A Quantitative Approach on Morphological Characteristics Study Using the Case of Nanjing

by Yuxun Song, Lian Tang & Wowo Ding
Nanjing University

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Abstract: After a century of development, the urban morphology of Nanjing, a historical city, has changed with the changes of society: historical districts reflected the old lifestyles, residential areas integrated modern lifestyles and urban central business districts as well and new expansion zone completely in accordance to the urban planning. Urban morphology provides a scientific and systematic approach in representation and explanation of urban fabric, which has enabled designers to understand the causes of morphogenesis. However, considering the objective of urban design, urban fabric needs to be identified and described in characteristics, so that it is worthwhile to further depict urban fabric characteristics based upon morphological research.
This paper takes four cases of urban fabrics generated in different periods in Nanjing as examples to analyse their characteristics based on physical forms and the cause of formation. Firstly, the morphologic elements are extracted and mapped in three hierarchies: street, building and space. Site coding and indexes are used to draw the morphological properties with area, average height and coverage. Combining with layered physical forms and morphological properties, the morphologic features of fabric cases are identified. The result shows the morphologic analysis can help not only to understand generation process but also to depict the form features. Finally, the paper puts forwards the quantitative methods and try to find co-relationship between shape, density, function and planning indexes with site pattern regularities.

1. Introduction

As the one of the objects of urban design, urban morphology connects the physical environment and the deep social mechanism. With the attentions to urban design, more and more researchers from different fields began to discuss the urban morphology from different perspectives (Moudon, 1997).

In the field of geography, the Conzen school divides urban morphology into multiple elements: streets, plots, buildings and open spaces, and uses historical maps to classify urban plans to describe the distribution, structure, and changes of cities (Whitehand, 2001). In the field of architecture, the Italian school's Muratori emphasizes the typological process, arguing that building type is the source of urban evolution (Moudon, 1997). And sociologists pay more attention to

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the impact of urban space policy on physical forms and the relationships between human behaviour and environment (Jacobs, 2005). These studies explain the formation mechanism, evolution process and social influence of urban morphology, but do not describe the results produced after the morphological process, the characteristics of urban form are still abstract. If the morphological features can be fully described, the future urban design will be more controllable.

Mapping is a crucial tool for studying the shape of the city. The so-called mapping is to use the graphic language to abstractly and selectively describe the research objects, and the way of graphic expression reflects the researcher's viewpoints and purposes. It not only can intuitively express the information, but also help extract, analyse and present the characteristics of the urban form and space. The most famous case is Nolli's New Roman Map in 1748 (Aurigemma, 1979). He used the figure-ground method to extract part of the information from the real map, and visually represented the urban form and space, public and private, external and internal. The graphical approach provides a visual and intuitive expression, but it is limited to direct description of the phenomenon and lacks comprehensive cognition of its characteristics, which makes it difficult for people to obtain more information directly from the graph.

At the same time, scholars are also exploring other tools for description. Meta Berghauser Pont, a professor at Delft University in Holland, proposed Spacemate from the perspective of density to combine the floor space index, ground space index, open space ratio and layers to establish a correlation chart for evaluating building density and urban form, and then added the network density based on this to form Spacematrix for supplementary. This method expresses and classifies the morphological features of the urban form by means of data, and unearth the intrinsic association of the morphological features, but this tool lacks an intuitive display and the results are slightly abstract.

The traditional urban morphology reveals important elements in the morphological process to a certain extent, and mapping is used as a tool to abstractly extract and visually express these elements. Then, the quantitative method provides a further description and evaluation based on mapping, and expresses these morphological features in a scientific and accurate way. At the same time, the morphological process is once again interpreted from another perspective, and guide future urban design.

Taking the historical city of Nanjing as an example, this paper selects four sections of urban fabric in the diverse development areas of Nanjing: traditional area, modern residential area, commercial area, and new district base on the three different morphological research methods. Secondly, this project generally describes the morphological process and characteristics of four sections of fabric from the perspective of architecture design and urban design, and combined with life needs and codes, five elements that controlling morphological features are extracted from different levels: road form, road structure, architecture, fabric and exterior space, pur-

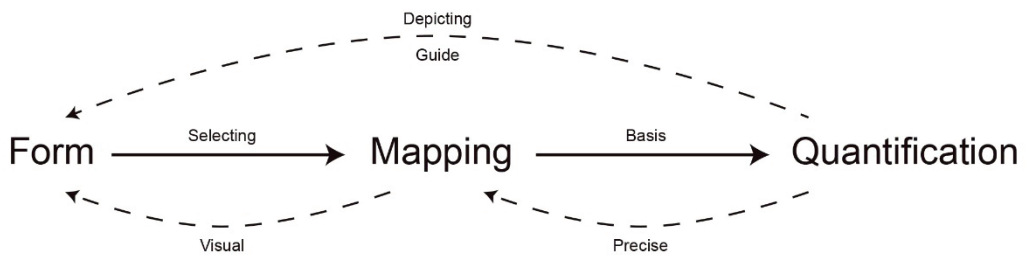

Figure 1. *The method and purpose of quantification in this paper.*

posefully transforming it into a quantitative language. Then, quantitatively analyses the five influencing factors of the four sections to find the commonness and dissimilarity, and selects the available quantitative indicators, so as to guide the future urban design. Finally, this paper proposes a graphical method to describe the important factors in morphogenesis, deeply describes and analyses the morphological characteristics of four typical fabrics in Nanjing by quantitative method, explains the reasons for their morphological characteristics, and summarizes a set of quantitative indicators.

2. Method and Research

Different graphical methods represent different cognitive perspectives, and quantification is based on this. While exploring different quantitative methods, scholars are also discussing different cognitive styles. Martin&March (1972) proposed three basic urban architectural models based on types and described the relationship between density and form in a data-based way. Benedikt (1979) applied the method of isovist to the analysis of architectural space and defined it mathematically. Karl Kropf (1996) used location, external outline of buildings (shape, size, proportion) and architectural arrangement (composition, quantity, relative location) to describe the characteristics of urban morphology. Hillier (1996) proposed the use of space syntax to abstract street space into a series of axes, thereby quantifying the degree of curvature, continuity and connection of these axes. Ratti (2002) uses rasterized graphics to render a map in three dimensions on a computer, transforming the flat information of buildings into individual unit pixels, using the grayscale information it represents to express the height. Fisher-Gewirtzman (2003) proposed the concept of spatial openness index, using 3D modeling to study the field of view on a three-dimensional scale. Stephen Marshall (2005) analysed and interpreted different street pattern types from the perspective of geometric configuration, hoping to establish a design approach assisted by coding. Zhang Lina (2012) abstracts China's slab apartments into rectangles with the same height and depth according to codes, and describes the different slab combination and arrangement patterns by partition and dispersion. Zhao Qin (2013) extracted the residential building plots and architectural outlines from the map, and scientifically studied the relationship between the plots and the residential buildings based on it. Homeira and Philip (2015) converted the residential type into an abstract grid, filled and assigned colors to different grids, and made case studies and comparisons based on it.

These studies focus on different fields of urban morphology. Based on different research purposes, they visually presented some physical information of the research objects hierarchically by means of mapping, and provided cognitive perspectives and quantitative methods. This paper hopes to do a more comprehensive analysis of the morphological characteristics of different fabrics in Nanjing based on the mature illustration and quantification methods, expects to guide the future urban design.

3. Cases

As the ancient capital of six Dynasties, Nanjing has a very rich history. At the same time, as a first-tier city in China, it has also shown a trend of rapid development and expansion. At present, the urban fabric of Nanjing has become more complex and diverse, therefore, taking fabrics

of Nanjing as the research object has certain universal significance in China, which covers most of urban fabric types in China.

Before the founding of the People's Republic of China, the urban development of Nanjing was relatively slow and mainly concentrated in the Ming City Wall. With the growth of population and improvement of economic level, the speed of urban construction and expansion got increasingly fast. A large number of traditional fabrics were replaced by modern architecture in this period. Along with the increasing emphasis on history and culture, the protection of traditional buildings began to be proposed in the protection plan for historical and cultural cities in Nanjing after 2000, and many historical features such as Chengnan, Yihe Road, the Presidential Palace, and the Forbidden City were set to be protected district, and the other area inside the city got to be the main development area. When the urbanization process went to a certain stage, the lack of land and intensification of the contradiction between protection of the old city and modern construction, Nanjing proposed the policy of "reducing in the old city, and adding in the new town" (Deng, 2009). And chose the Hexi area which was close to old city with vast space, made a top-down overall plan to serve for relieving pressure.

This paper selects four representative typical sections of fabric according to the expansion process of Nanjing. Each section is divided into similarly studied areas based on the center line of the road to ensure the integrity of the urban morphology and the comparability of the study.

The first is the traditional type of fabric, this section is located in the Mendong area next to the Gate door of the city. Different from the dilapidated traditional fabric of the other old area, the Mendong area shows a complex and interesting situation, includes the old houses left over from history, and the multi-storey houses, schools and hospitals built due to the tight land use and living demands. There are also villas and commercial streets with traditional form that are suitable for modern needs under the protection plan. Studying the morphological characteristics of the Mendong area can not only describe the traditional fabric, but also help the future urban design and architectural design for tradition. The second is modern living part, this section is located in the north of Jiqing Road. This area has not only multi-storey residential buildings in the 1980s and 1990s, but also high-rise residential buildings that have been built since 2000. Specially inside this area, the Laifeng Community was the "largest residential area in Nanjing" at that time. This section combines a variety of different residential types from the

Figure 2. *The selection of the research object.*

reform and opening up to the present, and is a typical case of modern residential areas in Nanjing. Then the commercial texture is located in the core area of Xinjiekou. Nanjing's commercial center gradually shifted from the south to the Xinjiekou area due to the change of urban development focus brought by urban expansion and urban planning. Now Xinjiekou has become a veritable commercial area and external window with a certain influence in the country. The last is the new town, the section is located in the south of the Olympic Center, covers the space main axis of the new town, the residential community and the mixed commercial building, it basically contains the key points of the planning and construction of the new town.

Traditional fabric has evolved from history, and their streets still retain the dense, narrow, and organic features of traditional roads. And it is difficult to build large-scale buildings at that time, limited by the production technology and construction methods. Usually, the standard width and depth are relatively uniform and the number of layers is below three layers with brick-wood structures and sloping roofs. After the founding of the country, some sloping roof buildings began to be replaced by multi-story flat roof in an acupuncturing way due to the application of concrete. Then in order to satisfy the growing demand for living, residential units that are regularly arranged by residential units appeared and replaced the traditional fabric extensively, at the same time, the large-scale service facilities followed, such as hospitals, schools, and community services. After the basic needs were guaranteed, Mendong were updated in order to pursue the unification of historical culture and modern life, high-class villas and commercial streets were built according to traditional types. These plausible traditional buildings have huge internal space, and show the characteristics of low, narrow, sloping roofs and courtyards consistent with tradition because of the architectural design of form.

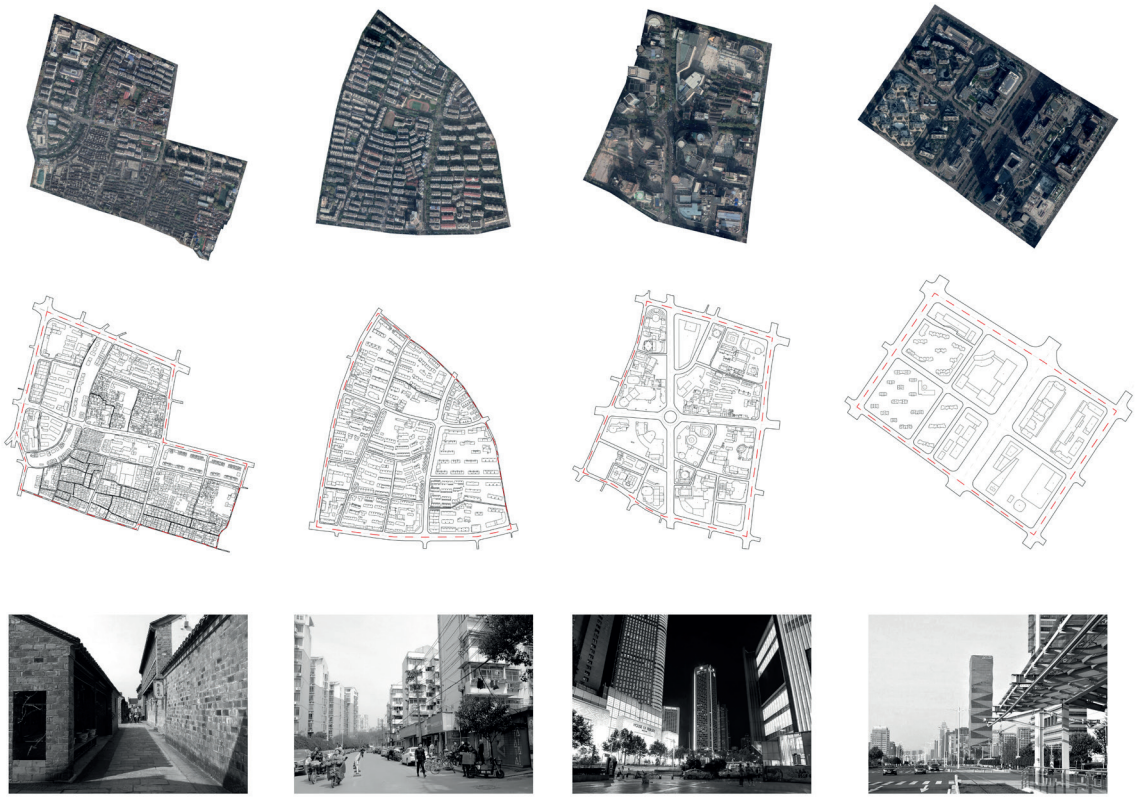

Figure 3. *The four morphological categories of urban fabric in Nanjing.*

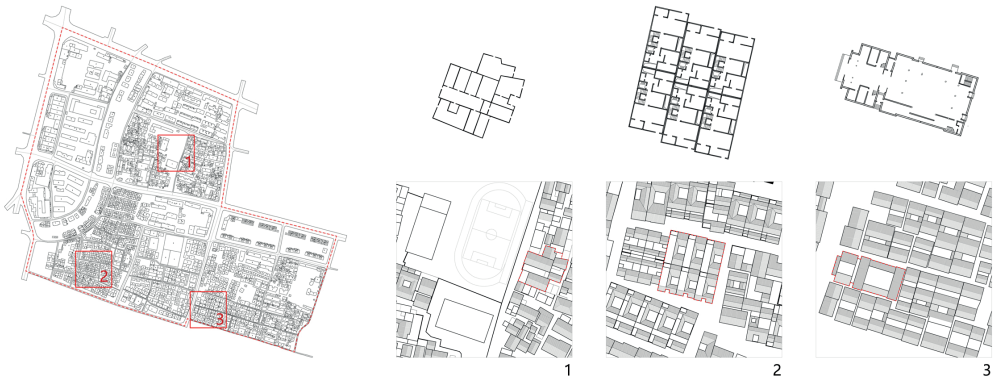

Figure 4. *Diagrams of traditional fabric features.*

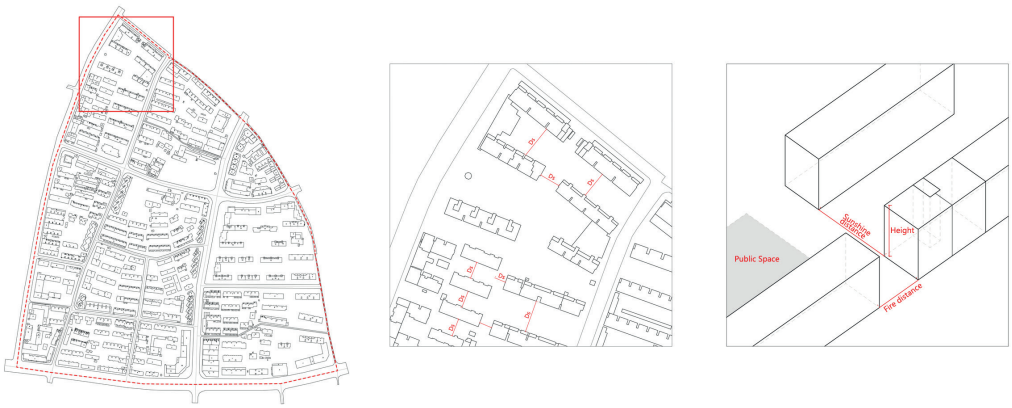

Figure 5. *Diagrams of modern residential fabric features.*

The modern residential part is mainly influenced by the neighbouring units and the Soviet-style planning. It is composed of group-style enclosure space at the beginning, but this model does not pay attention to the ventilation and lighting problems of the east-west direction and the corner unit, and does not conform to the living habits in China. Therefore, it gradually evolved into a community composed of residential units in rows. These residential units are simple in form and relatively uniform in standard width and depth, usually face to north and south, and the north-south space is calculated according to local sunshine demand. And the east-west space mainly meets the requirements of fire protection regulations and the internal traffic demand of the community. Along with the improvement of people's demand for quality of living, the residential buildings representing different living standards are enriched, the interior of the community is no longer monotonous, and landscape and public space are designed.

The commercial fabric directly reflects the relationship between land use and economic benefits. In 1927, the capital planned to set up Xinjiekou as a commercial district, broadening the roads that cross the region to ease future traffic pressures. Later, with the development of the national economy and the improvement of life, traditional businesses street no longer meet people's demand for shopping, and large-scale intensive department stores have become fashionable. These malls occupy a large area, although the shape is complex, but they height are highly similar due to the influence of building codes and construction demands. When the technical means matured, the Xinjiekou area began to build high-rise buildings, they were

erected on the shopping mall, pursued the maximum benefit while being limited by fire protection codes, making the plane area similar and slightly different in shape.

The New town is controlled by politic, economic and social factors and is the product of strong urban planning. In the plan, the urban center of Hexi New town is mainly composed of culture, sports, business and commercial functions, and is defined as a scenic spot beside river, and a modern residential area with work, living and employment. It has wide roads, open spaces and lush greenery. The network of road is mainly square grid, designed with multiple spatial axes and a series of functional areas. The residential parts are mostly high-rises, which are inclined to the plots and are well arranged, and buildings are similar to commercial section in business part.

From the perspective of morphological characteristics, the four sections show the features of the three aspects of the road, the building and its volume, and the external space. Based on this, this paper extracts and illustrates these common feature elements hierarchically as the objects for quantification. The first layer is the road form, which is the part enclosed by the road boundary and the research boundary, and describes the width and area of all accessible roads within the study area. The second layer is the road structure, which consists of the road center line, and expresses the length, quantity and accessibility of the road. The third layer is the buildings, showing the number and size of the building and the contour features. The fourth layer is the volume of the building, showing the shape, size and height of the volume of the building in the urban form. The last layer is the external space, showing the proportion of the external space of the research area.

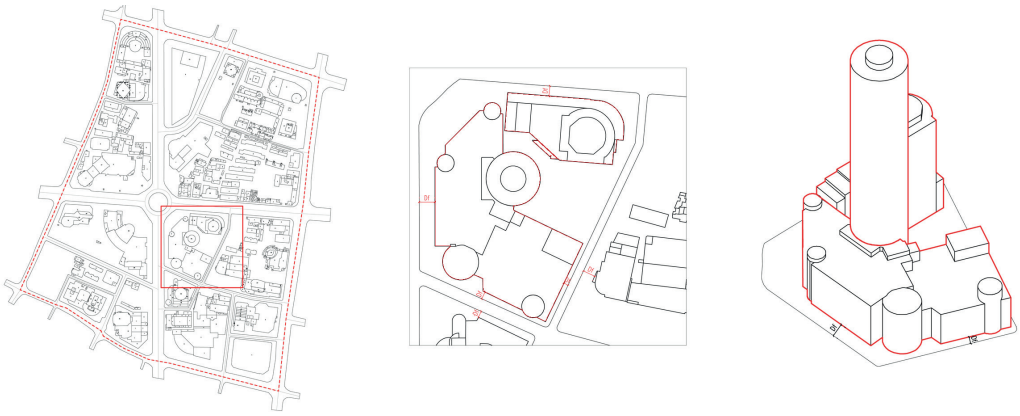

Figure 6. *Diagrams of commercial fabric features.*

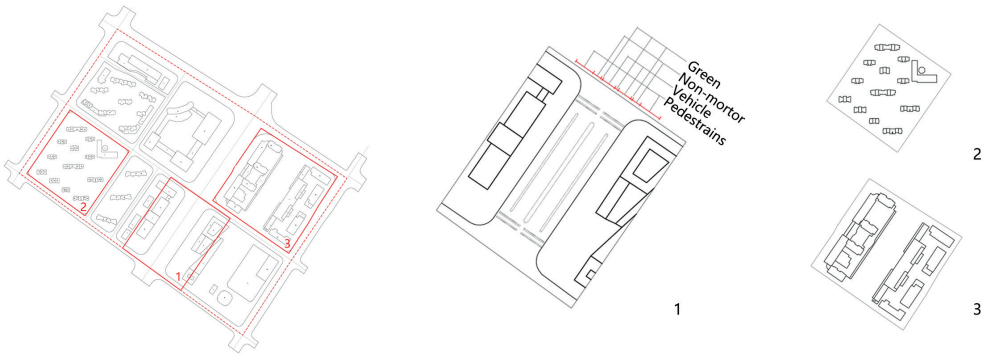

Figure 7. *Diagrams of new town fabric features.*

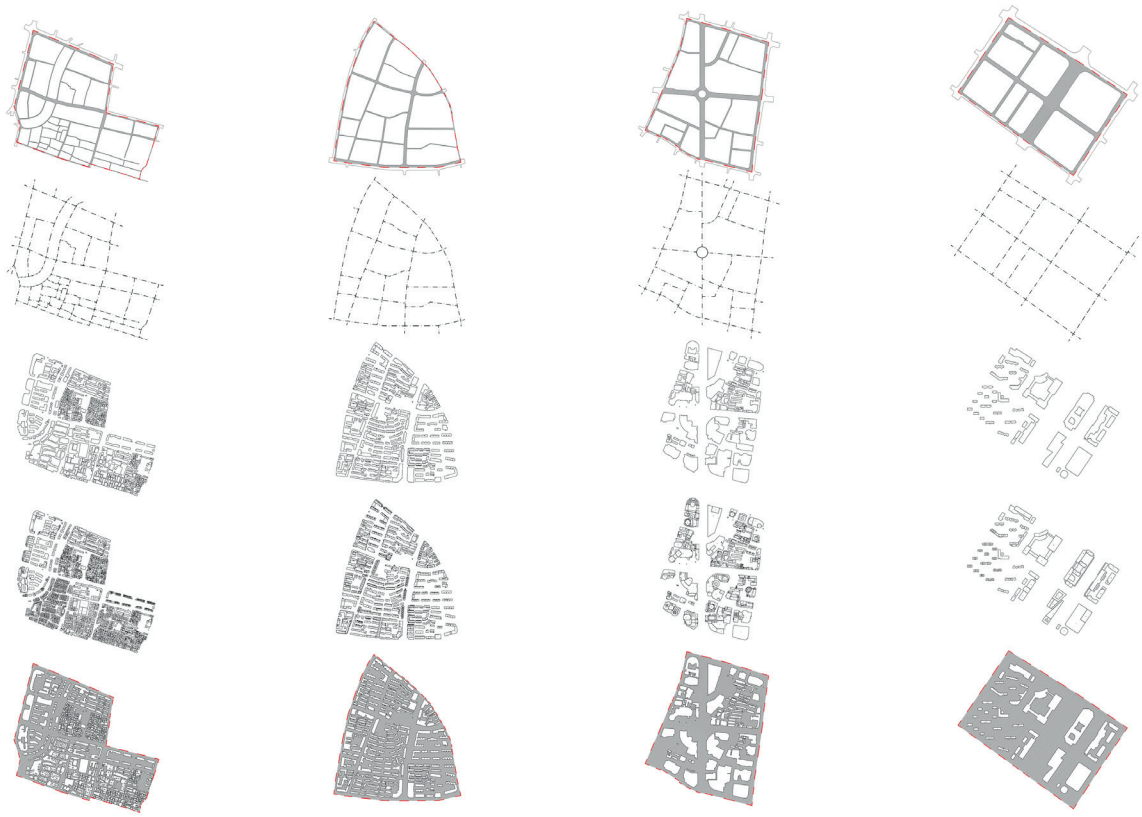

Figure 8. *Hierarchical mapping of the four fabrics*

4. Quantification and Analysis

Four typical fabrics have been characterized and mapped hierarchically above. This part is to select appropriate quantitative indicators for analysis based on the illustration. When several objects have the same shape, they can be compared by size (Figure 9a); when they are the same size, they can be distinguished by the difference in shape, they are the basic contents in this research for quantification (Figure 9b).

It can be seen from the figure 8 and the description above that the morphological features of the road are mainly concentrated on its area, size, quantity and its spatial connection. At first, road area can be compared (Figure 10a). When the road area is the same, different fabrics will have different road widths and network density (Figure 10b, c), and different number of roads and intersections (Figure 10d).

Similarly, the morphological characteristics of buildings and volumes are concentrated in size, shape, quantity, and height. In the same quantity of cases, it can be distinguished by the area, shape and degree of difference of them (Figure 11a, b); under the same coverage conditions, the number of buildings and volumes can be compared (Figure 11c); It can also be distinguished by height and its degree of difference (Figure 11d, e).The characteristics of the external space are mainly in space ratio and space continuity. Different fabric owns different open space area (Figure 12a). When the proportion of external space is the same, it can be distinguished by the number of consecutive spaces (Figure 12b).

In order to ensure that the research results can be compared with each other, the range of study of the four fabric sections is basically similar. For road form, road area ratio is a measure of the

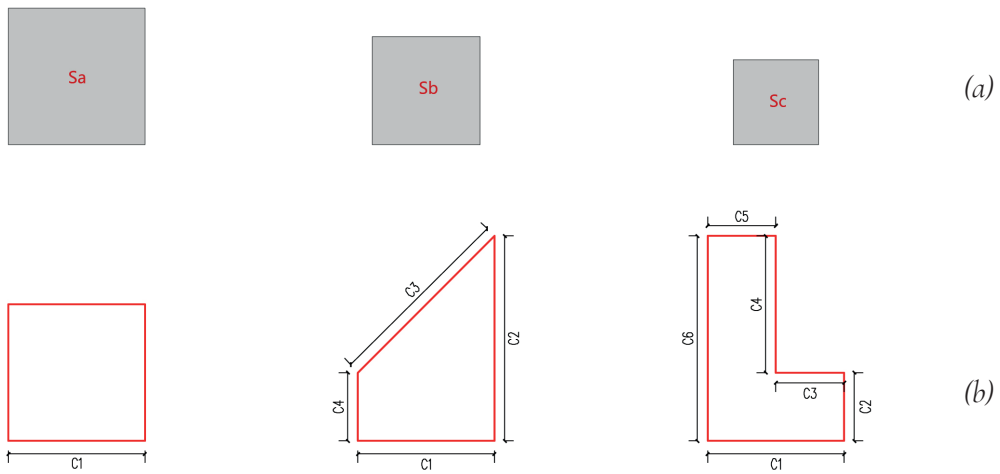

Figure 9. *The contents of quantification. (a) Area; (b) Shape.*
The Research Area is defined as Sra, and the Perimeter of the pattern is defined as L=C1+C2+...+Cn, and the Shape Index is define as α=S/L.

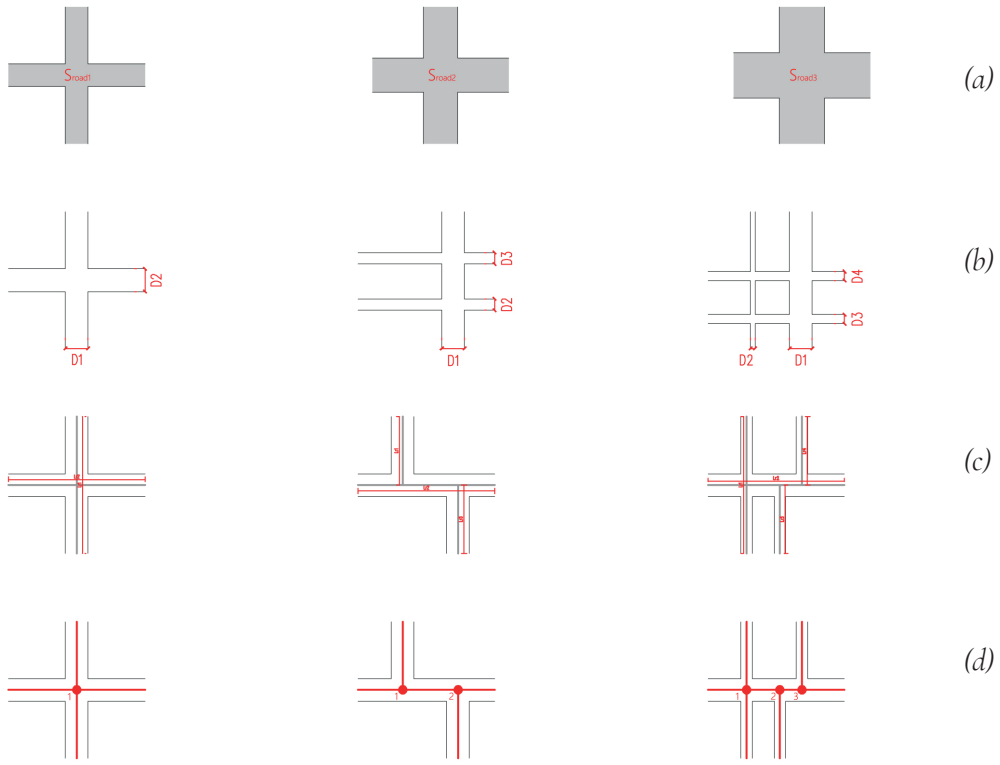

Figure 10. *Quantification method of road. (a) Road Area; (b) Road Width; (c) Road Network Density; (d) Quantity and Connection*

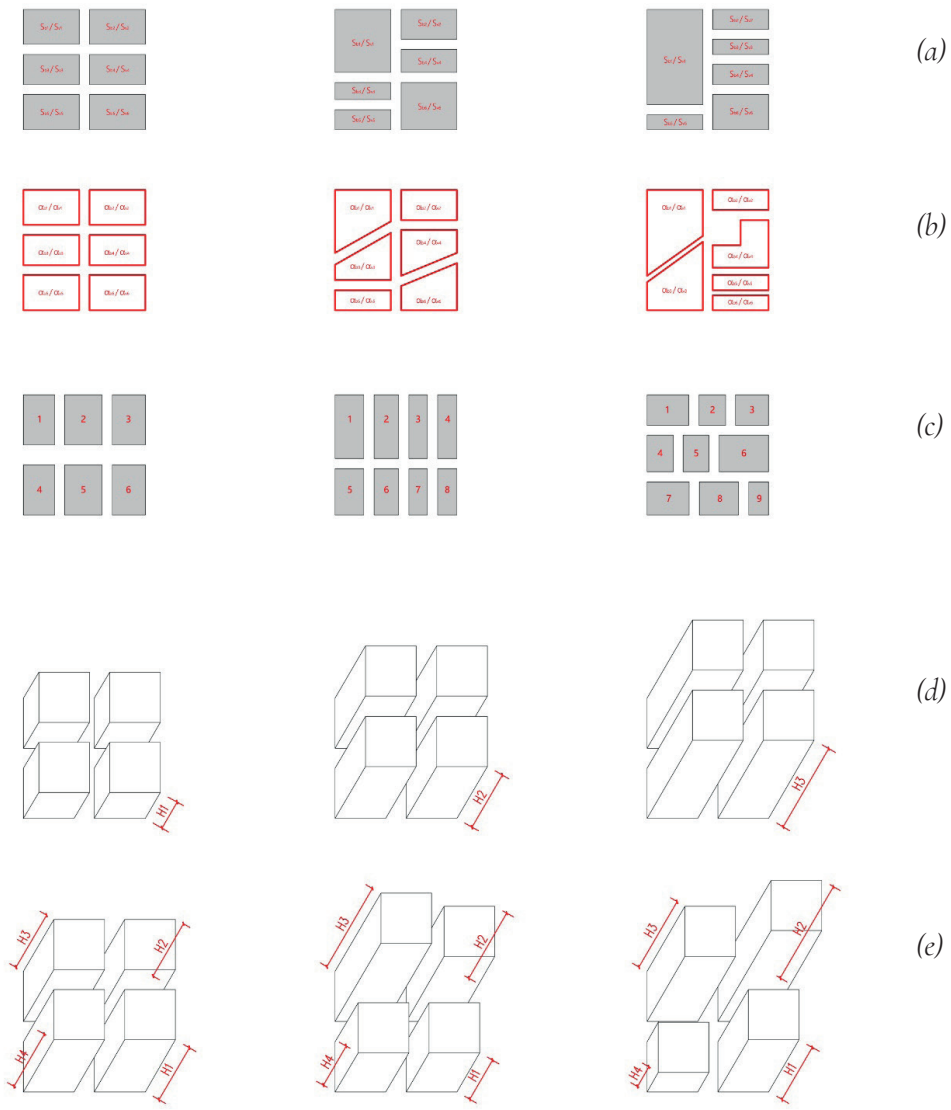

Figure 11. *Quantification method of building and volume. (a) Area and Area Difference; (b) Shape and Shape Difference; (c) Quantity of Building and Volume; (d) Height; (e) Height.*

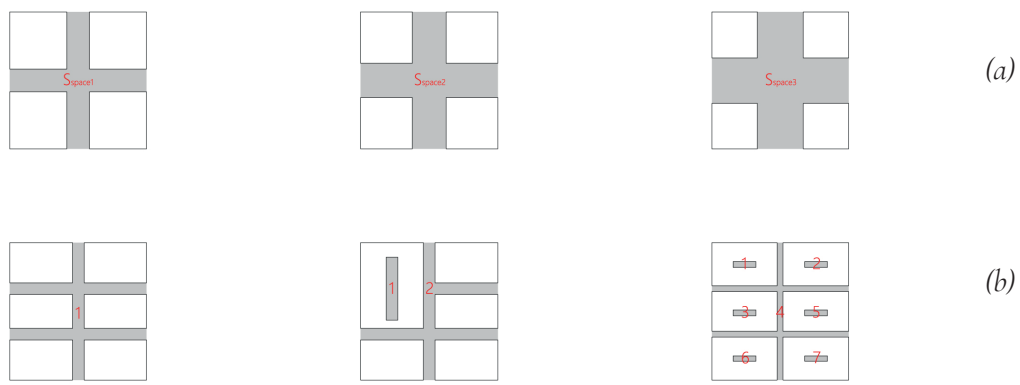

Figure 12. *Quantification method of external space. (a) Area of open space; (b) Quantity of continuous*

proportion of roads throughout the study, while the average widths describe the approximate size of the road. For road structure, the road network density can be obtained by using the total length to the total area, and the number of roads and intersections can be visually counted to measure the connection capacity of the traffic. For the building, the base area and its degree of difference and shape rate and shape difference directly indicate the geometrical features of the fabric, while the number of buildings and the average coverage have an indirect effect on the morphological characteristics. The volume area, height, shape rate and its degree of difference directly describe the morphological characteristics. At last, the open space ratio is used to describe the proportion of space, and the number of consecutive spaces is used to measure the continuity of the space.(Li Zhaocheng,2016)

These data directly or indirectly describe the morphological features of the urban fabric, but it is still difficult to compare and evaluate various features between different fabrics, and reveal the commonness and oppositeness. Therefore, this paper uses the mapping method to convert all the above data into the same interval of [0,1], so that each slice type can be compared in the same data table in relative size relationship, which can more intuitively reflect differences in various morphological features of the fabric and the extent of the differences.

Fomula:

y_{max}: The maximum value of the target interval;
y_{min}: The minimum value of the target interval;
x_{max}: The current maximum data;
x_{min}: The current minimum data;
x: Suppose it is any value of the current data;
y: The mapped value.

$$y = y_{min} + (x - x_{min}) * \frac{y_{max} - y_{min}}{x_{max} - x_{min}}$$

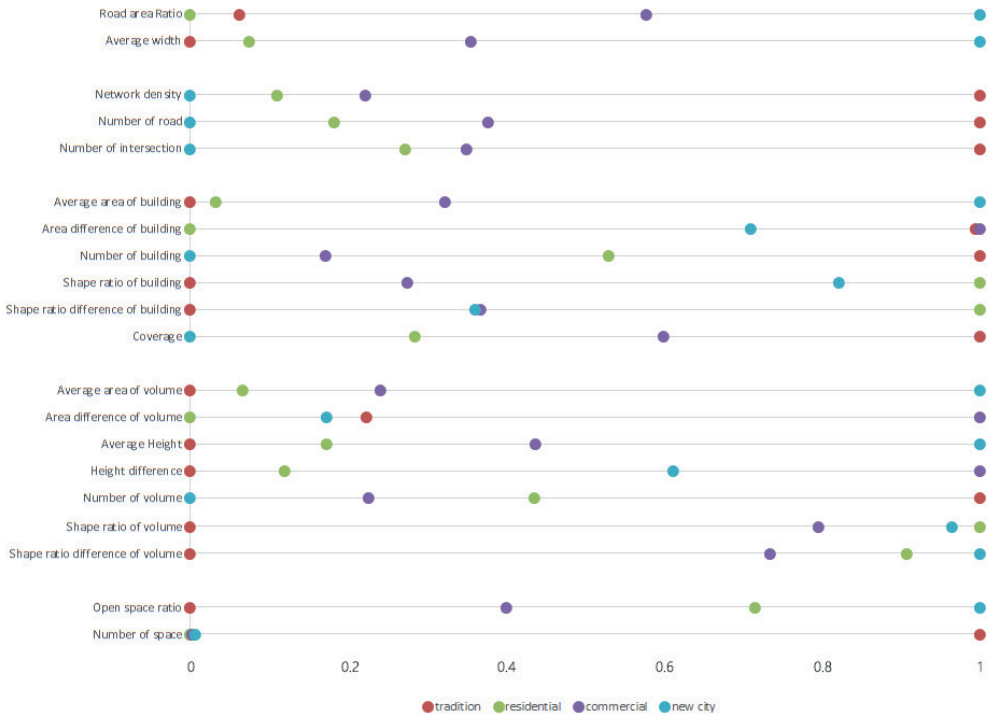

Figure 13. *The results of calculation for comparison*

Table 1. *The quantification result of the four morphological categories of urban fabric*

Layer	Object	Fomula	tradition	residential	commercial	new city
Road form	Road area Ratio	$\lambda = S_{road}/S_{ra}$	0.128	0.119	0.201	0.261
	Average width (m)	D_{ave}	6.569	8.455	15.521	31.711
Road structure	Network density	$\sigma = L_{total}/S_{ra}$	0.023	0.015	0.016	0.014
	Number of road(/ha)	$C_{road}=C/S_{ra}$	0.890688259	0.300601202	0.441767068	0.168855535
	Number of intersection(/ha)	$Cr=C/S_{ra}$	1.599190283	0.641282565	0.742971888	0.281425891
Building	Average area of building (m²)	$S_{ab}=\frac{1}{n}\sum_{n}^{1} Sb$	345.919	444.793	1291.507	3270.305
	Area difference of building	$\omega_{b}=\sqrt{\frac{1}{n}\sum_{1}^{n}(Si-Sg)}/S_{ab}$	1.980339328	1.336781379	1.984003184	1.796135223
	Number of building(/ha)	$C_{b}=C/S_{ra}$	12.79352227	7.174348697	2.891566265	0.825515947
	Shape ratio of building	$\alpha_{ab}=\frac{1}{n}\sum_{n}^{1}(\frac{S}{L})$	1.198	1.372	1.246	1.341
	Shape ratio difference of building	$\omega_{b}=\sqrt{\frac{1}{n}\sum_{1}^{n}(ai-ab)^2}$	0.221	0.354	0.27	0.269
	Coverage	$C_{cover}=\frac{1}{Sra}\sum_{n}^{1} Sg$	0.442	0.319	0.373	0.27
Volume	Average area of volume (m³)	$S_{av}=\frac{1}{n}\sum_{n}^{1} Sv$	80.53	135.404	278.401	898.508
	Area difference of volume	$\omega_{Sv}=\sqrt{\frac{1}{n}\sum_{1}^{n}(Si-Sv)^2}/S_{av}$	1.769812492	1.526587102	2.612663029	1.714119407
	Average Height (m)	$H_{ave}=\frac{1}{n}\sum_{n}^{1} H$	6.921	13.263	22.893	43.407
	Height difference (m)	$\omega_{h}=\sqrt{\frac{1}{n}\sum_{1}^{n}(Hi-Have)^2}$	7.0032	10.32	34.728	23.97
	Number of volume(/ha)	$C_{v}=C/S_{ra}$	51.31578947	23.76753507	13.53413655	2.43902439
	Shape ratio of volume	$\alpha_{av}=\frac{1}{n}\sum_{n}^{1}(\frac{S}{L})$	1.1	1.237	1.209	1.232
	Shape ratio difference of volume	$\omega_{v}=\sqrt{\frac{1}{n}\sum_{1}^{n}(ai-av)^2}$	0.181	0.307	0.283	0.32
External space	Open space ratio	$OP=S_{space}/S_{ra}$	0.558	0.681	0.627	0.73
	Number of space(/ha)	$C_{sp}=C/S_{ra}$	7.591093117	0.02004008	0.040160643	0.075046904

Combined with quantitative mappings and results, it can be found that in the road form, the fabric of the new town is very prominent in both road area ratio and road width. It is interesting to note that the commercial fabric is not much different from the traditional fabric and residential fabric in the width of road. It can be seen that although the commercial fabric has stronger development demands, its historical limits and gradual development methods restrict the development of transportation. Traditional fabric and residential fabric tend to be similar in the form of road.

In the road structure, the road network density, the number of roads and intersections of traditional fabric are significantly higher than others, the second is commercial fabric, which has greater demand for the concentration and evacuation of human flow. The new town began with strong centralized development with large divisions of plot, so the morphological data at this layer is the smallest and the road structure was weak.

Quantitative results at the road layers are intuitively bipolar, the architectural layer is more complex and confusing. At this layer, the average area of the traditional fabric is the smallest, but the difference of the base area is the largest, while the residential fabric is the same as the traditional fabric in the average area, but the difference of the area is the smallest. It is worth investigating that the average shape rate and shape difference of the residential fabric are larger than others. The reason may be that a large number of buildings are assembled in the form of bottom commercial and upper houses, which makes the building more Complex in a certain area. Although the commercial fabric differs from the new town in the average shape rate, the shape difference shows similarity. The number of buildings in residential fabric is more than that of commercial fabric, but its coverage is similar.

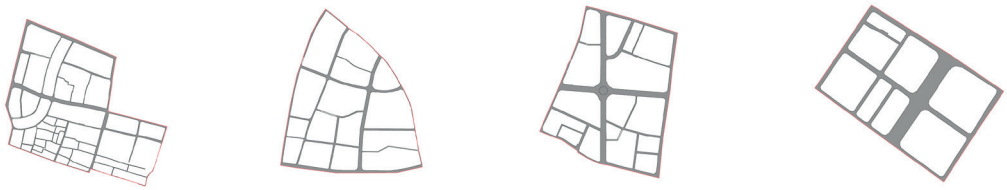

Figure 14. *The mapping of the quantification for road form.*

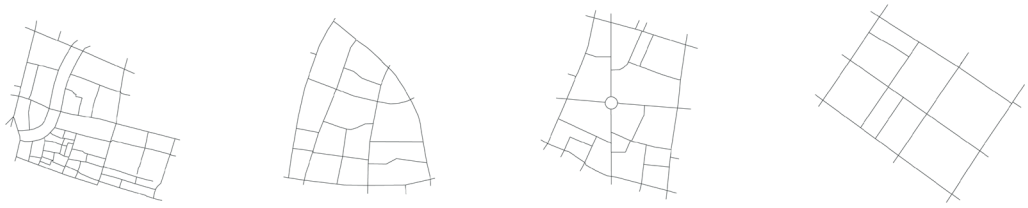

Figure 15. *The mapping of the quantification for road structure*

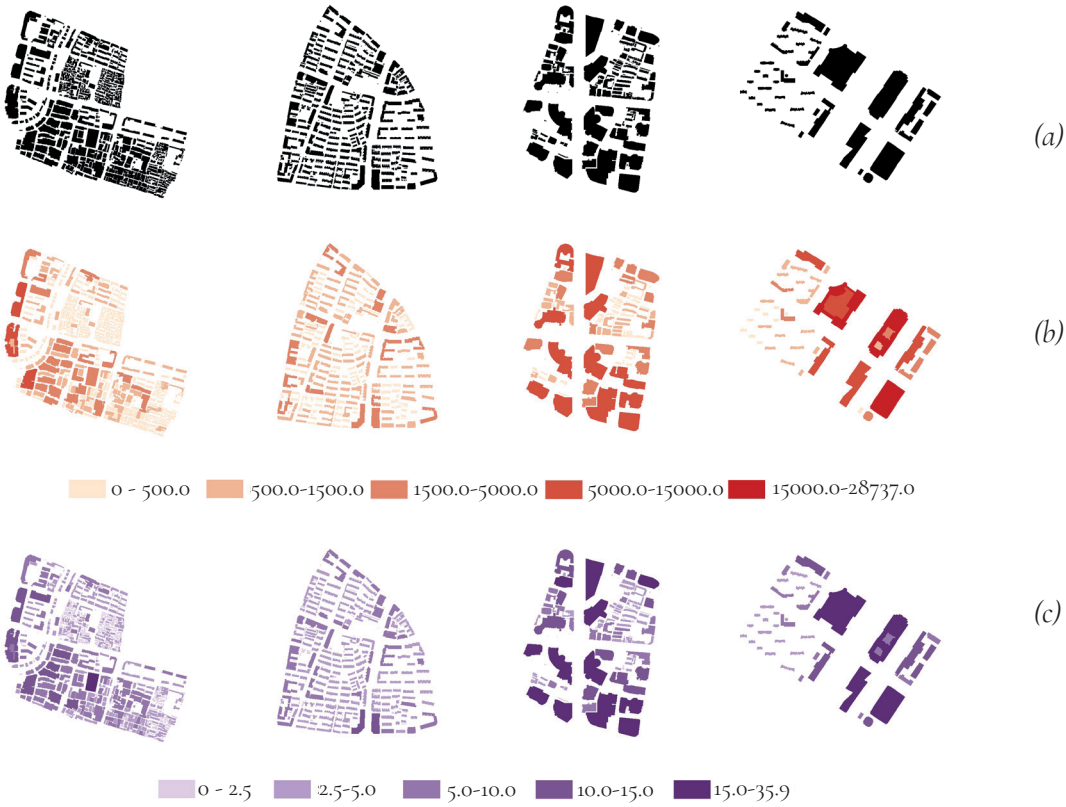

Figure 16. *The mapping of the quantification for building. (a) Coverage; (b) Area; (c) Shape ratio*

At the layer of volume, the average area of the new town is significantly larger than the other three textures, followed by the business, the traditional minimum, but the smallest in the size difference is residential fabric, the largest is commercial fabric which is totally different from new town. The average height of the new town is the largest, and its height difference is smaller than the commercial texture. The average shape ratio of the volume in the traditional fabric is

the smallest, and residential part and new town are similar, at the same time, the difference of shape is also consistent with this.

The openness in new town is the largest, while the residential fabric is greater than that of the commercial part. However, the traditional fabric is significantly more than other fabrics in the number of continuous spaces, while the other three textures tend to be consistent, which is a unique morphological feature of traditional fabric.

On the whole, the traditional fabric has the smallest road size and proportion, but enjoys a richer road structure. Its shape of construction unit and volume are simple, with the smallest size and the largest number, generally not high and the height difference is small. It has high

Figure 17. *The mapping of the quantification for volume. (a) Area; (b) Shape ratio; (c) Height*

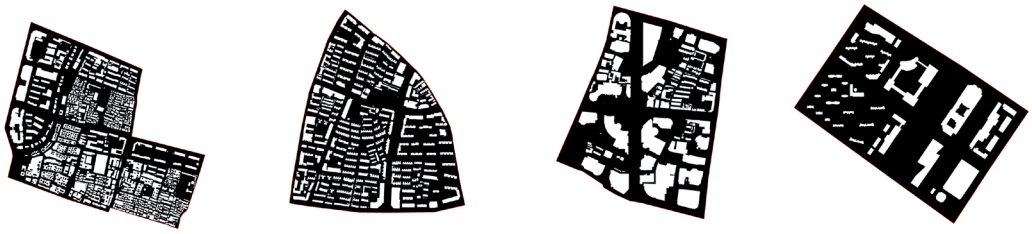

Figure 18. *The mapping of the quantification for external space*

coverage, while occupying the smallest space. The residential fabric is similar to the traditional part in road form with relatively simple structure, the difference between the building and the volume is the smallest, but the shape is the most complicated and the difference is obvious; The commercial fabric is at the intermediate level at the road layer, which is higher than the traditional and residential fabrics, and its traffic capacity is good. The size of the building and volume and its height are large, the density of this section is the largest, and the form is diverse and rich. The new town fabric has the largest road size and proportion, but the structure is the simplest, the size of building and its volume are generally larger, the average height is the highest, and the quantity is the least with a huge open space ratio. Compare to the commercial fabric which is similar to it in function, the shape of the building and the volume is similar, but it is significantly lower than the commercial part in terms of height and density. That means the development model of the new town still has a lot of possibilities for improvement.

These morphological features are rich and varied, but their roots can all return to morphogenesis. In the analysis of road form, traditional fabric experienced a long morphological process with historical imprints, showing multiple roads and dense intersections, while the new district began with strong development demands with large plots, the roads are big in width but small in number. For the architectural layer, the traditional fabric is limited by technology with a large coverage, the unit is small, the size and shape of the building are similar, and the street is narrow. On the contrary, the new town is affected by the development intensity, the volume is huge. And what is more interesting is the modern residential fabric, the interface of building is uneven due to the underlying business and residential lighting, and the shape rate and the difference are larger than the other three categories. The limitations of traditional fabric are obvious in the volume layer, which directly results in the characteristics that the height is low and similar, and the number of buildings and volumes is large, at the same time, this mode also makes the FAR lower. Due to the similarity of the residential fabric, the difference in size is small. Commercial fabric shows a large volume, high height, large gap and large open space based on the needs of economic development. The fabric of the new town is under the strong planning of the government, and the high-intensity development makes the overall height of the building higher, the volume is small, the building area is huge and the difference is small. Contrary to the average coverage in the external space layer, the new fabric shows a greater degree of spatial openness, but the spatial model has far less special experience. The traditional part is with more continuous spaces due to the application and innovation of the type of courtyard.

5. Conclusion

Based on the four typical fabric sections in Nanjing: traditional, modern residential, commercial, and new town, this paper explores the method of morphological quantification. Firstly, the four sections are abstractly extracted and described by the graphical method according to the morphological process. It quantitatively divides the urban fabric into three levels: street (form and structure), architecture (building and volume) and space. First, at the street level, the area, width, length, quantity and number of intersections of the street were calculated to quantify the form and structure of the street. Secondly, at the building level, the size, shape and the difference in them, quantity, height and height difference of the three-dimensional modal were comprehensively quantified. Finally, at the space level, the proportion of the external space and the spatial richness are expressed by the spatial openness and the continuous number of spaces.

In this process, it is found that the network density, number of road and intersection, the number of buildings, the shape ratio and difference, the coverage, the difference of volume in area, average height, height difference, quantity, and space openness ratio, 12 indicators in all. In these indicators, the two intermediate values are significantly different from the maximum and minimum values (greater than 0.1 in figure 12), which can effectively measure and distinguish the fabrics represented by the maximum and minimum values.

Other quantitative indicators are similar to extreme values. At the layer of road form, traditional fabric and modern residential fabric have both developed from history, and the construction needs are similar, showing that their road area ratio and average width are similar. At the architecture layer, traditional fabric and modern residential part are constructed based on dwelling units with similar average base areas; traditional fabric and commercial fabric, leave some small buildings while developing large buildings due to urban development needs, thus the size difference of buildings is large and similar. At the volume layer, the volume area is consistent with the architecture layer, the traditional fabric is similar to the modern residential part. The modern residential area has narrow and long podium buildings and unitized houses. The new town is divided into long plots, and the building layout is consistent with it, and there are large commerce and office and high-rise residential clusters with a mixed functions at the same time. Therefore, the shape and the difference of shape in volume is large and similar in the indicators of modern residential fabric and new town. The number of external spaces is more rich in the traditional fabric because of the type of courtyard, while the other three textures show that the external space is continuous and the number of spaces is similar.

At present, the quantitative research in this paper uses a statistical methods to average the characteristics of all urban fabrics. This is still a description based on the status quo, which can control urban design to certain extent. But from the perspective of architecture, it is still far from being able to perform specific morphogenesis. In addition, this approach ignores the very important positional relationships in urban design. Based on this, research and exploration in two directions may be carried out in the future. The first is to select the modern residential fabric with homogeneity characteristics (small area differences) appearing in the current morphological data, supplement the positional relationship to carry out quantitative research on the generation of urban form. It is hoped that this research will be related to urban microclimate and strengthen the control of urban design. The second is about commercial fabric and new town, as we all know the new town is a product of unified planning, but it is not complex in building size and height with a lower density compare to the commercial fabric with similar functions. This research is to compare the two sections in a comprehensive manner to find the commonality and the heterosexuality of the two, to provide ideas for the future development model of the new town.

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