Proceedings of the Ninth International Space Syntax Symposium
Edited by Y O Kim, H T Park and K W Seo, Seoul: Sejong University, 2013

A MORPHOLOGICAL STUDY ON THE RELATIONSHIP BETWEEN STREET PATTERN AND VITALITY OF URBAN BLOCKS:

Examples in central area of Beijing and Tianjin

Qiang Sheng
Tianjin University
e-mail : shengqiang1234@hotmail.com

Abstract

Using Space Syntax as a main tool, this paper studies the changing topological pattern of street network in Beijing and Tianjin in last century. The result shows that the introverted complex street structure (as a traditional Chinese pattern) and the extroverted regular grid (as a typical Western pattern) have different resilience under the impact of urban development. Furthermore, base on the detailed mapping of local shops inside 179 urban blocks and 114 blocks in Beijing and Tianjin respectively, the result of this paper shows a clear relationship between topological pattern of block and the vitality of everyday life. It also gives us an example on how Chinese culture can influence the appropriation of different types of street

Keywords: *space syntax, fractal structure, topological street pattern, local vitality*

Theme: *Urban Space and Social, Economic and Cultural Phenomena*

1. INTRODUCTION

1.1, the impact of rapid urban development on local vitality

The rapid urbanization in last decade has greatly improved people's living condition in most Chinese cities. While with the large-scale urban redevelopment projects and sprawl of suburbs, it also causes many social-economical problems, especially at local scale: on the one hand, the versatile local shops disappear with the relocation of original inhabitants. When the cultural identity is recognized as a commodity, many local places either become 'Disney land' or redevelop into non-places; on the other hand, the new gate-communities destroy the spatial continuity and transform the urban structure into many separated archipelagos. These communities are mostly containing highly homogenous social groups in an environment which lack of local services or intimate social activities.

Many scholars have criticized the role played by large urban redevelopment projects on killing local identity with their massive scales (Fang and Zhang, 1998). However, when considering local vitalities as gathering of shops and related social activities, the specific architecture style or the proportion of street or volume have little influence. It is rather the spatial pattern of street network that matters. How urban development process could change the street pattern and then affect the vitality of local places is the central concern of this paper.

1.2, the multiplicity of urban fabric and its influence on everyday life

This 'process' has a historical dimension as well as a spatial dimension. The development of Chinese cities is influenced by many different external forces and foreign cultures in last two hundred years. Taking Tianjin as an example of those port cities, it has many foreign concessions with distinctive urban fabrics comparing with the traditional Chinese street pattern. Even in the cities like Beijing which does not have colonial history, the urban development still reveals strong influence from the former Soviet Union. Furthermore, the modernization of transportation technologies has also spatial impacts on the evolution of Chinese urban fabrics. Most cities have a clear formed supper-grid network which is used mainly by motorized traffic.

What does this mixture of Eastern and Western, traditional and modern street fabrics mean to the emergence of local vitality? How could today's local Chinese people appropriate traditional Chinese urban space or imported Western concession space? Is there a continuous Chinese way of using local spaces? How spatial pattern could actively affect this tradition? These questions are the initial motivations of this research.

1.3, theoretical backgrounds

The relationship between urban space and function is one of key topics for space syntax researchers. Space syntax was developed by Professor Bill Hillier and Julianne Hanson in 1980s (Hillier and Hanson, 1984). As an urban theory based on the configuration of space and its influence on movement and function, it treats the street system of a city as interconnected straight lines. By calculating how each line is topologically connected with the other lines within certain range, it illustrates the degree of connectivity purely based on the geometry of these lines. This method draws a strong connection between the form of streets and the way people use them.

One branch of space syntax theory that provides theoretical guideline for this research is the layered movement network model developed by Stephen Read (Read, 2005). Instead of taking each space equally as a line, this method understands the urban system as constructed by different layers of movement networks, from regional, city to local scales. Each layer of movement network is actualized by specific types of movement technologies such as highway, metro or local streets. Under this framework, urban centralities could be conceptualized as

emerging on the interface between these different layers. Based on his research on Dutch cities, Read illustrates urban places in the inner city and suburbs as produced by different types of interfaces between local network and the scale above (See fig.1). Therefore he understands the problem of suburb could be understood as missing thick layers of middle scale networks.

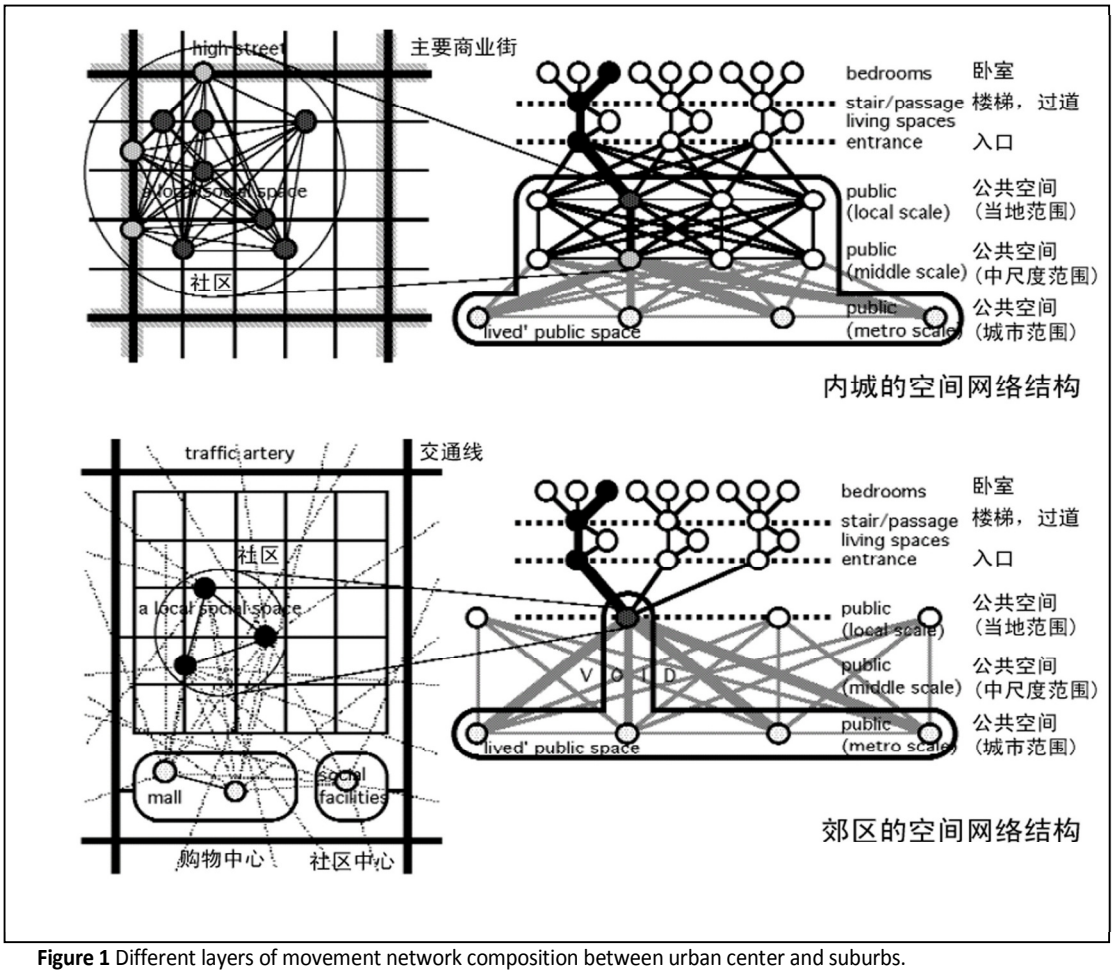

Figure 1 Different layers of movement network composition between urban center and suburbs.

Read and many follow-up researchers' works demonstrate the power of densely-built urban grid pattern as a good supporting structure to central functions (Mulders-Kusumo, 2005). This line of thinking could also be traced back to Jacobs (Jacobs, 1961). The further development of Space syntax provides methods to highlight different scales of movement networks and area effect of local street pattern (Hillier, Turner, Yang, Park, 2007).

Another line of thinking which stimulates this research is the fractal geometry between different layers of networks. According to Salingaros, the street patterns of historical cities reveal a fractal structure better than those of modern cities. He further suggests that the vitalized atmosphere and activities of historical cities are produced by this fractal structure (Salingaros, 2003). This theory is of great relevance to the context of Chinese cities because many scholars have pointed out that the traditional Chinese neighborhoods are structured by a highly structured hierarchical order: form big avenue (da jie), to street (xiao jie), local street (xiang) and small alley (hutong) (Gao, 2003, Sheng, 2005). By analyzing the 'context depth', space syntax researcher Yang Tao's work demonstrates that the inner city of Beijing can reveal a clear fractal structure (Yang, 2008). Now the interesting questions are: if the densely-built grid pattern is an ideal supporting structure for central functions in Western city, how traditional Chinese hierarchical space can contribute to the vitality? Are there other forms of good interface except for regular grid pattern? Furthermore, former concession spaces are now taken back by local Chinese

people. Will they appropriate these Western spaces differently? This research attempts to provide an empirical study on these questions.

1.4, research contents:

Using Space Syntax and layered movement network model as main analytical tools, this paper presents a spatial research on following issues:

1, By studying the changing fractal structure in Beijing and Tianjin as spatial continuity between different scales, this research will illustrate the resilience of different types of urban blocks under the modernization process.

2, Based on detail mapping of the local shops, this research will focus on studying the spatial logic of local vitality and quantifying the external and internal spatial conditions for the emergence of these functions.

3, By comparing the case of Beijing and Tianjin, this research will illustrate the differences between Eastern and Western urban blocks and the way contemporary local Chinese inhabitants using these spaces.

2. SPATIAL RESILIENCE OF REGULAR GRID AND HIERARCHICAL STRUCTURE DURING DEVELOPMENT

2.1, defining the fractal structure as relationship between different scales of movement networks

Inspired by Salingaros's idea and Yang Tao's method, this research understands the fractal structure as embedded in the relationships between different scales of movement networks. This relationship could be analyzed by the scatter plot analysis between different topological choice values of certain metrical ranges.

Furthermore, by showing the morphology of certain scale movement networks (based on certain topological choice), this research can also illustrate the impact of this development spatially. Due to the availability of detailed historical maps of Tianjin and Beijing, the analysis will focus on three different years: 1939, 1983 and 2005 in Tianjin's case; 1947, 1983 and 2006 in Beijing's case.

2.2, changing movement networks of Tianjin and Beijing

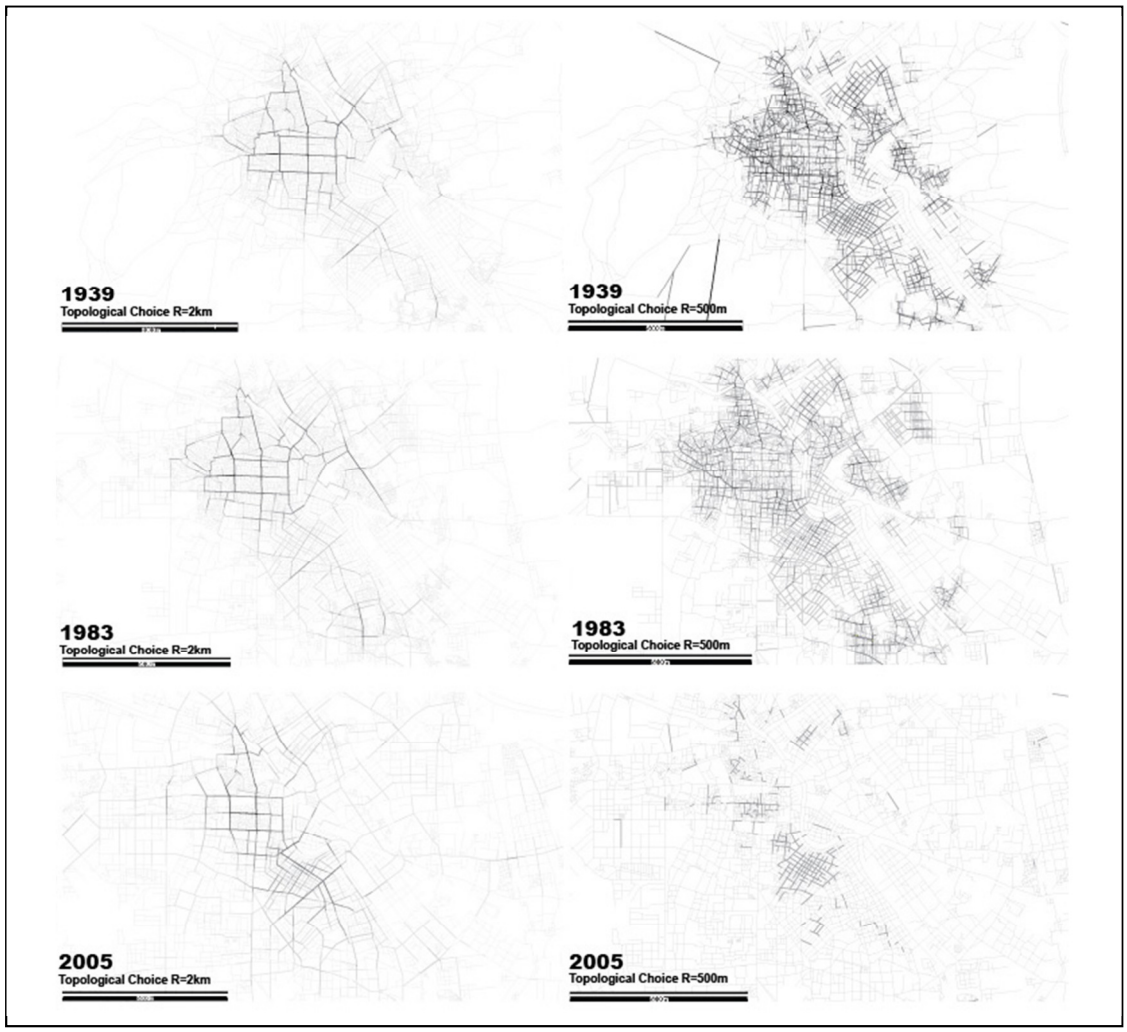

Figure 2 Morphology of Tianjin's city-scale (left, topological choice R=2km) and local-scale (right, topological choice R=500m) networks.

Tianjin's colonial history started from the beginning of the 20th century. In 1930s the construction of foreign concessions reached its peak times. After the founding of socialist China, the foreign people started to leave concessions and local Chinese took over the land. However, Tianjin did not develop very fast until 1990s with the opening of housing market. Figure 2 shows the changing topological choice values within 2km and 500m ranges. They could be understood as representing city and local-scale movement networks respectively. The city movement networks between 1939 and 2005 appear very consistent. While the local-scale networks keep fading and falling apart. In 1939, the streets used by 500m range movement still formed a continuous network. But in 2005, they clearly broke into several pieces.

Another interesting point is the different resilience revealed by different types of local street fabrics. As we can see in the map of 1939, the local choice of old Chinese part in northwest is even higher than those regular patterned concession grids. But in 2005, after the massive scale urban redevelopment, the Binjiangdao area (former Japanese and French concession) in the middle still retained its value and became the most powerful spatial structure supporting local-scale movement. This is of course partly due to the conservation policy, but it also due to the fact that: During this transformation it is easier for the regular grid pattern to retain its spatial continuity than traditional Chinese hierarchical street pattern. Most redevelopment projects limit their intervention within urban block. The seemingly irregular pattern is likely to

be totally wiped out and replaced by new gated communities which are extremely introverted and have few exits towards outside. This process will mostly break the connection between blocks. The concession areas, on the contrary, are of clear regular grid geometry which is easily recognized and retained by planners and designers. Its numerous exits also make it more possible to maintain the inter-block connections.

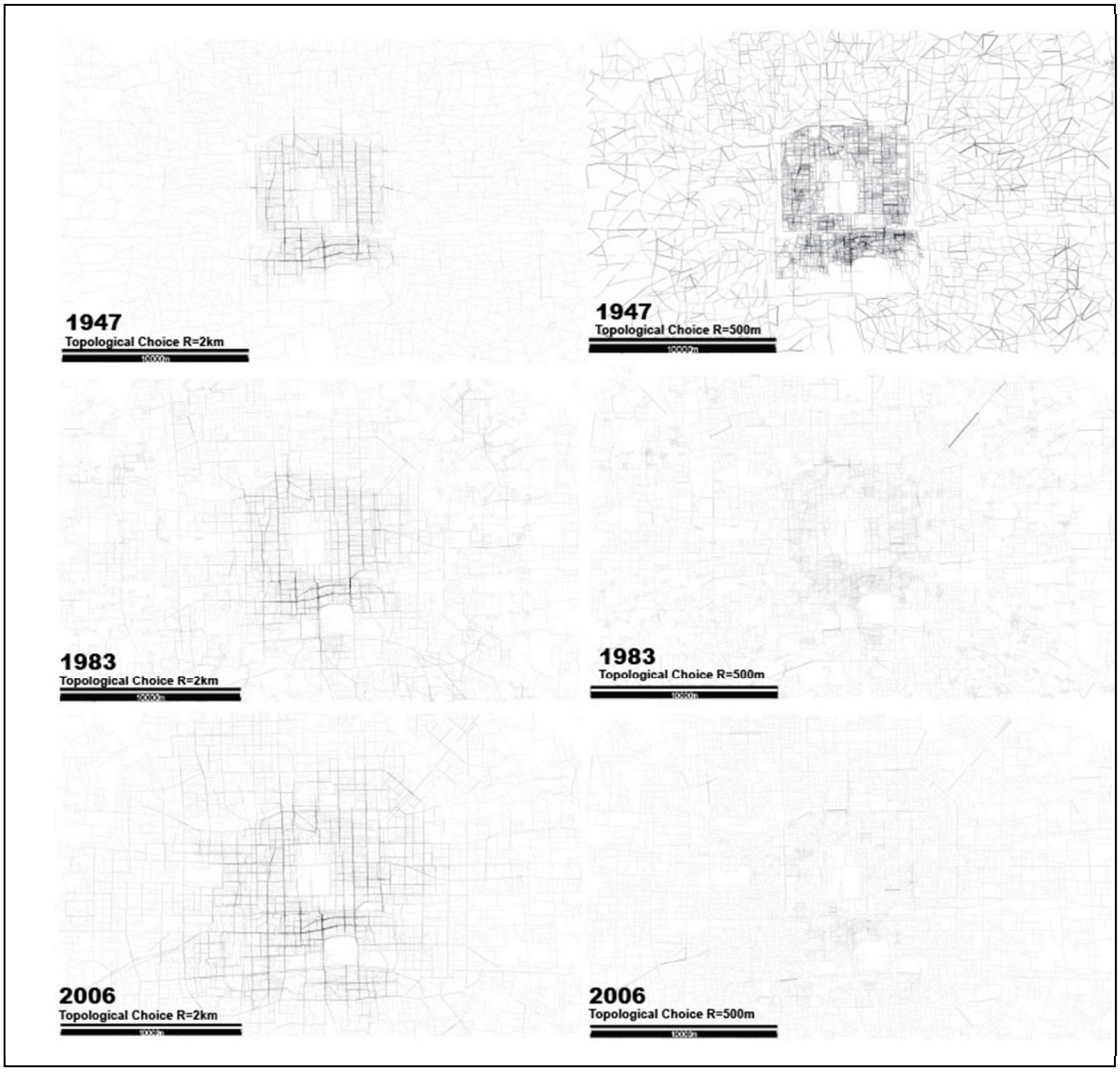

Figure 3 Morphology of Beijing's city-scale and local-scale networks

The same logic can also be found in the urban development of Beijing in similar periods (see fig.3). However, this logic is actualized differently because Beijing's street fabric is structured mainly by traditional spatial hierarchical pattern. At city scale it appears as regular orthogonal grids, while at local scale the fabric tends to be more irregular and complex. Tianjin is an opposite case: the concession areas have highly regular grid pattern locally, but since the city grows along the Haihe river, the city-scale movement network is of more organic form. As a result, in figure 3 we can see the expansion of Beijing's city-scale network follows the urban sprawl closely, changing the organic irregular country roads into a regular orthogonal grid structure. At local scale, the fragmentation of local-scale network is even more severe than in Tianjin.

Using scatter plot, this study could be detailed by analyzing the relationship (calculate R-square value) between different ranges of topological choice values. Table 1 presents the R-square values of 500m-1km, 1km-2km, 2km-4km, 4km-8km ranges. For a road system with clear fractal logics, the similarities between these two adjacent scales of networks will be stable. For

example, the road system of Tianjin in 1939 is one of such case except for the 4km-8km range. On that period the size of the city was too small (Beijing also). Therefore, 4km range analysis is already covered major part of the city, 8km range analysis makes little differences. However, as a well-planed city, Beijing in 1939 is of another story. There is clearly a drop of R-square value between 2km-4km range analyses. It indicates there is a sudden change of geometry in the movement network supporting 4km's range movement, which belongs to the regional scale on that period. These spaces function as main route system inside the city which connects Beijing to other villages outside.

Table 1 Relationship between different scales of movement networks.

R^2	Tianjin			Beijing		
Range	1939	1983	2005	1947	1983	2006
4km-8km	0.868	0.802	0.775	0.851	0.826	0.851
2km-4km	0.737	0.716	0.625	0.67	0.71	0.728
1km-2km	0.775	0.796	0.745	0.797	0.797	0.801
5km-1km	0.777	0.821	0.614	0.733	0.692	0.622

Similar with the findings before, from table 1 we can see the breaking of local-scale movement network. For both cases it drops clearly in 2005 and 2006. What does this mean to the urban vitalities? In general it means a tendency of shifting scales above. Especially for the city-scale shopping centers, nowadays they are more dependent on the connectivity at city-scale network which car traffic dominates. However, from this study we can see the local-scale network also played a role. In 1939, the old Chinese city of Tianjin still functioned as vital shopping center, but nowadays it has already shifted to Binjiangdao area. On the other hand, the formerly dominant position of Qianmen area in Beijing has gone and now the city-scale shopping centers are scattered in many places. Considering in both cases the city-scale networks either retain or develop into a continuous network, it is rather the pattern of local network plays more influential role on supporting the city-scale urban vitality. This finding supports Read's understanding of centralities as produced by different layers of networks, not just one layer. From this perspective, we could speculate the imported regular grid pattern reveals higher resilience and adaptability than traditional Chinese pattern. As an opening structure, it is a better platform for the central functions to emerge. However, the city-scale places are very important for economic and social life of inhabitants, but not everything. What does this mean to local everyday life? How can different street patterns affect the emergence of local vitalities? These are the central concerns of this paper.

3. THE SPATIAL CONDITIONS FOR THE EMERGENCE OF LOCAL CENTRALITY

3.1, identification of local centrality and division of urban blocks

Figure 4 Distribution of local centers in Tianjin and Beijing

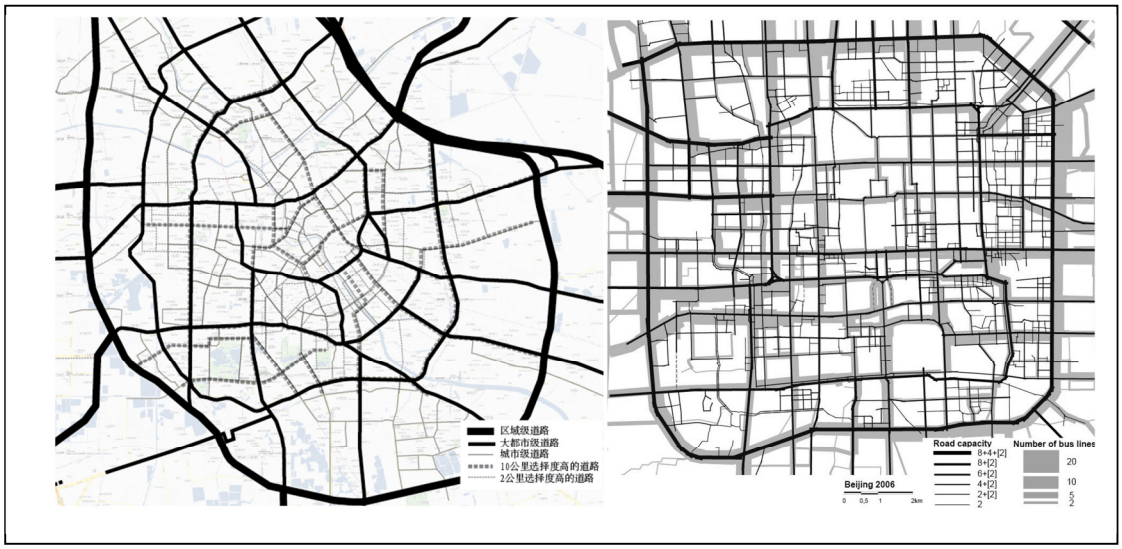

Figure 5 Division of urban blocks in Tianjin and Beijing

Generally speaking, the urban vitality is a subjective experience. There are many ways of defining and measuring vitalities through the type of urban functions, activity densities and even diversity of colors and sounds in the built environment (Guo and Wang, 2011). Since this research focuses on how street pattern affects the vitality at local scale, the identification of vitality is based on the presence of local shops such as markets, groceries, 'qipaishi' (local clubs), street venders, etc. The fieldwork of this research includes a detail mapping of all shops and street vendors on each street within the central area of Beijing and Tianjin. On each street segment if there is more than 5 such stores or 10 street vendors this local place will be identified as a vital local center (see fig.4).

Based on the road hierarchy (defined by the number of car lanes each road has) and public transportation networks (bus lines and metros), the central area of Beijing (inside 3rd ring) and Tianjin (inside the express way) can be divided into 222 and 135 urban blocks respectively (see fig.5). Considering the fact that some blocks are mostly not used for residential functions, only 179 and 114 blocks are selected for our analysis. For each of these blocks the external and internal spatial condition will be analysed.

Figure 6 the connectivity of blocks based on the number of exits and network hierarchy in Tianjin (left) and Beijing (right)

3.2, analysis on the external spatial condition

The external condition is referring to how this block is connected in the city as a whole. This connectivity value is measured by the number of exits each block has and the level of movement network each exit is facing. As an experiment, the exit value assigned for metropolitan scale network (more than 8 lanes) is 4, city network (more than 2 lanes) is 2, and local road is 1. This value could reflect the potential influence for outside.
In general, there are 59 out of 114 urban blocks in Tianjin which possess at least one local center inside, and 93 out of 179 urban blocks in Beijing's case. The similar proportion (51.75% for Tianjin, 51.96% for Beijing) suggests these two cases are comparable with each other.

Figure 6 illustrates the analysis on the exit value of Tianjin and Beijing weighted by road hierarchies. The results are shown as changing gray-scale colors (the darker the better connected). The numbers listed on the left of the legend (lower part of the map) show the total number of blocks in each category and the numbers of blocks which have local centers. The length of orange bar inside the gray bar indicates the percentage of the blocks which has at least one local center in relation with all blocks in that category. Therefore, from this diagram we can clearly see the correlation between how block in connected within the city and its capacity on supporting a vital local center. From the results, the tendency in Beijing is rather clear: although we are only looking at the function which provides local scale services, still the blocks with more exits on higher level roads have higher possibility to possess local centers. However, this tendency is not clearly visible from Tianjin's case. One possible explanation is the development of Tianjin's tourism economy is not comparable with that in Beijing. Therefore Tianjin's local centers might less affected by how it is exposed to outside flow than those in Beijing.

3.3, analysis on the internal spatial conditions

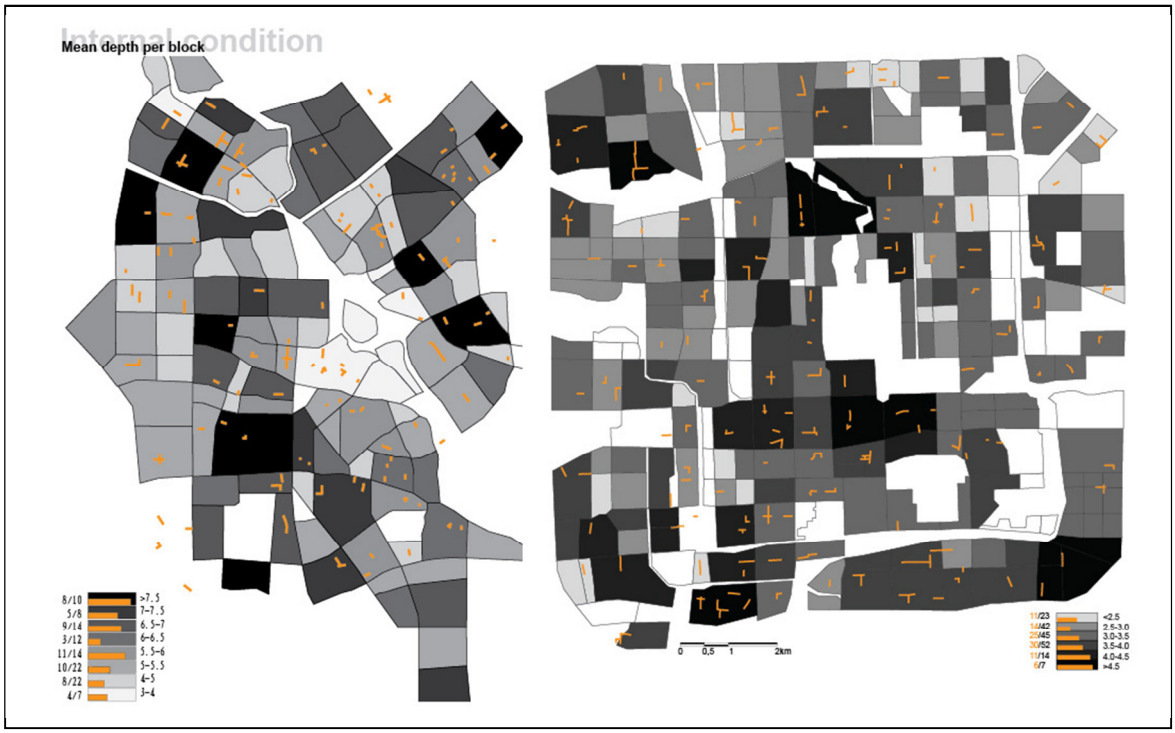

Figure 7 the mean depth analysis of blocks in Tianjin (left) and Beijing (right).

The internal condition is referring to the street pattern inside the block. This configurative value is measured by space syntax parameters such as mean depth and mean integration value. These values could reflect the complexity of street pattern inside the block and the 'inwardness' of the street pattern. For this part of the analysis the street fabric of each block has been cut out from the whole axial map, and then they are analyzed separately.

Figure 7 shows the mean depth analysis of Tianjin and Beijing. The blocks with higher topological mean depth value (presented in darker gray) are those with more complex internal street pattern. From the result, clearly topologically deeper blocks in Beijing have higher possibility to possess local centers except for the most shadow blocks. This may because those blocks are mostly occupied by institutions (Danwei) or gated communities which have less number of open streets. Therefore local activities have to concentrate on these streets. The logic in Tianjin shows different result again: the blocks with mean depth value higher than 6 reveal similar tendency with Beijing, while the blocks with lower mean depth value shows a reversed tendency: There is a clear increase of local centers in the urban blocks with mean depth value between 5 and 6. Considering the fact that most topologically shallow blocks (mean depth between 3 and 4) are mainly former concessions, recently many of these areas are under the process of gentrification. Otherwise, there should be more local activities appropriate these blocks.

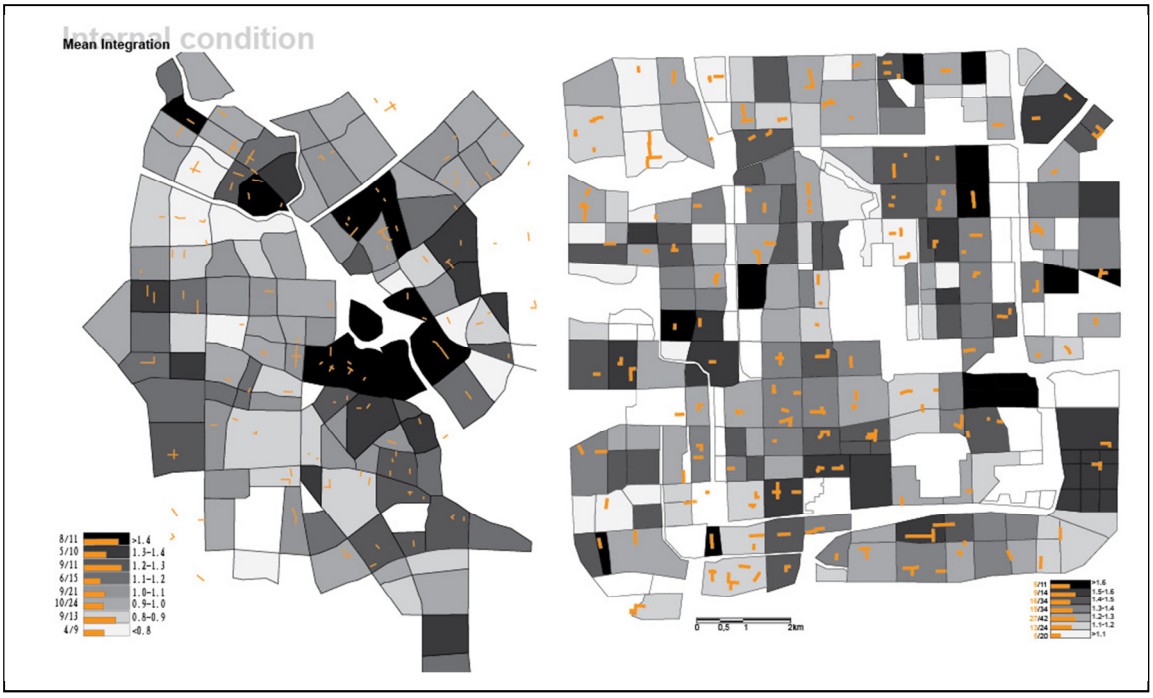

Figure 8, the mean integration analysis of blocks in Tianjin (left) and Beijing (right).

This tendency can also be found in the analysis of mean integration value of each block in Tianjin (see fig. 8). The urban blocks with mean integration value higher than 1.2 are mostly of regular grid street pattern. They reveal higher possibility to possess local centers. While those urban blocks with more complex street pattern (mean integration value lower than 0.9) also have increasing number of local centers.

4. THE FORM OF INTERFACE IN BEIJING AND TIANJIN

Previous study shows the emergence of local centers depends on the interface between external and internal spatial conditions. In the case of Beijing, the block better connected in the city as a whole and with more complex internal street pattern tends to reveal higher local vitality. In the case of Tianjin, the situation seems to be more complicated: Both the analysis on external and internal spatial condition indicate a hybrid of different logics. However, all of these studies are dealing with street patterns on statistical level. Searching for the form of spatial interface requires a close look inside each block. We need to illustrate how those local centers are exposed to the city-scale space outside and their spatial relationship with the street fabric inside.

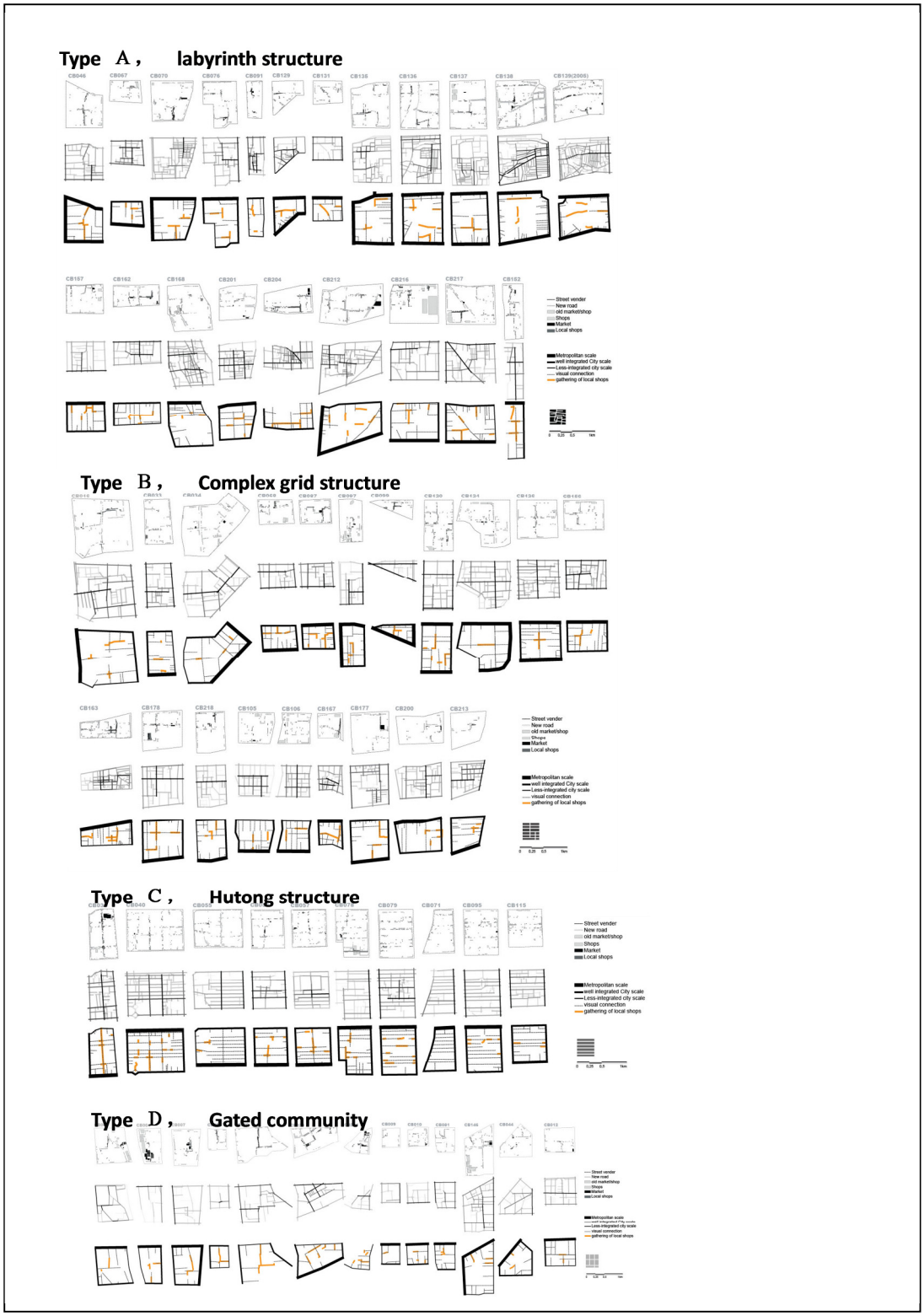

Figure 9 Street pattern analysis on the local centers inside different types of urban block in Beijing

4.1, the case of Beijing

Starting with the easier case of Beijing, figure 9 shows the street pattern analysis of local centers. According to the mean depth value and the type of housing, the urban block of Beijing could be classified into four types, from the most complex labyrinth pattern to the simplest tree-structured gated community. For each block three maps are presented in a column: the top map shows the distribution of all shops in gray and local shops in black; the middle map shows the local integration analysis (R=3) in grayscale, the darker streets are better connected; the lower map shows the hierarchy of the road outside each block and the visual lines from outside (equivalent with one topological step analysis), orange lines represent the street segments where local shops are gathering.

From this analysis, general interface logic can be described as follows: on the one hand local shops tend to gather on the street that is well-integrated locally. On the other hand they tend to locate one topological step away from outside. In another word, from the perspective of individual shop owners or street vendors, each of them are trying to stand as close as possible to their potential customers (mainly from local areas), and being visible from the flow outside. The blocks with different street patterns provide different conditions for the actualization of this general logic. Gate communities or the 'hutong' structure (similar to Manhattan grids) are easy ones. But labyrinth structure offers difficult condition because the best integrated streets are not always to be the one exposed to outside directly. In this case (very few) the local shops have to make their choices on those in-between spaces.

Figure 10 example of Nanluoguxiang (code CB055). Top left: the entrance of NaoLuoGuXiang is articulated by a traditional gate structure. Top right: bars and fashion shops on NaoLuoGuXiang. Bottom left: tourist activity stops at the entrance of the 'hutong', the 'hutong' retains its residential atmosphere. Bottom right: local shops and social activities concentrate on the main trunk of several 'hutongs' connecting to the outside as second choice.

An exceptional yet interesting example can explain how this interface logic works is Nanluoguxiang within the urban block coded CB055. Nanluoguxiang meets all conditions of a good interface. As a typical 'xiang' street it connects many 'hutong' in the form of a fishbone. It also has a direct connection to the city-scale street both on north and south. However, it is not being used as local center now because it is occupied by higher-scale functions such as bars and fashion shops which attract international tourists and customers from the whole metropolitan area. Interestingly, the local shops in CB055, instead of retreating to the 'hutong' connecting with Nanluoguxiang, choose, rather other spaces as second choice inside this block. This 'second choice', as we can see on the map, is not only directly connected to the outside but is also connected with several 'hutong' (see fig.10) in the form of a main trunk of a tree.

As a summary, in this interface logic we could see how a Chinese introverted spatial experience is embedded in the local street pattern, and how it holds the everyday life of local people. Instead of embracing the very open space offered by regular grid, the local center can find a delicate balance between introverted and extroverted, enclosed and exposed spaces. However, what if the Chinese people are provided with regular grid structure? Will they reveal certain cultural inertia? The case study of Tianjin could provide some clues for answering these questions

4.2, the case of Tianjin

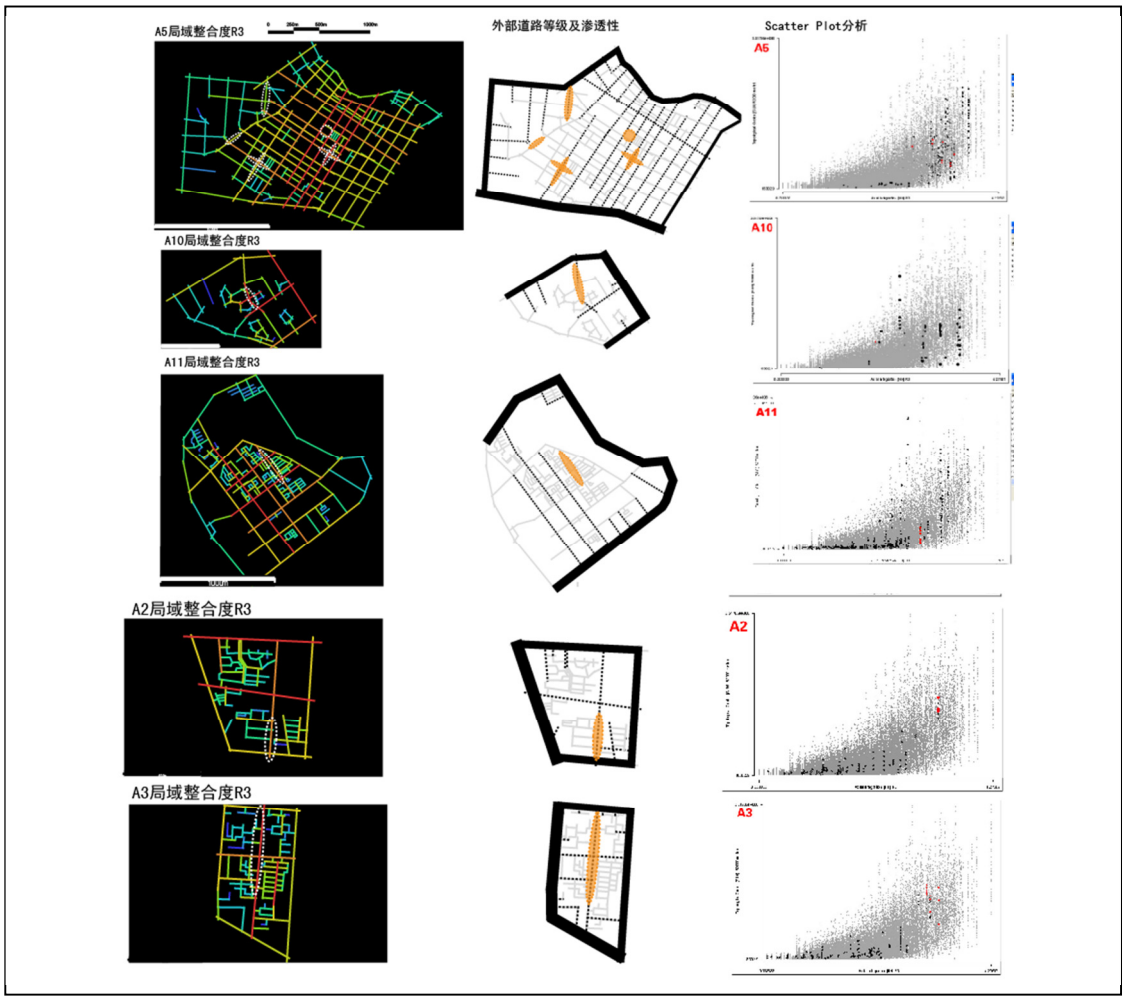

Figure 11 Some examples of street pattern analysis of Tianjin's urban blocks: left, local integration; middle, border road hierarchy and visibility; right, scatter plot analysis on 2km Choice and local integration.

Using similar method in the case of Beijing, the local integration (calculated for each block separately), the road hierarchies of the boundaries and the visibility of Tianjin's urban block have been analyzed (see fig. 11). Furthermore, scatter plot in space syntax software is used to analyze the relationship between topological choice 2km metric (Y-axis) and local integration R3 (X-axis, calculated for each block within the city as a whole).

Figure 11 shows five selected blocks. They can be understood as between two extremes: regular grid and hierarchical spaces. Urban block A5 is a typical concession area in Tianjin's city center. The north border is Hepinglu, east border is Bijiangdao. These two streets are the busiest shopping streets in Tianjin. From local integration map we can see the local shops are gathering around the most locally integrated streets which locate inside the block. And because the street pattern is regular grid, most streets are directly visible from outside. In scatter plot, all street segments in Tianjin are shown in the background in gray color. The street segments of block A5 are shown as black dots, the street segments with more than 5 local shops or 10 street vendors are shown as red dots. Not surprisingly, as the center of Tianjin and an area with typical regular grid street pattern, most street segments in A5 are of very high choice value (2km metric) and local integration value. However, in this context, the local centers (as red dots in scatter plot) are located on street segments with relatively low choice value. This result shows that even the street pattern of whole block is open and extroverted, the local Chinese people are still trying to appropriate space in an introverted way as they used to.

Block A2 and A3 are opposite examples. These blocks have a hierarchical internal street pattern which is similar to most urban blocks in Beijing. As we can see from the scatter plot, the distribution of dots is similar with the background gray dots cloud. This means the street pattern of A2 and A3 share the same structure with the city as a whole: very few streets with high choice and integration value plus many streets with low choice and integration value. As a result, the locally vital streets are mostly located on very few ones with high values.

Block A10 and A11 are in-between examples. When we focus on all street segments where local shops gather on the scatter plot (see fig. 12), we can see most of them locate in a middle zone. With this analysis, the complex interface between internal and external spatial condition in previous study could be illustrated more clearly. As a combination between the traditional hierarchical urban blocks and the concession grid-like urban blocks, Tianjin reveals a mixture version of interface logic. The concession blocks can also support local centers although they have lower mean depth value. After all, what Chinese local functions need is an introvert spatial experience in different types of street patterns. Even in open grid, they still tend to function inwardly, occupy the street segments with low choice value. Since in open grid pattern, visibility from outside is not a question.

From the scatter plot, we can also see some local centers choose the street segments with relative low local integration value. These are extroverted local centers making use of the exits of each block. They reveal simple gate way logic.

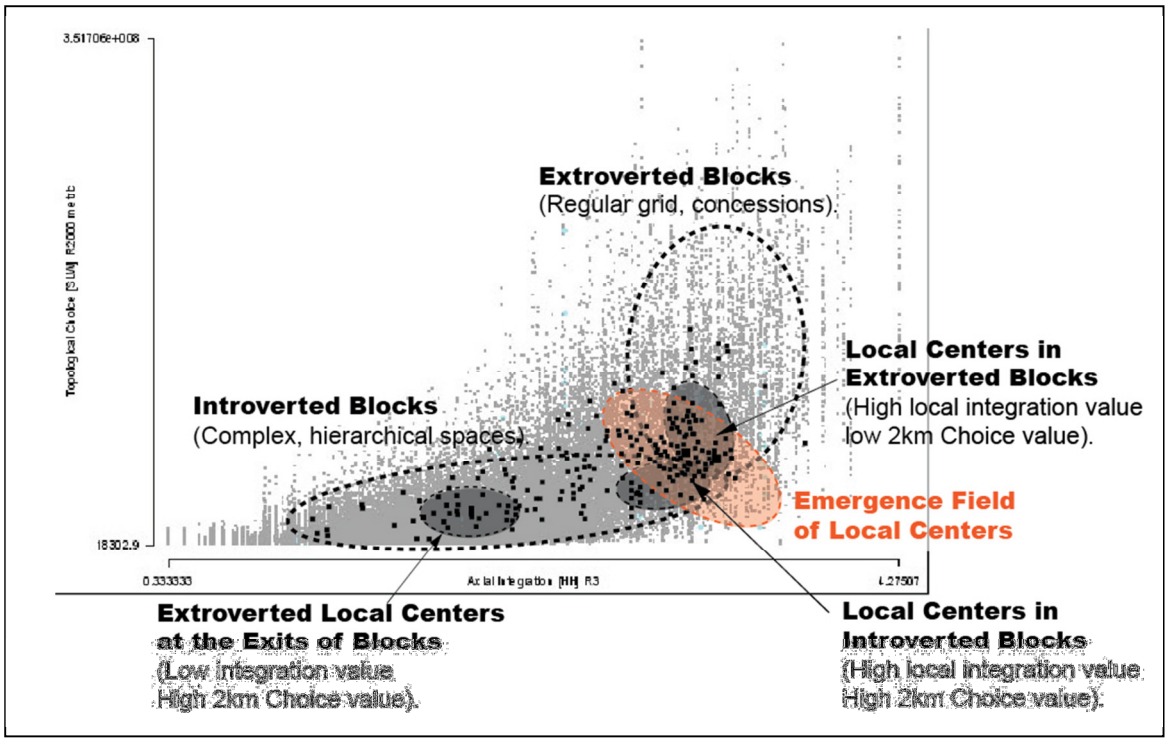

Figure 12 Scatter plot analysis for the street segments with local centers

5. CONCLUSION AND DISCUSSION

Starting with a morphological research on Tianjin and Beijing's movement networks, this paper studies how modernization process can affect the fractal structure by breaking the continuity at local scale. Comparing the imported regular grid pattern in concession areas in Tianjin with the traditional hierarchical pattern, the former reveals higher resilience and adaptability in retaining the local network continuity during this process.

However, the fragmentation of local fabric does not cause the loss of local vitalities. On the contrary, the local centralities as gathering of local shops, markets and vendors are affected by both the external spatial condition and internal spatial condition: Direct visibility from outside, high connectivity of blocks and more exits can boom up the emergence of local centers. Complex internal street pattern can also help consolidate the local functions. On the one hand, expansion of modern urban economy requires an extroverted space. While on the other hand, the local economy in China still prefers an introverted space which can gather the local flow. Even in the concession areas of Tianjin, the local people still tries to use the space that remains certain inwardness. In this case, the traditional local way of life not only inscribes itself into the organization of local fabric, but also appropriates spaces of other cultural origin actively. Comparing with the type of opening interface found in Western regular grid pattern, this marriage between extroverted and introverted spatial pattern could be understood as a generic spatial logic rooted in Chinese local places and cultural context. In this sense, when we evaluate the spatial impacts of some large urban projects, the criticism on the inwardness of gated community or fragmentation sometimes runs the risk of being too simple. Other than totally adapting an opening regular-grid spatial paradigm, there is an alternative way to build local fabric, which can take advantage of the modern urban economy on the one side, but can retain the traditional quality of local places on the other.

Acknowledgement

This paper is supported by the national natural science foundation of China “Research on street pattern and vitality in Beijing-Tianjin region” (Project Code: 51208343)

REFERENCES

Fang, K., and Y. Zhang. 1998. “On Ping′ an Street Redevelopment from the Perspective of Urban Planning.” *New Architecture* 3.

Gao, W. 2003. *Courtyard Housing.* Beijing: Xue Yuan Press.

Guo,A. and J. Wang. 2011. “SD Method Based Street Vitality Evaluation.” *Gui Hua Guang Jiao* 10(27):102-106.

Hillier Bill, and Julienne Hanson. 1984. *The Social Logic of Space*, Cambridge: Cambridge University Press.

Hillier, B., A. Turner, T. Yang, and H. T. Park. 2007. “Metric and Topo-geometric Properties of Urban Street Neworks: Some Covergences, Divergence, and new Results.” In *6th International Space Syntax Symposium,* edited by A. S. Kubat, O. Ertekin, Y. I. Guney, and E. Eyuboglu. 12-15 Jun. Istanbul Technical University, Istanbul.

Jacobs, J. 1961. *The Dealth and Life of American Cities*. translated by Jin Henshan, 2005, Beijing: Yilin Press.

Mulders-Kusumo, C. 2005. “Is a railway station a ‘central' urban place? Spatial configuration study of retail distribution pattern around railway stations.” In *the 5th Space Syntax Symposium proceedings,* edited by A. V. Nes. Delft: Delft University Press.

Read, S. 2005. “Flat city: a space syntax derived urban movement network model.” In *the 5th Space Syntax Symposium proceedings,* edited by A. v. Nes. Delft: Delft University Press.

Salingaros，Nikos A. 2003. “Connecting the Fractal City.” Keynote speech in: 5th Biennial of towns and town planners in Europe, Barcelona.

Sheng, Q. 2005. “Urban labyrinth: rebuilding everyday life in Beijing's inner city.” In *the 5th international space syntax symposium proceedings,* edited by A van Nes. Amsterdam: Techne Press.

Yang, T. 2008. “Urban space: a fractal object?” *Urban Planning Review* 32(6):61-64.