods. After comparing the evaluation results of different types and taking the high quality street space as a reference, suggestions are given for further optimization of different kinds of street space. This paper preliminarily demonstrates that it is valid to take the space syntax calculated value as a classification standard when it comes to street spatial morphological optimization.

KEYWORDS

Street Space, Street Buildings, Space Syntax, urban design, activities in street space

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1. INTRODUCTION

By making guidelines for street design, some important index of roadside buildings, such as setback distance, activities within the setback area, height, build-to-line ratio and transparency can be regulated. Thus, it can help creating lively street space which is suitable for people’s activities. In this regard, different cities apply different classification methods. For instance, street attribute, district and flowrate of people are taken as comprehensive standard for classification. Various methods cope with different urban condition. For example, zoning control is applied in Los Angeles and streetwall there is divided into three categories, namely retailer frontage, office or commercial and residential frontage, residential frontage with individual entrance (Los Angeles City Planning Commission, 2009). In Boston, urban streetwall is classified according to location, function, attribute, street grade, greening condition and whether the street is shared, thus nine types of streetwall are classified (City of Boston, 2013). Generally speaking, the existing classification mainly focuses on location, function, transportation, flowrate of people and urban greening condition (Chicago Department of Transportation, 2013; City of Philadelphia, 2017; Shanghai city planning and land resources administration, 2016).

For cities in China, especially within last two decades when rapid development has happened, the form of streetwall has not been controlled effectively. Rules and regulations have been changed for many times, and it leads to the disorder of street space. Control of the street form is mainly realized during the urban renewal, however, the classification methods are extremely complicated in such control. After preliminary research, it is found that the attributes of buildings, the constructing age, number of plots in one block, number of branches and the index for plot planning are in direct relationship with streetwall form (Tang, 2017a, 2017b, 2018). Due to this, proper classification method needs to be found and studied.

Controllable classification method needs to meet following prerequisites: The control requirements are similar in one classification, and the initial condition is similar in one classification. General classification takes similar control requirements into account, for instance, the consideration for location, function, traffic grade and the flowrate of people. Space syntax is a scientific and mature approach that can be used to describing the spatial configuration of street space. Integration calculated by UCL Depthmap can express the accessibility of the streets, thus helping grading and classifying different streets. There have to be further demonstration and study to figure out whether space syntax can be exploited for classifying when making street setback regulations.

This research takes typical streets in Nanjing as examples. With analysis of the form, attribute, setback distance and flowrate of people under different space syntax calculated value, the possibility of space syntax functioning as a classification standard is discussed. In order to demonstrate whether space syntax or the superposition of space syntax and other attributes can distinguish different streetwall, in this research, the roadside buildings that form the streetwall is numbered at first, then different kinds of information is collected, including form information, types, attributes, space syntax calculated value and flowrate of pedestrians. By counting and correlation analysis, this research can figure out the law of streetwall form and its relationship with land usage and the behavior of pedestrians, also the potential of space syntax for being a classification method.
2. STREETWALL INFORMATION COLLECTION

Firstly, after preliminary research, a form is designed to investigate and record the specific information of each frontage in the four streets in the central area of Nanjing City (Figure 1).

Each segment of the continuous streetwall is numbered, and important information is collected, including frontage form, type of setback, shape attribute, space syntax value, pedestrian activities and so on. This information will be used as a support for subsequent analysis.

1) Basic information of streetwall morphology

The form information of frontage includes the projection length, actual length, setback distance, shape of plan and height. The projection length refers to the length projected onto the street boundary line by roadside buildings; the actual length means a sum of the length of every segment of frontage along the street; the setback distance refers to the vertical distance between the frontage and the street boundary line (when the frontage is not parallel to the street boundary, the minimum and maximum values of the vertical distance are both recorded, and the maximum value is taken as the setback distance). The building spacing is the horizontal distance between the outer walls of two buildings. The length value mentioned above comes from the CAD map of Nanjing central area provided by Nanjing Municipal Planning Bureau. The setting of these items comprehensively reflects information of every segment of streetwall, such as plan, height, and their relationship with street.

2) Streetwall attribute

Land usage of the plot where the frontage is located is stipulated by Chinese urban planning management department according to the needs of the overall urban planning. We follow the <Urban Land Classification and Construction Land Use Standards> (GBJ137-90). The land usage of the plot in this research involves administrative office land (No. C1), commercial and financial land (No. C2), cultural and recreational land (No. C3), medical and sanitary land (No. C5), educational and research land (No. C6), other public facilities land (numbered C9), public facility mixed land (numbered Cb2), etc.
special land (numbered D1), public green space (numbered G1), industrial land (numbered M), residential land type2 (numbered R2), residential land type3 (numbered R3), residential land type4 (numbered R4), and primary and secondary school nursery land (numbered R5). Land usage will be exploited for classifying in subsequent analysis and study.

The actual function of the frontage refers to how the frontage is being used while the research is carried out. In order to improve the accuracy of the research, the actual function is used as the main classification standard.

The constructing age refers to the time when the frontage and the whole building are constructed. It is used to deduce the age of setback regulations that the building follows. The method of obtaining the age is to query the network or estimate the interval of the building construction age according to the image map of Nanjing central areas over the years.

The deduced age of setback regulation is the time when the setback regulations that the buildings follow came out. This value is deduced according to the constructing age. The setback regulation is issued by different city planning and management departments in China, and they are aimed at controlling the building setback distance from the street boundary line. Nanjing's setback regulations have 1928-1977, 1978, 1987, 1995, 1998, 2004, 2007 and other versions.

(3) type of setback and frontage

Areas generated by the frontage setback from street boundary line are classified according to the following two factors.

(1) Classification according to the scale of the setback distance from street boundary line
   a) No setback, the setback distance is 0, recorded as a; one of the upper part of the frontage overhead part is beyond the red line, shaped like an arcade, recorded as a0. b) The setback area can hold small-scale activities such as walking, walking the dog, and parking the bicycle, recorded as b. c) The setback area can hold large-scale activity such as green landscape and car parking, recorded as c.

(2) Classification according to whether the area generated from setback can be entered
   a) Closed, ordinary pedestrians without specific purposes are not free to enter and exit, such as government agencies with walls and guards. b) Semi-open, ordinary pedestrians without specific purposes need to enter and exit through obstacles, such as fences but pedestrians enter hospitals that do not register. c) Open, ordinary pedestrians without specific purposes are free to enter and exit, that is, places where no wall can pass freely.

Frontage alongside street is classified according to the degree of openness.

a) Frontage with multiple entrances, and each opening is separated by a wall only: A. totally open/full glass (continuous retailers). b) Frontage with an entrance: A. solid wall + entrance B. solid wall + entrance + window C. glass curtain wall + glass entrance D. solid wall + glass curtain wall + glass entrance. c) Frontage with no entrance: A. solid wall B. solid wall has window C. glass curtain wall D. solid wall + glass curtain wall. Organize the above classification into the type table (Figure 2).

(4) Corresponding flowrate of people

Baidu map is a travel application software launched by Baidu. The heat map function in the mobile version can represent the real-time traffic volume of each location in the map in different colors. Baidu maps the user's GPS positioning data collected by the mobile phone APP and the three Chinese
operators to locate the latitude and longitude information of the base station registered by the user's mobile phone, thereby obtaining a heat map. The flow of people from small to large is divided into 8 levels according to the color. We number them by the numbers "0" to "7" with colourless dark blue - light blue – green – green - yellow - orange red.

We extract the number values of the thermal color maps of the corresponding frontages in the street for subsequent analysis of spatial syntax and human traffic correlation. It is also used to analyze whether the space generated by the current building concession street matches the flow of people.

In order to ensure the accuracy and universality of the analysis, we choose two kinds of time periods that may be different between weekdays and weekends, and select the time when the pedestrians are active in the street from 7:00 to 23:00, and the heat of the case is separated by 2 hours. The screenshot of the picture is recorded once, and then the traffic level information of the corresponding frontage in all the heat maps is extracted and counted. Taking Zhonghua Street as an example, the screenshot results are as figure 3.

(5) Space syntax calculated value

According to the CAD street map of the main city of Nanjing, we connect the intersection of the street with the adjacent intersection, import it into UCLDepthmap, and use the method of segment calculation to obtain the connectivity and integration of the street. Then the operation value is corresponding to the frontage segment, and the corresponding information is recorded in the information collection table. The color from warm to cold represents the high to low integration value, which corresponds to the location and traffic accessibility of the street in the city (Figure 4).

3. STATISTICAL AND CORRELATION ANALYSIS RESULTS

The study preliminarily counted four streets, representing typical streets of different locations and attributes, and collected a total of 312 frontage (Figure 5). Through a series of statistical and correlation analysis, the study attempts to summarize the rules of frontage form, the relationship with pedestrian activities and the potential of space syntax. In the analysis, the types(representing form information) and attributes of the frontage is aimed at obtaining the causes of form, such as the relationship between setback distance and constructing age, and the relationship between frontage openness and function (land usage). The purpose of the correlation analysis between form type and flow rate of people is to express the flowrate of pedestrians corresponding to the current streetwall. The correlation analysis between space syntax calculated value, form and flow rate of people is to determine whether space syntax can help finding feature points, such as the location where flow rate of people is particularly high, the location where the form matches pedestrian activities, etc.

(1) The Law of Frontage Form

1) Types of frontage setback and land usage

The function of roadside buildings and the openness degree of setback area and frontage itself show a certain correlation. When the function is R, the openness degree of the setback area is the lowest. The openness degree in C2 region is various. Class Cb2 setback areas are highly open. In administrative office land, commercial land and public facilities land, most of the frontage has one entrance, and there are more open frontages in commercial land; in the second and fourth types of
residential land, there is mainly open frontage. The frontage of residential land is open because most of the streets are small retailers, so the frontage is open for commercial activities.

Table: Scale of classification

<table>
<thead>
<tr>
<th>Scale</th>
<th>Open</th>
<th>Semi-open</th>
<th>Closed</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>one entrance, multiple entrances</td>
<td>one entrance</td>
<td>one entrance</td>
</tr>
<tr>
<td>b</td>
<td>one entrance</td>
<td>one entrance</td>
<td>one entrance</td>
</tr>
<tr>
<td>c</td>
<td>one entrance</td>
<td>multiple entrances</td>
<td>one entrance</td>
</tr>
</tbody>
</table>

Figure 2: Classification according to whether the area generated from setback can be entered
Figure 3: Heat map of Zhonghua Street

Figure 4: Space syntax calculated value

<table>
<thead>
<tr>
<th>land usage</th>
<th>total length of frontage</th>
<th>percentage</th>
<th>setback distance from street boundary line (scale)</th>
<th>degree of openness</th>
<th>degree of accessibility</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>a0       a    b      c        -     0     1     10     0     1     10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>482.4</td>
<td>5.2%</td>
<td>7.1%     0.0%  64.3%   28.6%</td>
<td>7.1%     35.7%   14.3%   42.9%   28.6%   64.3%   7.1%</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>3739.7</td>
<td>40.1%</td>
<td>7.1%     29.5%  35.7%   27.7%</td>
<td>28.6%    13.4%   2.7%     55.4%   13.4%   50.0%   36.6%</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>320.3</td>
<td>3.4%</td>
<td>0.0%     20.0%  0.0%    80.0%</td>
<td>20.0%    40.0%   0.0%     40.0%   30.0%   60.0%   10.0%</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>284.9</td>
<td>3.1%</td>
<td>22.2%    22.2%  44.4%   11.1%</td>
<td>44.4%    0.0%    0.0%     55.6%   35.6%   33.3%   11.1%</td>
<td></td>
</tr>
<tr>
<td>C9</td>
<td>14.1</td>
<td>0.2%</td>
<td>0.0%     100.0% 0.0%    0.0%</td>
<td>0.0%     0.0%    0.0%     100.0%  55.4%   13.4%   55.6%</td>
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</tr>
<tr>
<td>Cb</td>
<td>689.9</td>
<td>7.4%</td>
<td>16.7%    25.0%  50.0%   8.3%</td>
<td>41.7%    0.0%    0.0%     58.3%   8.3%    83.3%   8.3%</td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>126</td>
<td>1.4%</td>
<td>0.0%     0.0%   75.0%   25.0%</td>
<td>0.0%     25.0%   0.0%     75.0%   25.0%   50.0%   25.0%</td>
<td></td>
</tr>
<tr>
<td>G1</td>
<td>28.9</td>
<td>0.3%</td>
<td>0.0%     0.0%   25.0%   75.0%</td>
<td>0.0%     50.0%   0.0%     50.0%   50.0%   50.0%   0.0%</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>206.1</td>
<td>2.2%</td>
<td>0.0%     90.0%  0.0%    10.0%</td>
<td>0.0%     30.0%   0.0%     70.0%   30.0%   0.0%    70.0%</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>63.5</td>
<td>0.7%</td>
<td>0.0%     0.0%   0.0%    100.0%</td>
<td>0.0%     0.0%    100.0%   0.0%    100.0%  0.0%    100.0%</td>
<td></td>
</tr>
<tr>
<td>R1</td>
<td>19.5</td>
<td>0.2%</td>
<td>0.0%     0.0%   0.0%    100.0%</td>
<td>0.0%     100.0%  0.0%     100.0%  100.0%  0.0%    0.0%</td>
<td></td>
</tr>
<tr>
<td>R2</td>
<td>1979.9</td>
<td>21.2%</td>
<td>2.9%     32.4%  45.6%   19.1%</td>
<td>16.2%    5.9%    15.0%    76.5%   10.3%   27.9%   61.8%</td>
<td></td>
</tr>
<tr>
<td>R3</td>
<td>56.6</td>
<td>0.6%</td>
<td>0.0%     0.0%   50.0%   50.0%</td>
<td>0.0%     50.0%   0.0%     50.0%   50.0%   50.0%   0.0%</td>
<td></td>
</tr>
<tr>
<td>R4</td>
<td>1233.6</td>
<td>13.2%</td>
<td>0.0%     86.7%  31.0%   2.4%</td>
<td>9.5%     26.2%   2.4%     61.9%   33.3%   26.2%   40.5%</td>
<td></td>
</tr>
<tr>
<td>R5</td>
<td>64.2</td>
<td>0.7%</td>
<td>0.0%     16.7%  50.0%   33.3%</td>
<td>16.7%    83.3%   0.0%     0.0%    100.0%  0.0%    0.0%</td>
<td></td>
</tr>
<tr>
<td>U2</td>
<td>11.6</td>
<td>0.1%</td>
<td>0.0%     0.0%   50.0%   50.0%</td>
<td>0.0%     0.0%    50.0%    50.0%   100.0%  0.0%    0.0%</td>
<td></td>
</tr>
<tr>
<td>add up</td>
<td>9321.2</td>
<td>100.0%</td>
<td>5.4%     33.7%  37.5%   23.4%</td>
<td>20.8%    16.7%   3.5%     59.0%   21.5%   41.3%   37.2%</td>
<td></td>
</tr>
</tbody>
</table>

Figure 5: Relationship between the types and attributes of the frontage
(2) Correlation analysis of setback attributes and other index

Figure 6: Comparison of type of setback, flow of people and space syntax calculated value

The sample data collected is sorted by the setback distance, followed by the search for the overall relationship between space syntax calculated value and flowrate of people (Figure 6). The results show that, except for type a0, as the setback distance increases, the total average flowrate of people increases and the space syntax calculated value decreases.

There is also a direct connection between land usage and setback attribute. When setback distance is of no difference, the data is classified according to different kinds of land usage. The result shows obvious characteristics.

The overall relationship between setback distance, land usage, flowrate of people and space syntax calculated value

When the land usage belongs to type Cb, the flowrate of people and space syntax values are positively correlated with the setback distance; when the land usage types are C1 and C2, the flowrate of people is positively correlated with the setback distance and negatively correlated with the space syntax calculated value; when the land usage types are C5, R2 and R4, the obvious connection between flowrate of people and setback distance cannot be found. It is deduced that it is mainly caused by the location and the function of roadside buildings (Figure 7).

The relationship between setback type and land usage when there appear maximum and minimum value of the flowrate of people

When the type of setback is a and b, the flowrate of people reaches the maximum when the land usage type is Cb. When the type of setback is c, the maximum flowrate of people occurs when the type of land usage is C1, and it is mostly affected by Shengzhou Road (S-K16-P1-J1-1 S-K16-P1-J1-2). When the land usage type is R4, the flowrate of people reaches the minimum.

Comparison of average human flowrate and the D-value between flowrate on weekends and weekdays under different land usage condition

Except C1, the flowrate corresponding to C class is generally larger than R class. R2 is related to bigger value than R4. M got a smaller value. The flowrate of people is less affected by period when the land usage type is C5, R2, M and R4 is hardly affected by period.

Relationship between type of setback and land usage

G1 mainly refers to type c and M mainly refers to type a. R4 only refers to type a, b and C1 refers to b,c. When the land usage is C and R2, it corresponds to multiple types of setback.
As for residential land, the obvious relationship between setback distance and human flow has not been found. According to the actual situation, data is further classified according to the function of buildings along the street.

When the land usage type is R2 and function of roadside building is C2, the average flowrate of people increases obviously, and the overall average value is proportional to the setback distance. When the function of roadside building is R2, there seems no relationship between setback distance and average flowrate of people. Therefore, for R2, function of roadside building is the main factor influencing the flowrate of people. In this case, the space syntax calculated value cannot reflect this feature. For R4, there is no correlation between the flowrate of people and function of roadside building, but when the building function is C2, the space syntax calculated value increases generally.

Therefore, it is concluded that for C1, C2, Cb2 and other types of land usage, space syntax calculated value can be used to overlaying the land usage in order to find the points that need to set different setback distances. Because the classification of land usage itself includes buildings with different functions, the existing land usage cannot be directly used as the basis of classification for residential mixed other land usage. For example, residential and commercial mixed land cannot show the attribute of residential land. Research shows that for R4, even the existence of buildings with different functions will not have a significant impact on the flowrate of people. Therefore, for such kind of land usage, subdividing function of roadside building and land usage can help us find the relationship between the type of setback and the flowrate of people. However, the correlation between the setback distance and the space syntax calculated value cannot be found.

In addition, with the same setback distance, the higher the degree of regional openness, the larger the flowrate of people, but their relationship with space syntax calculated value is vague. Function of roadside building and the degree of openness show a certain correlation. When the building function is R and C5, the opening degree reaches the lowest point; When it is Cb, the opening degree is high.

(3) Correlation analysis of attribute of streetwall and other index

1) Correlation analysis of attribute of accessibility degree and other index

After classifying the sample data according to the degree of accessibility, the overall relationship between space syntax calculated value and flowrate of people can be found (Figure 8). The results show that, when the frontage has an entrance, the flowrate of people reaches the highest point, while the space syntax calculated value is the lowest; when the frontage has no entrance or is completely open, the flowrate of people is low and the space syntax value is high; when the frontage is completely open, the space syntax value is the highest. Generally, there is little change in flowrate of people.

Statistical data shows that when the frontage openness is the same, different land usage and different setback distances show different attributes. With the same degree of accessibility, it is found that areas with large flowrate of people are usually commercial land or mixed land, while the areas with small flow of people are usually residential land; the areas with large flowrate of people without or with one entrance mainly belong to setback scale C. Thus, it can be predicted that land usage and the setback distance of frontage has an important influence on human flowrate. Attributes of setback
have been analyzed above, so the relationship between frontage openness and flowrate of people and space syntax calculated values is analyzed according to the classification of land usage.

Figure 7: Comparison of land usage, type of setback, flow rate of people and space syntax calculated value
(1) The overall relationship between setback distance, land usage, flowrate of people and space syntax calculated value

When it comes to administrative office land or cultural and entertainment land, flowrate of people is negatively correlated with the degree of accessibility, and it is also negatively correlated with space syntax calculated value. As for cultural and entertainment land, the average space syntax value of the frontage which has one entrance and which is totally open is almost equal; when the land usage is industrial land, flowrate of people and frontage openness are positively correlated, and space syntax calculated value is positively correlated. Negative correlation; when the land usage is mixed land for public facilities, there is little change in flowrate of people when the frontage has no entrance or one entrance. From one entrance to full opening, human flow is positively correlated with frontage openness and space syntax calculated value; when the land usage is commercial, medical and health, second-class residential and fourth-class residential, there is not any connection between human flow and frontage openness (Figure 9).

(2) Comparisons of different flowrate of people on weekdays and weekends when frontage openness is different

When the frontage in administrative office land has no entrance, the difference between weekday and weekend traffic is large, and when there is one entrance or open, there is small difference; when the frontage in mixed land for public facilities is open, the difference between weekday and weekend traffic is large. If there is no entrance or only one entrance, there will be small difference in the flowrate of people.

Relationship between the frontage openness and flowrate of people is not found in further analysis. For the second type of residential land and the fourth type of residential land, because the function of roadside building in residential land is not completely consistent with that of the whole plot, the function of the building along the street needs further classification.

When block land is second-class residential land and part of the land along the street is commercial land, flowrate of people is the largest when the frontage has no entrance, and it decreases when there is no entrance or only one entrance. The human flowrate is negatively correlated with the space syntax value, and the it hardly changed when one entrance is completely open; when the attribute of street land is residential land, the flowrate of people is hardly changed from no entrance to one entrance. At the entrance, the flow of people increases and decreases from having one entrance to fully open. The trend is negatively correlated with the spatial syntax value. For the four types of residential land, when

Figure 8: Comparison of open degree, flow rate of people and space syntax calculated value
Figure 9: Comparison of land usage, degree of accessibility, flow rate of people and space syntax calculated value
the nature of street land is residential land, from an entrance frontage to a fully open frontage, the increase of flowrate of people is negatively correlated with the spatial syntax value, and when the nature of street land is commercial land, the human flow is basically unchanged.

Therefore, it is concluded that for administrative office land, industrial land and other types of land, we can use the nature of superimposed space syntax calculated values to find the points that need to set different levels of frontage openness. For cultural and entertainment land, public facilities mixed land, some of the spatial syntax value corresponding to the degree of frontage openness are similar, and cannot be fully determined. For the second type of residential land and the fourth type of residential land, subdividing the land usage along the street and the land usage can find the relationship between flowrate of people, the degree of frontage openness and space syntax, but help determining the degree of frontage openness.

4. FEATURE ANALYSIS

(1) Analysis of the characteristics of setback/frontage in four streets

Figure 10: Characteristics of setback/frontage in four streets

Different space syntax integration values mean that each street has different degree of accessibility in the whole urban road system. The form above shows that Zhongshan East Road has the highest space syntax integration value and Dingxin Road-Xianhe Street has the smallest difference between the maximum and minimum value (Figure 10).
Zhongshan East Road is mainly commercial along the street with relatively large building volume. The main types of setback are b and c. The flow rate of people on this street is the largest compared with other streets.

To Dingxin Road - Xianhe Street, the major type of setback is b and the ratio of type a and type c is basically equivalent. When the type of setback is b, its corresponding land usage is mainly R. The buildings along Xianhe Street are all small shops. Since the type of setback is basically a and b, it forms a relatively continuous street wall. Along the Curve Section of Dingxin Road are many old houses. The different setback distances create uneven street wall form.

Zhonghua Road is also a commercial street. The land usage is mainly C2 on both sides. Its street wall is continuous and open. The ratio of the three types of setback is basically equivalent and it has the new type a0. A large number of arcades were designed in the same way during the renovation of Zhonghua Road in the 1990s, in order to reserve the historical features of the Zhonghuamen area.

Shengzhou Road is a residential street whose land usage is mainly R4, followed by C2. When it comes to the type of setback, type a accounts for the majority, which is basically related to the residential land. It is followed by type c and type b is the least. Due to the large number of small shops along the street, the degree of accessibility is high.

Commercial buildings are related to all the types of setback. As long as there are commercial buildings along the street, it is obvious that the flow rate of people is proportional to the setback distance. When the type of setback is a, the corresponding business type is most likely to be small shops, which has a great impact on the flow rate of people when the land usage is R2. Most large business are related to type c, the setback area of which are usually used as commercial plazas where multifunctional activities could happen. The traditional space syntax theory verifies that the higher the accessibility is, the more likely it is to have commercial buildings. In this study, Zhongshan East Road has the most commercial buildings, the corresponding space syntax integration value is also the highest. In addition, the business types of Shengzhou Road and Dingxin Road-Xianhe Street are mainly characterized by small shops along the street.

(2) Analysis of the special points of human flow rate and summary of the leading factors.
1) Flow rate of people and setback

There are few semi-open types of setback areas in the samples. Generally, they are separated by greening and fencing walls, with entrances but few passers-by, which correspond to some commercial buildings and the venues in front of hospitals. The two hospitals on Dingxin Road have the same spatial syntax value. Although the setback distance is relatively small, the high degree of regional openness still attracts more people than the low degree of openness.

The function is C3, the setback type is C, and it is located on both sides of a crossroad. The syntax value of Jiangning Weaving House is lower than that of Nanjing Library, but the flow of people is higher. In front of Jiangning Weaving House, a large area of land was conceded for human activities, and a green belt was distributed in the area, with a pleasant environment. The Nanjing Library has set up a fence to make the site closed. As a result, the flow rate of people is low. The same function is to set fences at the edge of the sidewalk, leaving the conceded site for internal use. Because there is no subway station around, the Jiangsu Museum of Fine Arts has fewer people than the Nanjing Library.
Except the large scale of setback, the average flowrate of people in schools on Dingxin Road is very low due to the closure of setback sites and the influence of their functions.

2) Flowrate of people and the degree of accessibility

In the correlation analysis, some points with closed frontage but large flowrate of people are found, or that with open frontage but small flow of people. And the reasons are analyzed concretely.

Although there is no entrance along the frontage, the Chinese apartment at the intersection of Zhonghua Road and Baixia Road is located at the intersection, surrounded by business buildings, with a large setback distance, an open setback area and a public green space for people to rest, which causes the crowd to gather.

The security room at the entrance of Jiangsu Inspection and Quarantine Bureau is closed along the streetwall, but it is surrounded by commercial land and administrative office land, with a large flowrate of people. The closure of the instreetwall is the reason for the function of the building itself, and the length of the frontage is very small, which has no effect on the flow of people.

The frontage of small shops along Shengzhou Road is open, but because of the residential land all around, and not close to the subway station or the intersection of main roads, there is less traffic.

3) Flowrate of People and Space Syntax Value

The syntax value of the road along the curve section of Dingxin Road is higher as a whole. Because of the four types of residential land along the street, the flowrate of traffic is very low. The southernmost section of Xianhe Street, near the intersection of Jiqing Road, is R2, with the lowest syntax calculated value, but the traffic volume reaches the highest in the whole street. It is speculated that it is mainly influenced by small shops along the street.

In a section of Zhongshan East Road, there are small shops along the street. The syntax value is high but the traffic is low. Buildings are small and dense, built relatively early, before 1976. The street boundary line type of streetwall setback road is a. Because the street is a small shop with a long history, the distance of building setback is small, compared with other commercial plazas, people's activities are relatively less.

The syntax calculated values of Nanjing Library and Jiangning Weaving House are on the low side as a whole. Because of their C3 function and adjacent to the subway station, the traffic volume is very high.

The commercial building along the street in the residential area of Qin Zhuangyuanli, Zhonghua Road, is a small shop along the street, which is opposite to the tourist attractions such as Zhanyuan, Maoye department store and other commercial complexes in location, attracting more traffic. The type of setback here is the arcade, that is, the frontage is close to the street boundary line, the sidewalk is narrow, some bicycles are parked on it, and some retail shops such as milk tea shops have waiting customers outside, so the sidewalk is crowded.

The small retailers on Shengzhou Road mentioned above are also the places where the space syntax value is relatively high. As the land usage is mainly residential, the traffic volume is low. The setback frontage here is also close to the street boundary line, which can meet the needs of pedestrians’.

Space syntax values cannot completely correspond to human activities, so it is necessary to take into account the function of buildings along the street, the opening of traffic stations and setback areas, and
the influence of surrounding buildings. Generally speaking, when there are commercial buildings and traffic stations, the flowrate of people increases significantly. At this time, it is advisable to open the setback site to carry more people.

5. CONCLUSIONS

(1) Streetwall in China (take Nanjing as an example) nowadays is the result of various kinds of comprehensive urban regulations. The form of street interface takes on some particular law. As for the samples being chosen in this research, projection length is 29.9m and setback distance is 8.8m on average. There are 21.1% of the setback area is closed and 21.8% of the frontage is totally sealed off. From what has been discovered in this research, form of streetwall is closely related to land usage. Generally speaking, frontage located in commercial plot tends to be open while that in residential plot is usually closed and sealed.

(2) The setback type and openness characteristics have a strong connection with the density of human activities. To be more detailed, in this research, as the setback distance increases, the total average human flow becomes larger. Also, with the same setback distance, the more open the setback area is, the bigger human flowrate it has. When the form, setback type and openness attribute of the frontage are integrated with land usage, there is a strong connection between the frontage and flowrate of people. In this research, flowrate of people in administrative land is positively correlated with setback distance. As for residential land, flowrate of people is closely related to the setback of frontage and openness degree if the function of roadside buildings is classified. However, there is also condition where the pedestrians’ activities are of high density, but the setback distance is small and the frontage is closed. Those areas tend to be extremely crowed and disordered in reality.

(3) The space syntax calculated value of the street corresponding to frontage can hardly match the density of pedestrians’ activities or the distribution of commerce. Therefore, only space syntax itself cannot be used to classifying the streetwall which needs to be controlled. Further classification combined with land usage, traffic stations and so on is demanded. For example, frontage in commercial can be divided according to space syntax value thus the setback distance can be controlled. As for frontage near public traffic station, even the space syntax calculated value is low, the setback distance should be bigger.

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