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NEW TOWN MODELING

REVIEWING DUTCH NEW TOWNS VIA QUANTITATIVE METHODS TO PROVIDE APPROPRIATE TOOLS AND STRATEGY FOR ACCELERATING CHINESE NEW TOWN DEVELOPMENT, USING SONGJIANG NEW TOWN AS THE TEST CASE



THESIS REPORT

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Abstract: China turned to the Open-Policy in 1978 and began its rapid urbanization process. To handle the urgent demand from working migration and reduce the problems triggered by congestion in mega cities, decentralization and new towns are widely accepted by Chinese urbanists and politicians. However, new towns in China lost their urbanity in the instant city-making while European new towns have experienced a long time reflection.

This master thesis intends to advance the knowledge on new town development by applying GIS-related quantitative methods to compare new towns in various contexts with their historically evolved peers. There are two main directions in this research: improving quantitative analytical methods and understanding the transformation process of new towns. This research dwells on quantitative modeling on three elements of urban morphology: street network, building types and function via GIS. By this way, a new quantitative analytical method about built environment can be raised based on the study of van Nes, Berghauser-Pont and Masshooi (2012). Through applying this new method to compare the development process of Dutch post-war new towns with historical city, a series of spatial principles will be found and applied into Chinese context. Specifically, in the Netherlands, the transformation process in Dutch new towns will be revealed and an urban diagnosis tool will be given. Then, all the knowledge getting from Dutch context will be converted into a Chinese case: Songjiang new town to provide guiding. Although the focus for this thesis will be on one new town, it contributes to the development strategy for other new towns in China as well.

Key words: new towns, GIS-related urban modeling, Space Syntax, Spacematrix, MXI

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SECTION I:

PRELIMINARY TEST AND PROBLEM STATEMENT

CONTEXT INTRODUCTION

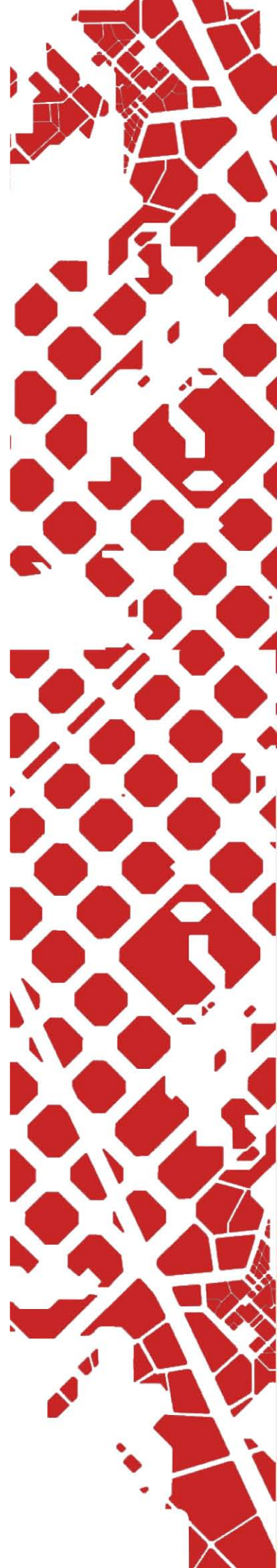
DESCRIPTION OF THE CASE STUDY

PRELIMINARY COMPARISON RESEARCH

PROBLEM STATEMENT

RESEARCH QUESTIONS AND DESIGN

REFLECTION



1. Context Introduction

1.1 New town developments

In the middle of 2009, for the first time, the number of people living in urban areas had surpassed the number living in rural areas and another three billion will living in cities by 2050 at the prospect of current urbanization rate (UNPD, 2009). To handle the urgent demand from work migrants and reduce the problems caused by congestion, cities expanded, or are expanding their housing and working areas at an astonishing pace. Therefore, new town developments are widely accepted as alternatives to cope with urban growth or avoid over-centralized mega cities in past one century.

The first attempt of new town development after Industrial Revolution was raised to tackle emerging urban problems. Howard (1898) initiated the garden city movement to seek the way of designing an ideal city. Planning was been seen as part of design and architects, such as Le Corbusier, were in charge of large scale city planning (Taylor, 1998). The second wave of new town development was promoted by rapid urbanization in Western Europe in the sixties (Brömmelströet & Stolk, 2007). The recent new town developments began from the 1990s are focused in Asia, especially in China (Engel, 2004). When most new towns built between the fifties and seventies are regarded as dull, monotonous places and even the planning debacle made by ideal modernist planning (Duivesteijn, 2010 cited in Provoost, 2010, p. 11), new towns in China are still trying to search their own identity (Den Hartog, 2010).

China turned to the Open Door Policy (ODP) in 1978 and started its dramatic economic leap process in the past three decades. Land use right was allowed to be transferred in 1988 and housing was marketed in 1994. From then on, China has been experiencing an unprecedented urbanization. The urbanization rate jumped from 17.92% in 1978 to 46.59% in 2009 (National Bureau of Statistics of China, 2010) and China has entered a fast urbanization phase (Chen, 2004), which plan to arrive at 70% in 2050. To handle the urgent demand from work migrants and reduce the problems caused by congestion in mega cities, decentralization and new towns are widely accepted for Chinese urbanists (Zhang, 2008). Since the early in 1990s, over one hundred new towns were planned or emerged in China (Zhou, 2008) (Figure 1.1).

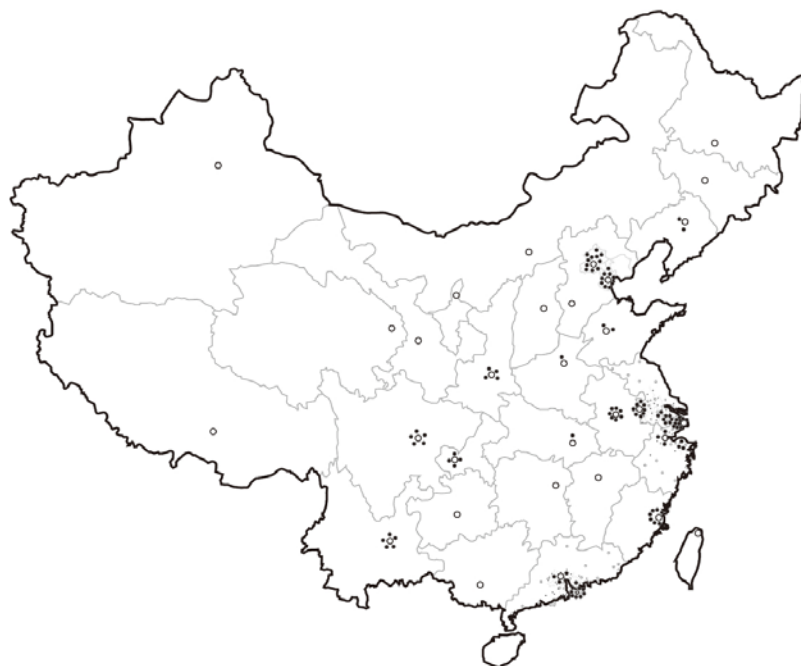


Figure1.1
New towns in China since
1990s, (source: Zhou, 2008,
p.122).

Meanwhile, most of them are built on a tabula rasa from which all existing agricultural structures and people have been removed (Den Hartog, 2010). Modernism new town planning was fermented in the Chinese middle class dream: gated communities and private car, finally mixed with high population pressure and created peculiar suburban areas where high population density and low urban vitality can cohabit. Social fragmentation and the lack of urban life become common characteristics in Chinese new towns (Figure 1.2). As one of the firstly built new towns in China, Songjiang new town demonstrates those characteristics as well.



Figure 1.2
One newly developed city in China, (source: Google earth).

Urbanists already confirmed the temptation to plan a theoretically universal model for new towns had failed because of its dazzling complexity. Actually, the shift in planning thinking occurred in the sixties, triggered by Jacobs (1961) and Alexander (1965). Scholars have realized the complexity of cities during decades review. Just as Healy (2007) pointed out: “such socio-economic activities make use of the city in all kinds ways that are often difficult to imagine in advance; they are too dynamic”. This raises the question of how to left space for the growth of complexity in new town development. Nowadays, no matter European new towns need regeneration or Chinese new towns under construction, the main aim of them is transforming to complete city (Reijndorp, 2006).

NEW TOWN vs. COMPLETE CITY

Monofunctional landuse;	High level of functional mixture;
High car depedency;	Growing dependency on public transportation;
lacking attractive public space;	Dynamic street life;
Suburban population mixture;	Diversification of population;
.....

Figure 1.3
The various differences between new town and complete city.

Here, new towns are defined as human settlements which are built according to a master plan, including satellite cities and large urban extensions (Provoost, 2010). While complete city is shaped by a variety of plans, ideologies, economic and political situations, etc. through a longer course of time (Figure 1.3).

This research dwells on the interacted relationships among spatial and socio-economic dimensions. Therefore, understanding the key spatial compositions which can provide conditions for urban complexity in such a way can promote the transformation of new town into a complete, multi-layered and varied city.

1.2 Spatial modeling in new towns

So many unsuccessful neighborhoods and new towns are built during the past 50 years and now it is time to learn from them (Hiller, 2006). Just as Hiller mentioned, large scale new towns are implemented on a fast speed but many of them are regarded as unsuccessful places. However, we seem to lack tools and understandings on how to improve them. How the spatial forces affect the development of more complete cities are seldom taken into consideration. Therefore, understanding the key elements in urban form (street network, density and function) which provide a condition for well-functioning urban areas is needed.

The calling for bridging the gap between urban morphology and urban modeling has been proposed by Kiril Stanilov (Stanilov, 2008). However, the mainstream GIS-related urban modeling developed from cellular automata (CA) and agent-based modeling (ABM) do not understand built environment from the perspective of basic urban form characteristics. Thus, their simulations cannot match the physical patterns of urban development very well. In this context, many scholars turned to integrate Space Syntax into GIS for modeling urban space (Jiang, Claramunt and Klarqvist, 2010).

During the last couple of decades, the development of Space Syntax and other related quantitative methods raise the possibility of researching urban form from its key elements. Specifically, Mixed Use Index (Van den Hoek, 2009) and Spacematrix (Berghauser Pont & Haupt, 2010) have been used as a combined way of categorizing urbanity. In this context, GIS provides the possibility of reflecting urban form with its three key elements: street network (Space Syntax), building types (Spacematrix) and function (MXI). It is a new direction to understand and measure urban form quantitatively and it can play an important role in new town researches. Detailed theory and method will be introduced later in Section II.

2. Description of the case study: Songjiang New Town

2.1 History

Songjiang is a quite small town on Shanghai's fringe with a long history since the 16th century and this situation was broken in 1959. Shanghai planning committee planned to Songjiang as an industrial satellite city to decentralize urbanization in central city. Although this plan was stopped shortly, it can be seen as the antecessor of the plan in 1990s. In 1986, a new Master Plan for Shanghai was drafted, Songjiang get another opportunity to grow again. Most of new projects developed near the historical center and the population raised at 500,000 people in the old town.

Deng set special the economic zones (SEZ) of Shanghai in 1990 and start Shanghai's third period of flourishing until now. International business sector was attracted and it generated the flow of working migrations. In order to reduce the congestion of central city, a new comprehensive plan was approved in 1999, which created a 1-9-6-6 Model. It consisted of a hierarchic system including one central

city toward the services sector, nine new decentralized cities (300,000-1,000,000 residents), sixty small towns (50,000-150,000) and six hundred central villages (2000 residents). The 'One City, Nine Towns Developments' was conceived as the first step of 1-9-6-6 Model, in which one new city (an extension of the old satellite city, Songjiang, originally having 50,000 residents) and nine new towns (30,000-100,000 residents) (Den Hartog, 2010, p.30). Songjiang new town is developed based on this plan and it is built across Highway A9, next to the Songjiang old town.

Through 10 years development, more than 300,000 people are living in Songjiang new town now. In 2006, the One city, Nine Towns Development Plan has been reviewed and three of them have come out on top: Jiading New Town, Songjiang New Town and Lingjiang New Town. They will have higher hierarchy and more population (more than 700,000). Based on the latest master plan (Master Plan of Songjiang New Area 2010-2020), Songjiang new town hope to become an important urban node and complete city in Yangzte River Delta, more than one million people will live in it (Figure 1.4). As one of the first built new towns in China, it has high research value and the results will contribute to the development strategy for other new towns in China as well.



Figure 1.4
Panoramic view on the city center of Songjiang new town, (source: Google Earth).

2.2 Location and development process

Songjiang new town is a large satellite town having 39 kilometers distance from city center of Shanghai. The time distance from Songjiang new town to Shanghai is nearly 1 hour by metro and 50 min by car. Now Metro Line 9 is connected this new town with city center of Shanghai. It lies in the southeast part of Shanghai municipality and on the regional development corridor from Shanghai to Hangzhou (Figure 1.5). And the main traffic connections between Songjiang new town and Shanghai are Highway A9 and Metro Line 9 (Figure 1.6).

The historically-grown old Songjiang city is located between Highway A9 and Hu-ning railway, while the Songjiang new town is developed on the north of Highway A9 (Figure 1.7). Infrastructures, key projects and economic sectors were finished in the first development phase (2000-2003), including the universities and central green belt. The second phase (2003-2005) aims to accept the population transfer from the 'central city' of Shanghai and focuses on residential projects (Wang, 2004). So far, this new town is almost finished, only a few housing projects and financial centre are still left in building. Overall, in ten years, a new town covering an area of 22.4 km² has been built. "An extensive road network has been completed; several universities have been operating, built environment is clean and green new housing are fully functional; this new town can be seen as an urban miracle" (Zhou, 2010).

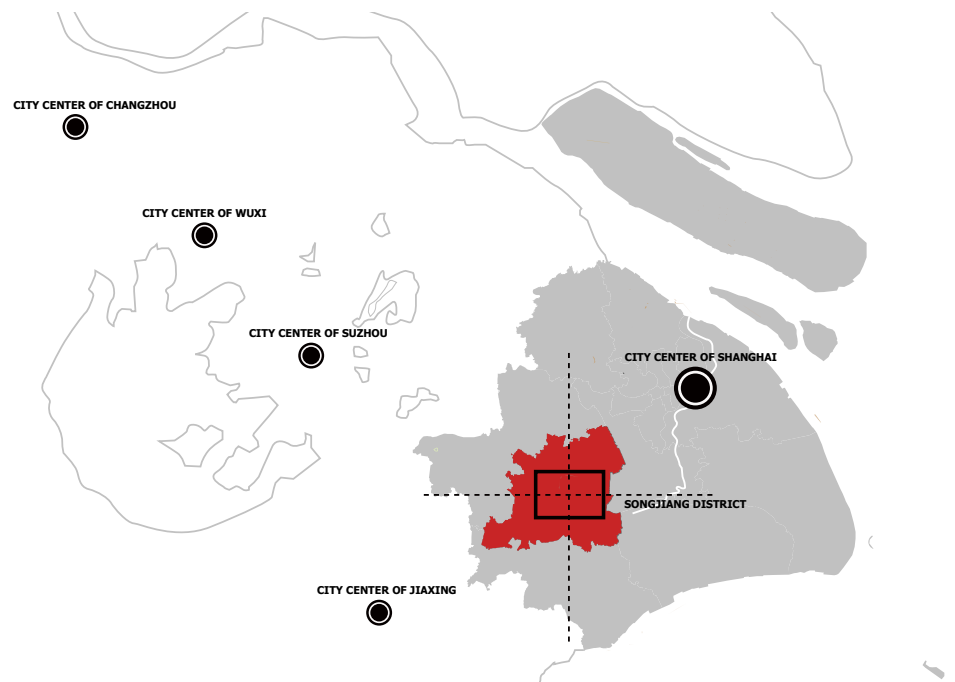


Figure 1.5
Regional Location: Yangtze
River Delta.

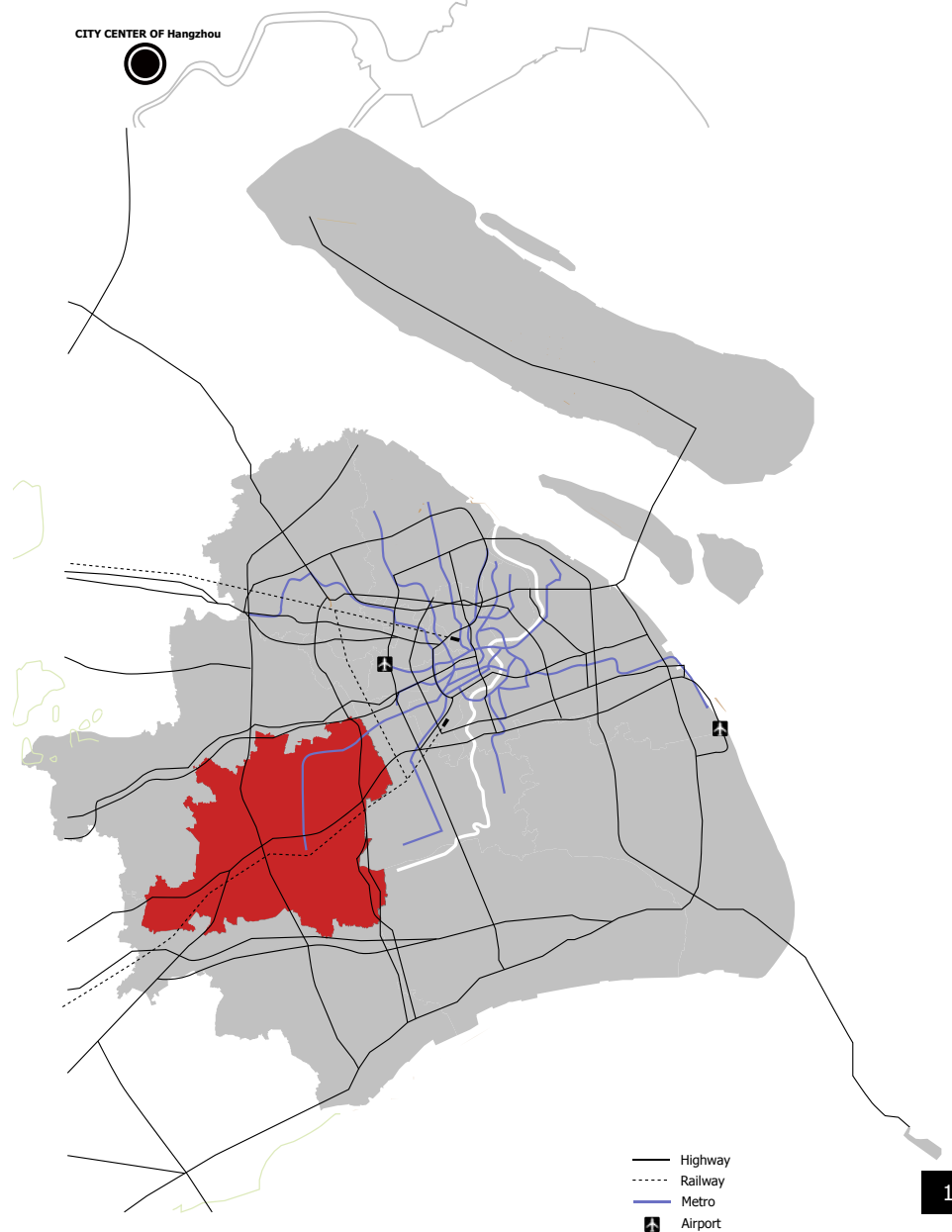


Figure 1.6
Regional Location: Shanghai
Municipality.

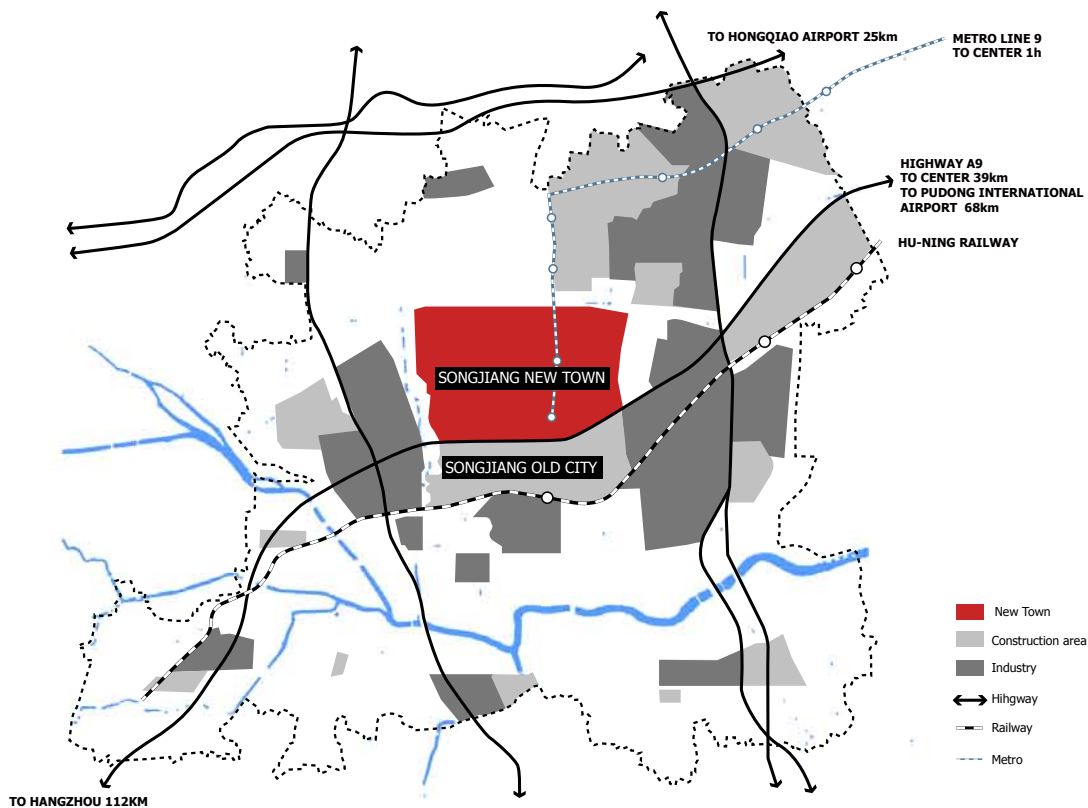


Figure 1.7
Local Location: Songjiang new town and Songjiang old town

In order to attract residents from crowded city center of Shanghai, the main function in Songjiang new town is living. Not only apartments for middle-class people, luxury villa is built in this new town as well. In addition, Chinese urbanists have learnt from European new town developments and the 'new-town concept' is based on independently functional nodes, in contrast to old dormitory towns. Take Songjiang new town for example, seven universities have moved in, followed with more than 100,000 students and 40,000 staffs, showed in light blue in the picture below (Figure 1.8). This is an attempt to avoid the oversimplified function in newly development areas. However, even the guiding theory of new town development has been improved, the urbanity is still low in this new town.

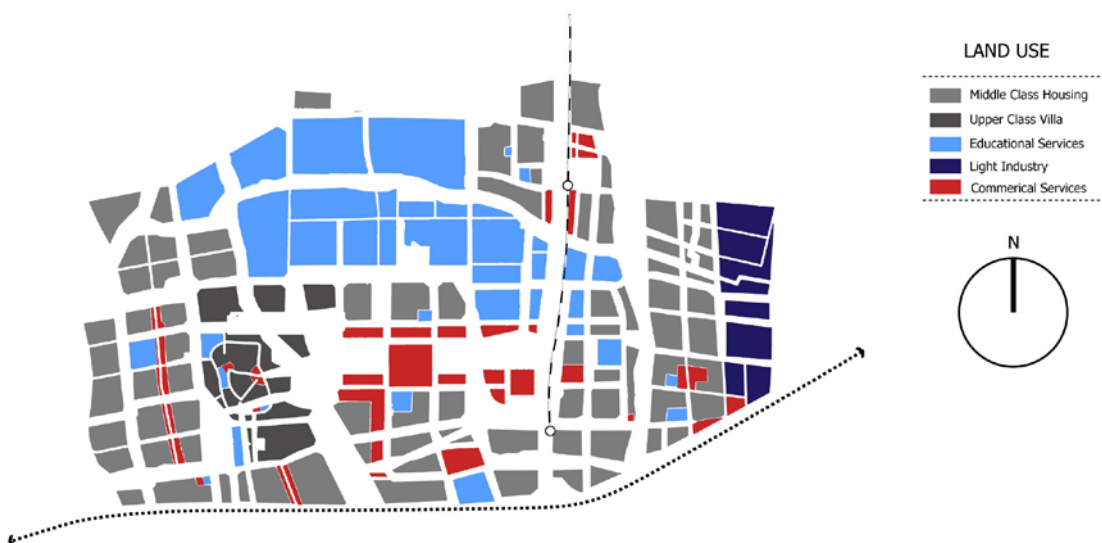


Figure 1.8
Functional distribution in Songjiang new town

3. Preliminary comparison research between Songjiang New Town and its historically-evolved counterpart, Old Songjiang City

An instant city making (22.4 km² in 10 years) guided by stark zoning and was fermented in the Chinese middle class dream: gated community and private cars finally forgot urban vitality (Figure 1.9). The image is urban, but the atmosphere is unanimated and suburban. Ironically, the population density in Songjiang new town is similar to its more successful old Songjiang city.



Figure 1.9
A comparison of urbanity
between Songjiang new
town and historically-grown
Songjiang city.

What are the differences between Songjiang new town and its historically-grown counterpart, old Songjiang city? A comparison between old Songjiang new town and the old city may help us to set the preliminary research direction for the future deeper study. In this process, three spatial research methods: Space Syntax, Mixed-use Index and Spacematrix will be used to make a quantitative research. And the socio-economic data will be taken into consideration as well.

3.1 Applying three quantitative methods for the study of new towns

At here, three quantitative research methods: Space Syntax, Mixed use Index (MXI) and Spacematrix are used to compare the spatial structure and functional mixture of new town and old city to get an objective understanding in terms of quantitative description on the spatial parameters. It is also a preliminary test in those methods I used, which is meaningful for my deeper study in next step.

Space Syntax is a set of theories and techniques for the analysis of spatial configuration. In this method, urban structure is abstracted and mapped with a network of axes representing the movement in the city. Through computer programs, such as Depthmap and Confeego, the network can be analyzed further and reveal a clear image of the hierarchy of urban spaces, and the patterns of movements in the cities (Figure 1.10). It is well acknowledged that the movement network decides the quality of urban areas (Hiller, 1996). The spatial accessibility and integration, key points of movement network, can demonstrate movement patterns we cannot observe directly. Other layers of data can be integrated to this map and get deeper understanding. This method has been used to review new towns in UK to understand their failures by Karimi, et, al. (2007).

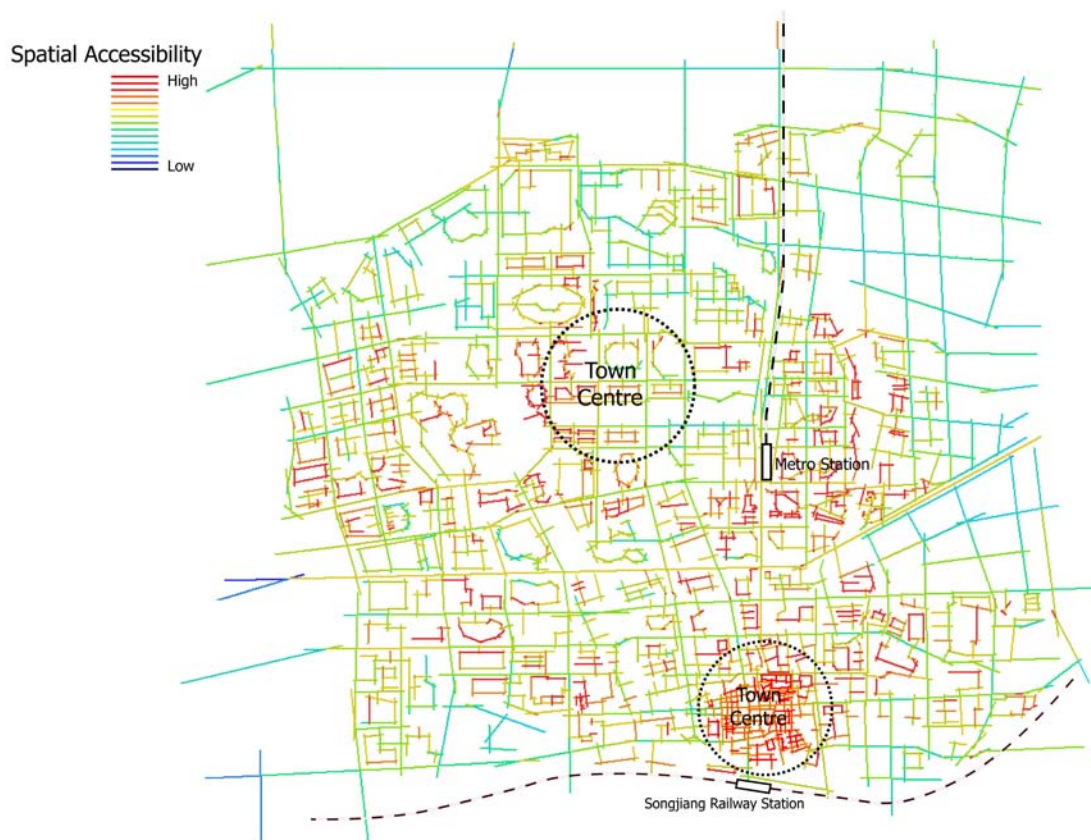


Figure 1.10

An analysis of Songjiang new town and old city using Space Syntax method, spatial accessibility is shown by a color index ranging from dark red – most integrated to dark blue – least integrated, spatial hierarchy has been revealed by this color pattern.

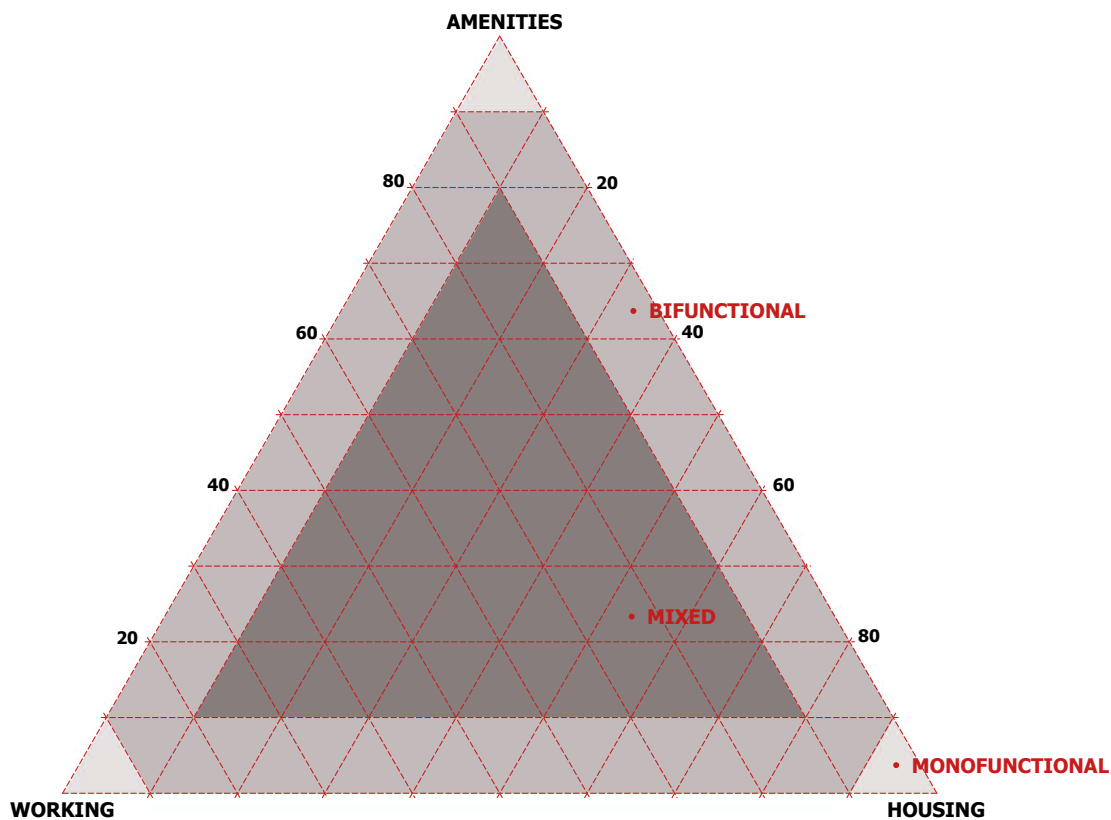


Figure 1.11

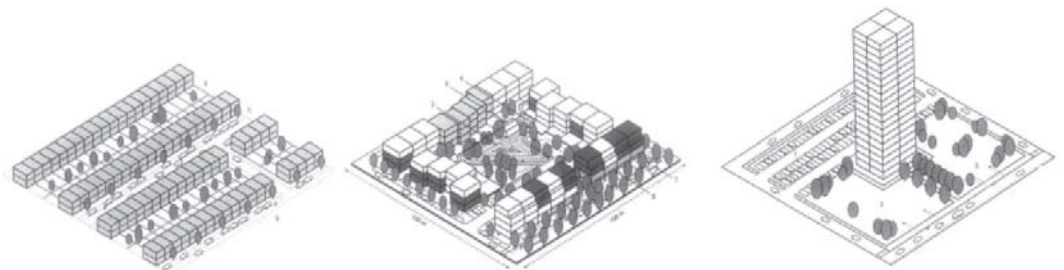
Ternary diagram: monofunctional, bifunctional, (source: Van den Hoek, 2009, p. 203).

At present, most new towns want to become real cities rather than faceless satellite cities (Reijndorp, 2006). In order to accelerate this transformation, employing mixed-use development has been on a rise. Take Almere for example, according to municipality's Almere principles (Feddes, 2008), a major transformation is the creation of richer mixes at different scales of the city. It is also important to note that the high mixed-use built environments are created during the course of time. New towns as a speeded-up city following routines of zoning must have very limited functional differentiation. However, a comparison of MXI between the new town and old city is still meaningful. Through mapping and analyzing spatial structure with functional mixture and many other types of data, more objective characteristics can be established. Many planning errors in spatial system can be prevented in the future as well.

Density is a crucial parametric in the daily practice of urbanists, however, there are various definitions about it. The Spacematrix method has contributed to a clarification of the density. In Spacematrix, density is defined as a multi-variable phenomenon to be able to relate density and urban form. Spacematrix find the relationships among density, urban form and other performances (Figure 1.12).

Figure 1.12

Three different types of urban areas with 75 dwellings per hectare, (source: Berghauser Pont & Haupt, 2010, p. 13).



Spacematrix uses the following measures: floor space index (FSI), ground space index (GSI), and network density (N). These three measures are represented in a three-dimensional diagram, the Spacematrix. Measures such as open space ratio (OSR) or spaciousness, the average number of floors or layers (L) and the size of the urban blocks (w) can be derived from that (Berghauser Pont and Haupt, 2010). Here FSI on the y-axis gives an indication of the built intensity in an area and GSI on the x-axis reflects the coverage, or compactness, of the development. The OSR and L are gradients that fan out over the diagram. OSR describes the spaciousness (or pressure on the non-built space), and L represents the average number of floors. Another diagram is constructed with N, b and T_f . The N on y-axis denotes the network density of the urban layout, and b on the x-axis the profile width of the street. The tare space (T_f) as a percentage of public space in a fabric is shown as gradients in the diagram (Figure 1.13; Figure 1.14).

The variables of Spacematrix used for this research are defined and calculated as follows (on urban fabric level and thus including public streets; for more details see Berghauser Pont and Haupt, 2010):

(1) Floor Space Index (FSI) is calculated as follows:

$$FSI_f = F/A_f$$

Where F is gross floor area in m^2 , and A_f is the area of the urban fabric in m^2 .

(2) Ground Space Index (GSI) is calculated as follows:

$$GSI_f = B/A_f$$

Where B is the built up surface or building footprint in m^2 , and A_f is the area of the urban fabric in m^2 .

The average number number of floors (L) and the open space ratio (OSR) are derived from the basic indicators FSI and GSI and can be calculated as follows:

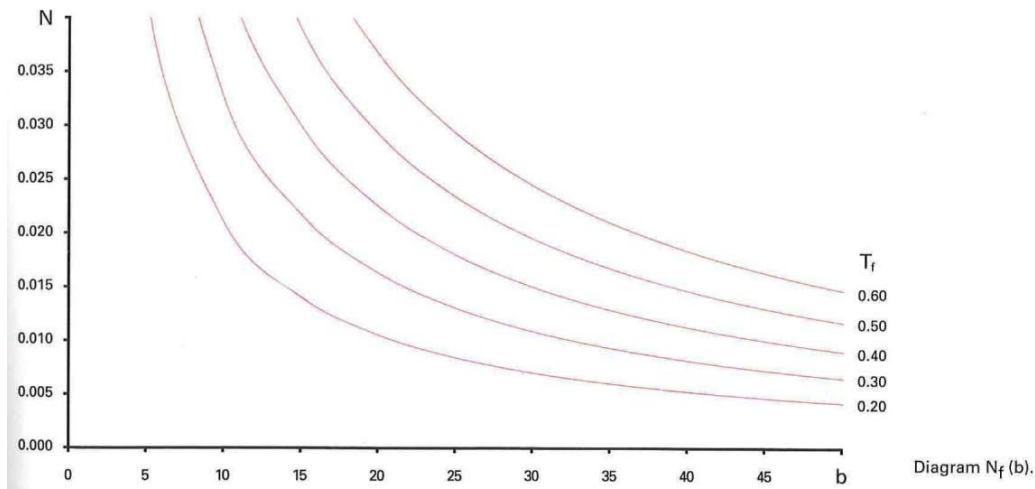
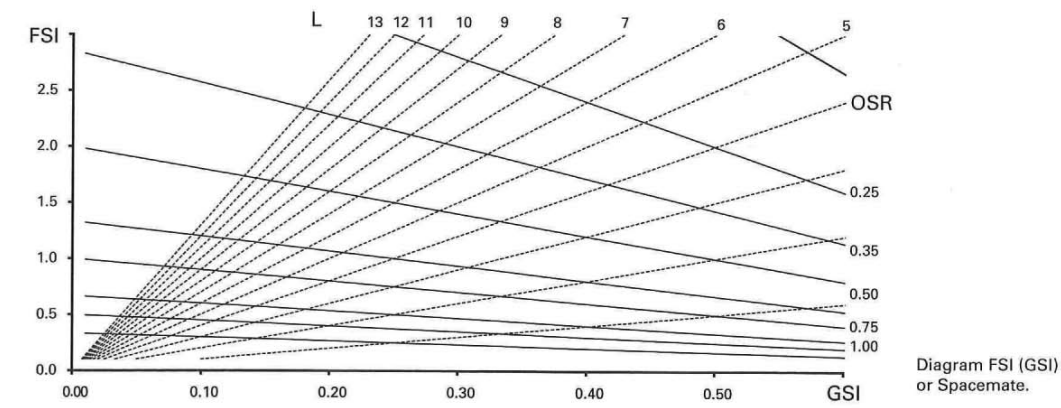
$$(3) L = FSI_x / GSI_x$$

$$(4) OSR_f = (1 - GSI_f) / FSI_f$$

$$(5) N_f = (l_i + l_e / 2) / A_f$$

Where l_i means the length of interior network (m), l_e means edge network (m) and A_f shows area of fabric (m^2).

$$(6) T_x = (A_x - A_{x-1}) / A_x$$



$$N_f = \frac{l_i + \frac{l_e}{2}}{A_f}$$

l_i length of interior network (m)
 l_e length of edge network (m)
 A_f area of fabric (m²)

$$T_x = \frac{A_x - A_{x-1}}{A_x}$$

x aggregation x
 $x-1$ level of scale of the components of which aggregation x is composed

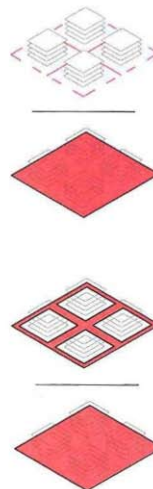


Figure 1.13

The relationships between FSI, GSI,OSP,L and N, b, T_f , (source: Berghauser Pont & Haupt, 2010, p. 117).

Figure 1.14

The definition of N_f and T_x , (source: Berghauser Pont & Haupt, 2010, p. 116).

3.2 Spatial comparison study between historically developed Songjiang old town and Songjiang new town based on Space Syntax

The most typical feature in historically-evolved Songjiang city is the highly integrated area (shown in dark red and orange) coincides with the town centre (Figure 1.15; Figure 1.16; Figure 1.17). Plenty of urban streets fulfilling various activities, commercial functions, pedestrian and vehicular movements can be found in this commercial town centre. In high metrical radius analysis, the town centre is well linked with main streets having high integration, which providing high accessibility in the global scale. While in low metrical radius analysis, the town centre itself is well integrated as well. Those conditions create a spatial accessibility core together. It is a walkable environment for both locals and visitors to support the overlapping of different place of flows and the creating of a “thick urban social space”. (Read, 2001).

Figure 1.15
Spatial accessibility analysis
of old Songjiang city with high
metrical radius.



Figure 1.16
Spatial accessibility analysis
of old Songjiang city with low
metrical radius.

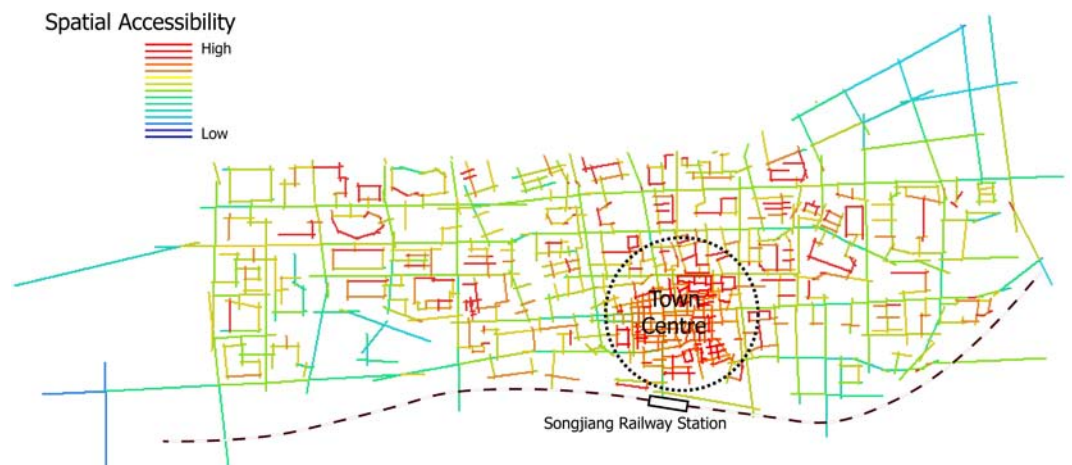


Figure 1.17
Commercial amenities of old
Songjiang city.



Furthermore, commercial function extends from town centre to the periphery following main streets. And town centre itself is quite close to railway station. This kind of spatial mechanism supports dynamic urban streets rather than roads for car traffic only. In addition, although the integration rate decreases from centre to periphery, the high density of connections and relations provide strong centrality and unique characteristics for old Songjiang city.

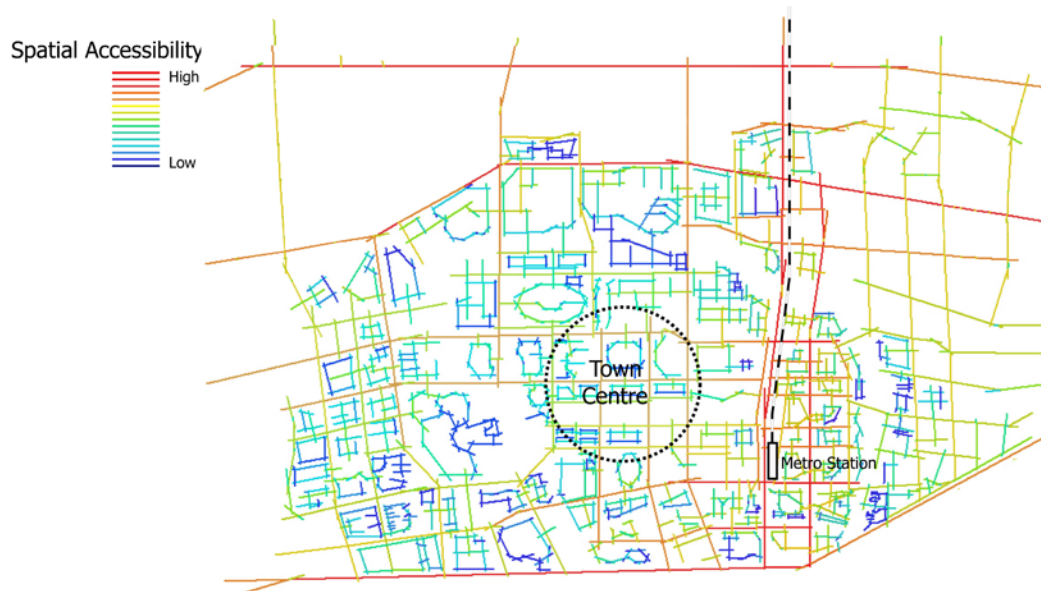


Figure 1.18
Spatial accessibility analysis of Songjiang new town with high metrical radius.

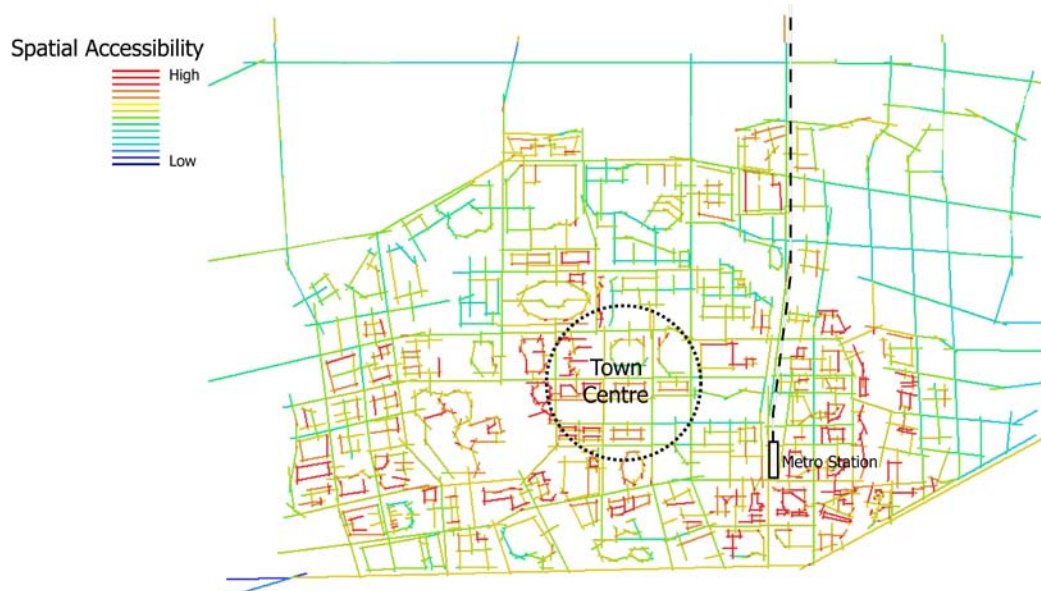


Figure 1.19
Spatial accessibility analysis of Songjiang new town with low metrical radius.

Figure 1.20
Commercial amenities of
Songjiang new town.



In contrast to the old city, Songjiang new town shows totally different spatial characteristics (Figure 1.18; Figure 1.19; Figure 1.20). In high metrical radius analysis, the most integrated areas are main vehicular roads and high centrality cannot be found in new town center. While in low metrical radius analysis, the integration does not perform well in city center. Actually, most integrated areas are located in the superblocks and far from the main roads. Therefore, the planned town centre does not show high integration in urban structure. Although the grid pattern provides well integration on main roads, the areas inside those self-closed superblocks (showing dark green in Figure 1.18 and red in Figure 1.19) are isolated, which obstructs the possible interactions and exacerbate the faceless pattern.

The two analyses mentioned above clearly demonstrate the differences of spatial structure between the old city and new town. In the new town, existing spatial structure might not generate the strong centrality to attract economic and social activities to support the creating of an attractive town centre. The commercial layout in old town is following the spatial accessibility and improving the concentration in the town centre. In contrast, Songajing new town tends to be more equal and decentralized. Moreover, the superblock pattern developing in new town structure separates the whole town into fragmented, isolated residential islands. Overall, there is a great difference between Songjiang new town and old town. The spatial structure in new town is less positive compared with its historical counterpart.

3.3 Comparison study between historically developed Songjiang old town and Songjiang new town based on Mixed-used Index

The data measured in this research is floor space in the units of m^2 . The specific functional data is collected and counted through zoning maps getting from the municipality of Songjiang and filed work. The total amount of floor space within buildings and different functions on different floors are taken into consideration. Because of the lacking of GIS database, little mistakes in the manual calculation process are inevitable. But all in all, the general result should be accurate enough. All those data is merged into three categories: housing, working and amenities. In addition, old Songjiang city and the new town are mapped together and divided into 275 spatial entities on neighborhood scale based on zoning plan in order to facilitate the collection of data (Figure 1.21). Some of the smallest units can be found in the city centre of old Songjiang, which is smaller than 5ha. The largest entities are the universities in the geometric center of new town, which is nearly 100ha.



Figure 1.21
Spatial entities of old Songjiang city and new town.

As a product of long-term evolution, old Songjiang city consequently has a higher mixture than short-term making Songjiang new town. But when positioning the proportions of 275 urban parts into the ternary diagram (shown in Figure 1.22), some other clusters can be found through the comparison:

1) Only in the old centre of Songjiang, balanced mixture can be found (Figure 1.22, 24). The averaged mix-balance is $MXI=28/33/39$. Housing, working and amenities are balanced around each other. While the new town centre is less multi-functional, the average $MXI=63/8/29$ (Figure 1.23; Figure 1.25).

2) Mono-functional residential units are dominant in new town. In old Songjiang city, most entities are gathering in the right corner of the triangle with 75 percent of housing (Figure 1.22). The non-housing functions highly influence the urban character in those blocks. The liveliness in these areas is totally urban.

However, in the new town, most of them are focused on the extreme right block with more than 90 percent of housing (Figure 1.23). They are built following the zoning restrictions of functionalist separation. The liveliness of these areas is suburban. During the daytime, they are quiet and empty.

3) Universities show an excessively mono-functional characteristic. Those campuses located in the middle of this new town, which ought to become the core to enrich diversity, are unattractive areas (Figure 1.24; Figure 1.25). Large block size, low population density and simplified function make this area unsafe during vacations.

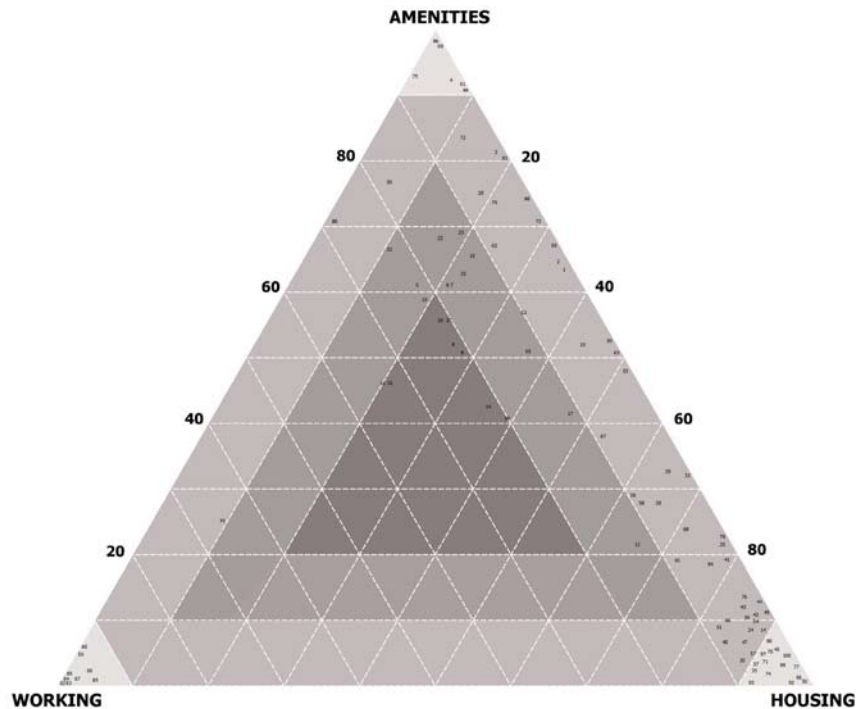


Figure 1.22
Ternary diagram: Functional mixture of old Songjiang city.

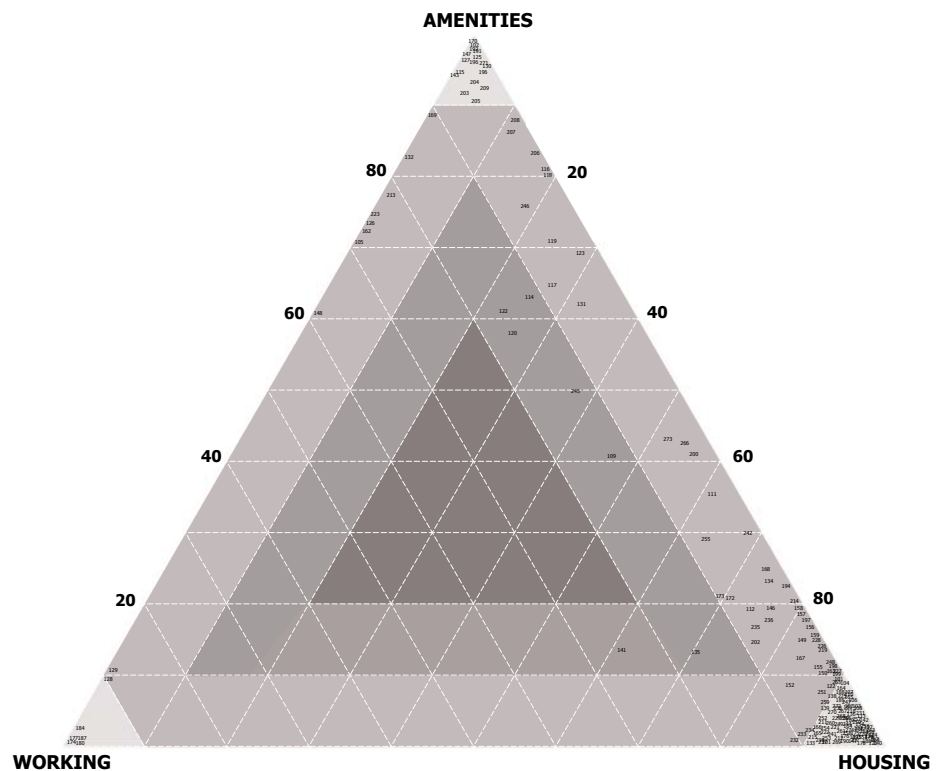


Figure 1.23
Ternary diagram: Functional mixture of Songjiang new town.

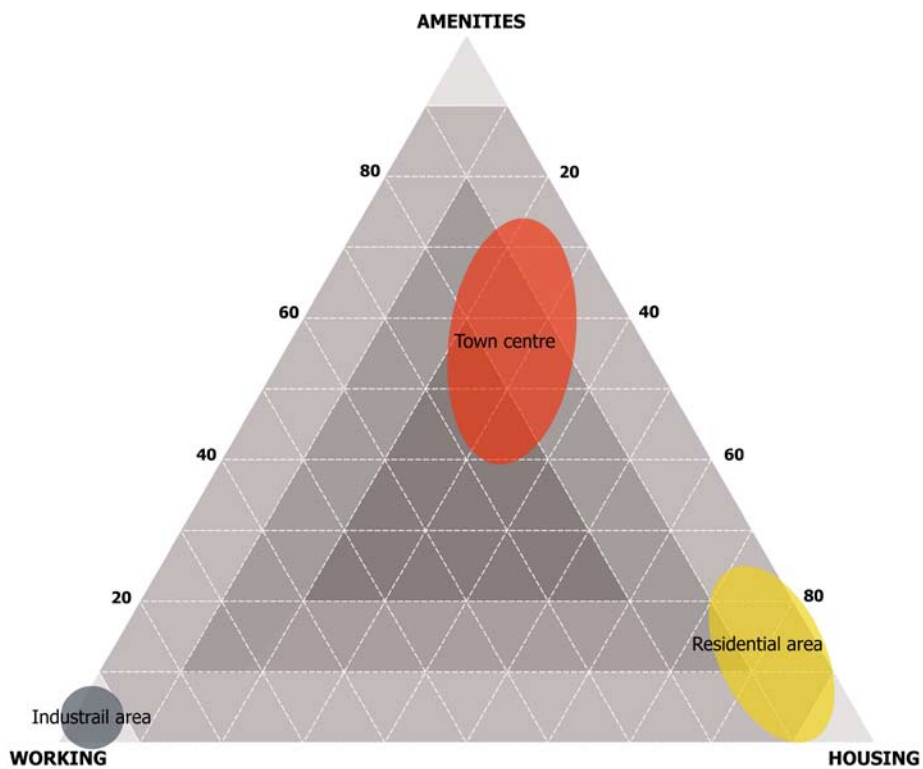


Figure 1.24
Ternary diagram: Urban typologies and their MXI positions in old city.

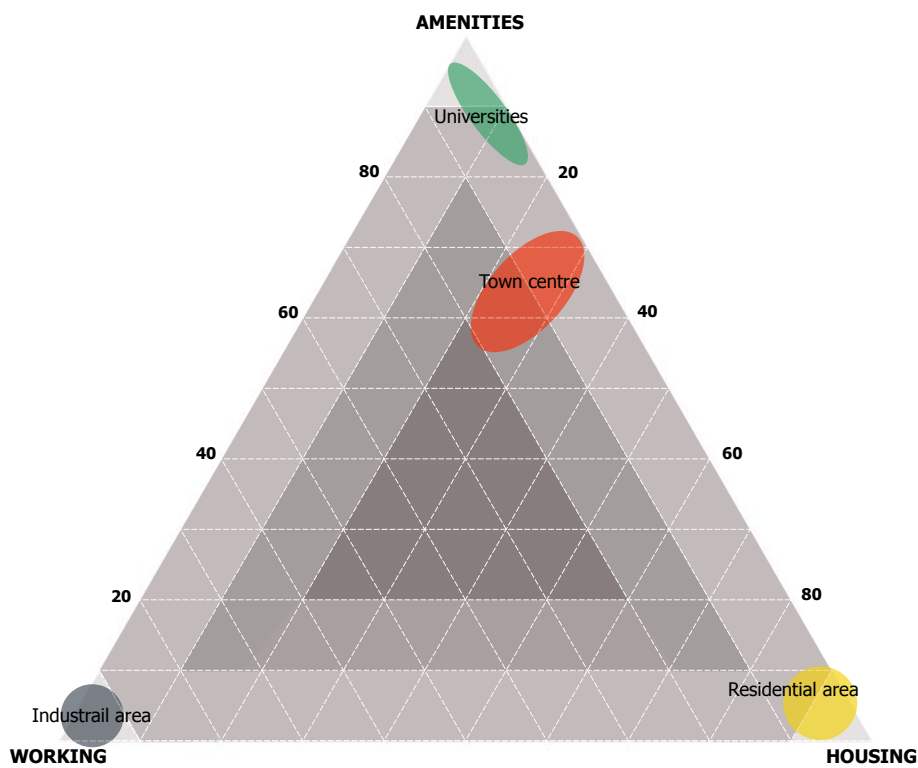
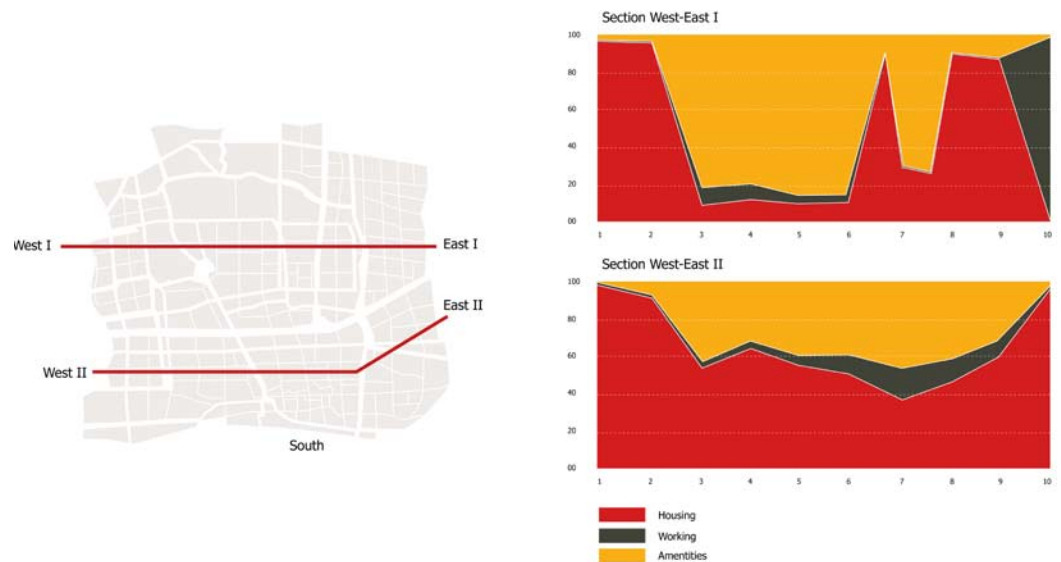


Figure 1.25
Ternary diagram: Urban typologies and their MXI positions in new town.

Figure 1.26
Functional sections of
Songjiang according to the
MXI.



More interesting is the analyses of the functional sections (Figure 1.26). The functional section of old city in West-East II clearly shows the increase of mixture from periphery towards the city center. It looks like there is a strong correlation between centrality, block size and mixture in Chinese historically-grown towns. This result corresponds with Van den Hoek's research to Amsterdam in 2009 (Van den Hoek, 2009). While in the new town, no relationship between centrality and mixture can be found in West-East I. Functional compositions show a causeless fluctuation. It seems like new town planners in China did not consider this correlation.

3.4 Comparison study between historically developed Songjiang old town and Songjiang new town based on Spacematrix

Based on the diagrams mentioned before, the number of building floors, FSI and GSI are chosen as the indicators to distinguish blocks. The density, urban form and their locations are analyzed in those diagrams below. In addition, the network density is investigated in Songjiang new town and its old counterpart as well.

Figure 1.27 shows the different urban forms in old Songjiang city. From the perspective of block type compositions, we can find that main block types in this city are middle-rise stripe and block types (61.0%), while low-rise block type is an important composition as well (13.0%). Furthermore, the city also consists of many high-rise developments, located in the periphery areas (12.0%).

From the perspective of geometric locations, in general, low-rise block type mainly located in the historical core and surrounded by middle-rise block type. Then, from center to periphery, the types tend to change from middle-rise stripe type, low-rise stripe to high-rise types. A clear clue about block types and geometric locations can be found in this old city.

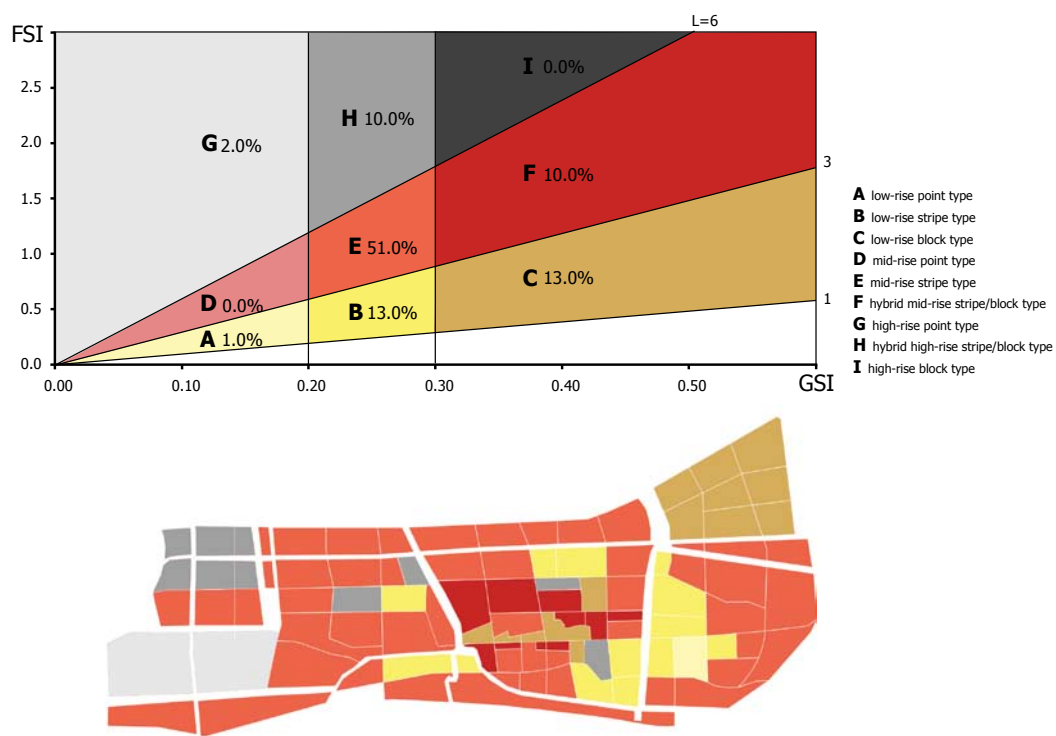


Figure 1.27
FSI-GSI of Spacematrix with 9 different environmental types in Songjiang old city.

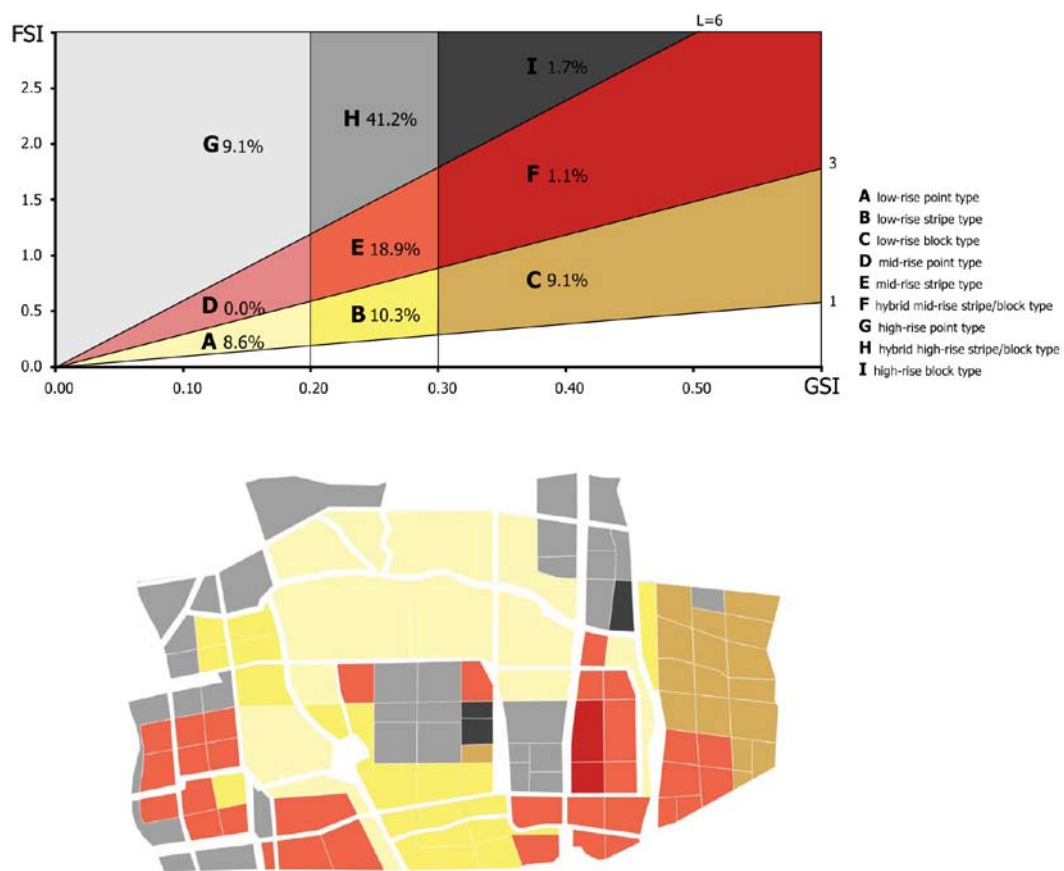


Figure 1.28
FSI-GSI diagram with 9 different environmental types in Songjiang new town.

However, this analysis shows totally different features in Songjiang new town (Figure 1.28). The high-rise point and stripe types play dominant role (52.0%) in it, while low-rise block types (28.0%) are common as well. But the number of middle-rise blocks makes a great fall down, from 61% decreases to 19.9%.

The geometric locations of various urban forms are different as well. Middle-rise types are mainly close to old Songjiang city. And low-rise point block type is located in the geometric center of Songjiang new town, surrounded by high-rise blocks. By contrast with low-rise and middle-rise block types in historical core of old Songjiang city, the commercial center in new town consists of high-rise stripe type. Overall, the clue of geometric locations and block types cannot be found.

Figure 1.29
Nf(b) diagram showing
network density and profile
width in Songjiang old city.

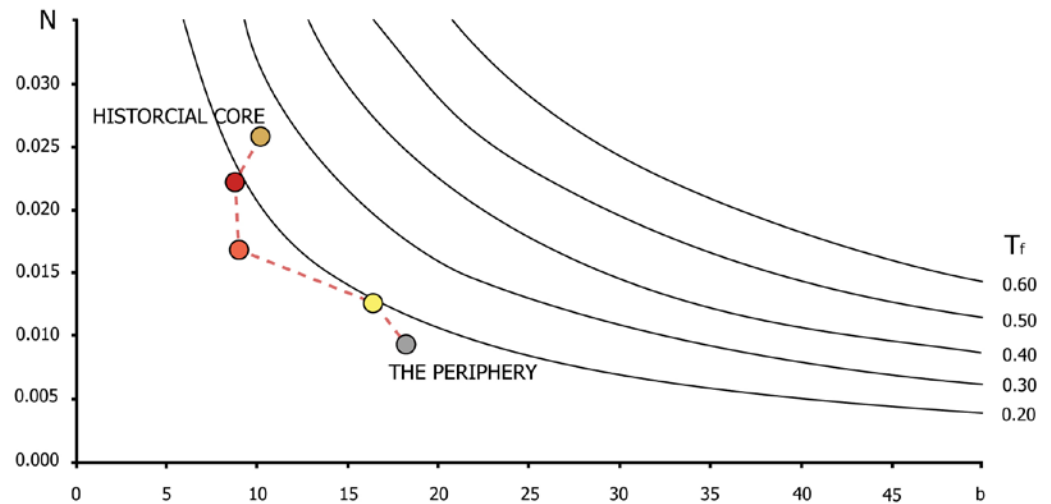
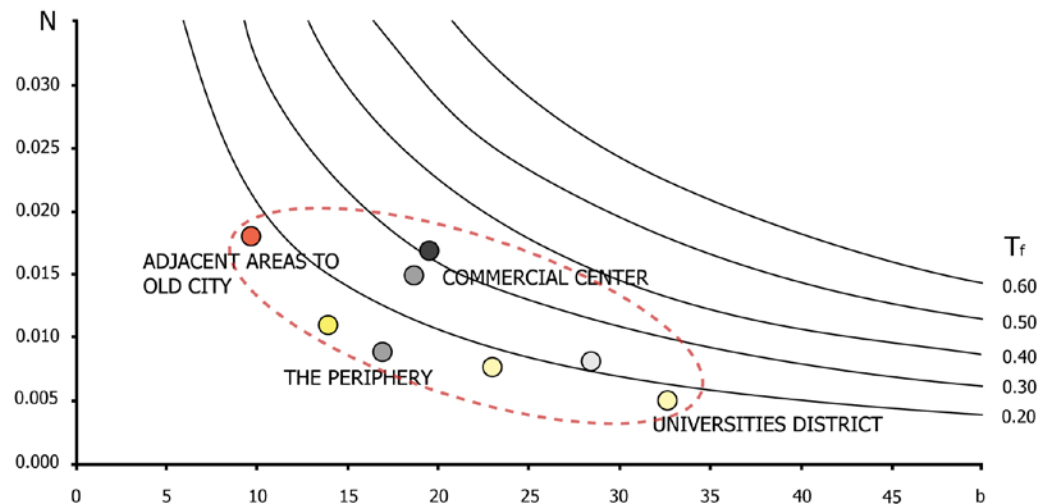


Figure 1.30
Nf(b) diagram showing
network density and profile
width in Songjiang new town.



The analyses in network density and profile width also reveal a different feature between old Songjiang city (Figure 1.29) and its new counterpart (Figure 1.30). In the old city, two obvious transforming features from historical core to the periphery can be found. There are high network density and low profile width in the historical core. Nevertheless, both two indicators decrease from the center to the periphery. It means that the urban form is transforming from small blocks mixed with narrow streets to big blocks mixed with wide streets.

In contrast with the clear changing trend, no clue about geometric location and network density can be found in Songjiang new town. The clutters scattered within a certain range, which generally have lower network density and higher profile width. What is meant by this is that big blocks and wide streets are the main mainstream in new town area.

To sum up, it seems like the historically-evolved old city has its own growth logic in urban form, while the newly built counterpart did not follow this hidden logic line. Nevertheless, I do not mean new town must follow old town's spatial logic. In addition, the comparison between new and old city demonstrates that middle-rise or low-rise block types and small block, dense network urban form may create positive influence on urban quality.

3.5 Comparison study between Songjiang new town and its historically developed old town from social-economic perspectives

In this comparison, three key indicators: commuter numbers, average incomes and average ages between Songjiang new town and the old city will be analyzed. And some features will be revealed from it (Figure 1.31).

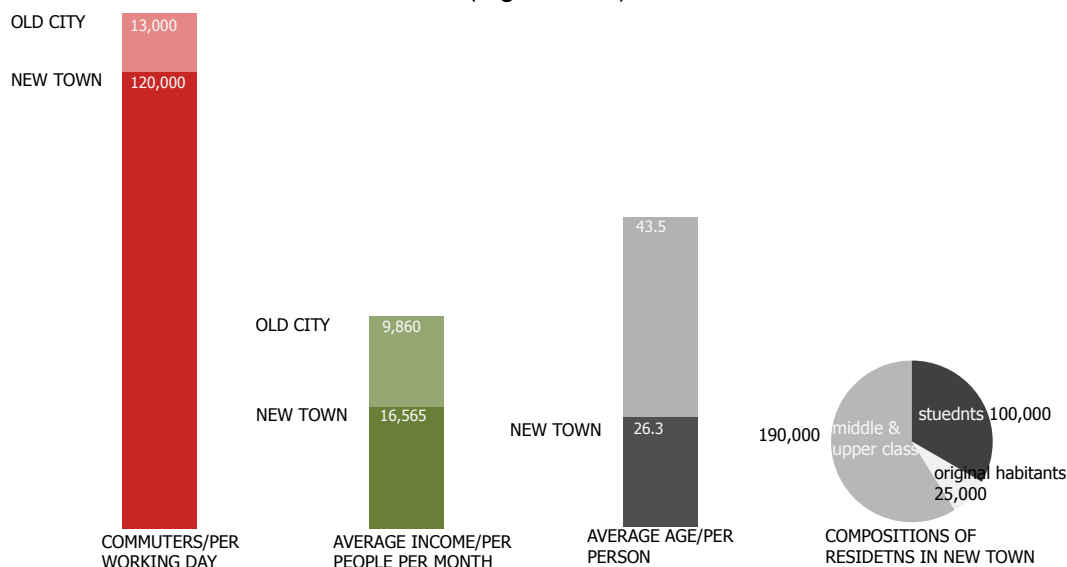


Figure 1.31
socio-economic indicators,
(source: Songjiang Statistic Bureau & Songjiang new town Master Plan 2000-2020).

The commuter numbers including people traveling by metro and bus. From this figure, we can find that commuters from Songjiang new town to the city center of Shanghai are 10 times higher than those who live in old city. Actually, after considering the population difference between those two peers, the number of new town commuters is still three times higher. Obviously, inhabitants in Songjiang new town are extremely depending on the city center of Shanghai while residents from Songjiang old city are tending to working locally.

And the personal income corresponds with the monotonous compositions of people in Songjiang new town: the mainstream residents in Songjiang new town are middle class and upper class people (nearly 190,000). College students also occupy a high portion in it (100,000). The left is original habitants, like farmers were living around. The high real estate price is the main reasons lead to this situation. Average price in Songjiang new town is nearly 1300 euros/ m², while the luxury villa is more than 2000 euros/ m². At the same time, average income per year in Shanghai is less than 5000 euros per person. Thus, the real estate price in Songjiang new town is unaffordable for most blue-collar people. Oversimplified human structure is an obstacle for the spatial and social diversity in Songjiang new town.

The average age reveals homogeneous population compositions in Songjiang new town as well. In the old city, because of its diverse residential structure – from

children to senior citizens, the average age is much older than the counterpart in Songjiang new town, where the mainstream habitants are college students and new families. Overall, as a newly-birther town, the population structure in Songjiang new town is oversimplified and most residents have to suffer a long commuter to city center of Shanghai. While Songjiang old city has more accomplished population and higher complete rate.

3.6 Conclusion of comparison study

Based on the analyses above, several spatial and socio-economic differences can be found between the new town and old city. Specifically, the old city has a spatial structure providing centrality, mixed functional distributions, clear development logic in urban form and diverse population compositions, which are lacking in the new town. **In conclusion, the meaning of preliminary study is it proves the existing of various spatial and social differences between new town and old town. And those differences can be measured by a series of quantitative methods.**

Nevertheless, the differences mentioned above cannot prove the new town must be transformed towards its old counterpart. The transformation process from the newly birthed town to a more attracted city is still unknown. Whether it is merely related with time, with spatial structure, with functional mixture, or with other spatial compositions in regional or local level? How to measure and accelerate this transformation process? **The trend of new town developments is totally new in China, which means it is very hard to find some precedents for studying. Therefore, reviewing the Dutch new town developments in past half-century will be a valuable research direction.**

Moreover, in this preliminary test, all those analytical results are separated and cannot be integrated together to get an objective understanding about built environment. **In order to make a deep understanding in urban form, combining spatial integration (Space Syntax), density (Spacematrix) and functional mixture (MXI) via GIS is the road we must follow.**

4. Problem Statement

- **Unexplored new town development process: transforming to a complete city**

As it stated above, the transforming process from new town to complete city is the main trend of new town developments. Therefore, special attention should be given to the changing spatial features during various developing stages. Thus, there is a need to study the Dutch new towns' spatial evolutions in past fifty years to define the transforming spatial features. Referring to the results, Songjiang new town can define its own developing goals in spatial aspects.

- **Unexplored method of spatial diagnosis: identifying strategies & interventions to accelerate new town transformation**

The developing goals of Songjiang new town can be given through answering the first problem. Nevertheless, how to fulfill those spatial goals? In this section, Songjiang new town as a research example has demonstrated its partly spatial problems in preliminary study. Apparently, higher spatial integration and better functional diversity are needed for building an attractive city. Nevertheless, are there other problems left? How to make the appropriate interventions in right place? In this sense, it requires a complementary diagnosis on regional, urban and local scales to seek suitable strategies and interventions which can promote this transformation.

5. Research Question and Design

5.1 Research questions

The main research question is:

How to identify newly-developed Songjiang new town's spatial goals in its transforming process towards a complete city and how to accelerate this process via interventions based on the conclusions from reviewing Dutch new town developments?

According to the previous analyses, the further study will begin with analyses in the Netherlands, and then converts the conclusions into Chinese context to guide Chinese new town developments. Newly built towns in China do not have enough references in past historical developments, nevertheless, through reviewing the development process of Dutch post-war new towns, the changing trend towards more complete cities can be raised. Moreover, a spatial diagnosis method indicating appropriate interventions in new town's potential areas will be given in this process

The way of researching Dutch new towns firstly, and then applying the conclusions & developed methods in Chinese new towns is operable in regional and urban scale. That is because new towns, no matter in the Netherlands or China, most of them are built up in a short time with a particular spatial structure and clear social-economic paradigm. They can be seen as a kind of mass producing goods and have high similarity. Therefore, new towns in China are also applicable in this model in a long course of time. **The identified Dutch new town developing trends also can be regarded as the future goals of Chinese new towns. The proposed spatial diagnosis method can be applied in new towns in China as well.**

However, on the local level, the great differences between Dutch and Chinese context make the direct comparison nonsense. Several meaningful analyses directions should be chosen according to the strategy defined in urban scale study. In other words, I will try to **use local comparison between the Netherlands and China to put the strategy into effect rather than trying to search local principles for new towns.**

In order to better understand the elements contained in the main research question, three sub-questions are formulated:

The Netherlands:

- **In regional and urban scale, how to measure new towns' developing stages via socio-economic indicators? How to identify the positive spatial principles in regional and urban scale quantitatively? How to develop a diagnosis method based on quantitative spatial modeling?**

China:

- **In regional and urban scale, what is Songjiang new town's position compared with its Dutch counterparts and how to accelerate its transformation based on the conclusion & method defined from Dutch context?**
- **In local scale, how to put the strategy from urban scale into effect based on the quantitative spatial modeling?**

5.2 Research design and approaches

In order to answer the questions, the research will be divided into three parts:

The Netherlands:

Step 1 Identifying the transforming process of Dutch new towns in regional and urban scale aims to search positive spatial principles and develop a quantitative urban diagnosis method.

- Comparing the indicators of city completeness rate to define new towns' developing stages.
- Searching the positive spatial principles in regional and urban scale based on the developing range proposed above.
- Understanding the inherent rules in those spatial principles and providing a GIS-related urban diagnosis method.

Methods: **Literature review; Quantitative research** of transformation in post-war new towns in **regional and urban scale; Space Syntax; GIS-related spatial modeling methods: Mixed-use Index; Spacematrix, Comparison study among Lelystad, Almere, Zoetermeer and Haarlem**

China:

Step 2 Applying the spatial principles and diagnosis method in Songjiang new town to accelerate its transformation by strategies in regional scale and appropriate intervention directions in urban scale.

- Based on the spatial features and suggestions defined from Dutch context, regional strategies will be given in Songjiang new town.
- Applying the quantitative diagnosis method to point out the potential areas and appropriate intervention directions in urban scale.

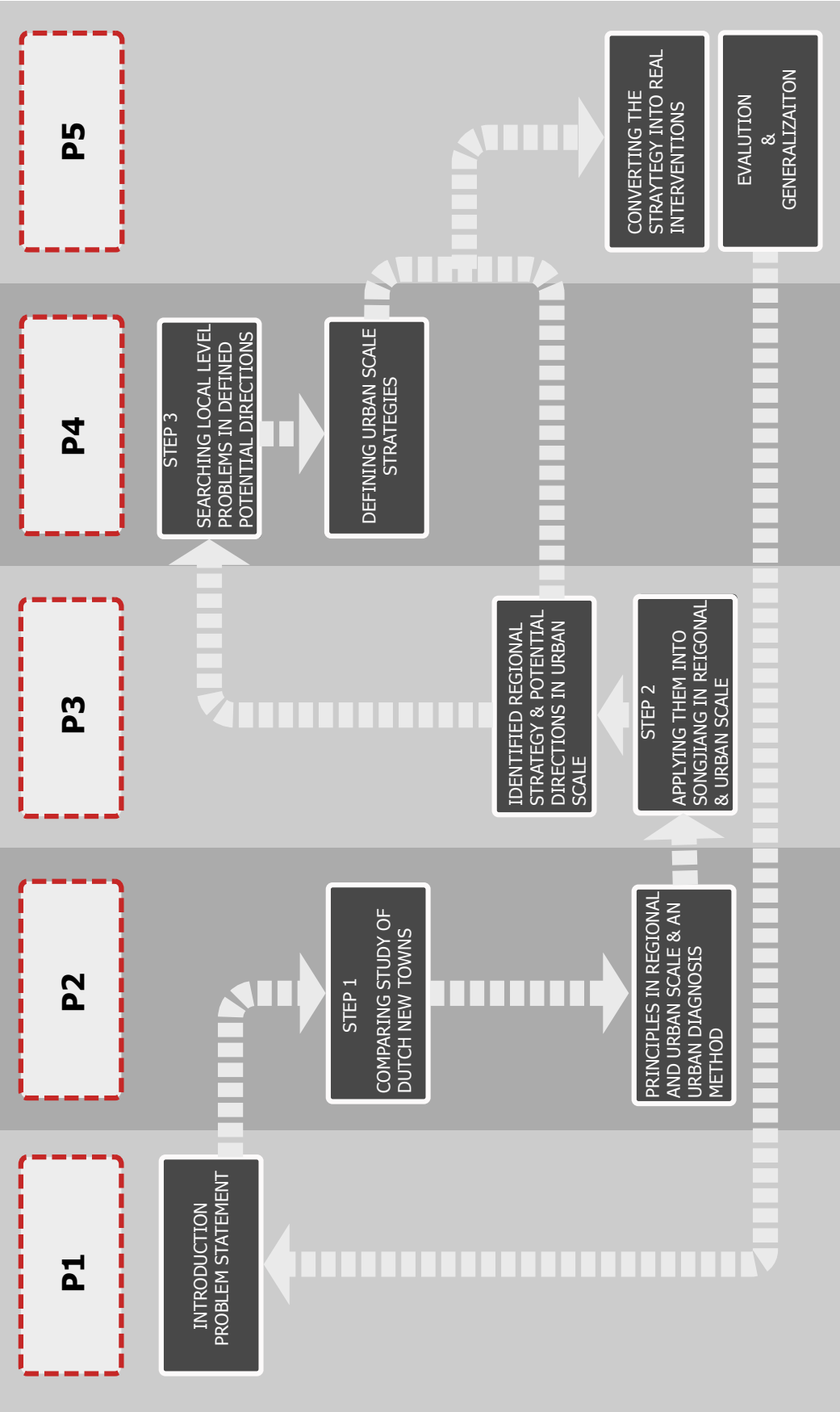
Methods: **GIS-related spatial modeling methods: Space Syntax; Mixed-use Index; Spacematrix;**

Step 3 Identifying the problems leading to the lacking of urban vitality on local levels through comparing with Dutch counterparts to convert intervention directions toward urban scale strategy.

- Based on the directions defined in step 2, comparison between Dutch new towns and Songjiang new town in local scale will be made in several pertinent directions
- Through local scale analyses, strategy in urban scale will be finally proposed.

Methods: **Scatter plot analysis via Depthmap in Space Syntax, Regression analyses via SPSS, Comparing Chinese urban blocks with its Dutch counterparts;**

5.3 Research structure and timetable



6. Relevance

The proposed research takes on qualitative issues such as urban vitality and street life from an angle of quantitative research. It is mainly related to the department of Urbanism, TU Delft's studies focusing on the socio-economic performance of urban form through spatial analysis with a quantitative approach, including the works of Akkelies van Nes, Meta Berghauser Pont, Joost van den Hoek, Bardia Mashhoodi, Birgit Hausleitner, etc.

The investigation will allow for the better understanding of hidden urban orders in new town development. It is also contribute to the former studies of International New Town Institution (INTI).

SECTION II:

KEY CONCEPTS AND RESEARCH METHODS

INTRODUCTION

CONCEPT I: INTERACTED SPATIAL & SOCIO-ECONOMIC ASPECTS

CONCEPT II: MEASURABLE CITY COMPLETENESS RATES

CONCEPT III: THE NEW WAY OF SPATIAL MODELING



1. Introduction

This section is aiming to demonstrate the theoretical background and research methods will be applied in the future researches. Three key concepts are mentioned in this section: 1) interacted spatial and socio-economic aspects, 2) measurable city completeness rates and 3) the new way of spatial modeling.

2. Concept I: Interacted spatial and socio-economic aspects

The first discussions about space, political organization and economic power were proposed by Harvey (1973) and Lefebvre (1970, 1976). They recognized the organization of space as a material product, with the relationship of spatial-social structures of urbanism.

...When we use the words “urban revolution” we designate the total ensemble of transformations which run throughout contemporary society and which serve to bring about the change from a period in which questions of economic growth and industrialization predominate to the period in which the urban problematic becomes decisive... (Harvey, 1973).

Based on their works, the concept of a socio-spatial dialectic was proposed by Edward W. SoJa (1980) aiming to conclude the interacted spatial and socio-economic dimensions. SoJa pointed out the dialectic between social and spatial structures- the interplay between the social and territorial division should be a central issue to understand urbanity. The spatial problematic is highly integral with socio-economic issues.

In the meanwhile, other scholars, like Hiller (1984, p. 6) also try to describe this relationship from another perspectives. He mentioned that: “By giving shape and form to our materialized world, architecture structures the system of space in which we live and move. In that it does so, it has a direct relation – rather than a merely symbolic one – to social life...”

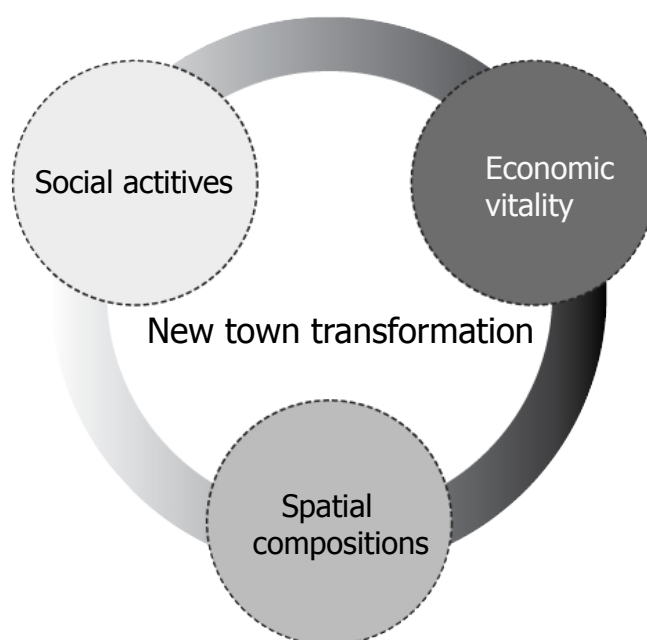


Figure2.1

Interacted spatial and socio-economic dimensions in new town development.

This kind of dialectic is also applicable in new town developments. New towns often find themselves lacking quality of socio-economic context on the one hand and the spatial context on the other (De Bois, 2009) and suffer from a fundamental shortcoming: the inability to reproduce complexity, diversity and richness of the traditional urban fabric.

My research will focus on the spatial principles in regional and urban scale. Then, those principles will be converted into real interventions via local analyses. Through interventions in spatial aspects underlying city's socio-economic dimensions, we can improve the development of three aspects together (Figure 2.1). This is the theoretical foundation for my thesis: seeking spatial principles to promote spatial aspects in new town development and then affect socio-economic aspects as well.

3. Concept II: Measurable city completeness rates

3.1 Previous researches

Just as the ambitions expressed in the book of 'Groeten uit Zoetermeer: Stedebouw in discussie' (Nio, 1997), what the Dutch new towns and probably also in other parts of Europe really want is to become real cities. Besides spatial transformation, the new town changing during this process also happens in socio-economic senses. Thus, it is possible to measure new town's developing stages via various socio-economic indicators. City completeness rates can be compared and be used to indicate developing stages. Actually, this direction has been researched by Reijndorp (2009) in his book: *Vernieuwing van de nieuwe stad*. He compared a series of Dutch new towns, (Almere, Zoetermeer, Capelle, Nieuwegein, etc.) through several parameters (Figure 2.2). Selezneva (2011) also applied several indicators to compare new town Almere's development with other historically-evolved cities.

Those previous researches have proven the possibility of judging new towns' completeness rates by socio-economic indicators. Therefore, through selection of appropriate indicators, the city completeness rate can be reflected.

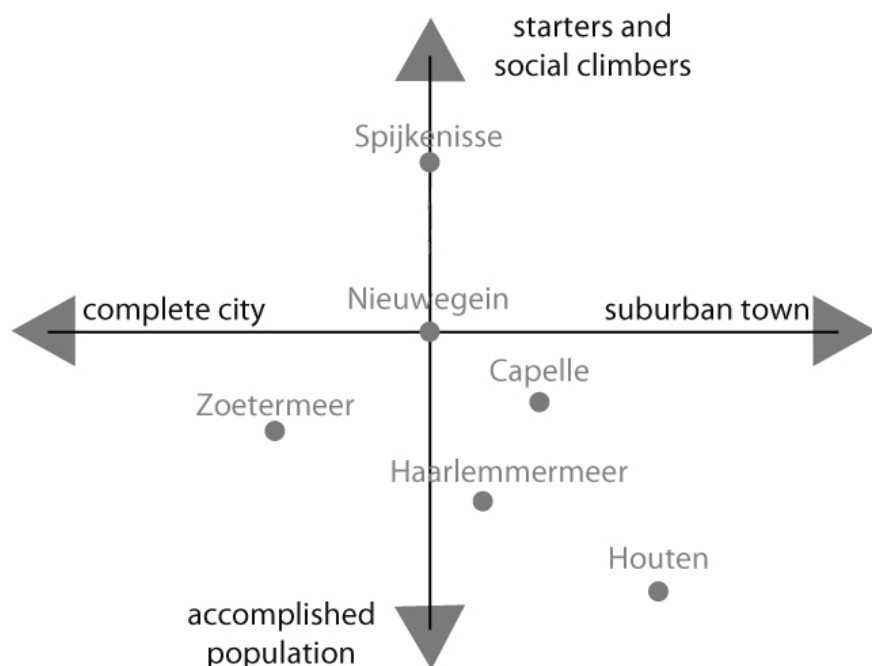


Figure2.2
Urban development in various Dutch new towns, (source: *Vernieuwing van de nieuwe stad*, 2009).

3.2 Selecting indicators of city completeness rates

So far, two research directions are highly related to my study about the measurable completeness rates. Firstly, in regional scale, theories of economic geography (Christaller, 1933; Lösch, 1945; Friedman, 1964) are meaningful to measure the city development. Therefore, according to their researches, new towns should reflect more complex socio-economic qualities during development. Thus, several easily identified indicators can be chosen to illustrate economic and cultural performance of Dutch cities. They are the amount of catering facilities, retail and office surface area, cultural capacity, population / employment density. In detail, they are

- 1) population and employment density per inhabitant;
- 2) surface area of retail facilities in m² per 1000 inhabitants;
- 3) density of catering per 1000 inhabitants;
- 4) office surface area in m² per 1000 inhabitants ;
- 5) percentage of the creative class and theater capacity;

Nevertheless, I need to claim that those indicators are chosen based on empirical study and previous researches. There are not firmly theories existing to prove that these indicators are the most precise or correct ones. But those indicators work well in reflecting city development, thus, they are being applied at here.

Apart from the economic geography theories, networks and mobility (Batten, 1995; Rooij, 2005) are helpful for understanding new town transformation as well. According to this theory, new towns should place more important roles in regional network, which means better spatial integration in regional network and less asymmetric commuting situation. Therefore, regional commuter rates, especially the asymmetry of commuting patterns, should be taken into consideration. Secondly, in urban scale, the focusing point is changing human structure in new towns. This is because middle class families in the beginning phase of new town will confront with other groups of people (Reijndorp, 2006). Specifically, the proportions of start-ups (18-25) and over 55s are two important indicators to measure the maturation rate of new towns. Moreover, the number of newcomers with high income and education also can be regarded as an indicator. In the beginning process of new town, the first pioneers are 'middle middle class' and they are looking for a peaceful suburban myth. Then, the population is transforming into an accomplished population because of the growing number of higher incomers. They bring a broader base for facilities because of their higher incomes. This will attract immigrant population and it will make new towns like real cities from a social point of view.

Overall, the changing socio-economic route in urban level has been revealed and measured through indicators below:

- 1) age structure;
- 2) income structure.

Those two indicators are meaningful as well to reflect city completeness rates.

3.3 The role of city completeness indicators

At here, it is very important to distinguish the indicators of city completeness and spatial principles may accelerate the new town transformation towards a complete city. In the following researches, the city completeness indicators mentioned above will be used to define new town's developing stage. Then, based on the order

in developing stages, positive spatial conditions which are important for becoming a more complete new town would be searched (Figure 2.3).

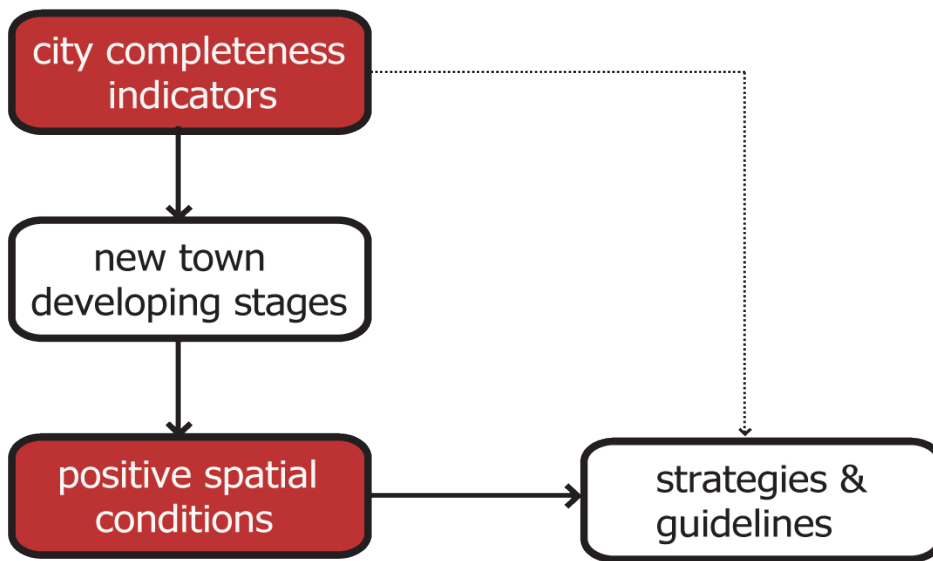


Figure2.3
Different functions of two categories.

4. Concept III: The new way of spatial modeling

Based on the conclusion of city development range, we can compare the spatial aspects in various cases to define the positive spatial principles. Before I explain the new way of spatial modeling, a brief review towards related spatial research methods is needed.

4.1 Classical research methods

The research only focusing on spatial aspects of new towns is limited. However, the study about suburban built environment is widely discussed with appearing of 'urban field' (Friedman and Miller, 1965). The first written spatial research about suburban areas started with Michel Conzen as well as Saverio Muratori. Cozen and Muratori attributed most of classical suburban morphology analyses (Conzen, 1960; Whitehand, 2001). Classical urban morphology defines the fundamental features of urban form through the structure of land subdivision and the open space system. Based on his work, various studies on contemporary suburban area were raised. For instance, Michael Southworth and Peter Owens (1993) studied the morphological evolution of several San Francisco suburbs. Analysis is mainly focusing on street patterns. They show how increasingly private and quieter streets are also accompanied by limited route choices and a diminished spatial interconnectedness. They claimed that street patterns, as the basic skeletal structure of communities, affect the urbanity. Thus, urban designers need to build a visible public structure to promote lively urban areas.

There are of course other studies using morphological analyses to handle the contemporary suburban tissues. The book "Suburban Form: an international perspective", edited by Stanilov and Scheer (2004), provide an overview on the subject. Just as Stanilov points out, "the need to perform analysis simultaneously on the macro level (urban context) and on the micro scale (urban fabric) presents a methodological challenge which still needs to be resolved." (Stanilov, 2004, p.4).

On a macro level, a theory of functional-spatial structure for vital city is developed by De Bois and Burmans (1998, 2005, 2007). This theory confirms that the completeness of the urban frame is in fact a prerequisite for the identity and

liveliness of the city as a whole. The complete urban frame is created through a 'parallel' urban decision making while new town development is a 'serial' planning process (De Bois, 1998; De Bois and Buurmans, 2007) (Figure 2.4).

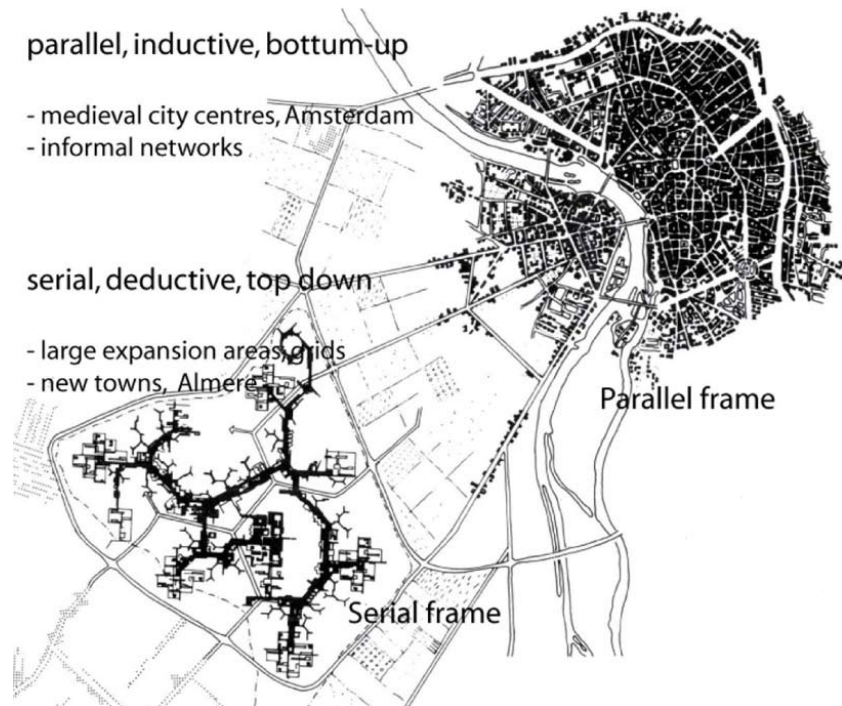


Figure 2.4

The principal difference between a 'parallel' and 'serial' urban system; (source: De Bois and Buurmans, 2007, p. 8).

In the meanwhile, Stephen Read (2001, 2005, 2007, 2009) proposed his 'Flat City' model of contemporary metropolitan movement networks, further developed on a series of subsequent papers. Based on Hiller's research (1999) about 'centrality as a process', he pointed out the emergence of centrality and peripherality is a condition mainly produced by the movement and communications network infrastructures rather than historical-evolution which we have no power (Read, 2005, p. 13) (Figure 2.5). Read uses this model to explain the spatial structure of cities behind the central core and into the periphery. Moreover, he claimed the urban liveliness and quality is creatable if we can well organized high-scale connections and low-scale grounding movement (Read, 2007). Read's model demonstrates an analytical framework that allows various scales of movement to be rigorously identified and analysed in practice, which is meaningful for new town researches.

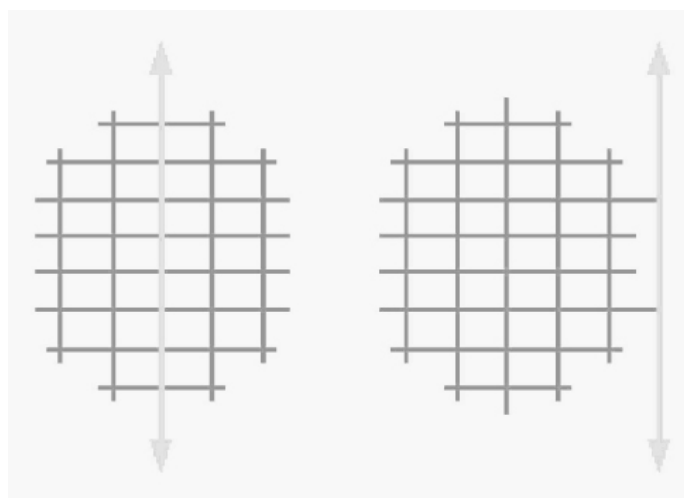


Figure 2.5

Centred and de-centred neighbourhoods; (source: Read, 2005, p. 14).

On a local level, Stephen Marshall (2005) proposed a series of new methods for analyzing the structure of street networks in his book 'Street and Patterns'. He claimed that the reversal of the relationship between urban movement and urban place is the fundamental difference between traditional and modern urbanism. "The most important traffic routes were no longer streets. The relationship between main routes and central places was reversed" (Marshall, 2005, p.4-5). The relationship between movement and urban place has inverted (Figure 2.6).

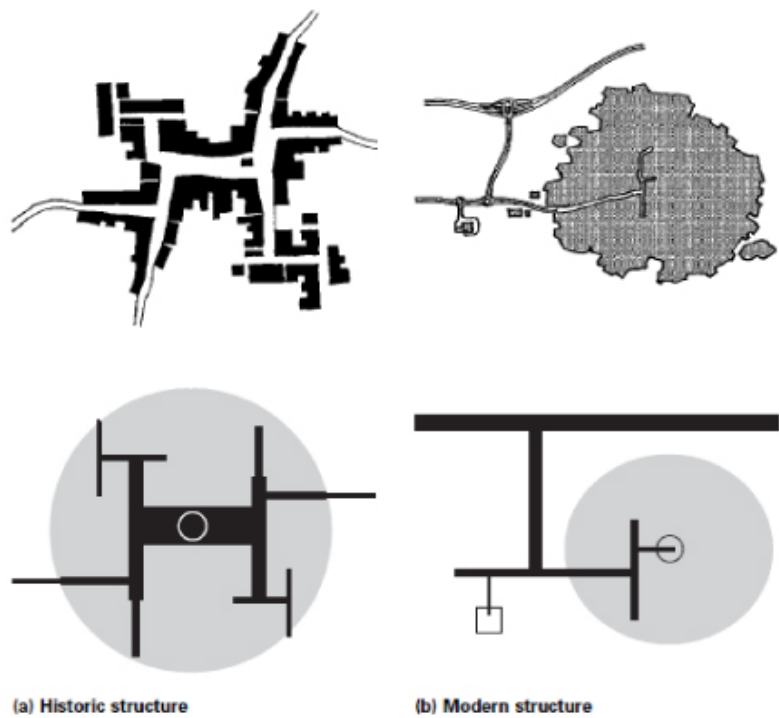


Figure2.6
The Modernist inversion of the relationship between urban movement and urban place; (source: Marshall, 2005).

Based on his basic distinction, Marshall is able to create a first set of elemental type, leading to one more level of typological definition and to an increasingly similarity with actual street patterns (Figure 2.7). Then, Marshall introduces four parameters: the 'T and X ratios' and the 'cell and cul ratios, which are able to quantify the position on the morphological continuum. He used simple techniques to explore the individual street patterns and the emerging morphology of the collective spatial network of the city-region, which provide a useful tool to understand new town from local level.

Macro:	Linear	Tree		Grid
Micro:		Tributary	Radial	
Tree				
Grid				

Junction type	Configuration	
	Tree	Cell
T-junctions		
X-junctions		

Figure2.7
Creation of hybrid patterns as permutations of macro and micro scale structures; (source: Marshall, 2005).

4.2 newly-emerged quantitative research methods

In the previous review, various classical methods are presented to analyze built environments' spatial properties. However, quantifying, calculating and visualizing spatial relationships become in particular useful when comparing these results with a registration of socio-economic activities in built environments. At least, it provides knowledge about the society – space relationship (Van Nes, 2011).

In general, urban designers tend to ignore the socio-economic impacts of their design proposals, which lead to vague presumptions on how these new urban areas should work after implementation. Conversely, urban sociologists and urban geographers have in general precise research questions and methods. However, they still have the problem of combining socio-economic data with spatial solutions on how to make livable built environments (Hillier and Hanson, 1984). Thus, quantitative as well as qualitative ways of comparing human activities with spatial force of built environments' need to be set up.

Based on the advances in computer technology, various urban simulation models provide us with tools to gain insight in built environment and teach us how to develop plans and strategies in a complex reality (Brömmelströet and Stolk, 2007). The newest GIS-related urban modelings developed from cellular automata (CA) and agent-based modeling (ABM) provide new possibility to underlying the conceptualization of urban form (Batty, 2005; Parker et al., 2003). The calling for bridging the gap between urban morphology and urban modeling has been proposed by Kiril Stanilov (Stanilov, 2008). Nevertheless, CA and ABM models do not understand built environment from the perspective of basic urban form characteristics. Thus, their simulations cannot match the physical patterns of urban development very well. In this context, many scholars turned to integrate spatial analyses tools with GIS for modeling urban space (Jiang, Claramunt and Klarqvist, 2010).

During the last couple of decades, the development of Space Syntax and other related quantitative methods raise the possibility of researching urban form from its key elements. Space Syntax, a renowned method developed by Bill Hillier and his colleagues, regards simultaneous relations between spaces as “configuration”, and understanding cities from that perspective (Hillier et al, 1998; Hillier, 1999). It has been widely used in spatial analyses about urban form. But Space Syntax, as a renowned method to study spatial configuration, does not consider density and functional issues in urban object. Therefore, it seems not to reflect built environment very precisely (Joosten and Van Nes, 2005; Stephen Read, 2005). Based on this kind of understanding, Ståhle, Marcus and Karlström are trying to incorporate Space Syntax with urban morphology. It is so far known the first trying to incorporate the spatial accessibility (Space Syntax) with other two elements (density and diversity) (Ståhle, Marcus and Karlström, 2005). Nevertheless, the measurements in the issues of density and diversity they used are still can be improved in a more quantitative way.

At present, two tools have been proposed: Mixed Use Index (Van de Hoek, 2009) and Spacematrix (Berghauser-Pont and Haupt, 2010), which provide possibility to measure diversity and density issues respectively. Specifically, the Mixed Use Index (MXI) is used to measure the functional mixture while Spacematrix can be applied in density and building types study. Those two methods can remedy the drawback in Space Syntax and assist us in gaining an objective understanding in built environment.

Later on, Birgit Hausleitner (2010) applied Space Syntax and Spacematrix in her study about urban form and human behaviour. Then, van Nes, Berghauser-Pont, Mashhoodi (2012) made a series of combinations about Space Syntax with Spacematrix and Spacematrix with MXI through GIS in Rotterdam analyses (Figure 2.8, 2.9). The combinations between Spacematrix and MXI can reveal some inherent spatial features. The combination of Space Syntax and Spacematrix is trying to reflect the built environment in a measurable way.

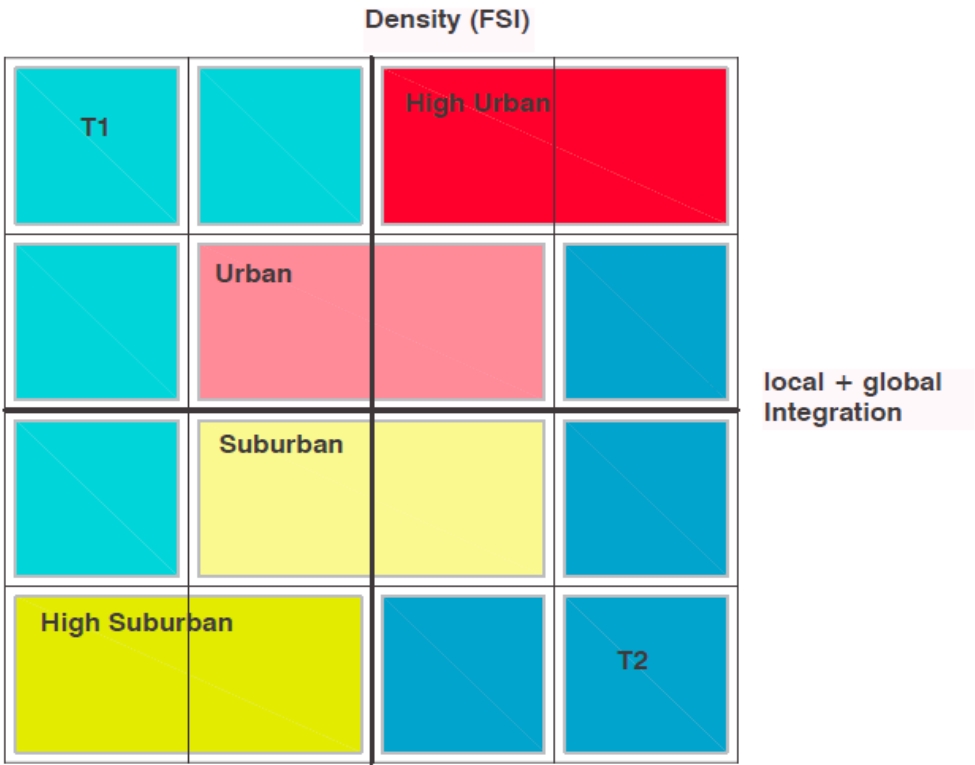


Figure2.8
The Matrix with colour codes used for aggregating the Space Syntax and Spacematrix data in GIS, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 19).

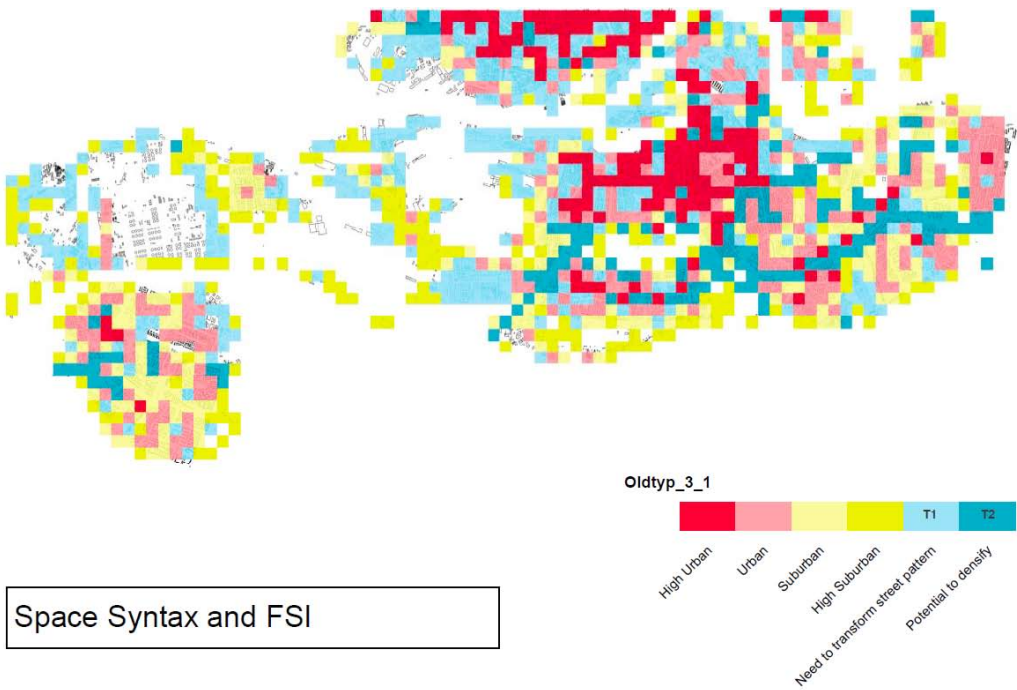


Figure2.9
The combination of Space Syntax and Spacematrix in GIS, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 19).

4.3 A new step forward based on previous quantitative method

Based on the method developed by van Nes, Berghauser-Pont and Masshooi, I make a step forward to combine all the three measurements together: Space Syntax, Spacematrix and MXI with the help of GIS. Space Syntax, Spacematrix and MXI representing street network, building types and land use respectively are integrated in the same matrix through GIS. Bringing this combination method further into the new town discussion is aiming to understand the spatial differences between new towns in comparison with old towns in terms of the spatial configuration of the street and road network, the degree of densities of the built mass, and the degree of mono-functionality versus multi functionality. A classification of various types of urban area, based on a combination of the above-mentioned elements, is made and discussed.

By this way, three constituent elements (street network, building types and land use) of urban form can be quantified and overlapped with each other (Figure 2.10). This new spatial modeling will gain us with a more objective understanding about urban form.

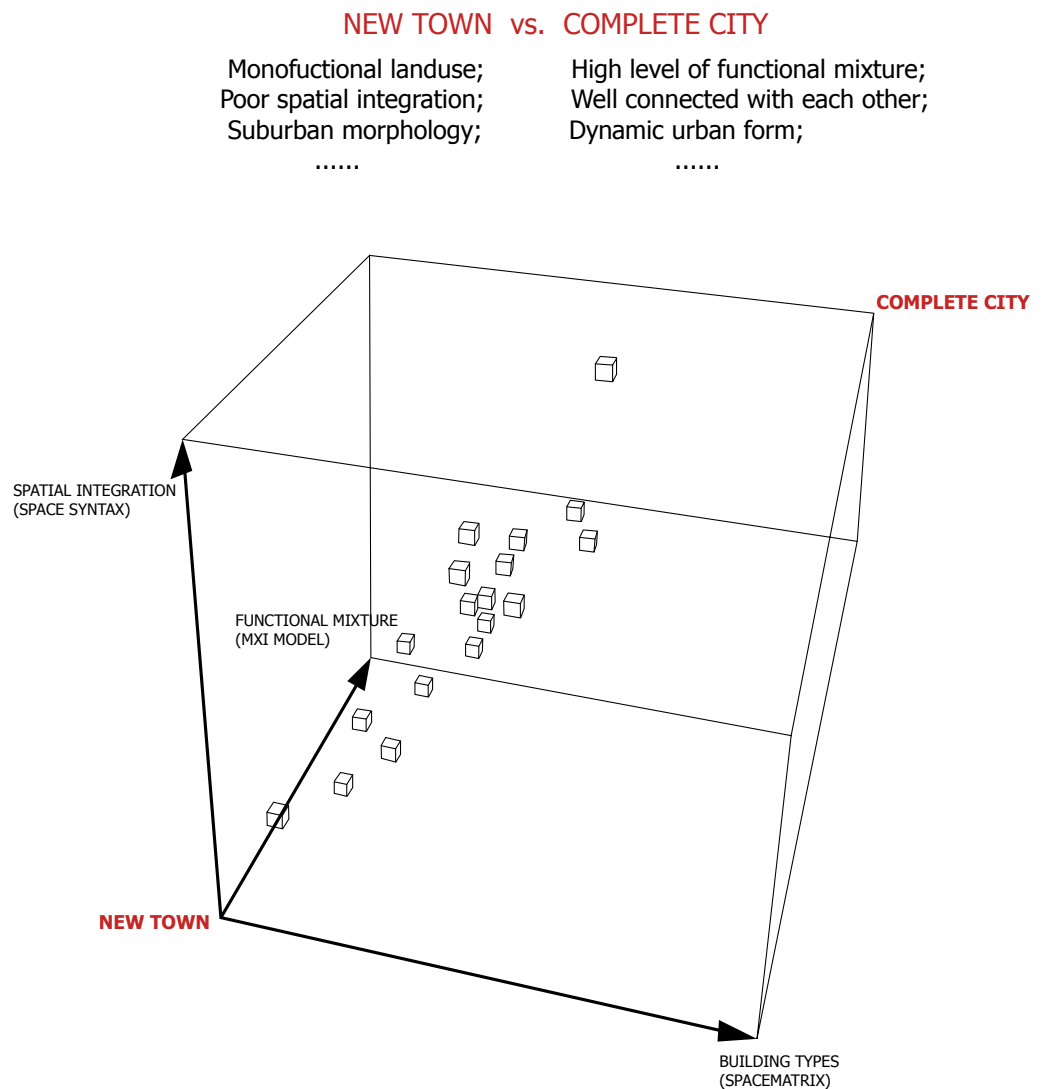


Figure2.10

The new spatial modeling method: the spatial integration on the x-axis is measured by Space Syntax, and the urban morphology on the y-axis is measured via Spacematrix. The functional mixture on the z-axis provides us with information from MXI model.

In my following researches about Dutch and Chinese new towns, the degree of spatial balances and imbalances between building density, network integration and degree of function mix can be visualized. Through statistics analyses, the relationship among the three measurements can be clear.

According to this relationship, an urban diagnosis aiming to point out potential areas to improve development can be made. In particular, this combination can show where the weaknesses are, what they consist in and what needs to be done to upgrade the urban area at issue. This method is beneficial for promoting urban simulation and it could be used as a tool for understanding and diagnosing various types of urban areas. It is a useful tool for both Dutch new town regeneration and Chinese new town development.

Based on those works, I can generalize the principles of the natural urban transformation process and principles of the planning process in newly developed areas. Deeper study in this direction will be made in my future research.



SECTION III:

ANALYSES IN DUTCH CONTEXT

INTRODUCTION TO THE EMPIRICAL STUDIES

THE RANGE OF CITY COMPLETENESS RATES

SPATIAL PRINCIPLES IN REGIONAL SCALE

SPATIAL PRINCIPLES IN URBAN SCALE

1. Introduction to the empirical studies

The main aim of this section is trying to understand Dutch new town transformations in regional and urban level. Then, a transforming rule in Dutch new towns will be proposed and applied in guiding the development of Songjiang new town.

To explore the transforming rules leading to a complete city, the selection of research cases need to be made. The set of criteria is used to choose a set of cities developed during different time. Specifically, new towns built in different time and one historically-evolved city will be chosen. Through comparing their various regional and urban features, the conclusions could be used to guide new towns in China.

Lelystad: As the capital in province of Flevoland, the building process of new town Lelystad started since 1967. It was developed from a large barren area, however, there are about 72,252 inhabitants living in this new town after developments in past 45 years.

Almere: The city of Almere is the largest and youngest new town in the Netherlands. In the beginning, it was planned to provide a solution for housing shortages in the metropolitan area of Amsterdam. The plan was implemented since 1974. After thirty years development, it is the seventh largest city in the Netherlands with more than 19,000 inhabitants and 13,000 businesses.



Almere



Zoetermeer



Lelystad



Haarlem

Zoetermeer: Zoetermeer has a long history but it was a small village until 1960s. Its real growth started in 1966 in order to handle the urgent need of houses from people around Den Hague. Through developments in new town Zoetermeer during past half century, there are 12,580 inhabitants living in Zoetermeer and it becomes a famous ICT-city with a great number of factories and job opportunities.

Haarlem: As a historically-evolved city, Haarlem has a rich history tracing back to pre-medieval ages. And it was one of most important Dutch cities during Dutch Golden Age. Now it is still an important city in Amsterdam metropolitan area and Randstad. There are 150,611 inhabitants living in.

Overall, Lelystad, Almere and Zoetermeer are chosen as the representatives of Dutch new towns because of their relatively long history and similar size. Meanwhile, Haarlem is regard as the sample of a more complete, attractive city developed during much longer time. As a historical city having a strong connection to Amsterdam, Haarlem is a perfect sample to compare with those three newly developed towns. It is also necessary to mention that although all three new towns are built from 1960s or 1970s, they are located in quite different stages of development now. Through those empirical case studies, the transforming process from new towns to more attractive cities in regional and urban scale will be explored. Whether this process is merely related with time, with spatial structure or with other compositions could be answered. The principles aiming to accelerat new town transformation will be defined in regional and urban scale.

.....

"FIRST OF ALL, THE ANALYSES WILL BE FOCUSED ON THE INDICTORS OF CITY COMPLETENESS RATE. THEN, THE RANGE OF CITY DEVELOPMENTS IN THESE FOUR CASES WOULD BE GIVEN. AFTER THAT, BASED ON THIS CONCLUSION, THE POSITIVE SPATIAL CONDITIONS IN REGIONAL AND URBAN SCALE CAN BE IDENTIFIED"

.....

2. The range of city completeness rates

Just as the research method I mentioned above, my study will starts from the indictors of city completeness rate. And thenI will turn to the positive spatial principles based on the developing stages

2.1 Indicators of city completeness rate in regional network

A series of indicators, including the amount of catering facilities, retail and office surface area, cultural capacity, population / employment density will be studied below.

2.1.1 population and employment density per inhabitant



Figure 3.1
Population and
employment density
per inhabitant, (source:
Selezneva, 2011; CBS NL,
2009)

In Figure 3.1, the population density and employment density in three new towns and most populated cities in the Netherlands are demonstrated. The population density signifies market potential for localization of socio-economic functions and the opportunities for creativity and cultural engagement. The employment density is crucial for the quality of business climate and job opportunities (Selezneva, 2011, p. 80). As seen from the analysis above, in Almere and Lelystad, their population and employment density are lower compared with other historically-evolved city.

However, those two indicators in Zoetermeer are similar to other cities, like Rotterdam. In addition, Haarlem shows higher two indicators compared with new towns. In this aspect, Almere and Lelystad are still largely suburban with low economic significance for the Randstad, while Zoetermeer occupies a better position.

2.1.2 surface area of retail facilities in m² per 1000 inhabitants;



Figure 3.2
Surface area of retail facilities in m² per 1000 inhabitants, (source: Selezneva, 2011; LOCATUS, 2009).

From Lelystad to Almere to Zoetermeer, a slightly growth in average retail facilities can be found. But this number is still lower than other historically-developed cities (Figure 3.2). Haarlem, which benefits from its long history and resorts, has much higher number compared with the three new towns.

2.1.3 density of catering per 1000 inhabitants;



Figure 3.3
Density of catering per
1000 inhabitants,(source:
Selezneva, 2011; CBS NL,
2009).

Small cafeterias and restaurants are treated distinguishedly. We can see that the result in Figure 3.3 is similar with the analysis above. The number increases from Lelystad to Almere to Zoetermeer, nevertheless, it is still much lower than the number in Haarlem. In addition, in some regional central cities, like Groningen and Utrecht, the density of cafeterias are close to the density of restaurant. This situation cannot be found in new towns.

2.1.4 office surface area in m² per 1000 inhabitants;



Figure 3.4

Office surface area in m² per 1000 inhabitants, (source: Selezneva, 2011; VGM, 2007).

The result has a slight difference in office area analysis (Figure 3.4). As an important center of ICT, Zoetermeer has higher office surface area compared with Haarlem. It might be one of the reasons leading to its successful development. Although both Almere and Lelystad show a low grade in this indicator, Almere still performance better than Lelystad.

2.1.5 percentage of the creative class and theater capacity;

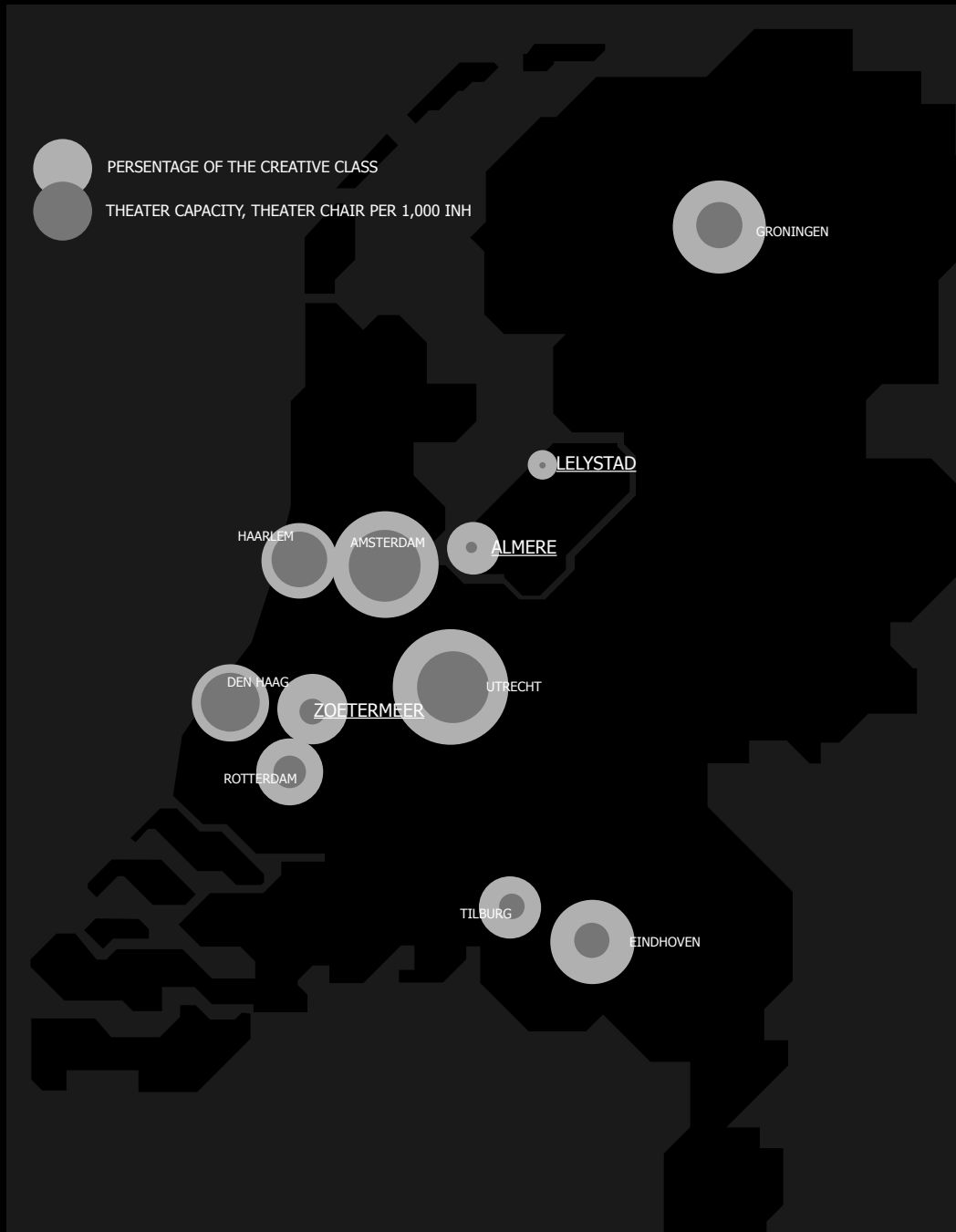


Figure 3.5
Percentage of the creative class and theater capacity,(source: Selezneva, 2011; VGM, 2007).

Cultural capacity is also an important indicator to measure new towns' developments and it really reveals some interesting points in Figure 3.5. In the percentage of creative class, the routine from Lelystad to ALmere to Zoemeteer and Haarlem is still existing. However, theater capacity distinguishes old and new cities objectively. Higher theater capacity is obvious in Haarlem, Amsterdam, Den Haag and Utrecht while this number is extremely low in new towns.

2.1.6 Regional commuting rate

Asymmetry of commuting patterns between municipalities in the Randstad during different time will be analyzed. The changes in commuting directions and numbers could be used to understand new town's regional positions.

The asymmetry score is calculated as the $(a \text{ to } b \text{ minus } b \text{ to } a) / (a \text{ to } b \text{ plus } b \text{ to } a)$. A score of 0% indicates complete symmetry (equal amount of in and out commuting) while a score of 100% indicates complete asymmetry (there is only a flow from one side to the other) (Van Eck and Snellen, 2006, p. 10).

From Figure 3.6 it is easy to see that during 1990/1994, commuting patterns in ALmere and Lelystad are highly asymmetric and their commuting directions are very limited – only pointed to Amsterdam. Various commuting directions can be found in Zoetermeer. But Zoetermeer still have a main commuting direction to Den Haag, which is shown in yellow. As a more complete city, Haarlem demonstrates various main commuting directions and relatively equal commuting numbers on different directions.

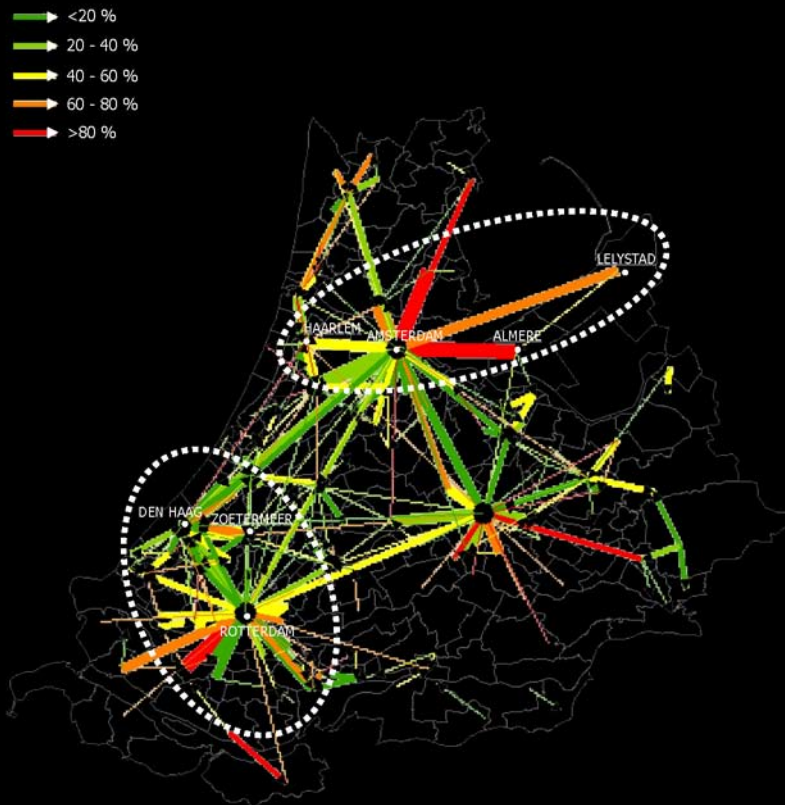


Figure 3.6
Asymmetry of commuting
patterns between
municipalities in the Randstad
1990/1994, (source: Van Eck
and Snellen, 2006, p.12).

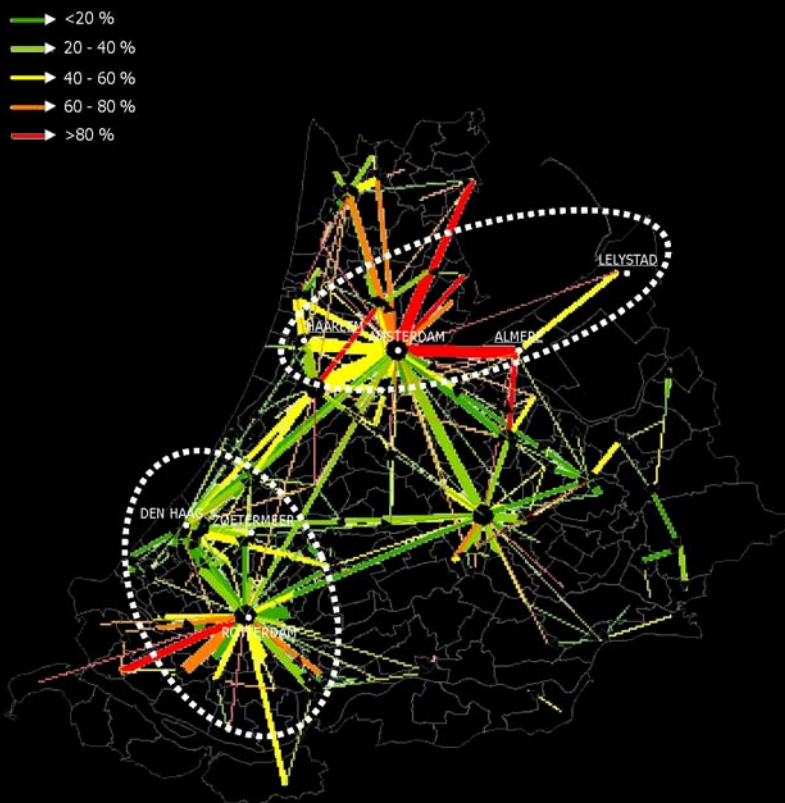


Figure 3.7
Asymmetry of commuting
patterns between
municipalities in the Randstad
2001/2003, (source: Van Eck
and Snellen, 2006, p.12).

Nevertheless, the commuting patterns are changing during time. Ten years later, the asymmetric commuting between Almere and Amsterdam decreased and Almere had more commuting directions. Similar situation can be found in Zoetermeer. Its asymmetric commuting to Den Haag declined and at the same time, more connection directions emerged around Zoetermeer. Even in Lelystad, we can see that the connection between Almere and itself was increasing.

2.2 Indiactors of city completeness rate in urban scale

As mentioned before, the socio-economic transformation from new towns towards complete cities will be considered in urban scale, which mainly focuses on population issue (bevolking). There are two indicators will be investigated: 1) age structure; 2) income structure.

2.2.1 Population pyramid analyses

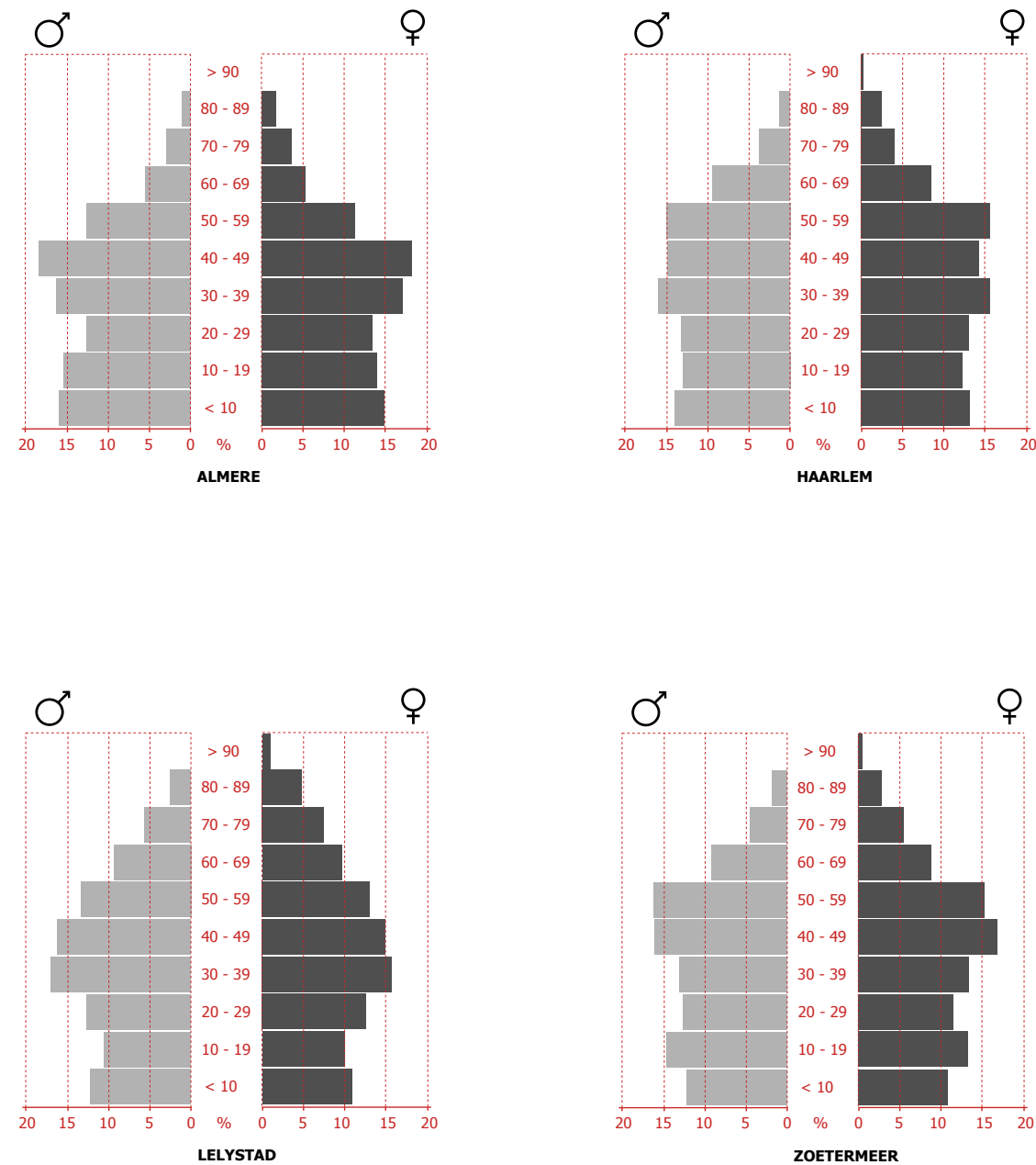
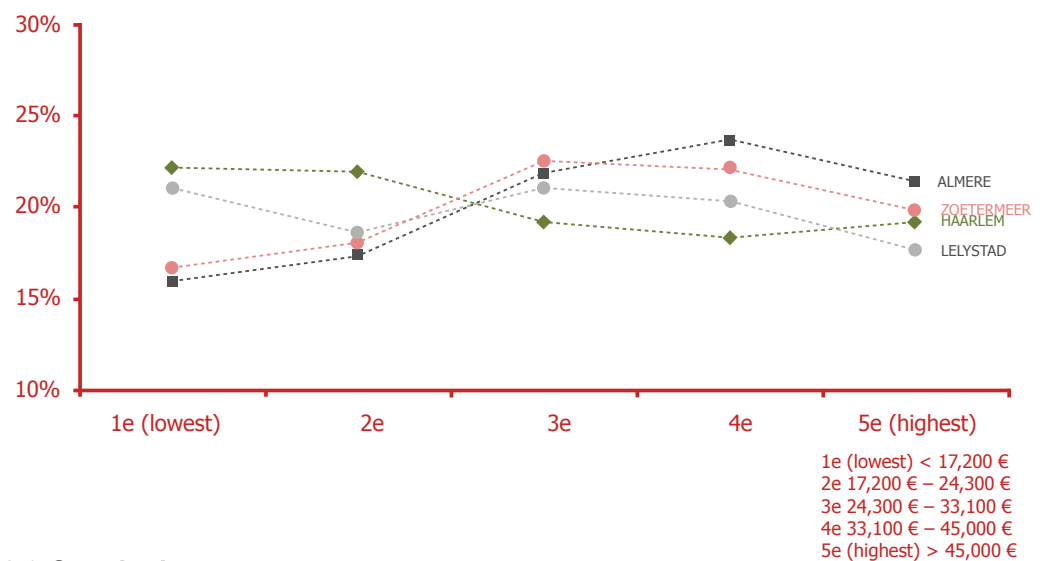


Figure 3.8
Population pyramid in four cities,(source: Stadline, 2007).

The characteristics and developing trends of new towns have been revealed based on the illustration in Figure 3.8. In typical new towns: Lelystad and Almere, a broad feet can be found because of their high birth rates. A waist is clear as well because of the exodus of young people and the continuous inflow of young families. However, those two features are not obvious enough in Zoetermeer, a more mature city and also historically-evolved Haarlem. In contrast, in both Zoetermeer and Haarlem, we can see higher proportion of youth (20-29) and elderly people (>50). Those two particular groups are crucial for a city because they produce and consume cultures, spend time and money in the city; while the working parents of middle classes are too busy with work and kids. Nevertheless, this feature cannot be found in Lelystad and Almere.

Apart from the population pyramid, income structure can demonstrate the developing stages of new towns as well. As we all know, new towns begin from the population consists large number of middle class families, which will be changed with inflow and outflow of other classes. This process is demonstrated objectively (Figure 3.9). In Lelystad, Almere and Zoetermeer, we can find high proportions of middle-class families (3e-4e) and limited percentages of start-upers with lower incomes. In addition, well-developed new towns can attract high-income people, which are illustrated in the comparison between Lelystad and Almere. Overall, the changing socio-economic route in urban level can be defined based on researches in population aspects.

Figure 3.9
Household income group
in four cities (20% groepen
inkomensverdeling
particuliere
huishoudens), (source:
Stadline, 2007).



2.3 Conclusion

Overall, we can find that no matter in regional or urban scale, Haarlem has highest city completeness rate, which is followed by Zoetermeer. Almere occupied the third and Lelystad is located in the last one, which proves that **time is not the only element affecting new town transformation.**

The city completeness rate from high to low:

'Haarlem > Zoetermeer > Almere > Lelystad'

Then, I will turn to spatial aspects and try to identify the positive spatial conditions based on this conclusion of city completeness rate.

3. Spatial principles in regional scale

3.1 Comparing analyses

The Space Syntax analysis based on Depthmap can reveal relational positions of those new and old cities within regional network. The effects of relational movements and configuration may have an impact on positional hierarchies, which is important as it reveals its potential for housing activities and functions. Therefore, the configuration rate could be regarded as a factor to measure cities' maturation process and it can be used to understand the changing positions during new town developments.

This Space Syntax calculation is mainly focus on Randstad area because all of four cities are located in Randstad or closing to this area. Moreover, typological and metric analysis will be used because this tool can integrate typological and metric aspects at the same time.

This Space Syntax analysis in intercity level (Figure 3.10) demonstrates that both historical city (Haarlem) and well-developed new town (Zoetermeer) have good connections in intercity level, which are lacking in other two new towns (Almere and Lelystad). But the difference between old city and newly-developed city is obviously as well. A centrality to the city center could be found in old cities like Haarlem and Leiden, while this situation cannot be found in all three new towns. Compared with Almere, neither regional connection nor inherent centrality is positive in Lelystad.

In other words, we can suppose a better organized regional network could accelerate the new town transformation towards the complete city.

From a higher level (Figure 3.11), we can find that both historical city (Haarlem) and well-developed new town (Zoetermeer) have good regional connections in more than one directions. Newly-developed town (Almere) only demonstrates one good connection to Amsterdam, while no strong connection can be found in Lelystad. Overall, the configuration rates correspond with former studies about those new town developments and the conclusion also reveal some new ideas, especially in intercity level.

In conclusion, we find that there are two spatial conditions can accelerate new town developments in regional scale.

1) INTENSIVE CONNECTIONS IN INTERCITY LEVEL

2) VARIOUS REGIONAL CONNECTIONS

That is why Zoetermeer has higher completeness rates compared with Lelystad, even they are built in the same period.

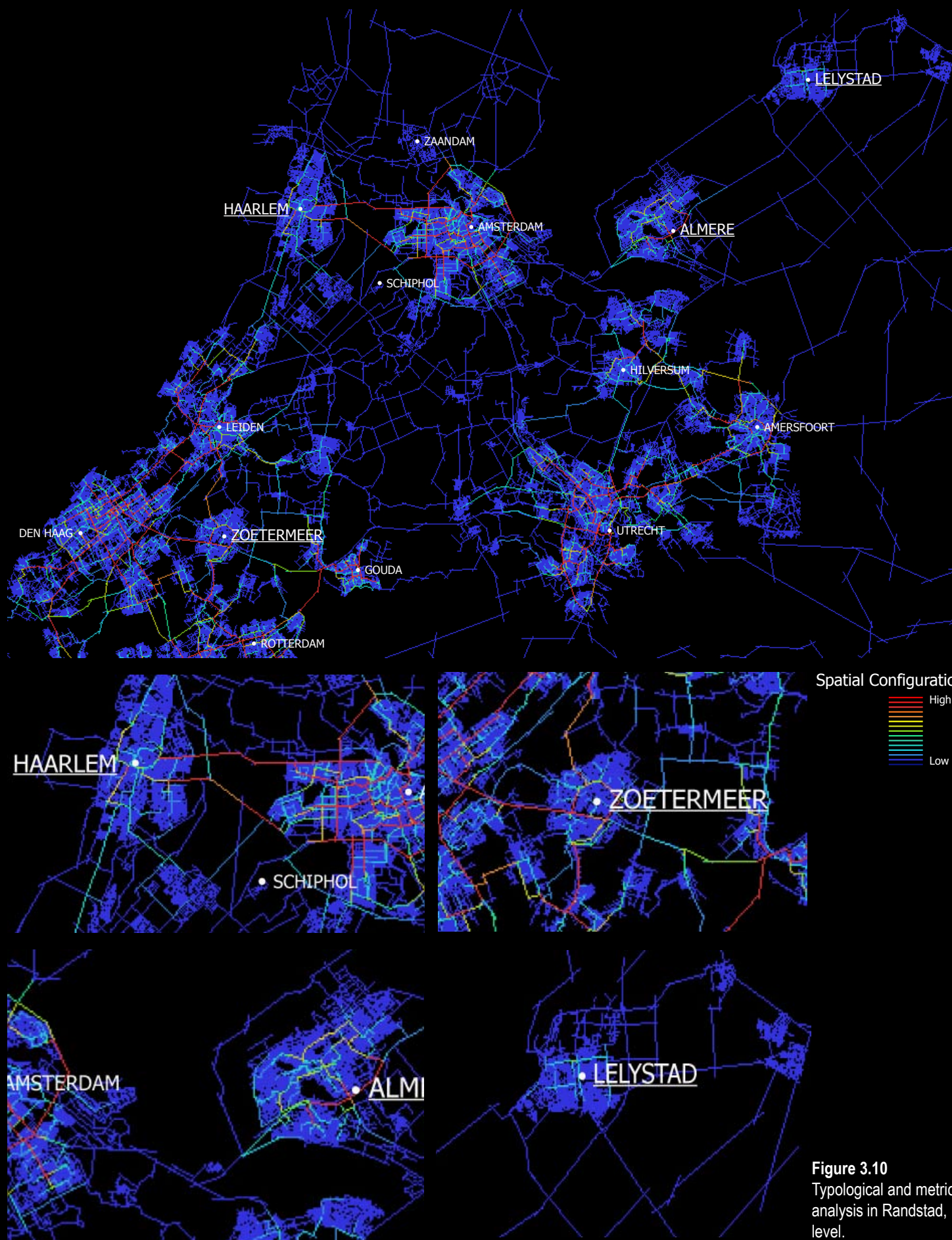
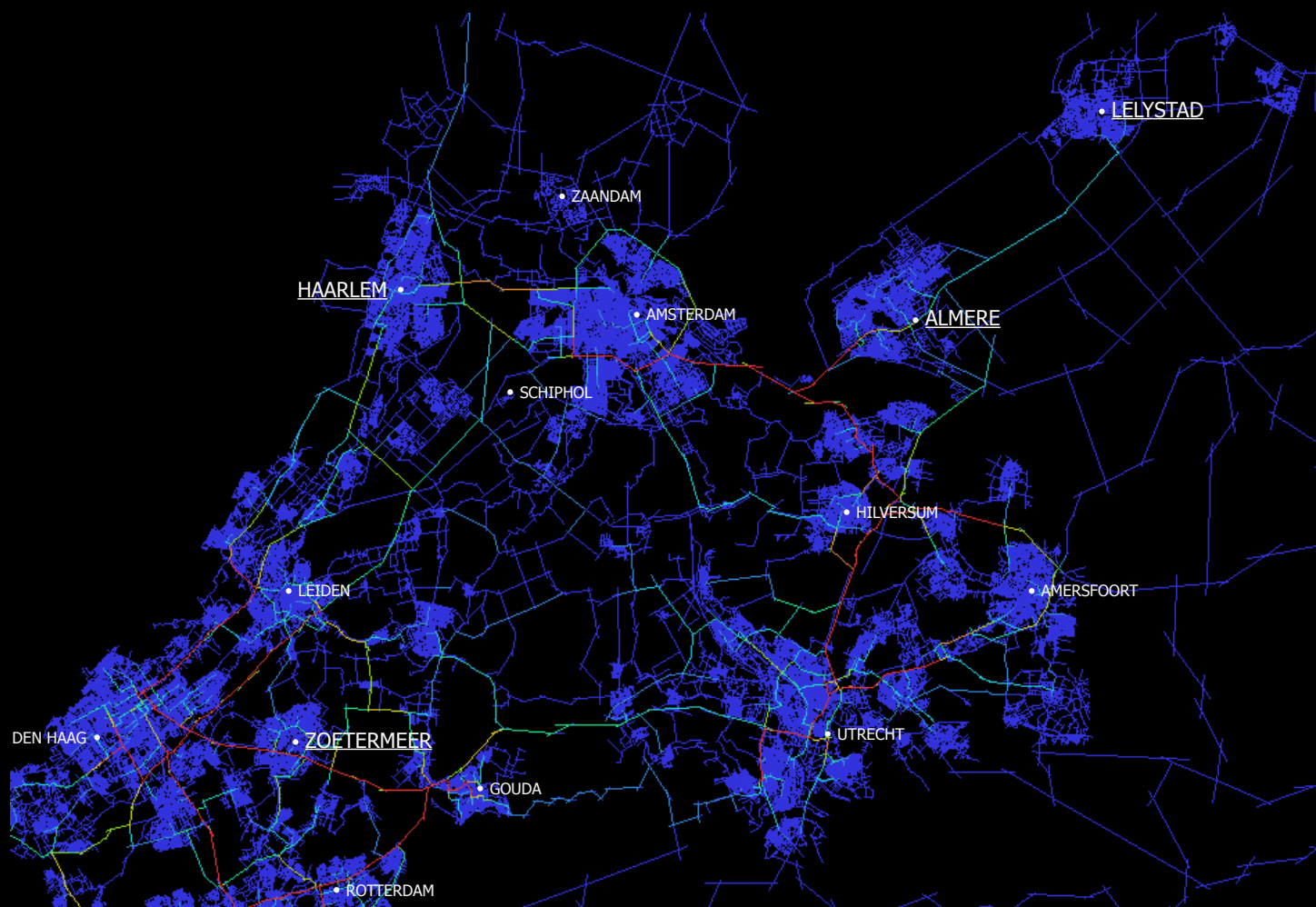


Figure 3.10
Typological and metric
analysis in Randstad, Intercity
level.



Spatial Configuration

High

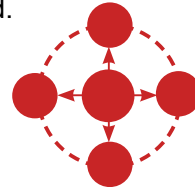
Low



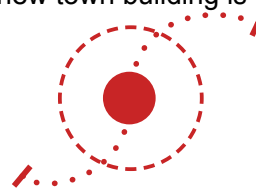
Figure 3.11
Typological and metric
analysis in Randstad, North
wing & South wing level.

3.2 Suggestions for urban planners in regional scale:

1) intensifying new towns' connections in intercity level or planning new towns in areas having highly intensive networks: the importance of surrounding area (city) connections has been proved in previous studies. Through adding new roads (showing as red arrows) to promote spatial integration in intercity level, the new town development can be accelerated.



2) increasing directions in new towns' regional connections: various regional directions are the other important suggestion in accelerating new town development. Nevertheless, this kind of interventions needs huge funding and time, which is impossible to be made in a short time. Thus, as urbanists, planning this kind of connection in the beginning of new town building is more appropriate.



4. Spatial principles in urban scale

As I mentioned in the problem statement, GIS would be applied to bring three measurements (Space Syntax, Spacematrix and MXI) into one framework. By this way, we can try to define the characteristics of urban area based on a combination of various spatial analytical methodologies. The different characteristics in various Dutch new towns will be analyzed and then be generalized.

Specifically, I will follow Van Nes, Berghauser Pont and Mashhoodi (2012)'s way to combine those above mentioned methods. The approach is to impose a grid with cells of 150 x 150 meter covering the whole city in GIS file. Various values can be transferred into cells and then be integrated with each other. The chosen size of the cell is depended on the context. In general, smaller cells contribute to more precise results. However, a too small cell-size can also disturb the correlation between different factors. A cell should therefore be at least of such a size that the results from both methods are represented. In other words, the biggest building should be covered by a cell (Van Nes, Berghauser Pont and Mashhoodi, 2012). Figure 3.12 demonstrates an overview of how different values will be aggregated into each cell in different layers.

Layer	Agglomeration rule	Description
Spacematrix	Accumulation	Sum of gross floor area and footprint per area of cell
Space Syntax	Maximum	Maximum integration value of axis within a cell
MXI	Weighted average	Percentage of the three functions in each cell (measured in gross floor area)

Figure 3.12

Techniques of aggregation of information, (source: Van Nes, Berghauser Pont and Mashhoodi, 2012, p.18).

4.1 Lelystad as an example

Following the instructions above, new town Lelystad will be analyzed firstly as an example to demonstrate the operating method.

4.1.1 Integration analyses with Space Syntax

Figure 3.13 shows the angular analysis of Lelystad. The map on the left shows the local angular Space Syntax analyses from Depthmap, while the right map shows the distribution of integration on the raster created in GIS. The axes with different integration values are reflected in cells with various colors. At here, only local angular analysis is chosen. That is because, generally speaking, local angular analysis is the best reflection on angular integration result. Some test also prove that the combination results of global and local angular analyses do not coincide with the real situation, while the local angular analysis can reflect it well.

Global analysis (left) and local analysis (right) of Lelystad in typological & metric way are showed in Figure 3.14. When applying the typological and metrical radiuses, the results will be different with angular analyses because metric radius will be taken into consideration. In addition, the integration value from high to low are defined separately according to *Natural breaks (Jenks)* through ArcGIS.

Through integrating combined typo-metric analyses (Figure 3.15) with analyses (Figure 3.13), results considering both angular and typological-metric radius can be created (Figure 3.16). A matrix with 3 x 3 cells was made on the relationship between high, medium and low metrical radius values and the analyses with high, medium and low integration values. Obviously, the most vital urban areas tend to be where streets have both high integration values (angular analysis) with high typo-metrical radiuses values (typo-metric analysis). In addition, it is also important to mention that the results in angular analyses have higher weighting compared with typo-metric radiuses values, which has been proved by some previous researches.

As can be seen from the combined map (Figure 3.16), partly of the main roads tend to have both high integration values and typo-metric radius. In addition, we cannot find an accumulation in the city center, or we can say there is a centric lacking in the Space Syntax aspect. What we have, is just a highly integrated circle around the geometric center. After that, the next step is to reveal the FSI and GSI values in these areas through the use of Spacematrix.

Natural breaks (Jenks)

Classes are based on natural groupings inherent in the data. ArcMap identifies break points by picking the class breaks that best group similar values and maximize the differences between classes. The features are divided into classes whose boundaries are set where there are relatively big jumps in the data values.

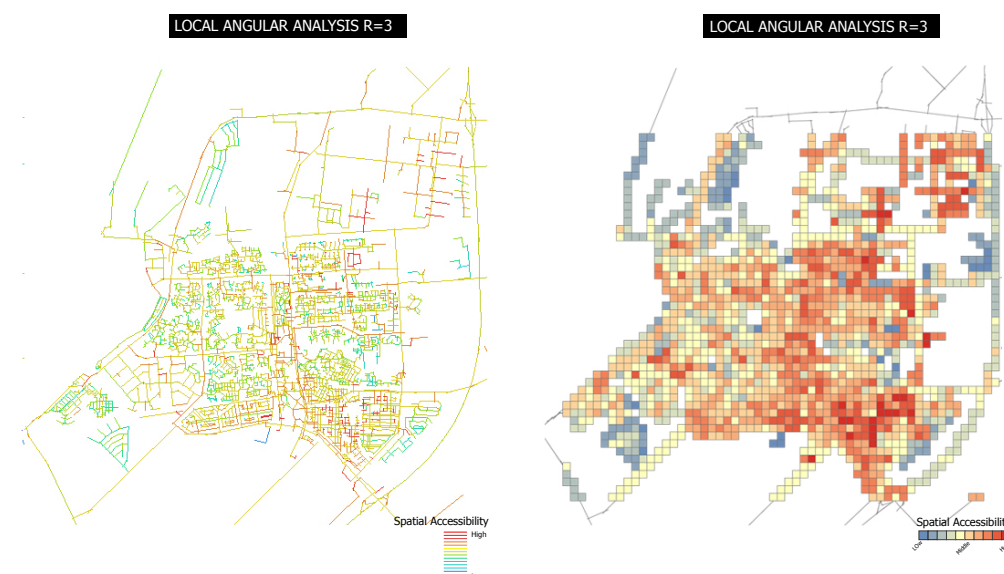


Figure 3.13
Local angular analyses in Lelystad.

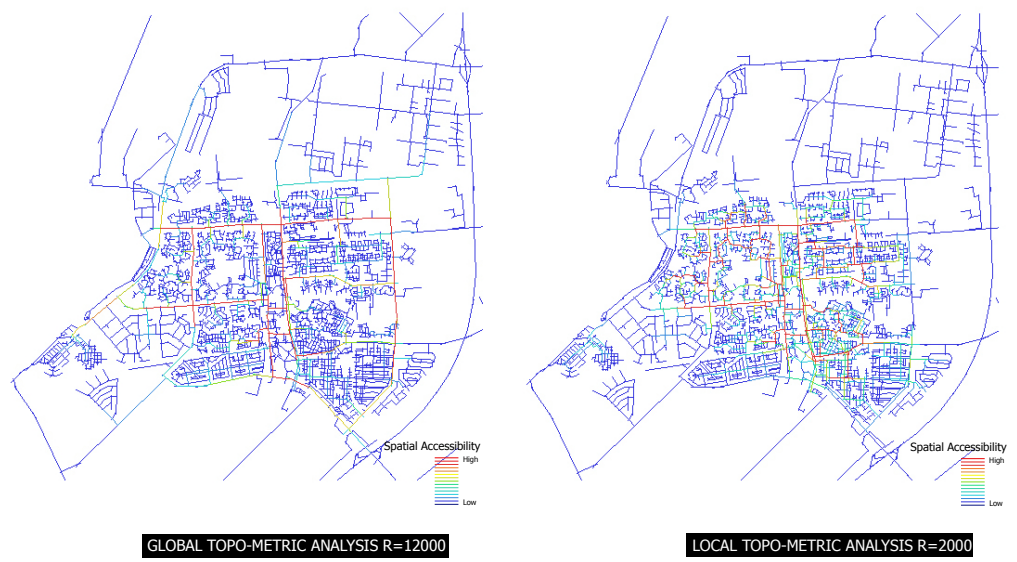


Figure 3.14
Typo-Metric analyses in Lelystad.

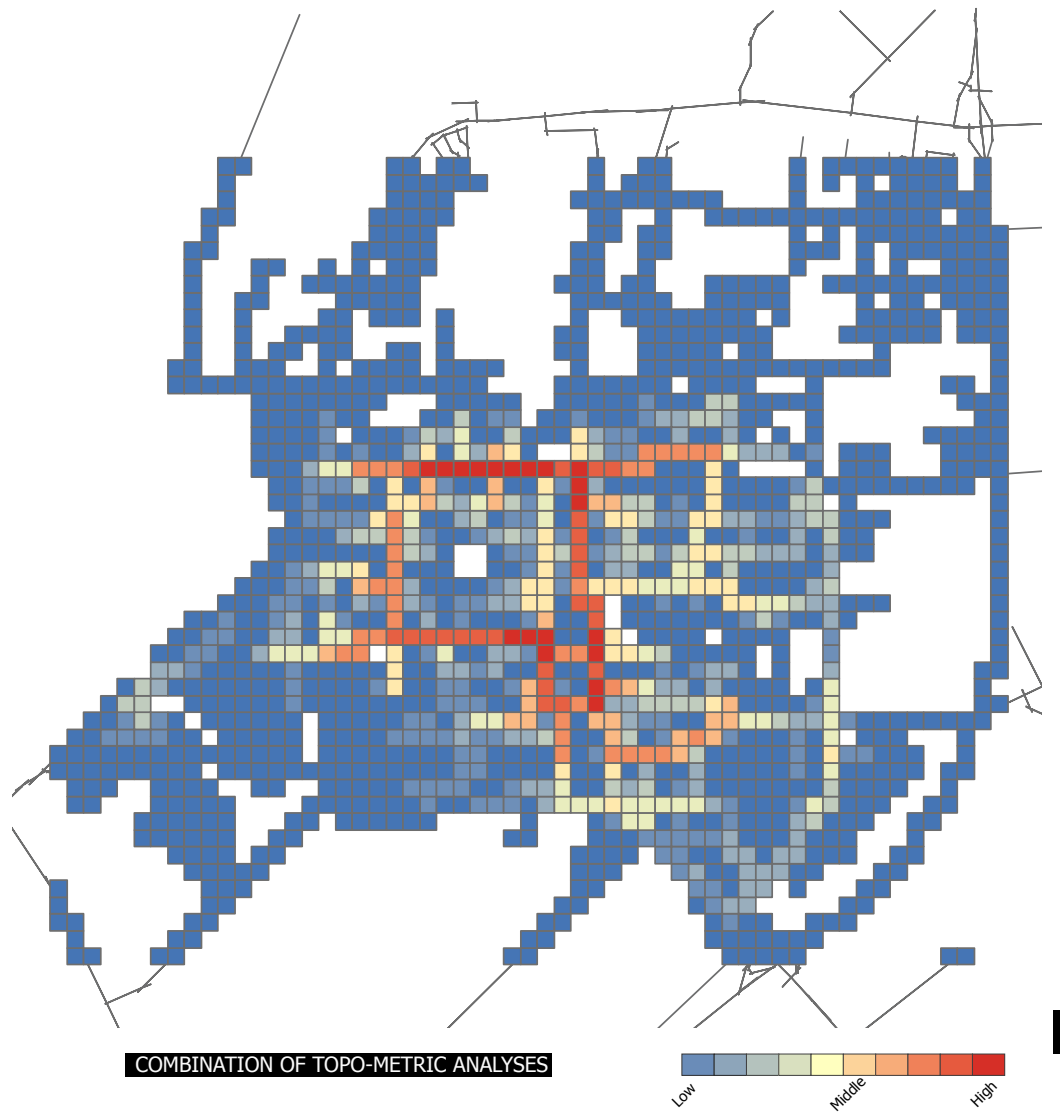
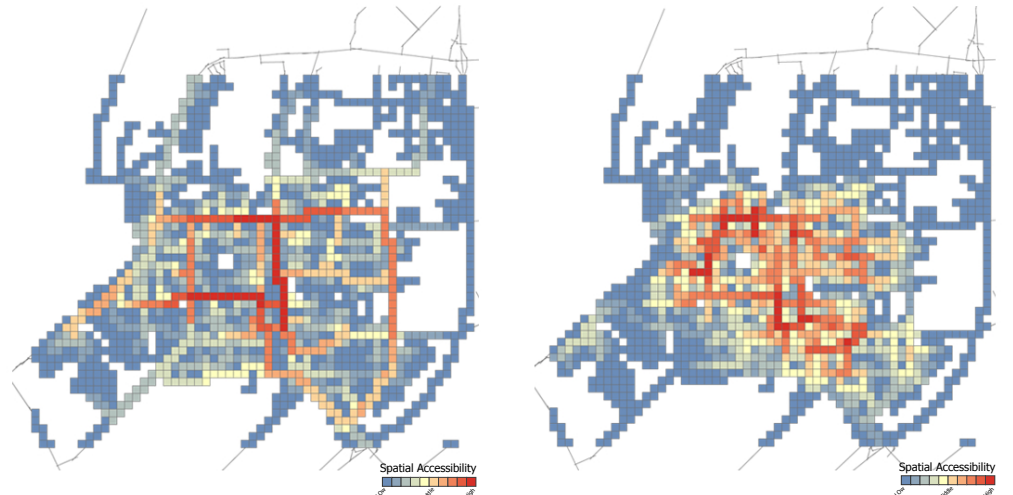


Figure 3.15
The combination of topo-Metric analyses in Lelystad.

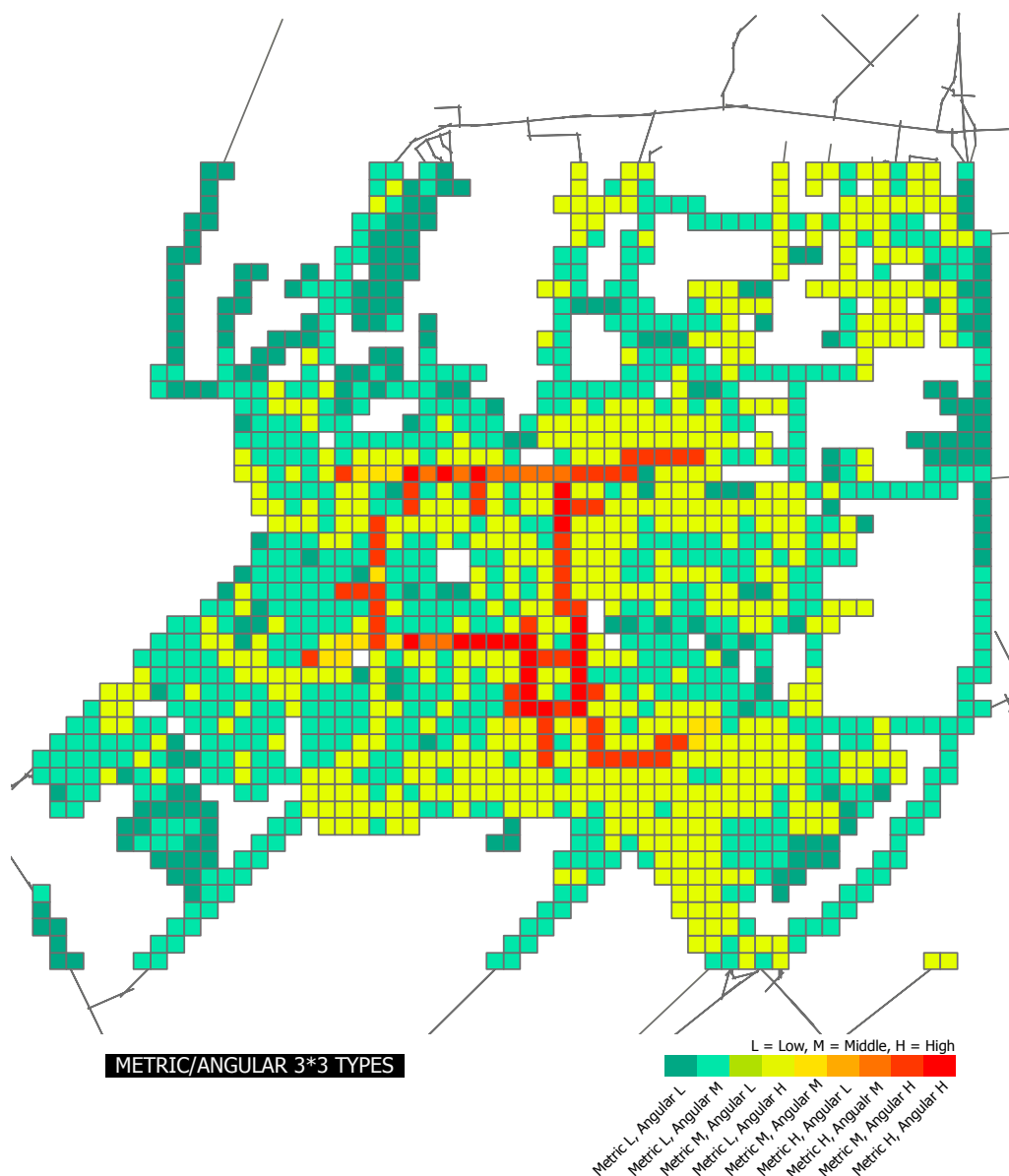


Figure 3.16
The combination of angular
and typo-metric analyses.

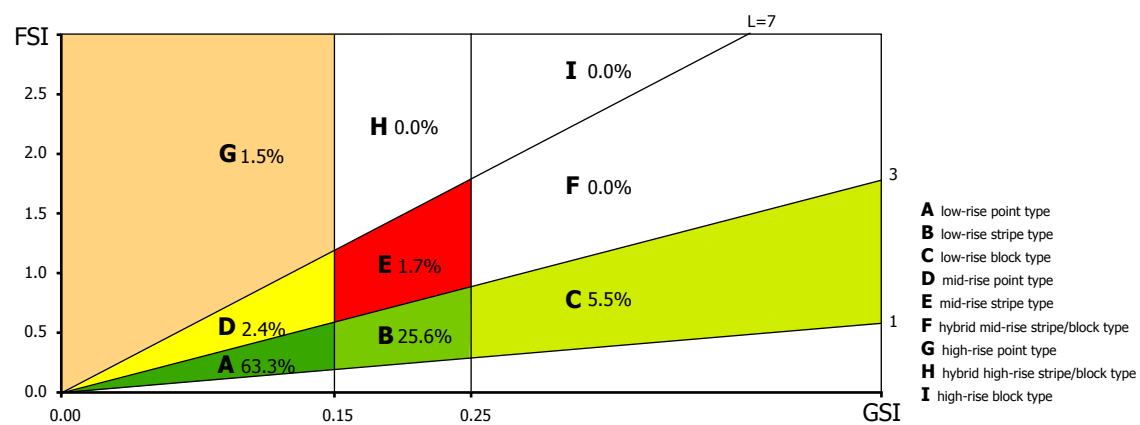
4.1.2 Morphology analyses with Spacematrix

Figure 3.17 shows the nine built types defined by Spacematrix. The whole built environment is separated into low rise, middle rise and high rise based on floor numbers. It is also separated into point type, stripe type and block type based on building forms. The percentages of various types are illustrated in the FSI-GSI plane of the Spacematrix (Figure 3.18). Overall, the density of the built mass is low in Lelystad. More than 60% of the cells consist of low-rise buildings with lesser than 3 floors (dark green cells). More than 95% of the built mass has a FSI lesser than 1.0. Moreover, the lacking of positive urban types (middle rise stripe and block types, high rise block types) is obvious in Lelystad. Especially the proportions of middle rise block and high rise block types are both zero.

In general, the building density is low in Lelystad. Low rise point and stripe types are dominant (Figure 3.19). Some low rise block and middle rise points are scattered over the built mass of low rise types. In addition, the city consists of very limited number of high-rise developments (the red cells in the map) locating close to city center and the main entrance from highway node to Almere and Amsterdam .



Figure 3.17
The demonstration of various building types in Spacematrix



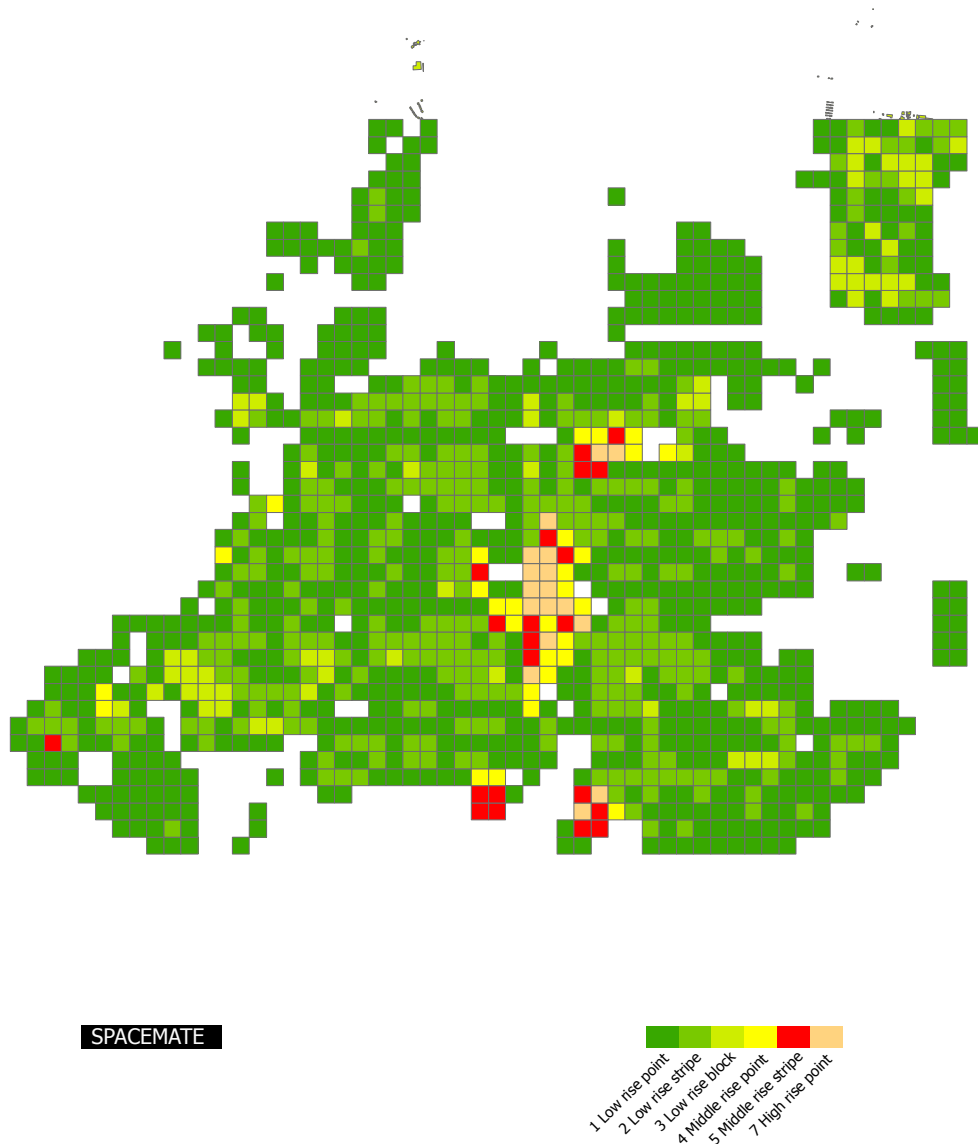


Figure 3.19
The location of the 6 different environmental types in Lelystad as defined with Spacematrix in Lelystad.

4.1.3 Functional mixture analyses with MXI

Before I show the functional distribution map in Lelystad, the definition of MXI should be explained (Figure 3.20). The functional distribution is separated into three levels: mono-functional, bi-functional and triple-functional. Mono-functional means purely amenities, housing or working areas. Bi-functional means the mixture of two functions while triple-functional represents highly mixture within three functions.

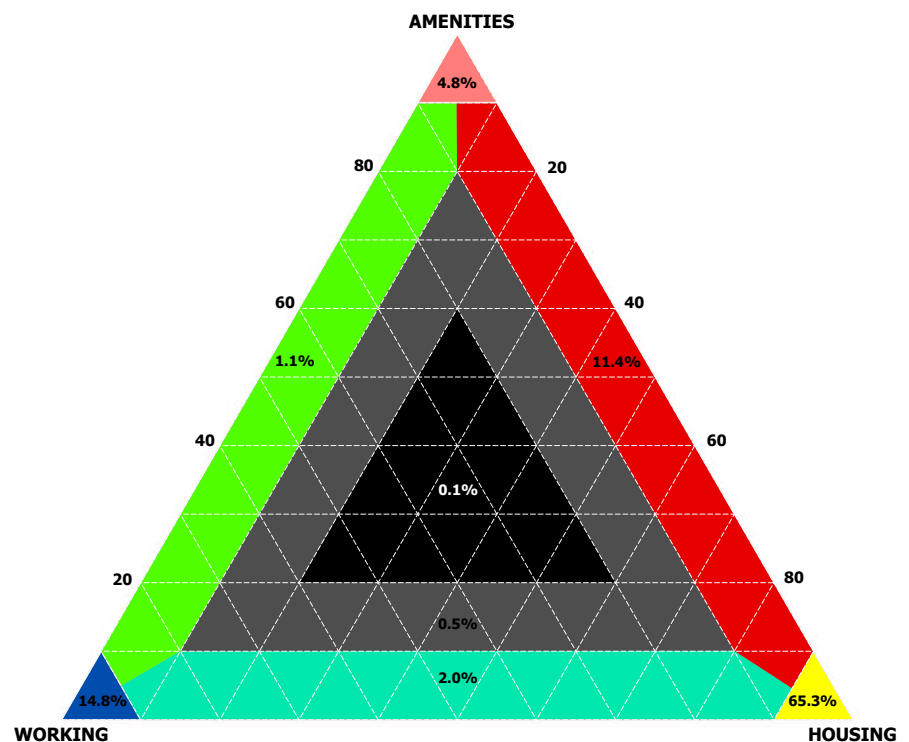
From the perspective of functional composition, in Lelystad, only 0.6% of the cells has a mix of all three functions (gray & black in Figure 3.21). Further, 65.3% of the cells are dominated by dwellings and 14.8% of the land is dominated by working places. Overall, the trend of mono-functional is obvious, even the bi-functional mixture only occupy 14.5%.

Figure 3.22 demonstrates the distribution of functions in Lelystad. As can be seen from the map, new town Lelystad tends to be rather mono-functional. The brown areas are working, the red areas are amenities (shops and services), while the large yellow areas are housing. The red areas have a mix of housing and amenities and the grey cells represent a mix of all kinds of functions; the greyer the cell the more mixed it is. Only in the centric area of the new town, we can find one black cell meaning a balance between amenities, dwellings and working places.

Figure 3.20
The demonstration of various
functional mixture in MXI.



Figure 3.21
The triangle diagram of MXI
in Lelystad.



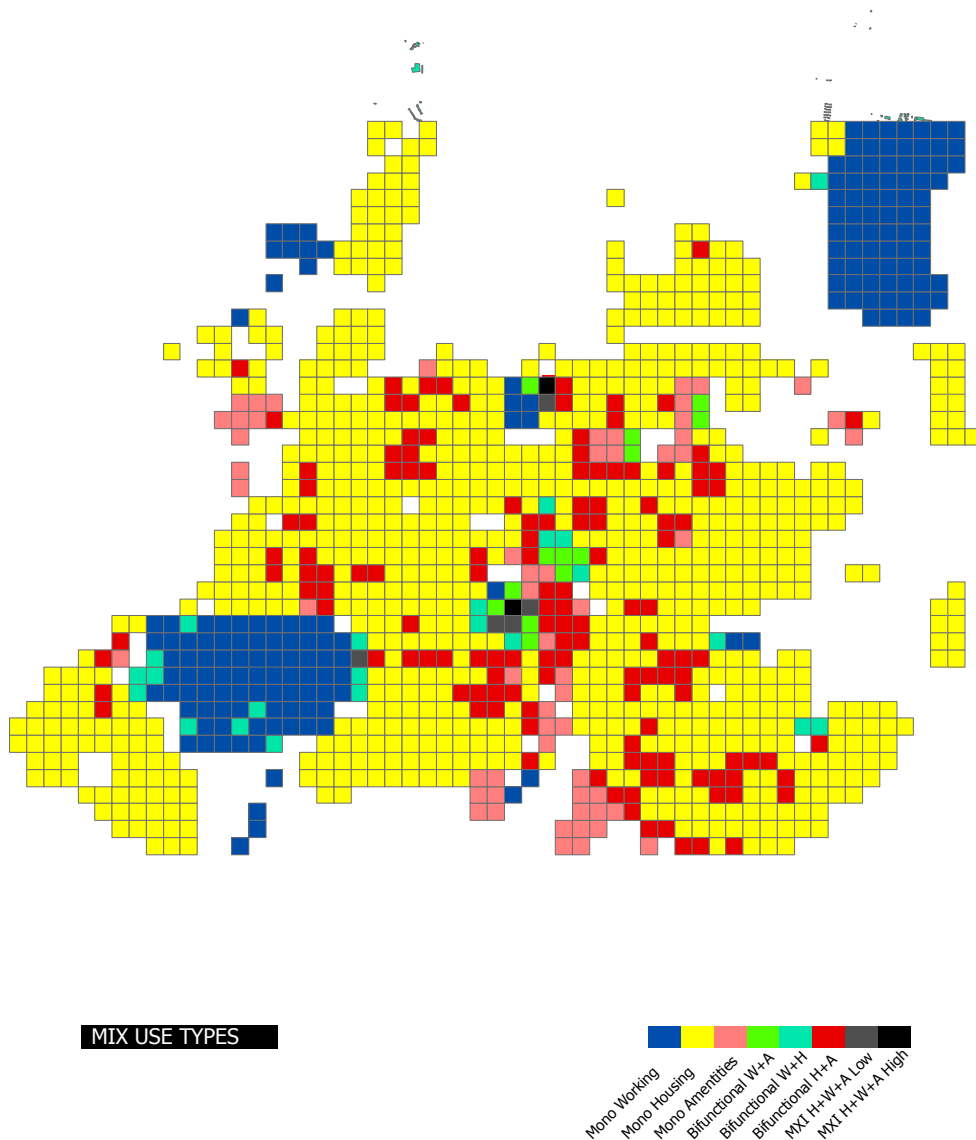


Figure 3.22
The degree of functional mixture in Lelystad.

4.1.4 The combination of Space Syntax. Spacematrix and MXI

Through the use of GIS, it is possible to aggregate the data from the Space Syntax, Spacematrix and the MXI analyses. Through this kind of overlapping, we can get an objective understanding about urbanity in the built environment of Lelystad.

At here, all the three measurements will be divided into three level (high, middle and low), and then be integrated with each other (Figure 3.23). But each measurement is separated into three levels according to its own definition. Specifically, in Space Syntax, high level means both high values in metric and angular analyses or high value in metric and middle value in angular analyses or middle value in metric and high value in metric analyses. Middle level represents two middle values in metric and angular analyses or high value in metric and low value in angular analyses or low value in metric and high value in metric analyses. Low level reflects both low values in metric and angular analyses or middle value in metric and low value in angular analyses or low value in metric and middle value in metric analyses. In Spacematrix, Middle rise stripe and block types; high rise block type belong to high level. Low rise block and middle rise point, high rise point and stripe types are categorized into middle level. Low rise point and low rise stripe types mean low level. In MXI, the mixture of three functions belonging to high and bi-functional means middle level. Only mono-functional areas are categorized into low level.

category of space syntax	Meaning
High spatial integration	Two high or one high, one middle in metric and angular integration
Middle spatial integration	One high and one low, or two middle in metric and angular integration
Low spatial integration	Both low or one low, one middle in metric and angular integration

category of spacematrix	Meaning
High degree of FSI & GSI	Middle rise stripe and block types; high rise block type
Middle degree of FSI & GSI	Low rise block and middle rise point, high rise point and stripe types
Low degree of FSI & GSI	Low rise point and lowrise stripe types

category of MXI	Meaning
High degree of functional mix	mixture of three functions
Middle degree of functional mix	bifunctional areas
Low degree of functional mix	Monofunctional areas

Category of final combination	The value of space syntax, MXI and spacematrix	balance
1) Suburban	L/L/L, M/L/L, L/L/M, L/M/L	low
2) Low urban	L/M/M, M/L/M, M/M/L	balanced
3) Low potential	H/L/L, L/H/L, L/L/H	unbalanced
4) Middle potential	H/M/L, M/H/L, L/M/H, H/L/M, L/H/M, M/L/H	
5) high potential	H/H/L, H/L/H, L/H/H	
6) Middle urban	M/M/H, M/H/M, H/M/M, M/M/M	high
7) high urban	H/H/H, H/M/H, M/H/H, H/H/M	

L = Low, M = Middle, H = High

In the final combination, the whole built environment is separated into three groups and seven categories. The three groups are: low balanced areas (suburban & low urban), unbalanced areas (low potential & middle potential & high potential) and high balanced areas (middle urban & high urban). The low or high balanced areas mean those areas have relatively equal value in the three measurements. For instance, the category of suburban contains three low levels or two low levels and one middle level in all three measurements. Thus, it is located in a kind of low level balanced situation and there is not big difference among the values of three measurements. Because all the three measurements are relative low, it is hard to develop those areas toward high urban areas.

The unbalanced areas means the three measurements have wide gaps between each other in those areas. However, this gap also brings potential for further development. For example, the category of High potential contains two high levels and one low level in all three measurements. Obviously, a big gap among those measurements can be found. In the meanwhile, this kind of area can easily be developed into high urban because we only need to improve one missing measurement.

Nevertheless, it is necessary to mention that this kind of classification criteria (Figure 3.23) is not a proved academic method and only based on my empirical study. In other words, this kind of classify method might not be very accurate. But my main aim applying this method in all four cases is to create a reference frame to help the comparison rather than identifying the urbanity. Therefore, the potential mistakes in my classify method are acceptable. Subject to the limited time in MSc graduate project, I cannot pay too much attention on verifying the classification criteria. Further study to verify the validity of those categories will be made through other dependent variables in my future research.

Figure 3.23

The definition of various categories.



Suburban
three low or two low, one
middle measurements



Low urban
two middle and one low
measurements



Low potential
one high and two low
measurements



Middel potential
one high, one middle and
one low measurements



High potential
two high and one low
measurements



Middle Urban
one high and two
middle, or three middle
measurements



Highly urban
three high or two high, one
middle measurements

To bring measurements of Space Syntax, MXI and Spacematrix within a same frame, three types of spatial integration values, three types of density and three types of functional mixture rate were combined in a matrix. Figure 3.24 shows the result of combining these data.

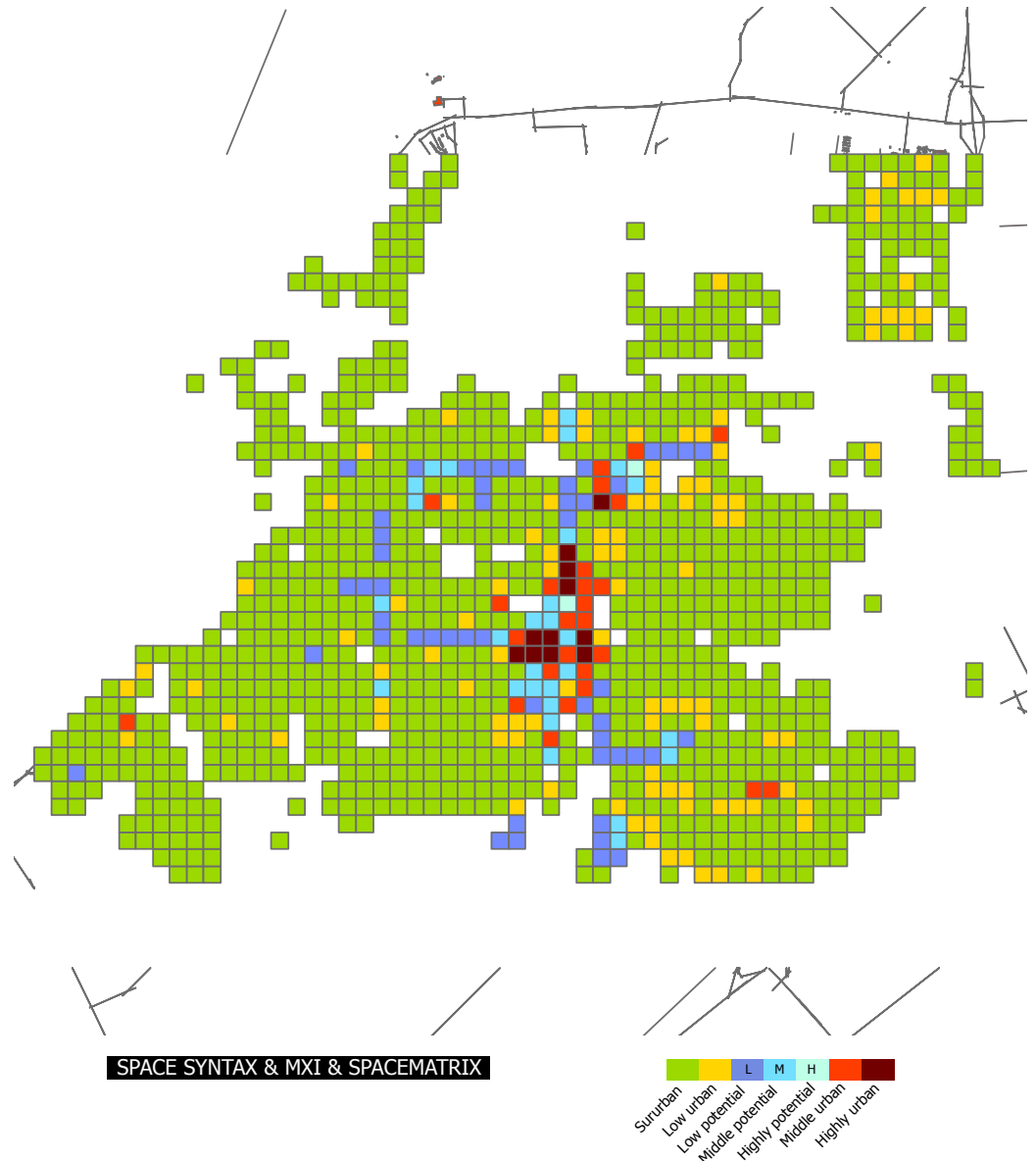
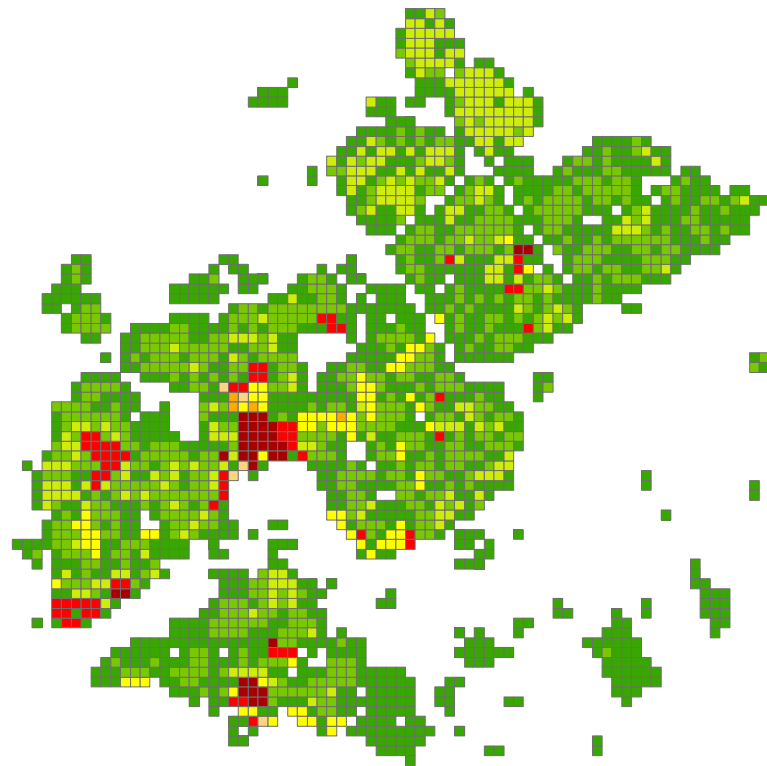
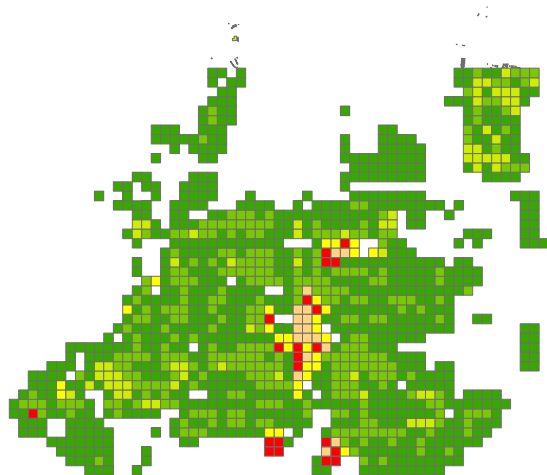
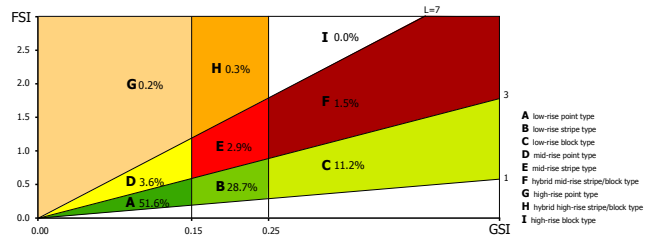
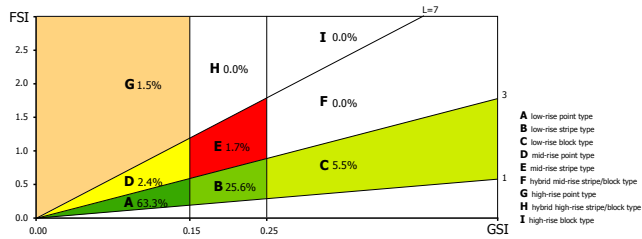
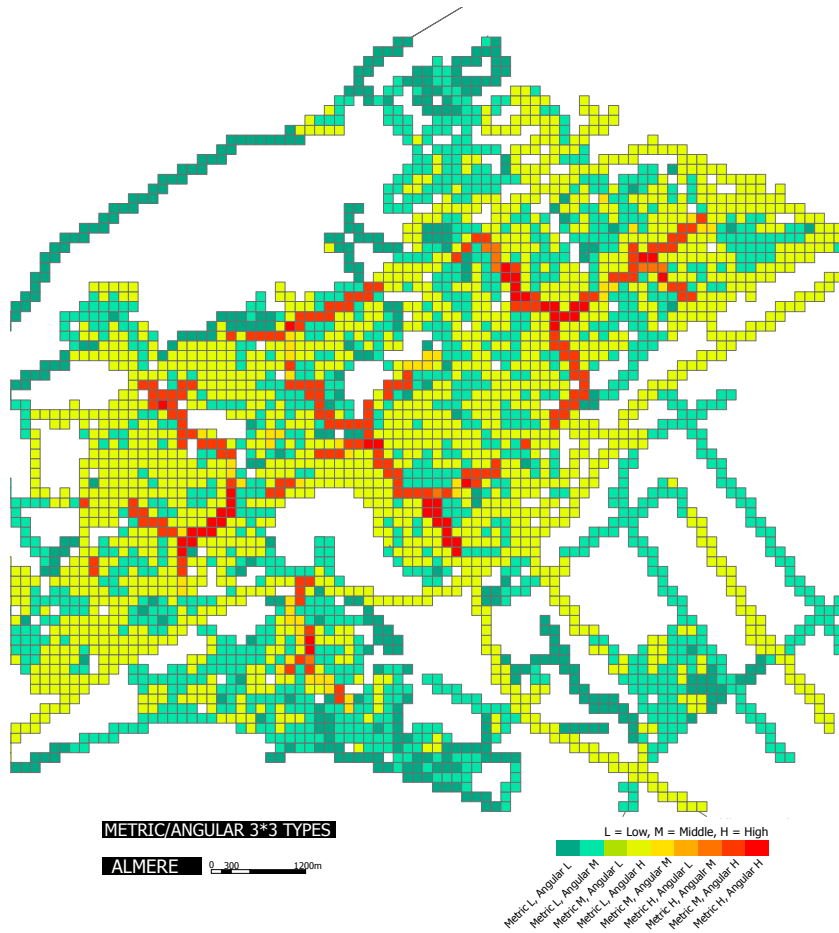
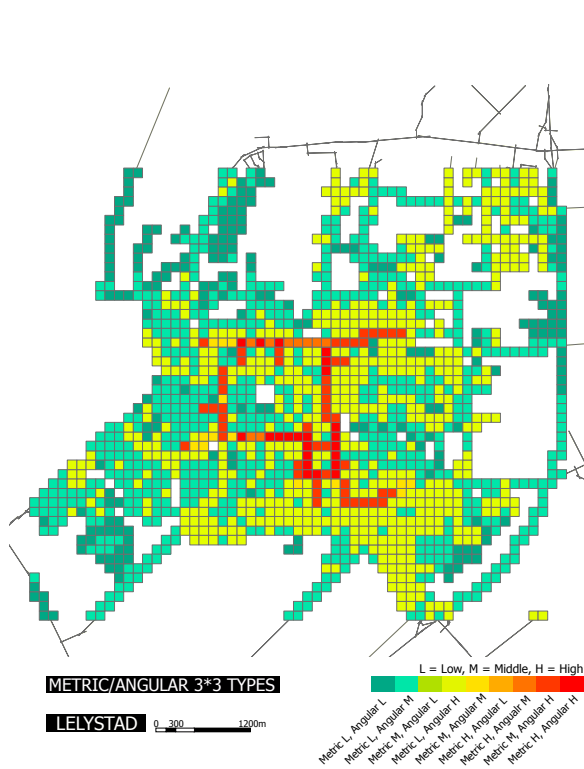


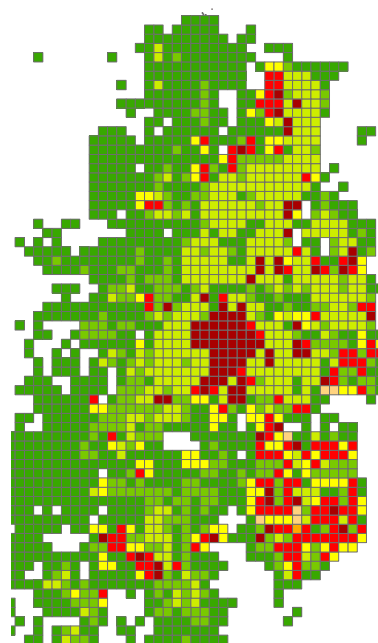
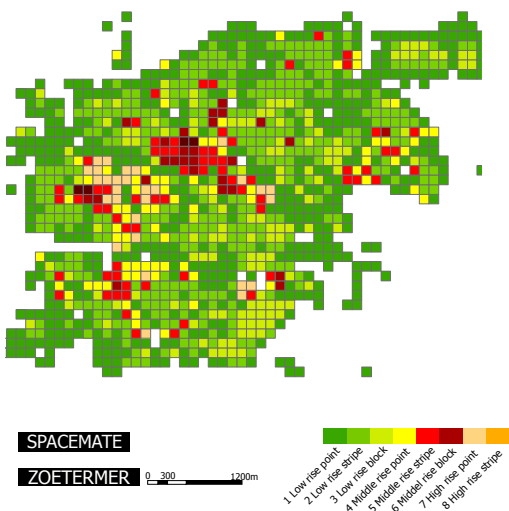
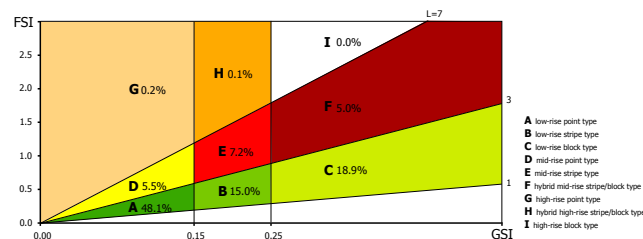
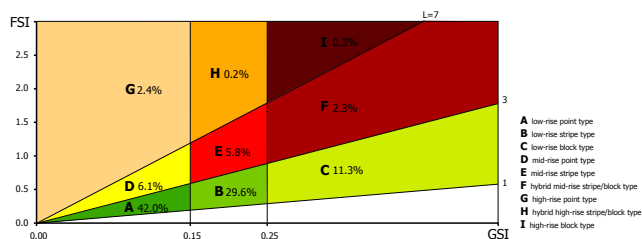
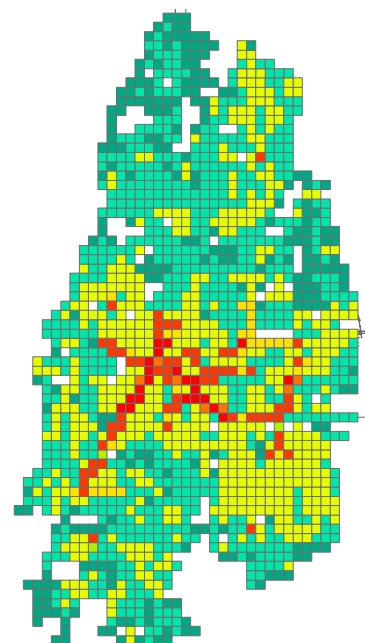
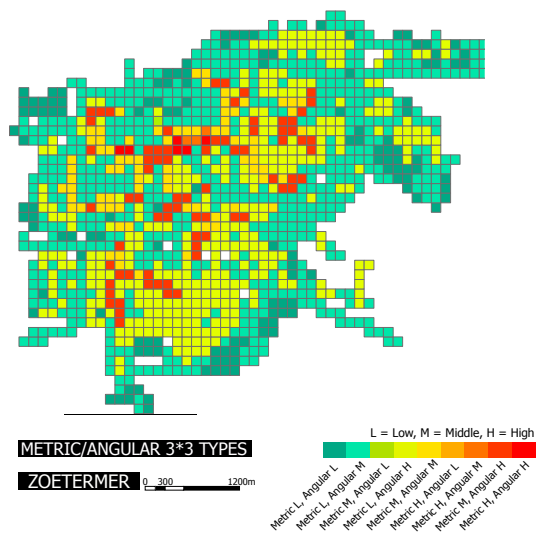
Figure 3.24
The combination of Space Syntax, Spacematrix and MXI in Lelystad.

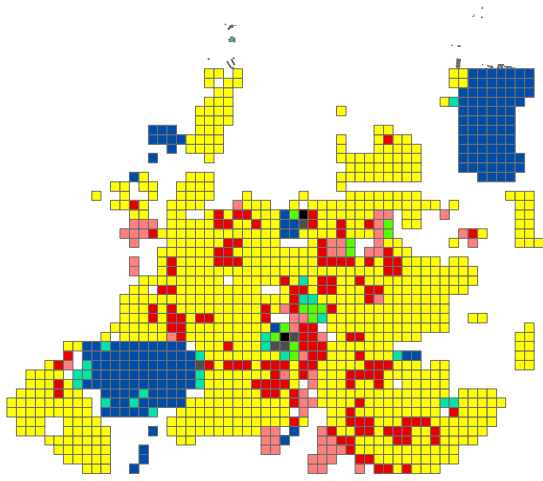
From the combination map, we can have an objective understanding about built environment in Lelystad. Most of cells belong to the highly suburban areas while highly urban and urban areas only appear in the planned city center. Areas having potentials for further developing are mainly located along inner main road of Lelystad or scattering in neighborhoods. Generally speaking, Lelystad is still a newly-developed new town after a long term development.

4.2 Comparing analyses in four cases

Following the method illustrating in Lelystad, the four cases have been analyzed and demonstrated underneath. The analyses of Space Syntax, Spacematrix, MXI and the final combination are included.

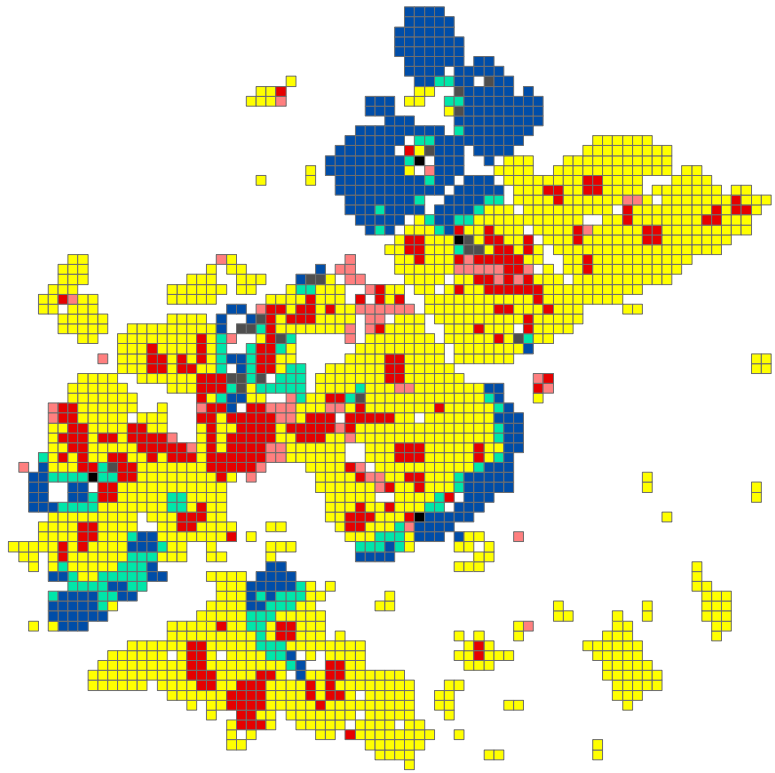






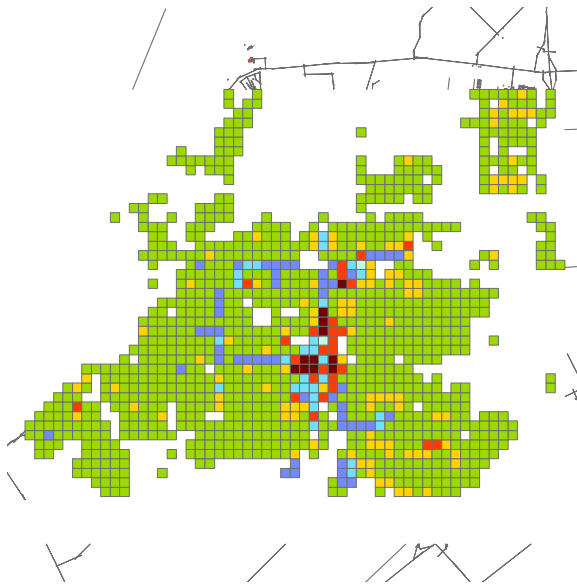
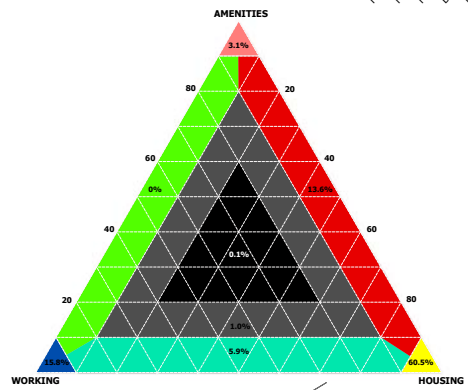
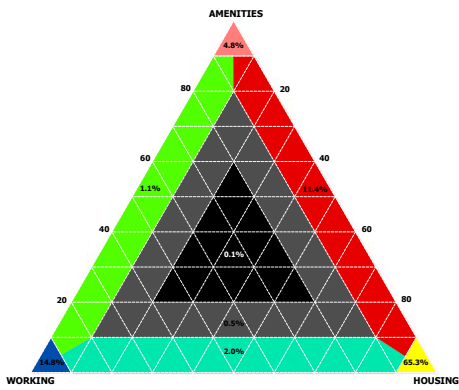
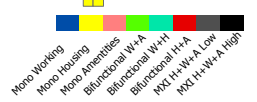
MXI USE TYPES

LELYSTAD 0 300 1200m



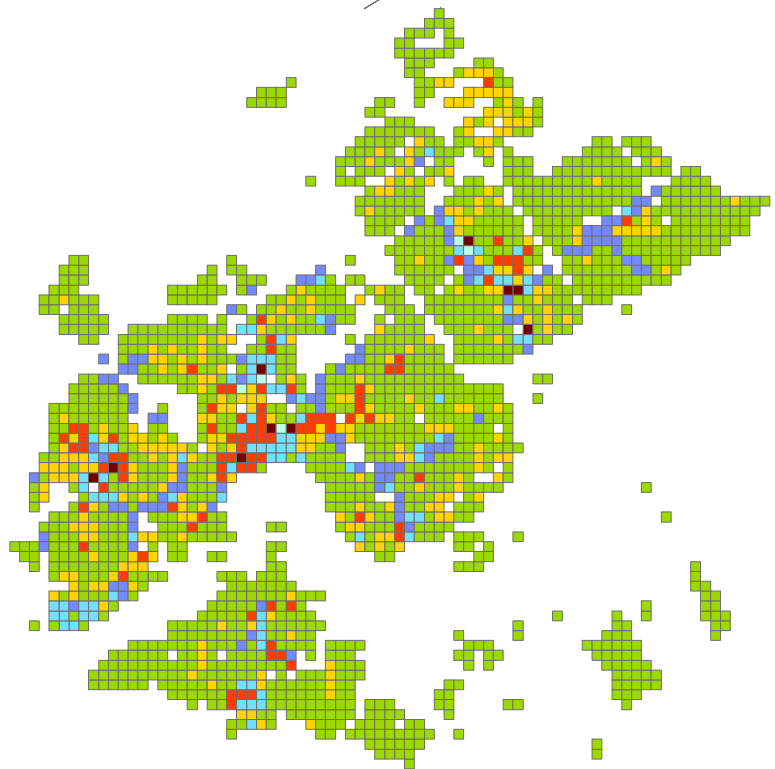
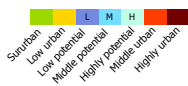
MXI USE TYPES

ALMERE 0 300 1200m



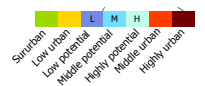
SPACE SYNTAX & MXI & SPACEMATRIX

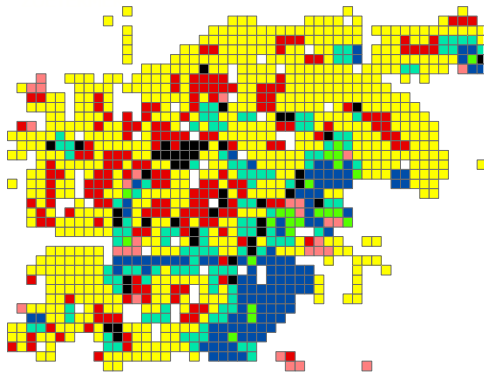
LELYSTAD 0 300 1200m



SPACE SYNTAX & MXI & SPACEMATRIX

ALMERE 0 300 1200m

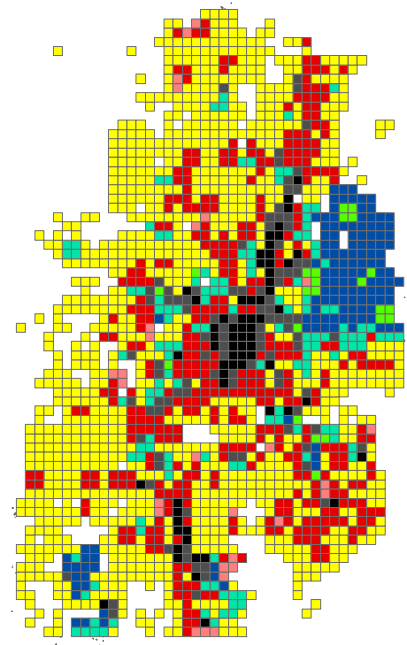




MXI USE TYPES

ZOETERMEER 0 300 1200m

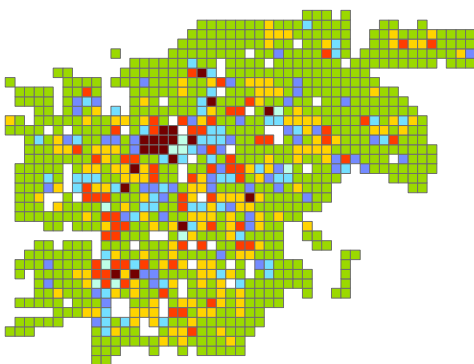
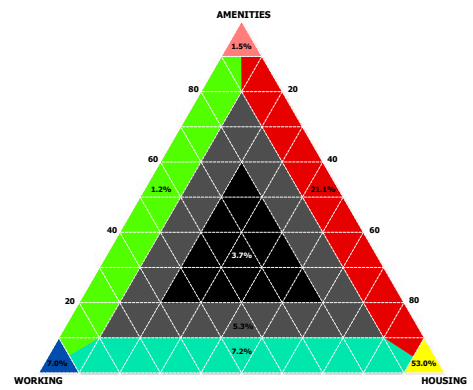
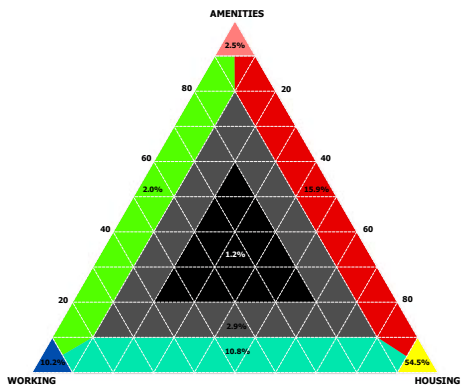
Mono Working
Mono Housing
Mono Amenities
Bidirectional W-A
Bidirectional H-A
MXI H-W-A Low
MXI H-W-A High



MXI USE TYPES

HAARLEM 0 300 1200m

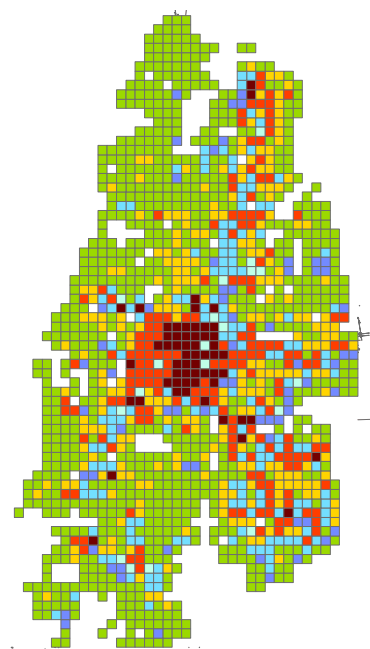
Mono Working
Mono Housing
Mono Amenities
Bidirectional W-A
Bidirectional H-A
MXI H-W-A Low
MXI H-W-A High



SPACE SYNTAX & MXI & SPACEMATRIX

ZOETERMEER 0 300 1200m

Sururban
Low urban
Low potential
Middle potential
Highly potential
Middle urban
Highly urban



SPACE SYNTAX & MXI & SPACEMATRIX

HAARLEM 0 300 1200m

Sururban
Low urban
Low potential
Middle potential
Highly potential
Middle urban
Highly urban

Following the method illustrating in Lelystad, the four cases have been analyzed and demonstrated underneath. The analyses of Space Syntax, Spacematrix, MXI and the final combination are included.

4.2.1 Integration analyses with Space Syantx

The spatial integration rate seems well in all cases. Nevertheless, we can find the city center tends to have a little bit better integration from newly-developed new town (Lelystad) to historically-evolved city (Haarlem).

4.2.2 Urban form analyses with Spacematrix

Compared with the spatial integration rate, the changing in density and morphology are obvious. The middle rise stripe and block types, high rise block type, which belong to the high value in Spacematrix, occupy much higher percentages from newly-developed new town (Lelystad) to historically-evolved city (Haarlem), Specifically, the proportion of grids belonging to high value increases from only 1.7% in Lelystad, to 4.3% in Almere, and then 8.4% in Zoetermeer and finally 12.2% in Haarlem.

4.2.3 Functional mixture analyses with MXI

There is an obvious trend in the functional mixture analyses with MXI as well. The number of grids having three functions makes a great leap forward. This percentage increases from only 0.6% in Lelystad increases to 1.1% in Almere, and then 4.1% in Zoetermer and finally 9.0% in Haarlem. In the meanwhile, the bi-functional mixture (amenities +housing) increases as well (from 11.4% in Lelystad to 21.2% in Haarlem). At here, we can find a clear relation between density and mixed use, while the link between MXI and integration values is not so obvious.

4.2.4 Combined final map analyses

Through comparing the four cases, a clearly visual trend can be identified: a stronger city center is emerged and a more complex urbanized network supporting centrality is created. As a typical newly-developed town, Lelystad has very limited numbers of urban areas and its centrality is low. In the relatively more mature new town Almere, more urban and potential areas can be found in the centric area. In addition, this kind of transformation does not only emerge in the city center. Several embryonic sub centers can be found as well. In the well-developed new town Zoetermeer, a highly urbanized center already emerged. Moreover, urban areas and potential areas construct an urbanized network to support the centrality. Contrast to the simple urban structures in those new towns, historical city Haarlem demonstrates a much complex structure to support centrality. It is also companying with a much bigger highly urbanized center.

Therefore, it seems like there are two tentative trends in the transformation process from new town to complete city:

1) increasing urbanity, complexity and size of the city center.



2) emerging of sub centers and then constructing networks to support centrality.



4.3 Data analyses in four cases

4.3.1 The new town development hypothesis

According to the analyses mentioned before, the main trend from new town to complete city is clear now. However, how this kind of transformation can be fulfilled has not been revealed. Therefore, the changing percentages of various categories during different stages should be considered to answer this transformation route.

Based on the data analyses in Figure 3.25, we can see from New town stage 1 (Lelystad) to New town stage 3 (Zoetermeer) and to a historical city (Haarlem), the increase in high balanced areas and decrease in low balanced areas are clear. The percentage of high balanced areas increases from 3.4% in Lelystad to 6.8% in Zoetermeer and 15.9% in Haarlem, while the number of low balanced areas decreases a lot (from 89.4% in Lelystad to 78.5% in Zoetermeer and 67.9% in Haarlem). Thus, we can say low balanced areas develop towards high balanced areas is the main transformation route during new town development.

However, how to understand the urban transformation process in various categories? Do low balanced areas jump into high balanced areas directly? Or is it a step-by-step long process? It means mainstream developing trend in suburban areas is developing into low urban and unbalanced areas firstly. In the meanwhile, in unbalanced areas, various potential areas are developed toward high balanced areas. Obviously, the last one seems more logic if we consider the hardness of improving areas from suburban (two low values and one middle value in three measurements) to high urban (two high values and one middle value in three measurements) in one time. In addition, it does explain the quickly increase in low urban areas (from 9.4% in Lelystad to 16.3% in Haarlem). This situation won't appear if suburban areas develop into high urban or middle urban directly.

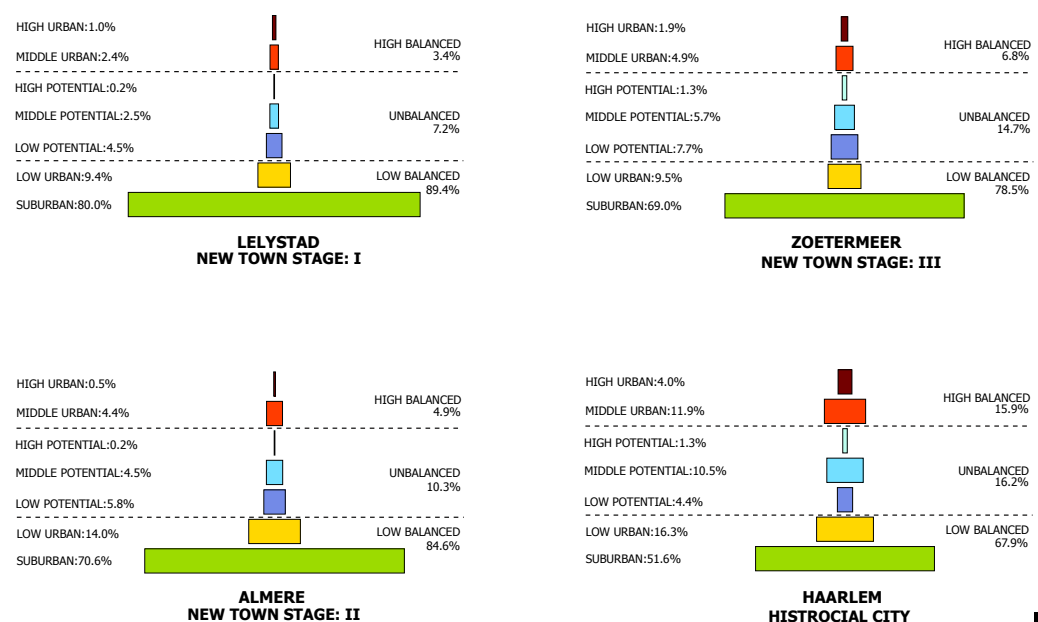
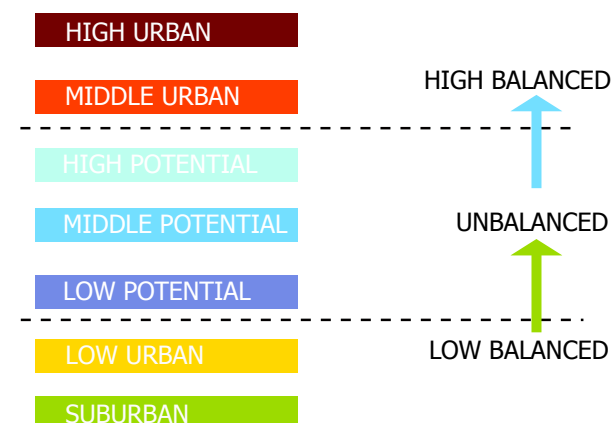


Figure 3.25
The percentages of various categories in four cases.

Therefore, we can propose a strong hypothesis at here. The unbalanced areas can be regarded as a bridge to promote the emerging of high balanced urban areas during new town developments. On one hand, low balanced areas mainly develop into unbalanced areas. On the other, existing unbalanced areas are converted into high balanced areas, just like the diagram shows in Figure 3.26. These two routes are equally important for new town developments.



The diagram on the left shows a strong hypothesis and it is already partly proved. The only way to totally prove it is following urban areas in a time period, which will be left for my future research. At here, in my master thesis, I will continue my study based on this defined hypothesis.

Figure 3.26
Unbalanced areas as a bridge
in new town development.

4.3.2 Unbalanced areas are crucial

Nevertheless, as an urbanist, how to accelerate new town development more efficiently in the defined two routes? Should we do this via promoting low balanced areas develop into unbalanced areas or promoting unbalanced areas toward high balanced areas?

First of all, it is much easier to promote unbalanced areas towards high balanced areas. The reason is the potential areas have one or two kinds of lacking in spatial integration, density or functional mixture, which also bring potentials for their further developments. In contrast, it seems too hard to implement interventions in enormous suburban areas. Therefore, considering the large amount of suburban areas, it is very hard to seek possible areas to do the intervention, just like what we do in unbalanced areas.

In addition, suburban areas as a whole is not a negative description, actually, suburban areas are often regarded as appreciated urban environments to live in. Intervening in this area is therefore problematic and maybe not even desirable. The factor that might make a change possible is the direct context of the suburban or low urban areas. When its context has more positive spatial conditions and socio-economic requirements leading to more unbalanced or more urban, the suburban areas might follow. Areas that are surrounded with "sub-urbanity" are less probable to transform.

Therefore, the route of promoting suburban areas to low urban and urban areas is unsuitable for direct interventions made by urbanists. **Considering the limited power of urbanists, the unbalanced areas should be regarded as the focus point in future interventions.**

4.3.3 Relationship among three measurements

The bar chart above has illustrated the transformation route in new town development. Nevertheless, what are the roles of spatial integration, functional mixture and density in this transformation process is unclear.

As we all know, because of the long existing time of street network, spatial integration is generally regarded as the first developed element and the foundation of urban development (Hiller and Hanson, 1984). The close linking between building

types (Spacematrix) and functional mixture (MXI) has been proved by previous researches (van Nes, Berghauser-Pont and Masshooi, 2012). Nevertheless, the relationship among three of them still need to be studied.

The table underneath analyzes the lacking elements (spatial integration, density and functional mixture) in the whole city during different developing stages (Figure 3.27). At here, the main aim is to find the changing relationship among space syntax, spacematrix and MXI from a newly-developed new town (Lelystad) to a relatively well-developed new town (Zoetermeer) and to a historical city (Haarlem). This is why I make the calculation based on values of elements rather than cells. Analyses about features of cells will be given later.

Those bars underneath the table reflect the developing situation in three measurements. Specifically, red, green and gray bars represent the developing situation in spatial integration, functional mixture and density & building types respectively. The higher the bar is, the more developed measurement is represented. In addition, the scale of bars only relate to the interrelations among three measurements rather than a numerical description.

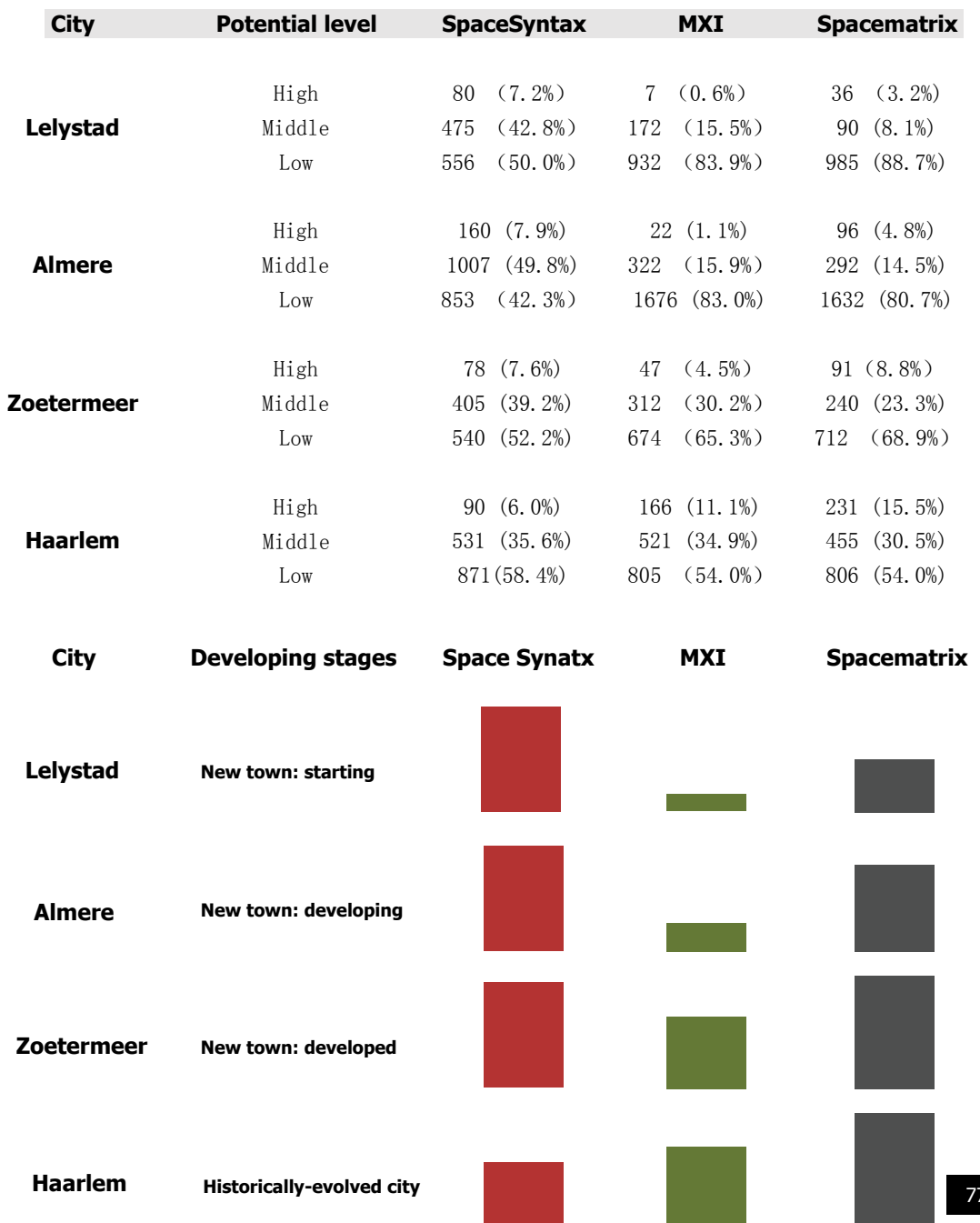


Figure 3.27
Statistic analyses
about lacking in three
measurements.

In this picture (Figure 3.27), we can find two interest points:

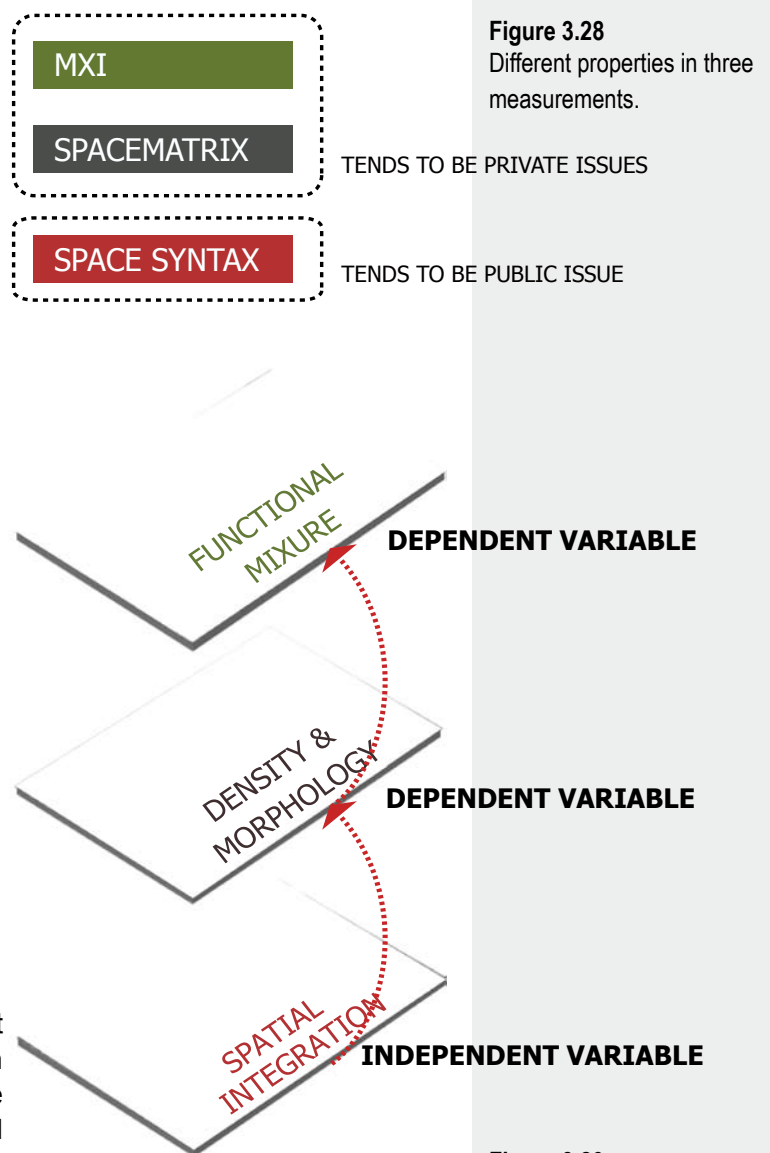
1) The spatial integration in whole map does not change too much in three new towns while historical city Haarlem shows different value. This result corresponds with the conclusion that spatial integration as the first developed element will not change too much during time without special interventions. Because of the different street network structure, it is reasonable that historical city Haarlem has different value compared with other new towns.

2) The value in Spacematrix increases first and then followed by the value in MXI. In typical newly-developed town (Lelystad), the lacking of density and functional mixture are common features in it. Then, in a relatively higher developing stage (Almere), we can see an obvious increase in density. But the missing in functional mixture is still obvious. In the well-developed new town (Zoetermeer) and historical city (Haarlem), following the development in spatial integration and density, the functional mixture has grown as well.

Based on the conclusions in 1) and 2), we can say it seems like the density/morphology is the precondition of functional mixture while spatial integration is the first developed elements in three of them.

This situation is quite reasonable. Because of the different properties in three measurements (Figure 3.28), density & building types (Spacematrix) and functional mixture (MXI) can change automatically by private developers; while spatial integration (Space Syntax) as a public issue, tends to do not change without special interventions leading by urbanists. Normal building programs are sure to change existing density & building types (Spacematrix) and functional mixture (MXI) but they won't change spatial structure too much. Large scale interventions on new streets, which generally lead by municipality and urbanists do change spatial integration (Space Syntax) a lot. However, this situation is very rare, especially in newly built new towns. **Therefore, in a new town model, we can regard density & building types (Spacematrix) and functional mixture (MXI) as linear changing measurements during time. Nevertheless, the spatial integration (Space Syntax) tends to keep stability in a long period and then leap forward through special interventions on spatial structure.**

In conclusion, the spatial integration is the first developed measurements tending to be fixed in beginning. After that, density & morphology will be the second step. Functional mixture is built based on the previous two steps (Figure 3.29). In other words, **spatial integration is an independent variable while both density and functional mix are dependent variables.** It is a key rule to help us understand various roles in the three measurements.



Nevertheless, there are two doubtful points are still existing:

1) I believe the distribution of the high and low values matters a lot. **Is there a linear value can describe this changing distribution during various developing stages?**

2) **why density & building types (Spacematrix) and functional mixture (MXI) show less developed in three new towns while the less developed element in historical city Haarlem is spatial integration (Space Syntax)?** In a complete historical city, a well-developed and equally developed three measurements should be more logic. Why the real situation does not follow this plausible assumption?

4.3.4 Match rates hypothesis: spatial integration, density & building types and functional mixture during new town development

A hypothesis attempting to answer the first question is beginning from the stable spatial integration rate in various new towns. Since the spatial integration rate does not change too much from newly-developed new town to well-developed new town, which reason leading to the increasing in high balanced areas? Since those areas need a well combination of three measurements at the same time, the most possible explanation is match rate in three measurements is increasing during development.

Then, the problem is how to identify and measure this match rate? We need to review two points we discussed before: 1) the definition of high balanced areas; 2) the relation among three measurements. As I mentioned in Figure 3.23, high balanced areas are defined as cells obtaining more than or at least equal to middle value in all three measurements at the same time. Moreover, based on the relation among three measurements, spatial integration is regarded as the foundation, which is followed by density & building types and then functional mixture. Therefore, through measuring how many high or middle integrated grids have been used to support the other two measurements' developments, the match rate can be defined. In other words, the mate rate can be equal to the grid number of high balanced areas dividing high or middle integrated grid numbers.

$$\text{MATCH RATE} = N(h) / N(s)$$

N(h) means the number of grids obtaining more than or at least equal to middle value in all three measurements, which also is the gird number of high balanced areas.

N(s) means the number of grids obtaining more than or at least equal to middle value in spatial integration (Space Syntax)

City	N(h): Grids obtaining value \geq middle level in three measurements	N(s): Grids obtaining value \geq middle level in spatial integration	Match rate
Lelystad	38	555	6.8%
Almere	98	1167	8.4%
Zoetermeer	89	486	18.3%
Haarlem	237	621	38.2%

Figure 3.30

Match rates between high or middle integration grids with high balanced grids (middle urban and high urban areas).

A test about the match rates proves this hypothesis (Figure 3.30). Although the percentage of high or middle value in spatial integration does not change too much during various developing periods, more grids obtaining high or middle integration, density and mixture at the same time. In Lelystad, 6.8% of high or middle integration grids can develop high or middle density and mixture at the same time. This number increase to 8.4% in Almere, 18.3% in Zoetermeer and 38.2% in Haarlem. This result can be used to explain why the general spatial integration value is lower in Haalerm but its urbanity is high. Because the match rate among three measurements is higher. **At here, a linear value measuring the distribution in various values can be given.** The doubtful point (1) (P. 79) has been answered.

Obviously, the high match rate means high integrated cells are well used. In the case of low match rate, there are two kinds of explanations: time is not enough for new town developments or inappropriate distributions of density & building types (Spacematrix) and functional mixture (MXI).

Now, this match rate hypothesis can explain the doubt point (2) (P.79) of different less developed measurements between new town and historical city. Take new town Lelystad for instance, no matter its low match rate is made by limited time or wrong distribution, both of explanations mean current spatial structure still have high potentiality to support development (Figure 3.31). Density & building types (Spacematrix) and functional mixture (MXI) are relatively less developed measurements, which corresponds with the conclusion in Figure 3.27. However, in historical city Haarlem, high match rate means current spatial structure is well used by density & building types (Spacematrix) and functional mixture (MXI), thus, the developing potentiality provided by its spatial structure is exhausted. In other words, spatial integration (Space Syntax) becomes the relatively less developed measurements (Figure 3.32).

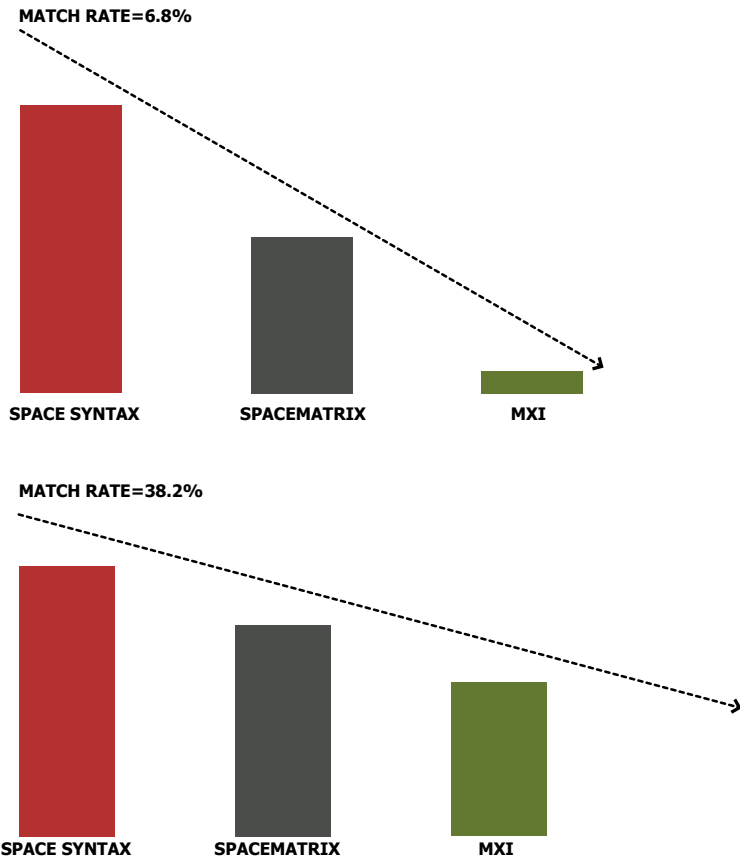


Figure 3.31
Match rates among Space Syntax, Spacematrix and MXI in Lelystad.

Figure 3.32
Match rates among Space Syntax, Spacematrix and MXI in Haarlem.

Therefore, when the match rate is high, the main development obstacle will be changed from density or functional mixture to spatial integration itself. Through analyses on the match rate hypothesis, now all the analyses results are self-consistent. Nevertheless, another important role of the match rate hypothesis must be mentioned. **It can be used as an index to forecast new town development: whether time will make a new town more dynamic or not.**

According to this analysis, when the match rate increases during time into a certain level, the developing pressure / obstacle will be changed from density (Spacematrix) and functional mixture (MXI) to the spatial integration (Space Syntax). In addition, spatial integration tends to keep stability in a long time. This situation only can be change through special interventions on integration rather than leaving it for time. Therefore, though calculating this match rate, we can judge whether this new town still has the changing potentiality. **If the match rate is low, intervention focus are density & building types (Spacematrix) and functional mixture (MXI), which can be developed through normal building programs during time. If the match rate is already high, the obstacle will be turned to spatial integration that will not be changed by time issue. In this context, new town will be stopped in its developing stage without interventions in integration aspect.** More systematic discussions about applying match rate as a quick index for new town development will be made in next section (P.96).

4.4 Revising the two trends in the transformation process from new town to complete city

Based on the previous work in 4.3, we have a deeper understanding helping us to revise the exist conclusion in the end of 4.2: two spatial trends from new town to complete city. From the analyses in statistics aspects in 4.3 and visualized map in 4.2, we can say historical city Haarlem has a huge gap with three new towns in spatial structure. In Haarlem we can find a high integrated cluster while in the new towns they are more disturbed. The same can be said for density and mix.

Thus, considering the relationship and property of three measurements (explained in 4.3.1, 4.3.3, 4.3.4), the totally spatial structure changing from a relatively equally distributed urban form (new towns) to a high integrated urban form (historical city) is unlikely. That means they will not develop toward a completely similar urban form with historical city Haarlem. In other words, the complete city developing from new towns will have several differences with a complete city developing from history. Nevertheless, according to the changing trends from Lelystad to Almere to Zoetermeer, we can foresee the new towns will still strengthen their center areas and urban networks. But new towns should evolve toward a relatively equal urban form rather than extreme concentrated density and mix. **Therefore, the two trends in the transformation process from new town to complete city are still exist. But this time, the importance of improving centrality will be relatively weak while strengthening urban network will be more crucial:**

1) a well developed urban network based on high integrated spatial structure is crucial



2) a strong and dynamic city center is still important



4.5 New urban diagnosis method in unbalanced areas

The important of unbalanced areas has been discussed. Then, based on the defined relationship among the three elements, we can classify various potentials in unbalanced areas. This is a diagnosis method to understand various lackings in built environment, which can reflect the missing elements (Figure 3.33). Specifically, there are five kinds of potentials/lacking in whole unbalanced areas.

Low Potential Areas: High, Low, Low

Potentials Category	A	B	D=A+B
MXI	Low	Low	High
Spacematrix	Low	High	Low
Space Syntax	High	Low	Low

Middle Potential Areas: High, Middle, Low

Potentials Category	E=A+C	A	C	A	B	B
MXI	Low	Middle	Low	High	High	Middle
Spacematrix	Middle	Low	High	Low	Middle	High
Space Syntax	High	High	Middle	Middle	Low	Low

High Potential Areas: High, High, Low

Potentials Category	C	B	A
MXI	Low	High	High
Spacematrix	High	High	Low
Space Syntax	High	Low	High

A: Potentials for densification / Morphological improvements

B: Potentials for spatial integration improvements

C: Ground floor / Design level improvements

D: Containing A and B at the same time

E: Containing A and C at the same time

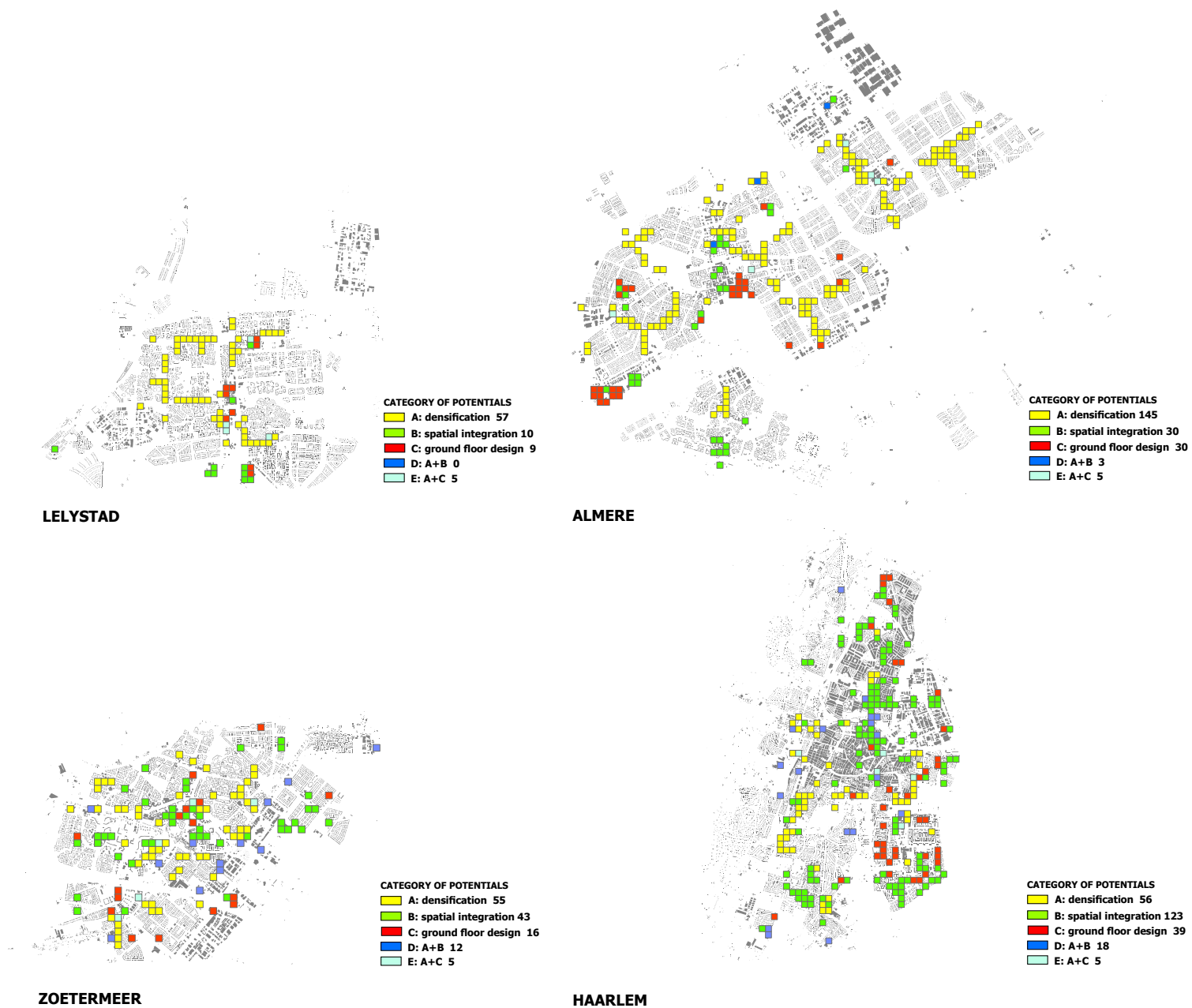
For instance, in areas belonging to the category A, spatial integration performs well (valued in high or middle). However, the spacematrix is judged as low, which means the problem leading to low functional mixture is density or building types. Thus, we can say those areas have potentials for further densification or morphological improvements. The situation is similar in category B, the measurement of SpaceSyntax becomes the drawback in all three measurements. In category C, both Space Syntax and Spacematrix have high values but the MXI is still low. In this kind of situation, the main reason for this should be ground floor / design level problems.

At here, we can see this analysis proves my previous conclusion about match rate in 4.3.4 (P.80). For the newly developed new town (Lelystad), because of its low match rate, the pressure to improve spatial integration should be low. This conclusion is reflected on the limited numbers of category B: potentials for spatial integration improvement. With the increase of match rate, spatial structure itself will suffer higher pressure and the developing obstacle will be changed from density and functional mixture towards spatial integration itself. This conclusion is perfectly reflected on the gradually increasing numbers of category B from Lelystad to Almere to Zoetermeer and finally Haarlem.

Figure 3.33

Classification of various potentials in unbalanced areas.

Through this urban diagnosis, where the potential areas are and what kinds of potentials they have are clear now. It is a great tool to tell urban designers they should make interventions in which areas and what kinds of interventions they should make in. This method can play an important role in accelerating new town development and it might can be used to guide other normal cities as well.



A new urban diagnosis method has been proposed. However, the validity of this method needs to be verified. Thus, this diagnosis will be applied in four cases firstly. Then, the accuracy of the results has been checked through street views via Google maps. Although there are some small mistakes, general speaking, this method can reflect spatial features accurately.

EXAMPLES FOR POTENTIAL AREAS IN NEW TOWNS

A: potential for densification / morphological improvements



B: potential for spatial integration improvements



C: potential for ground floor / design level improvements



D: potential for densification/ morphology+ integration improvements



E: potential for densification/ morphology+ ground floor improvements



EXAMPLES FOR POTENTIAL AREAS IN OLD TOWNS

A: potential for densification / morphological improvements



B: potential for spatial integration improvements



C: potential for ground floor / design level improvements



D: potential for densification/ morphology+ integration improvements



E: potential for densification/ morphology+ ground floor improvements



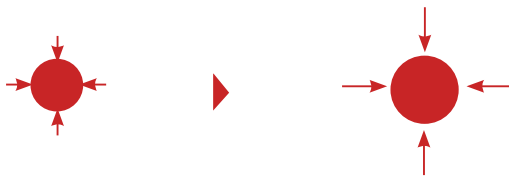
4.6 Suggestions for urban planners in urban scale

4.6.1 goals for new town development.

1) a well developed urban network based on highly integrated spatial structure is crucial



2) a strong and dynamic city center is also important



4.6.2 understanding the relationship among spatial integration, urban morphology and functional mixture.



4.6.3 The match rate and urban diagnosis are important to understand new town developments



SECTION IV:

ANALYSES IN CHINESE CONTEXT

ANALYSES IN REGIONAL SCALE

THE STRATEGIES & INTERVENTIONS IN REGIONAL SCALE

ANALYSES IN URBAN SCALE

DEFINING THE PROBLEMS VIA LOCAL ANALYSES

THE STRATEGIES & INTERVENTIONS IN URBAN SCALE

EVALUATION OF THE STRATEGIES

A NEW STARTING POINT

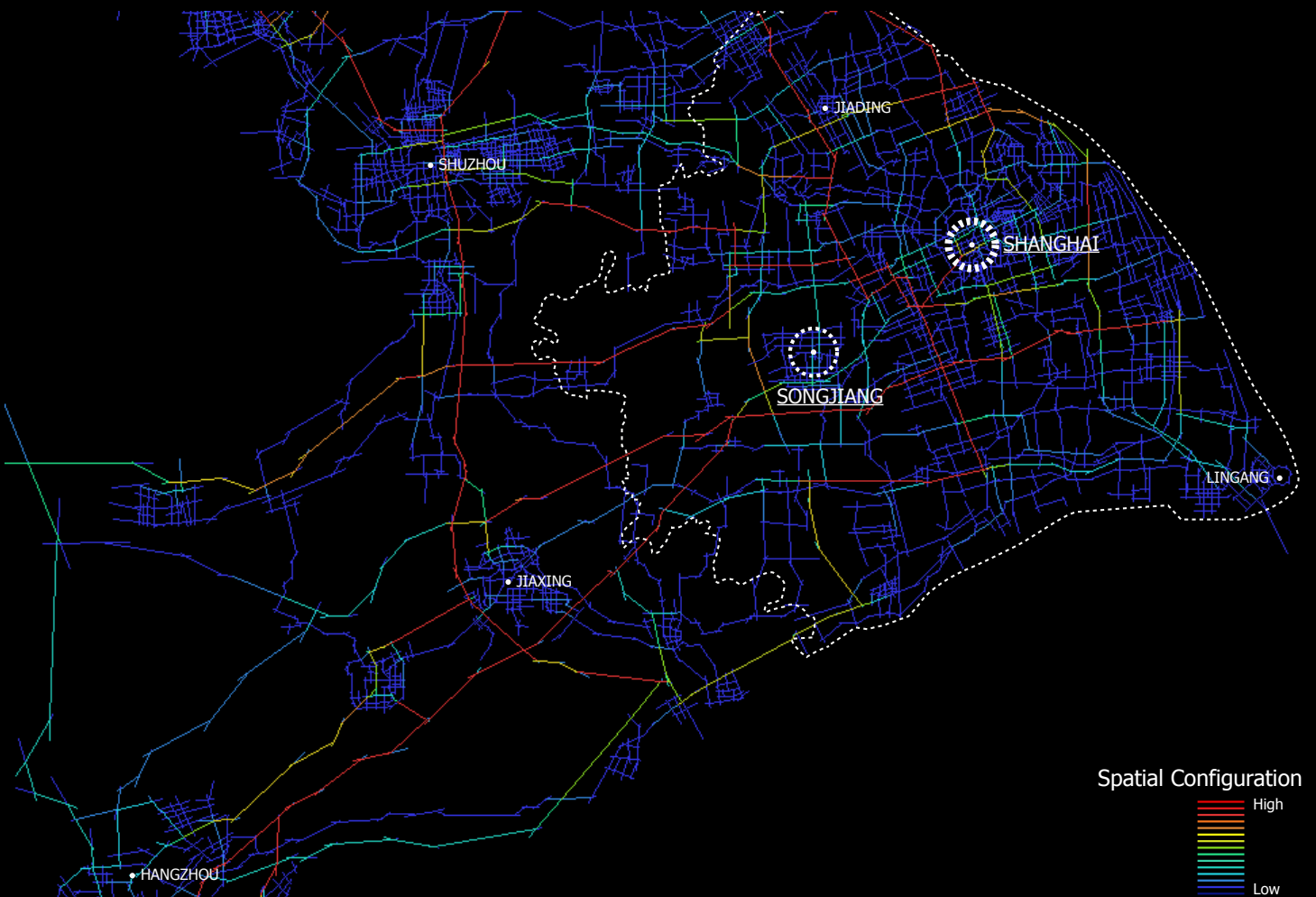
1. Analyses in regional scale

Based on the conclusions from Dutch context, Songjiang new town will be researched following the two points: 1) verifying its regional connection directions 2) verifying its intercity level connections.

The Figure 4.1 shows regional level connections in Yangzi river delta. Three main cities in this region: Shanghai, Suzhou and Hangzhou are included into analyses. Three firstly finished new towns: Songjiang, Jiading and Lingang are included as well. Only main streets or streets in higher level are calculated in this map. At here, we can find that the regional connections of Songjiang new town are not very strong but diverse directions still can be found. In detail, the regional connect through Hangzhou to Jiaxing to Songjiang and Shanghai is obvious. The other direction pointing to Jiading is also well.

In addition, two regional directions also appear in Jiading new town while the situation in Lingang is not very well. Maybe it is the reason that Songjiang new town and Jiading new town have higher development speed in the nine new towns of Shanghai municipality. Overall, the regional connection direction is well for Songjiang new town development.

Figure 4.1
Typological and metric analysis in Metropolitan area of Shanghai, Regional level,.



However, in Figure 4.2, we can find that Songjiang new town's spatial integration in intercity level looks is not good enough. The west-east direction connection between new town and surrounding areas is poor.

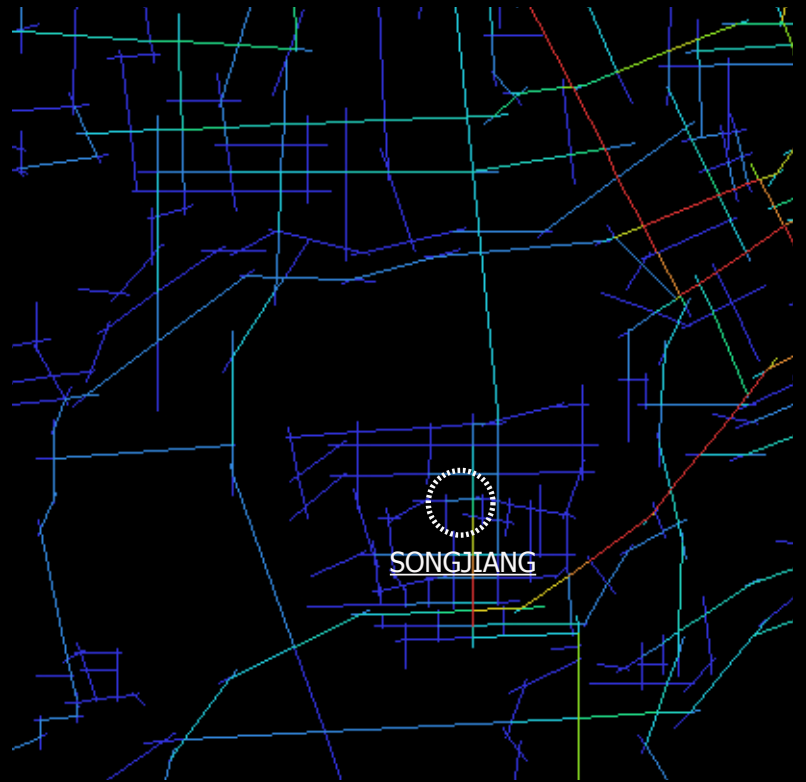
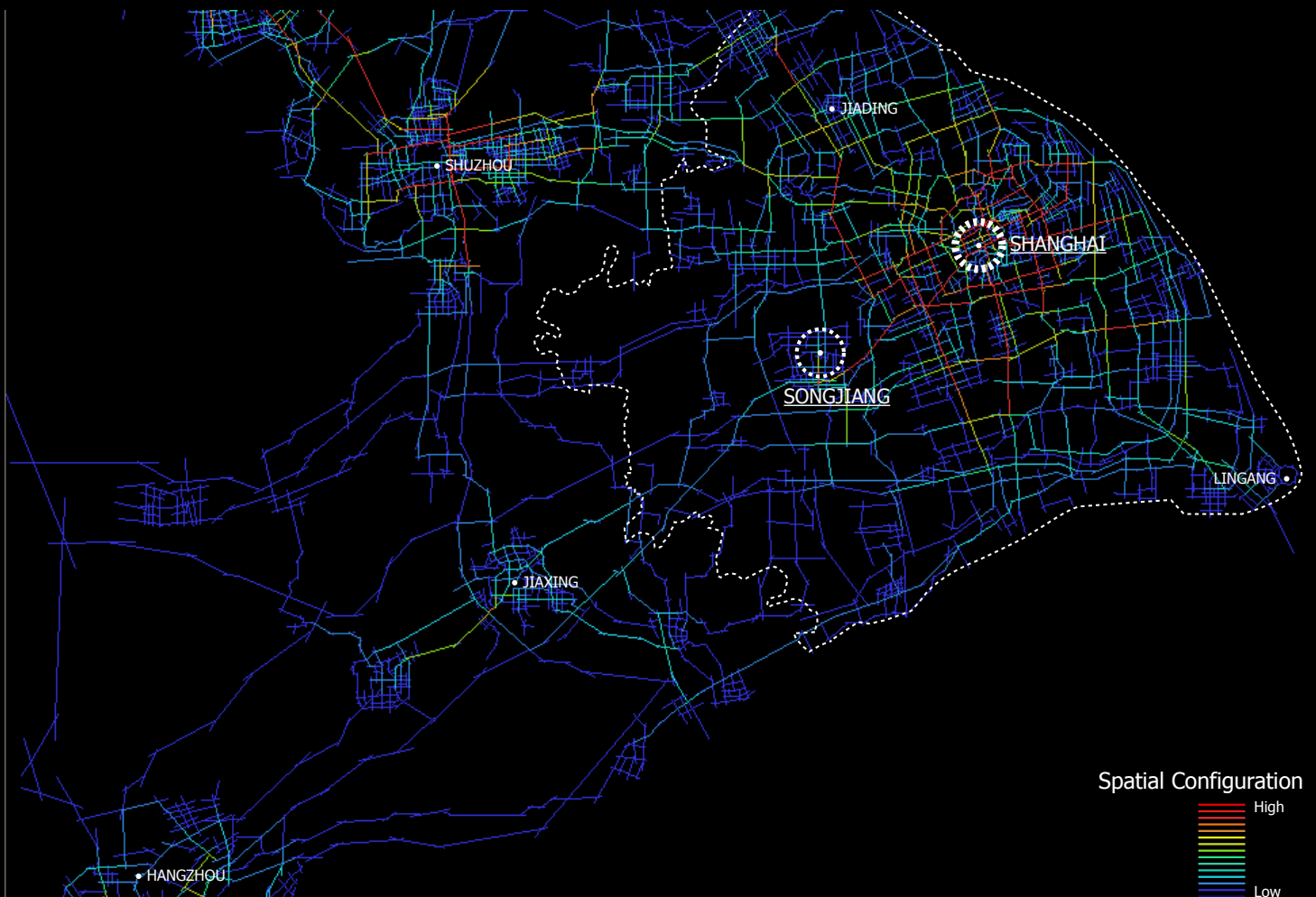
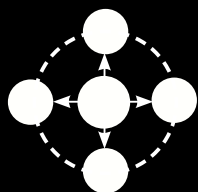


Figure 4.2
Typological and metric
analysis in Metropolitan area
of Shanghai, Intercity level.



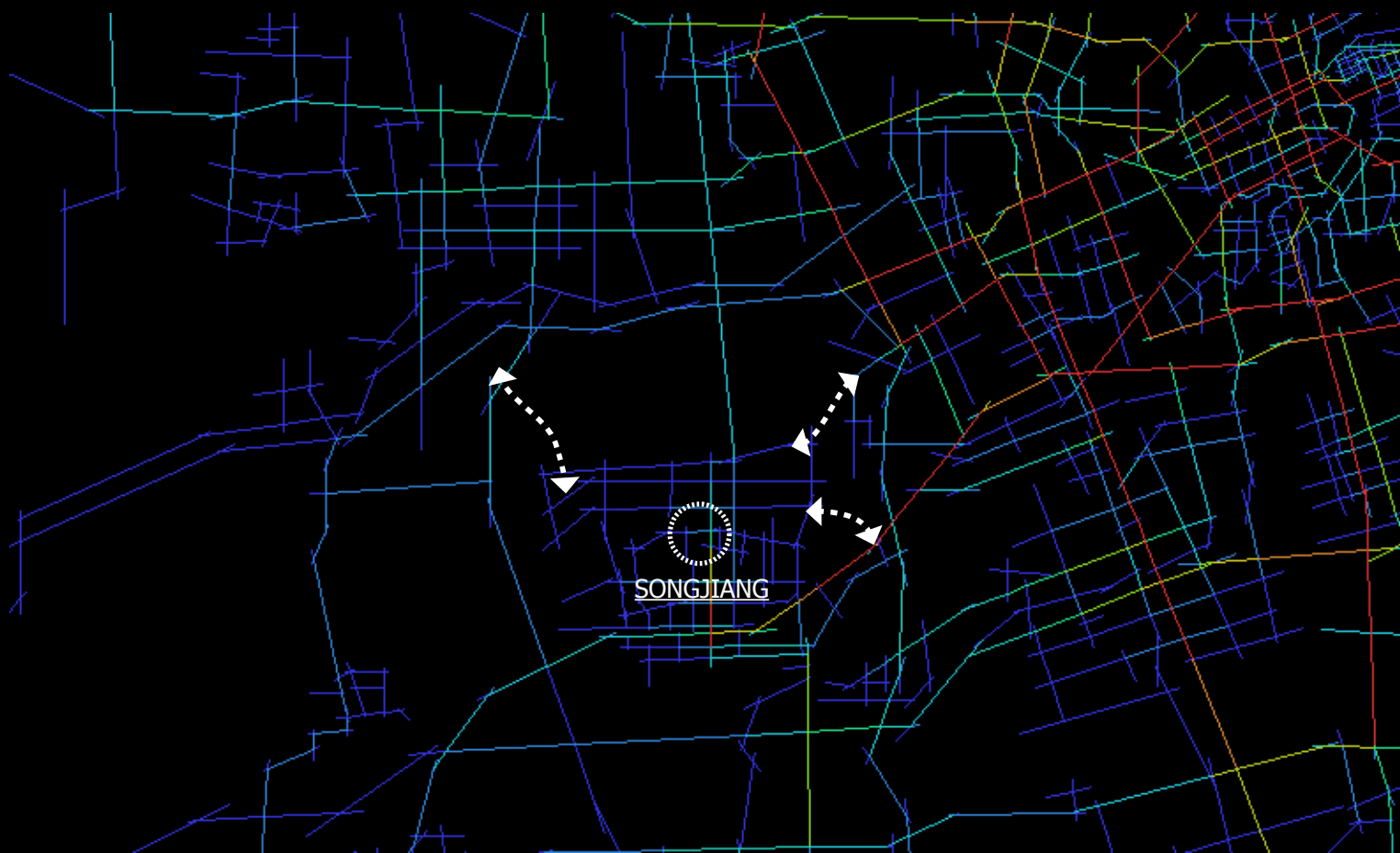
2. The strategies & interventions in regional scale

For Songjiang new town, its regional strategy should mainly focus on promoting connections with its surrounding areas.



Converting the strategy into interventions, three new roads should be added to improve Songjiang new town's intercity level integration (Figure 4.3). Just like the diagram shows, new road on the left is aiming to strengthen the connection to west built up areas. The other two roads are trying to strengthen Songjiang new town's connection with Shanghai city center.

Figure 4.3
Interventions to improve Songjiang new town's intercity level connections.



3. Analyses in urban scale

3.1 GIS-related analyses in Songjiang new town

3.1.1 Integration analyses with Space Syntax

Figure 4.4
Angular analyses in
Songjiang new town.

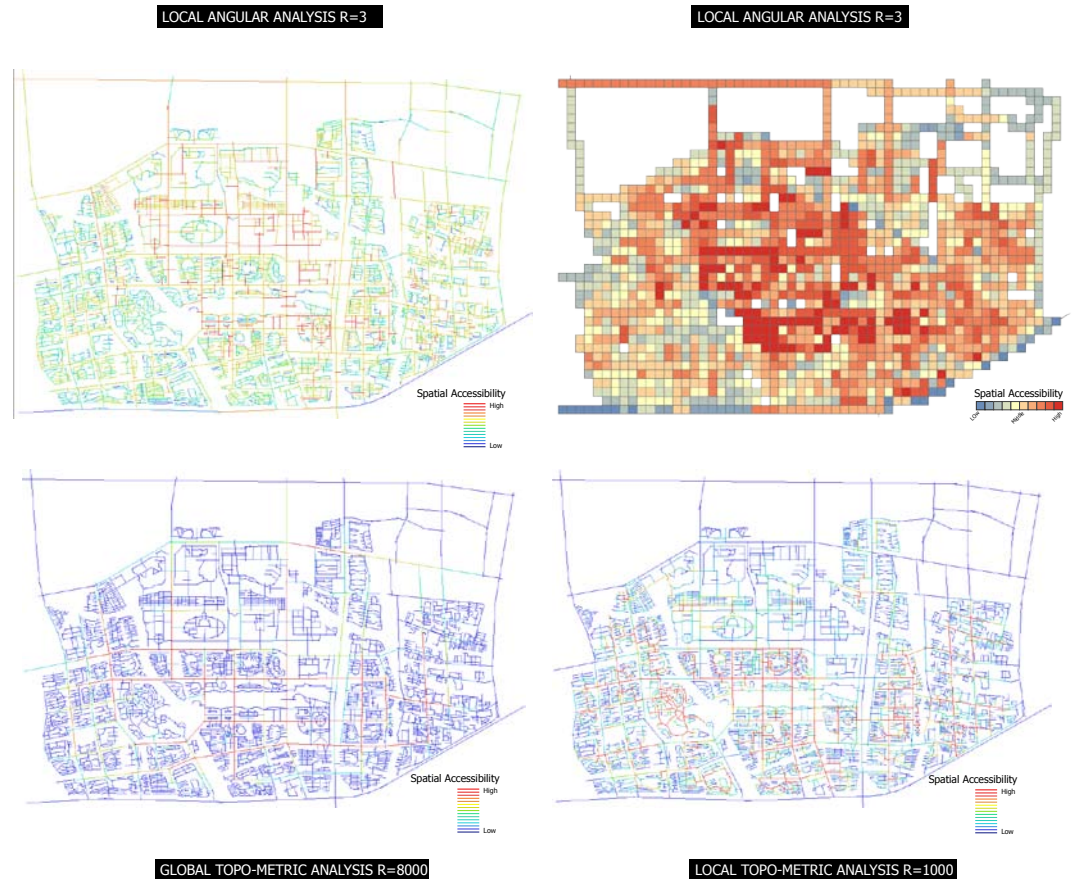
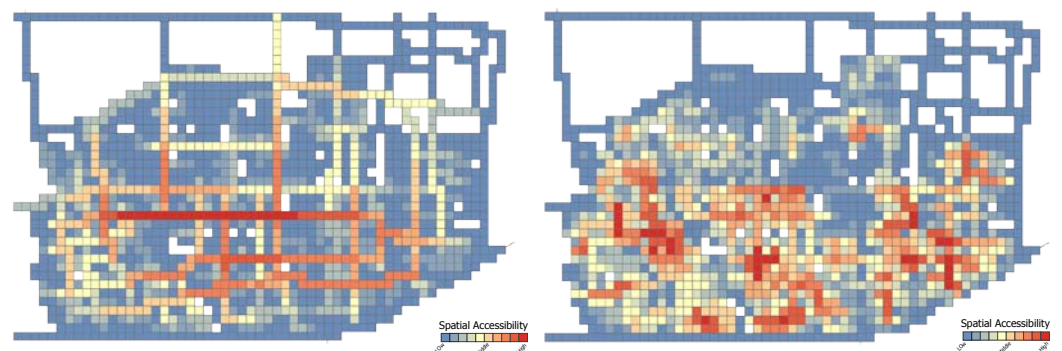


Figure 4.5
Typo-metric analyses in
Songjiang new town.



The integration value in both typo-metric (Figure 4.4) and angular (Figure 4.5) will be transformed into cells. Then, results in typo-metric analyses (global+local) and angular analyses (local) will be combined based on GIS. By this way, we can get spatial integration map (Figure 4.7).

Just like the results in Lelystad and Almere, lacking of centrality is obvious in the Songjiang new town's spatial integration map. In addition, most of well integrated areas are only located on the main roads. The integration rates in some areas tend to make dramatic decrease once leaving the main roads. Moreover, there exist large areas with low integration in Songjiang new town.

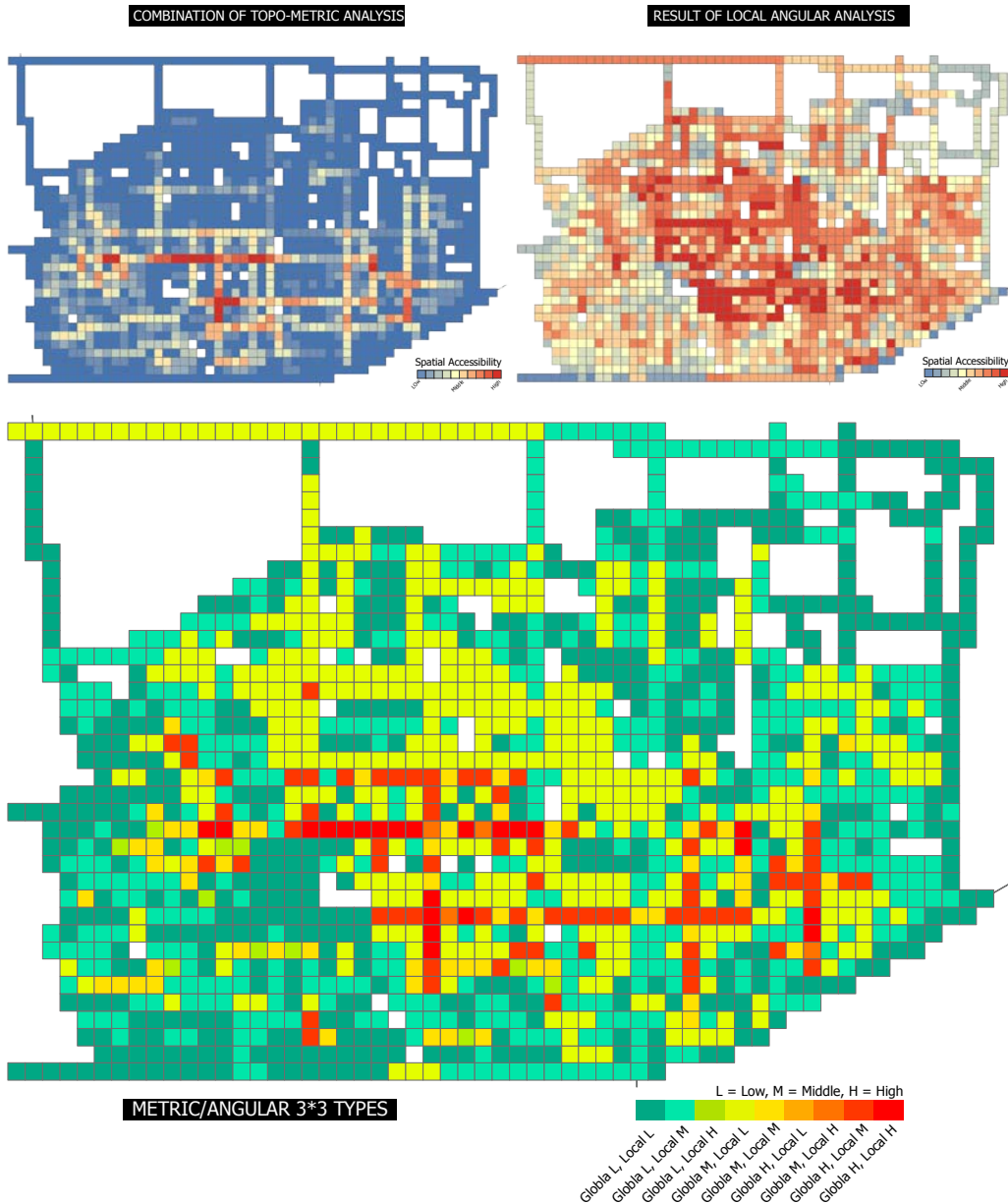


Figure 4.6
Angular and typo-metric analyses.

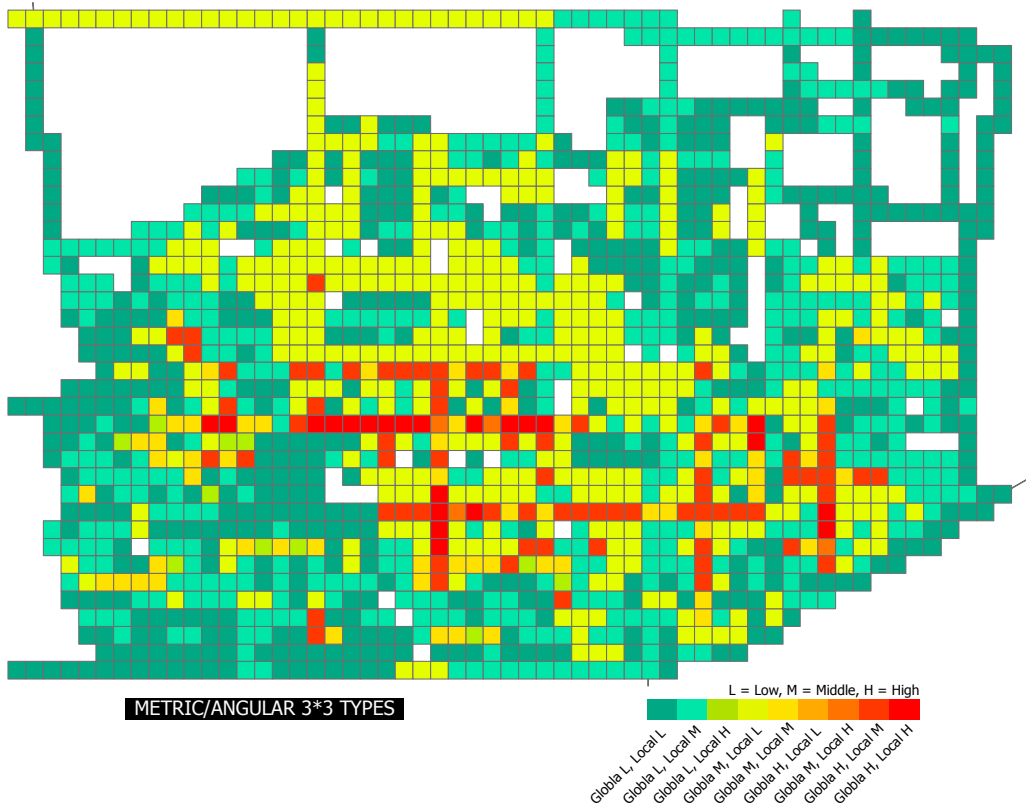


Figure 4.7
The combination of angular and typo-metric analyses.

3.1.2 Morphology analyses with Spacematrix

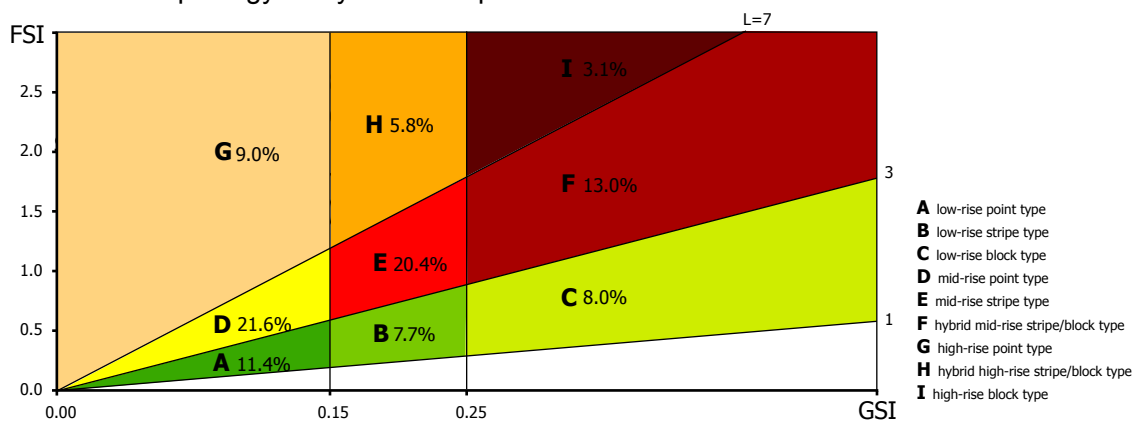


Figure 4.8
The FSI-GSI plane of the Spacematrix with various built types in Songjiang new town.

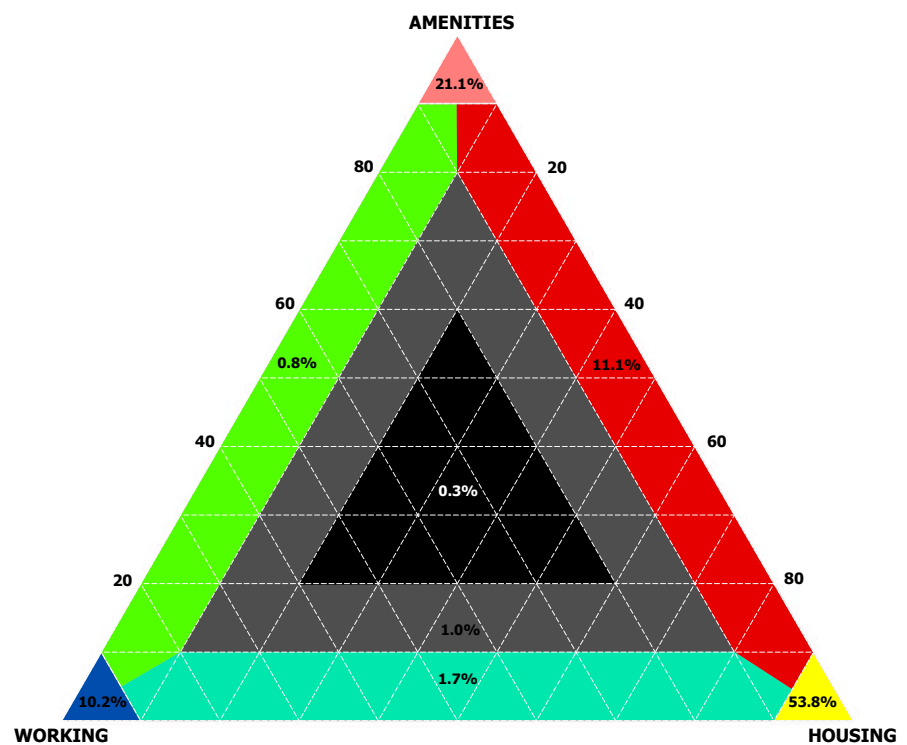
Because of higher population stress, the density in Songjiang new town is high. Middle rise stripe and middle rise block types are dominate, even the high rise stripe and block types are not rare (Figure 4.8, 4.9). However, why such a new town having high density still be suffered by the lacking of urbanity? The reason should be researched.

Figure 4.9
The location of different environmental types in Songjiang new town as defined with Spacematrix.



3.1.3 Functional mixture analyses with MXI

Figure 4.10
The triangle diagram of MXI in Songjiang new town.



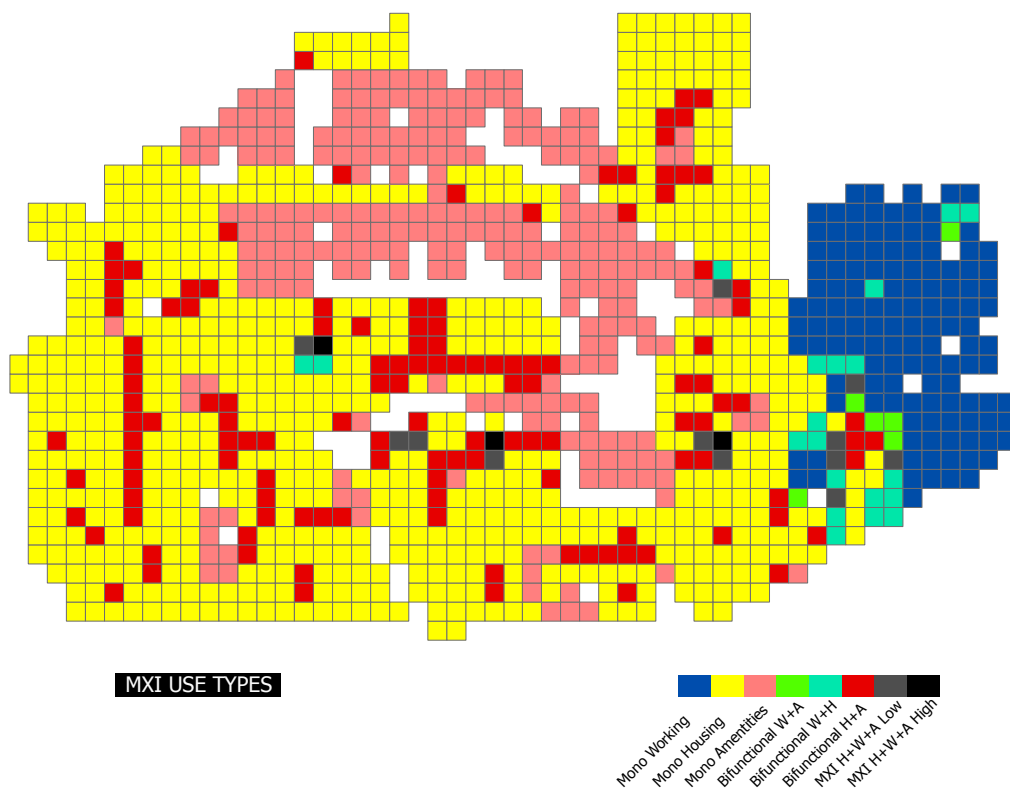


Figure 4.11
The degree of function mix in Songjiang new town.

Songjiang new town tends to be very mono-functional. Its bifunctional mixture rate is only 13.6%, even lower than Lelystad (Figure 4.10, 4.11). Moreover, functional mixture mainly appears along the main roads, the other areas tends to be extremely mono-functional. A highly functional mixture center does not exist in this new town.

3.1.4 The combination of Space Syntax. Spacematrix and MXI

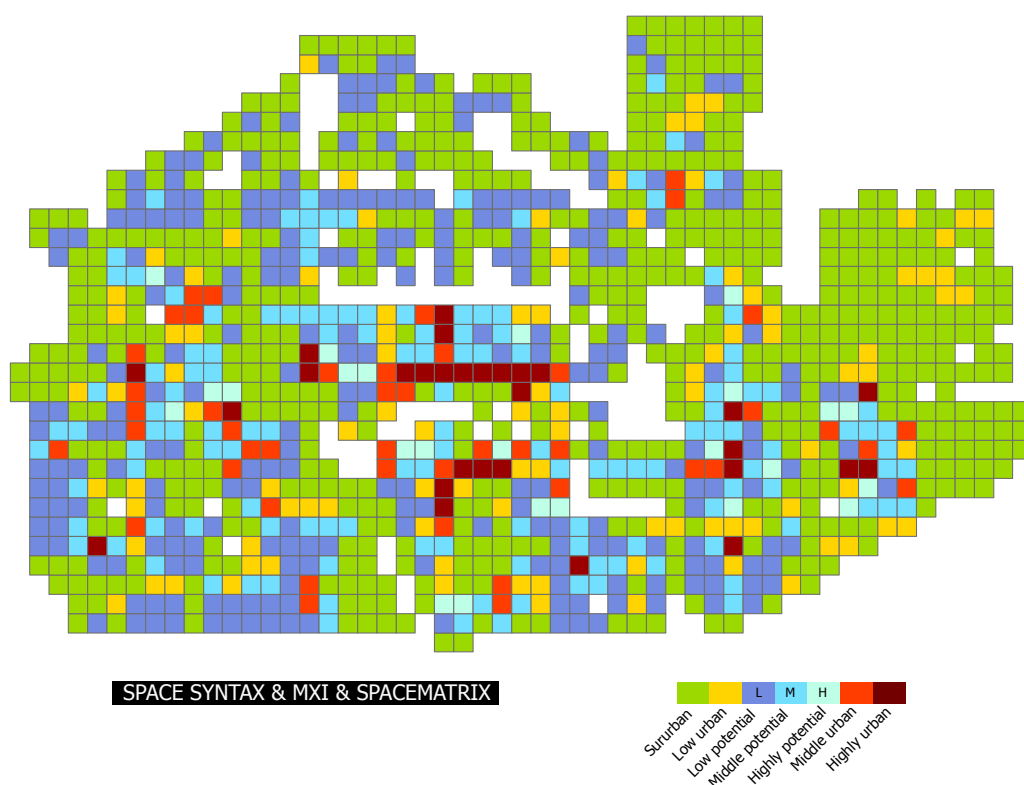


Figure 4.12
The combination of Space Syntax, Spacematrix and MXI in Songjiang new town.

Songjiang new town does not have a well developed city center and a strong urban network. According to those points, it can be belong to a newly-developed new town. However, there is a large number of potential areas, which is even higher than historical city Haarlem. What kind of reason leading to this situation and how to define the developing stage of Songjiang new town?

3.2 Data analyses in Songjiang new town

Dutch new towns				
City	Potential level	SpaceSyntax	MXI	Spacematrix
Lelystad	High	80 (7.2%)	7 (0.6%)	36 (3.2%)
	Middle	475 (42.8%)	172 (15.5%)	90 (8.1%)
	Low	556 (50.0%)	932 (83.9%)	985 (88.7%)
Almere	High	160 (7.9%)	22 (1.1%)	96 (4.8%)
	Middle	1007 (49.8%)	322 (15.9%)	292 (14.5%)
	Low	853 (42.3%)	1676 (83.0%)	1632 (80.7%)
Zoetermeer	High	78 (7.6%)	47 (4.5%)	91 (8.8%)
	Middle	405 (39.2%)	312 (30.2%)	240 (23.3%)
	Low	540 (52.2%)	674 (65.3%)	712 (68.9%)
Chinese new towns				
City	Potential level	SpaceSyntax	MXI	Spacematrix
Songjiang new town	High	100 (6.5%)	15 (1.3%)	424 (36.5%)
	Middle	453 (29.5%)	155 (13.4%)	515 (44.3%)
	Low	983 (64.0%)	991 (85.3%)	223 (19.2%)

Figure 4.13
Data analyses about imbalances in three measurements.

As shown in the Figure 4.13, Songjiang new town shows different features in the three measurements. The different value in Space Syntax reveals different spatial structure in Songjiang new town. From the visualized map, we can find high integrated or middle integrated grids in Songjiang new town are mainly located on main roads, which is different with Haarlem and Dutch new towns.

Another thing I want to mention is that higher densities are very common in Chinese cities and might be so that the density types as defined in the Spacemate need to be revised. Nevertheless, based on my own experience as an urbanist in China, defining Spacemate via nine categories is still an appropriate way to measure density and building types. A slightly revision in detailed definition (GSI, Floor number) of each category might be needed. But this revision is time-consuming and it may lead to comparison difficulty with Dutch cases in my master thesis, thus, I will handle it in my future research.

Overall, the most obvious features in the table are high value in Spacematrix and low value in MXI. The result coincides with the conclusion from visualized map. What is the reason leading to the lacking of functional mixture? Especially this new town is just finished, whether this situation is only because of time? Should we left time for this new town and let it dynamic itself? Or are there some other reasons? The analysis in match rate can help us to make the preliminary diagnosis.

Figure 4.14
Match rates between high or middle integration grids with high balanced grids (middle urban and high urban areas).

City	N(h): Grids obtaining value \geq middle level in three measurements	N(s): Grids obtaining value \geq middle level in spatial integration	Match rate
Songjiang new town	93	553	16.8%

The Figure 4.14 reveals a surprising point for Songjiang new town. Its match rate in three measurements is high (16.8%), even close to well developed new town Zoetermeer (18.3%). Nevertheless, the high match rate is not conflicting with the low functional mixture and urbanity. Because this high rate only proves existing high integration areas in current spatial structure are well used. It cannot judge whether the spatial structure is good or not. In other words, current Songjiang new town may not have a well integrated spatial structure, nevertheless, because of the high density, this poor structure is well used and creates a relatively high match rate. Therefore, at present, there should be a high pressure on improving spatial integration for further development, just like what we can find from urban diagnosis in Zoetermeer (P.83).

In addition, as mentioned in the last section, the spatial integration in new town will be shaped in the beginning and would not be changed too much in various developing periods without special interventions. That means current lacking in functional mixture is not related to time issue. **Even enough time is left for Songjiang new town, it will be blocked in this situation as well. Interventions in spatial integration must be an important part to promote this new town's development.** By now, the reason leading to huge number of potential areas is partly clear. The problem in spatial structure must be one of the reasons.

3.3 Match rate as a quick index to foresee new town development

Match rate - a quick index to judge city completeness and foresee new town development: whether time will help to make new town more dynamic or not? (Figure 4.15).

Match rate	Spatial integration	City completeness	Potentials for development	Time influence	Examples
Low	Low	Extremely less developed	Spatial integration; Density & Functional Mix	Helpful for development	unfounded
	High	Less developed	Density & Functional Mix	Helpful for development	Almere
High	Low	Less developed	Spatial integration	Might not be helpful	Songjiang new town
	High	Well developed	Spatial integration	Might not be helpful	Zoetermeer, Haarlem

Low match rate $\leq 10\%$, High match rate $>10\%$; Low spatial integration means the rate of low value in spatial integration is higher than 60%, High means the rate of low value in spatial integration is less than 60%,

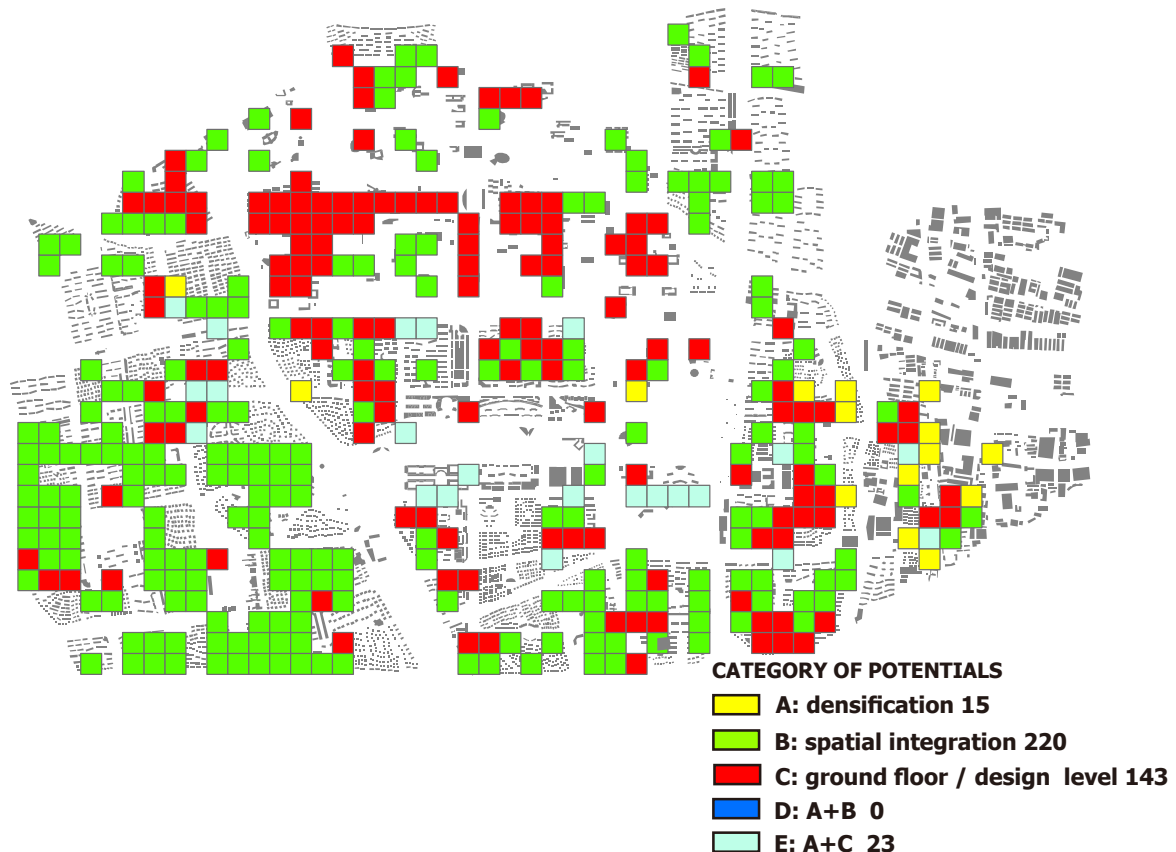
At here, city completeness is easy to be judged through spatial integration (foundation of three measurements) and the match rate (how many well integrated areas are used by the other measurements). But the time influences need more explanations. For instance, low match rate and high spatial integration mean this new town has a good spatial structure but density and functional mix are relatively less developed, just like the situation in Almere. In this context, density and mix will be gradually developed during time and make this city more dynamic. Both low in match rate + spatial integration is not possible for a planned new town. High match rate and low spatial integration represent the situation in Songjiang new town. In this context, spatial structure which tends not to change during time is the obstacle of further development. Thus, time might not be helpful and interventions in spatial structure are needed. Both high in match rate and spatial integration reflect a well developed city. Because of well developed density & mix, the obstacle of further development is changed into spatial integration aspects, just like the diagnosis results in Zoetermeer and Haarlem. Therefore, time might not help to the further development.

Figure 4.15
Match rate as a quick index to foresee new town development

Nevertheless, it is still a preliminary conclusion. The judgment of high and low values in match rate and spatial integration are given according to limited empirical study in Dutch and Chinese new towns. More case studies are needed in this direction. Moreover, whether time is helpful for development does not consider many other influencing factors like policy, regional development and so on. Thus, this conclusion about time can only be regarded as a reference. Further conclusions should be made considering other non-spatial influencing factors.

3.4 Applying the urban diagnosis method in Songjiang new town

Based on all the analyses above, a diagnosis and guiding for future interventions can be made in urban scale. Through this urban diagnosis, those potential areas can be identified and appropriate interventions directions can be given.



As shown in Figure 4.16, the category B and category C are dominant. In the whole unbalanced areas, there are 220 cells have potential for spatial integration improvements while the number is 143 for ground floor / design level improvements.

3.5. Intervention directions in urban scale

At present, several areas in unbalanced areas have been identified. Nevertheless, it does not mean we need to improve them all. We should choose the appropriate potential areas which are highly related with the developing goals of new town: 1) constructing urban network and 2) strengthening town center. In addition, the feasibility issues, like land ownership, intervention space, etc. should be considered as well. Moreover, the rasterized simulation method will bring some random calculation mistakes and lead to several miscarriages on some cells. Those meaningless cells should be removed from the intervention areas. Overall, the criteria of intervention cells selection in all potential areas is demonstrated as follow (Figure 4.17).

association degree with new town development goals	whether it is meaningful for strengthening town center
	whether it is meaningful for constructing urban networks
feasibility issues	whether land ownership is allowed the interventions
	whether has possible intervention space
	consider the limited power of urbanists
random mistakes	random calculation mistakes should be removed

Figure 4.17
The criteria of intervention cells selection.

Considering the criteria mentioned above, two intervention directions can be given:

1) surrounding intervention areas (Figure 4.18)

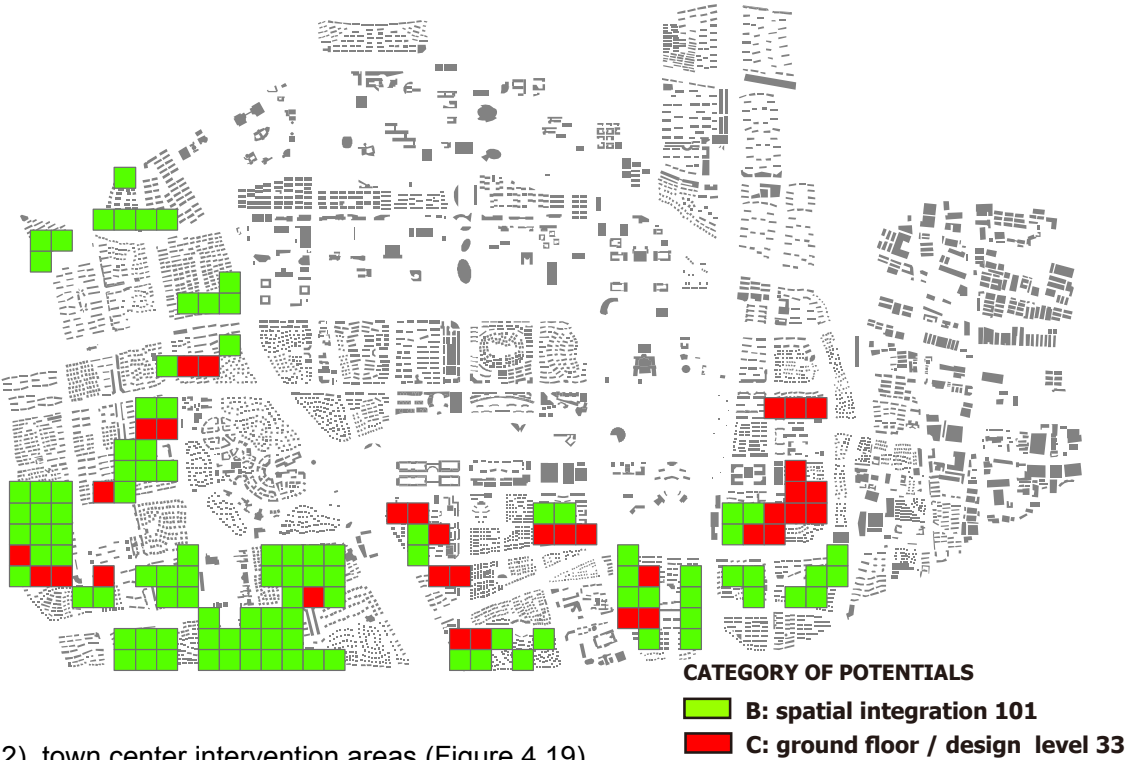


Figure 4.18
Surrouding intervention areas.

2) town center intervention areas (Figure 4.19)

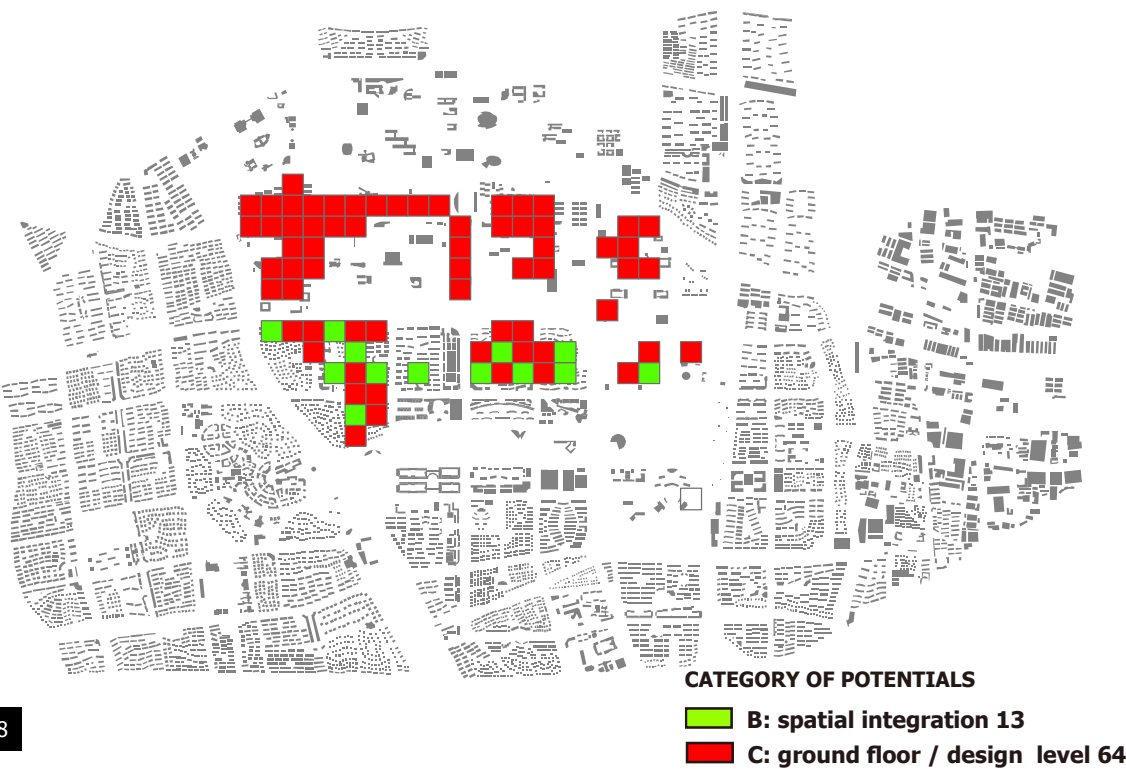


Figure 4.19
Town center intervention areas.

4. Defining the problems via local analyses

According to previous research, two reasons behind the unbalanced areas are defined: 1) poor spatial integration and 2) problematic ground floor/ urban design aspect. Nevertheless, the detailed spatial features leading to those two kinds of lacking in Songjiang new town are unclear, which will obstacle the strategies & interventions in next step. Therefore, identifying the problematic features in those two directions will be an important step for proposing strategies in urban scale

4.1 Problems in spatial integration aspects

In order to understand the spatial integration problems, I will study 4 cases in Songjiang new town. In the meanwhile, 4 cases in Dutch new towns (Lelystad, Almere and Zoetermeer) and 2 cases in historical city Haarlem will be chosen as the contrast. In this comparison, both residential areas and town center will be studied. The methods applying at here are Scatter plot analyses, step depth analyses and network density analyses.

Through those analyses, whether the spatial integration problems are created by its urban scale or local scale features can be identified. The key spatial elements leading to the problems can be revealed as well.

4.1.1 Scatter plot analyses

Scatter plot analyses can reflect the study areas' global and local integration at the same time, which is meaningful for understanding the configuration structure. For instance, a well-integrated area should have relatively equal distributed global and local integration rate at the same time.

Just as the Figure 4.20 demonstrated, as the well developed city Amsterdam, its Scatter plot distribution is quite well. A regression analysis is made in those scatter plots. The regression line is close to 45° means a relatively equal distribution in both global and local integration. Moreover, the R square is high, which means the two kinds of integration tend to be overlapped rather than separated with each other.

Based on the understanding about Scatter plot, we will turn to comparison study of Songjiang new town, Dutch new towns and historical city. All the cases at here will be corresponding to the cases researched in step depth analyses respectively.

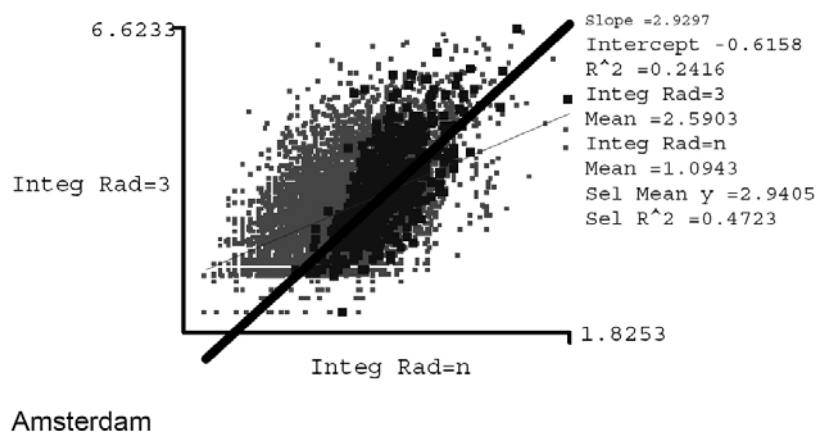


Figure 4.20
Scattergrams showing correlations between global and local integration in Amsterdam, (source: van Nes, 2012, p.145).

1) Residential areas comparison study

First of all, the scatter plot analyses in residential areas will be done. Three typical residential blocks in Songjiang new town, three typical residential blocks in Dutch new towns and one residential block in Dutch historical city Haarelm will be chosen as cases.

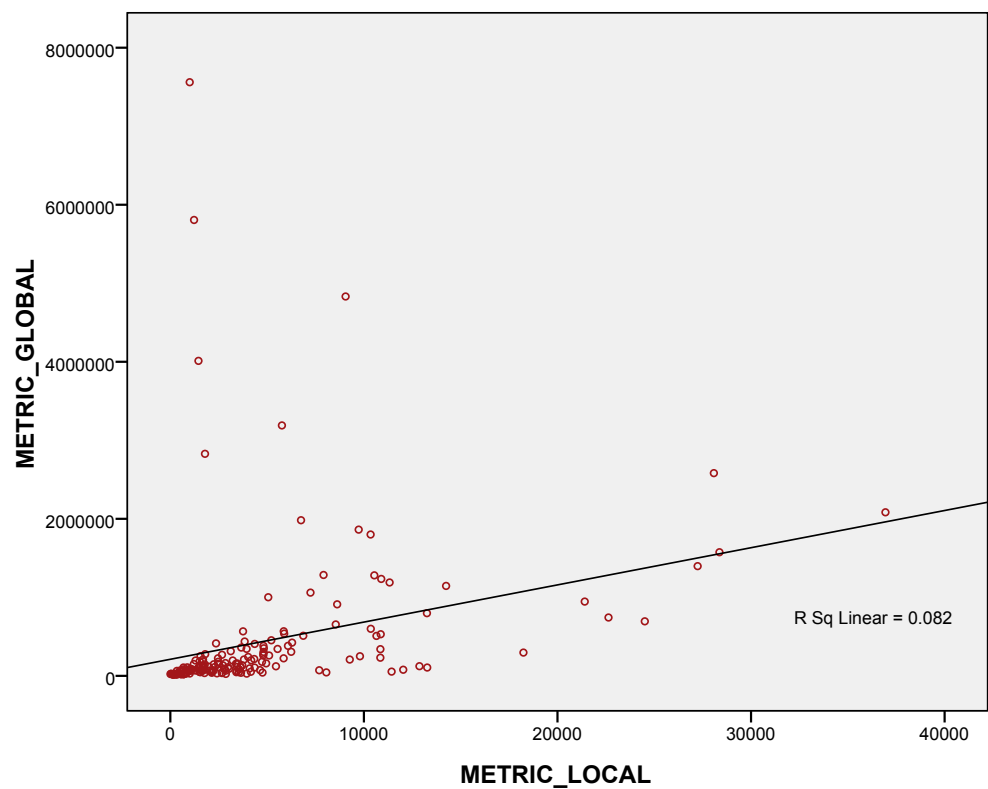


Figure 4.21
Regression analysis on
Scatter plots in Songjiang
new town, Residential area I.

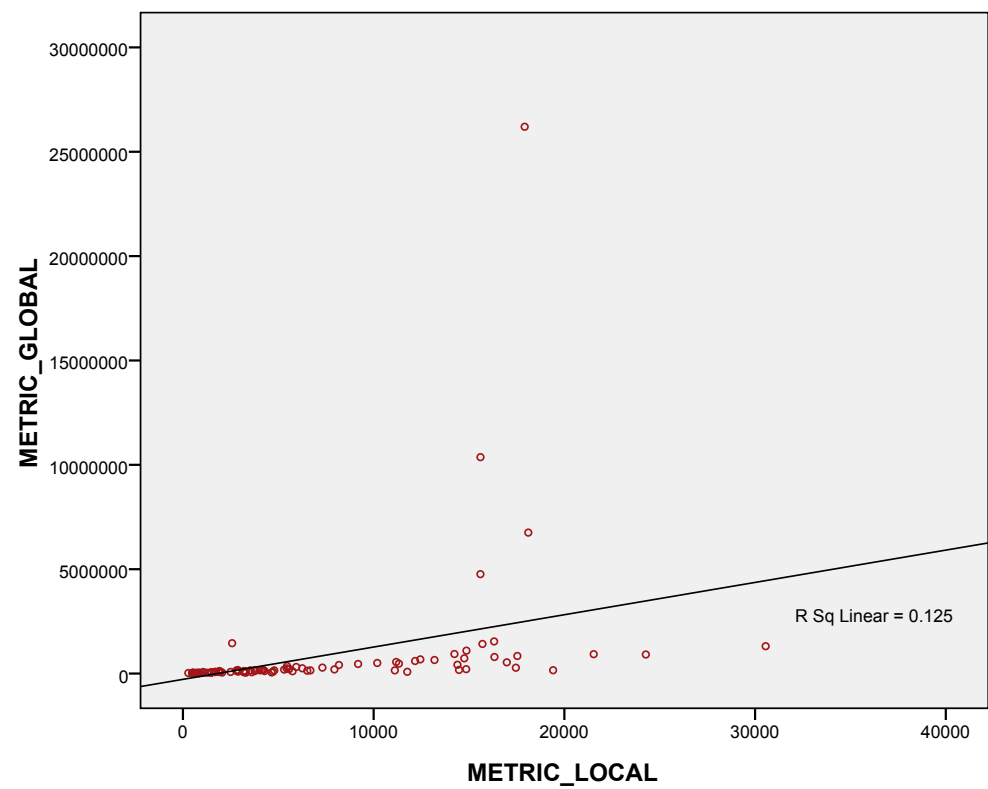
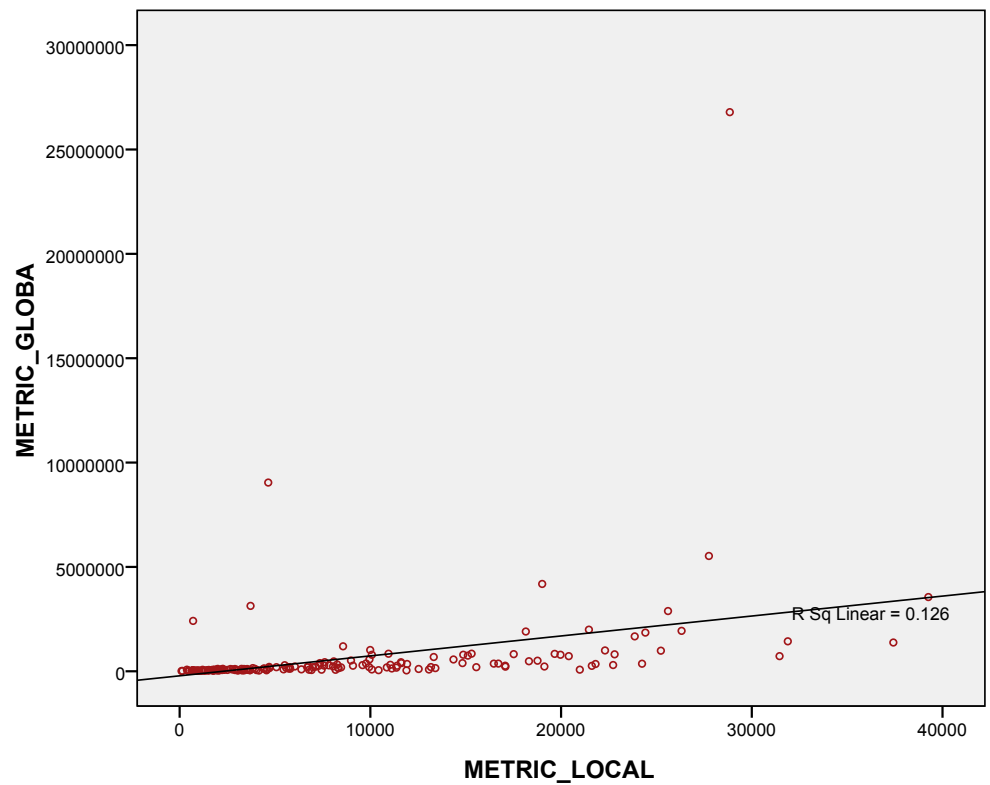


Figure 4.22
Regression analysis on
Scatter plots in Songjiang
new town, Residential area II.

Figure 4.23
Regression analysis on
Scatter plots in Songjiang
new town, Residential area
III.



The tables containing streets integration values are exported from Depthmap (Space Syntax) and then calculated in SPSS. Finally the three diagrams (Figure 4.21, 4.22, 4.23) demonstrating results of regression analyses on scatter plots can be raised.

Take Figure 4.20 as an example, one red dot represents one street in the chosen block. The x-axis reflects the street's local integration value while y-axis reflects the street's global integration value. The line in diagram is regression line fitting the dots. At here, its slope rate can reflect the relationship between global and local spatial integration. In this case, if the block has well spatial integration in both global and local scale, the slop rate will tends to around 45°. Otherwise, it tends to close to global (y) or local (x) axis.

In addition, the R square mentioned in the diagram is a number between 0 - 1 shows the relative predictive power of the model. The higher the number is, the linear model can describe real situation better. In other words, it reflects the dispersion degree between global and local integration. If the R square is high, that means the global and local integration values obtaining by the streets tend to overlap. Streets tend to have both well global and local integration at the same time. If the R square is low, that means the global and local integration values obtaining by the streets tend to be separated. More streets are showing either high global or high local integration.

In three cases from Songjiang new town, we can find a clear distinguish between high integration plots in global scale and high integration plots in local scale. Those two kinds of integrations tend to be separated rather than overlapping with each other. It is reflected on the very horizontal regression lines and the extremely low R square numbers. These two characteristics reflect neagtive spatial features in urban environment.

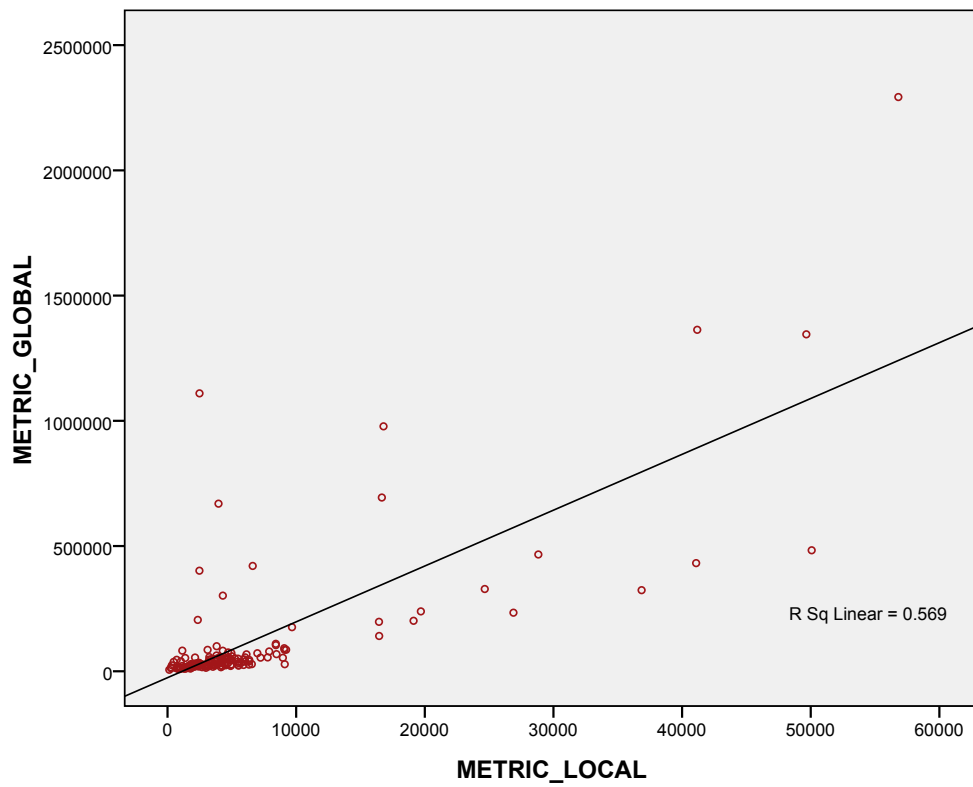


Figure 4.24
Regression analysis on
Scatter plots in Zoetermeer,
Residential area I.

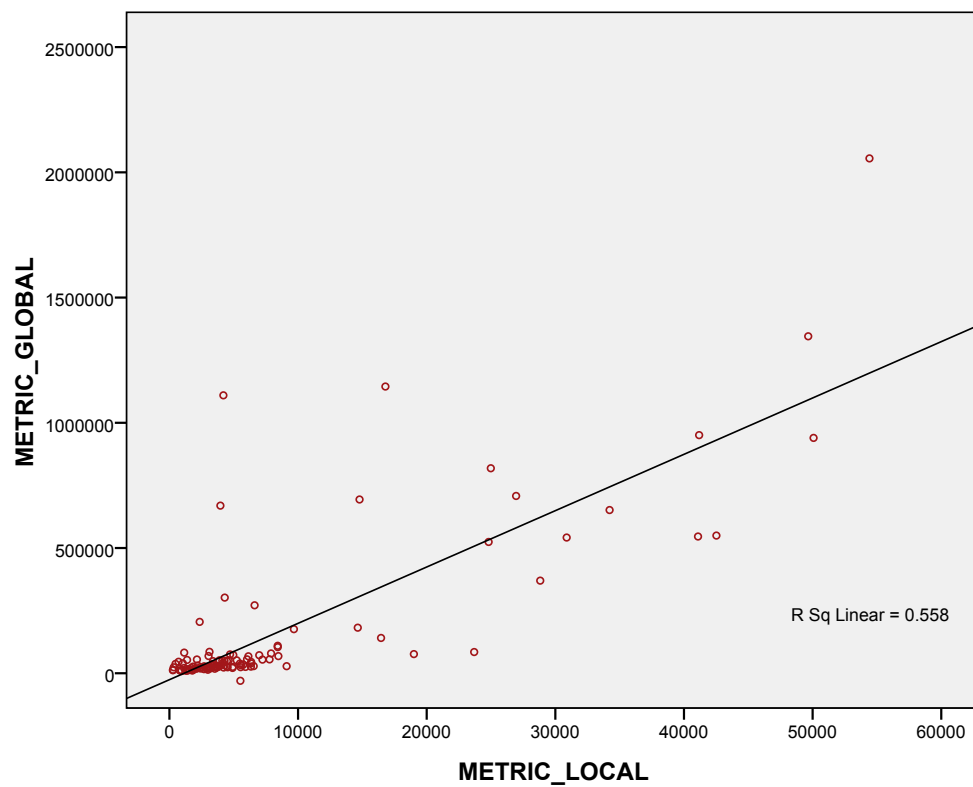


Figure 4.25
Regression analysis on
Scatter plots in Zoetermeer,
Residential area II.

Figure 4.26
Regression analysis on
Scatter plots in Almere,
Residential area.

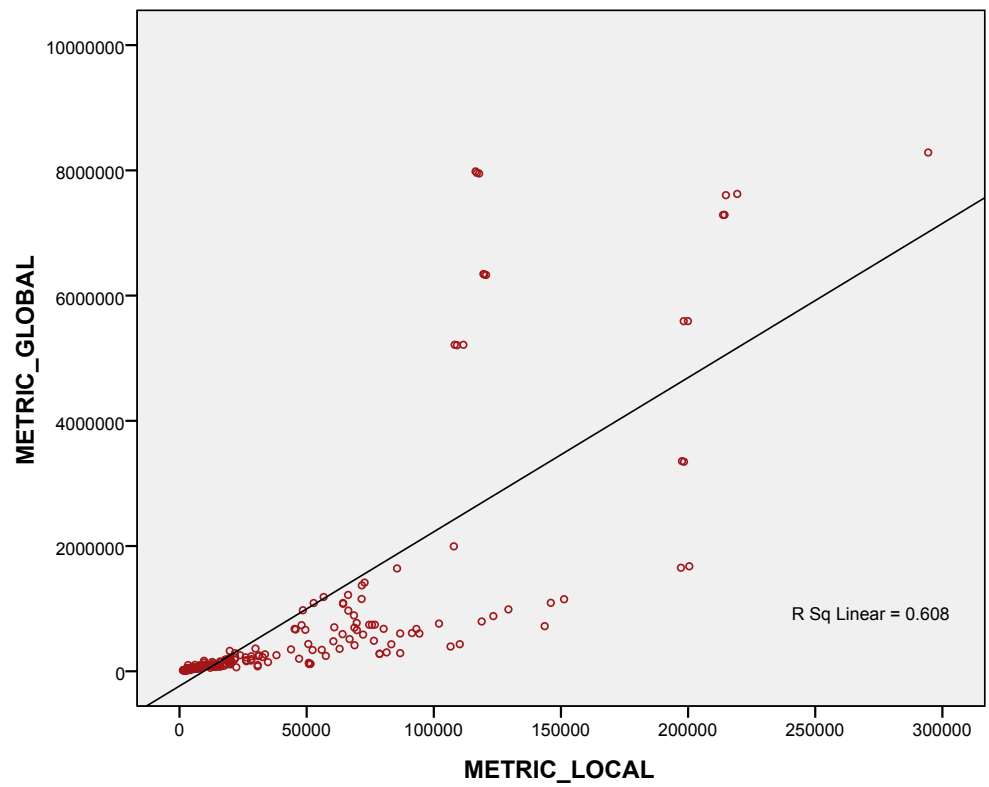
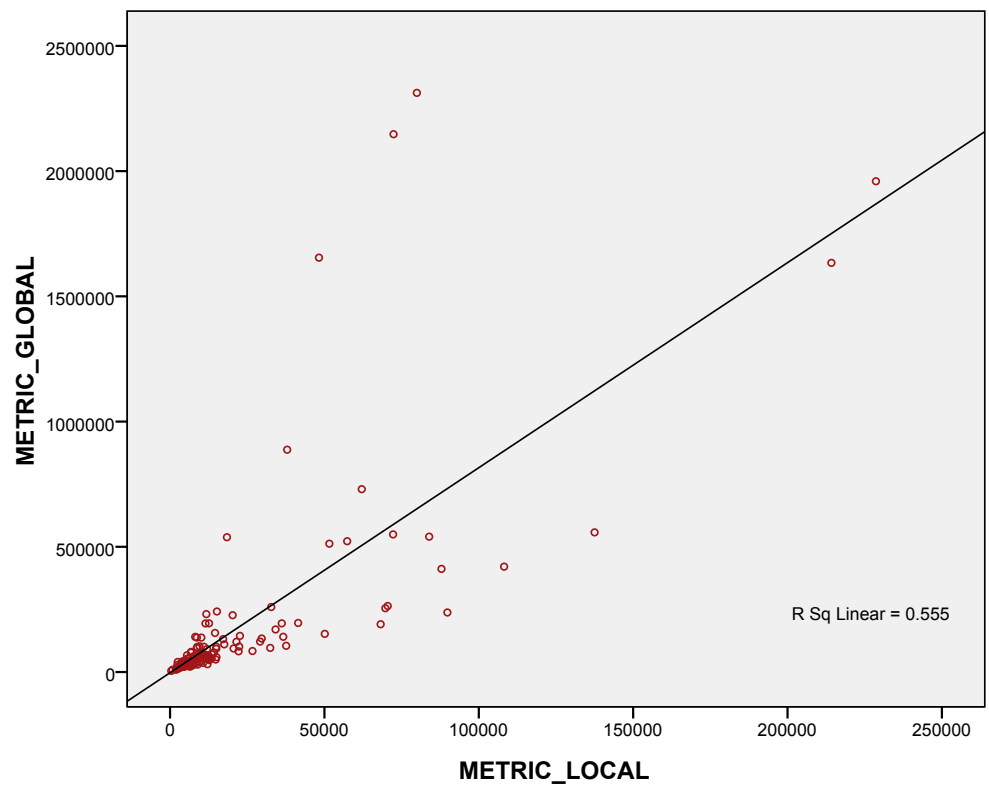


Figure 4.27
Regression analysis on
Scatter plots in Haarlem,
Residential area.



Contrast to the poor situation in Songjiang new town, those research samples perform relatively better integration in both global and local scale in Dutch new towns (Figure 4.24, 4.25, 4.26). This situation reflects on two measurements. First of all, those regression lines in Dutch new town cases are more far away from horizon. In addition, the R square numbers are much higher than cases in Songjiang new towns. Moreover, this kind of global and local integration demonstrates even better In Dutch historical city (Figure 4.27). At there, better regression line and R square can be found.

2) Town center areas comparison study

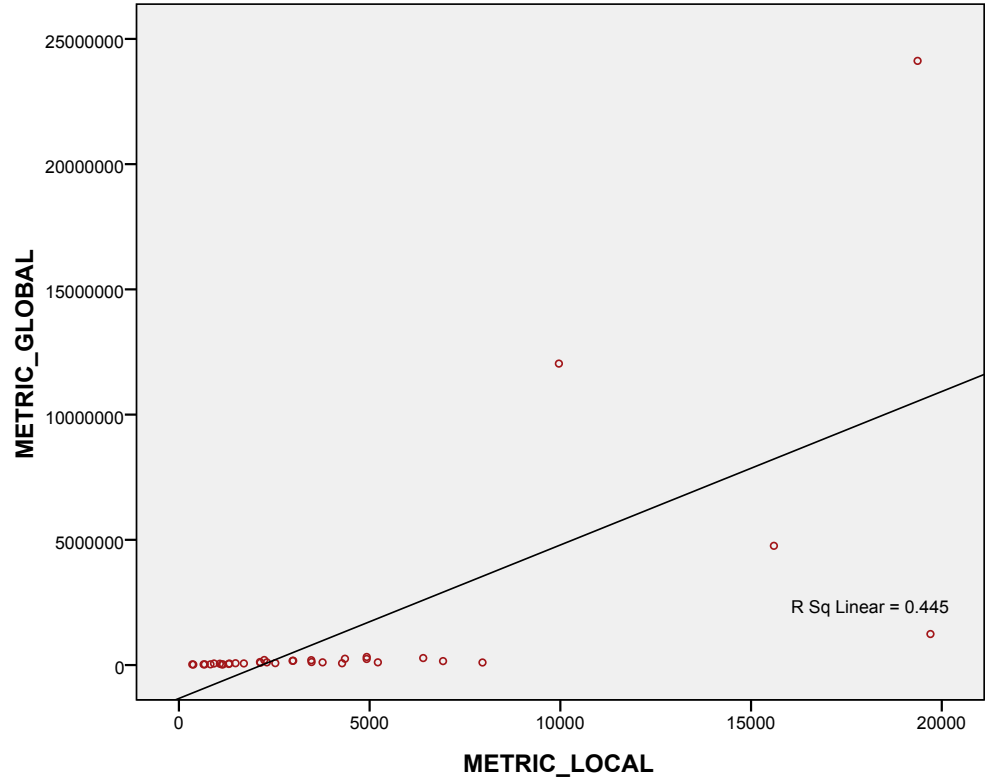


Figure 4.28
Regression analysis on
Scatter plots in Songjiang
new town, center area.

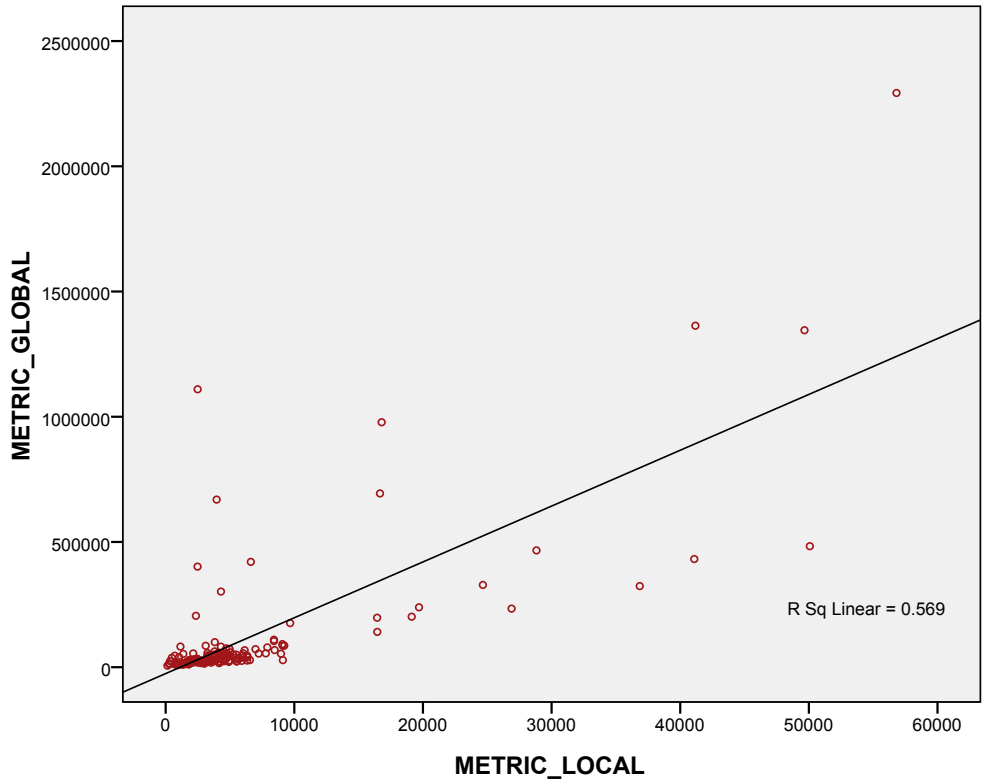
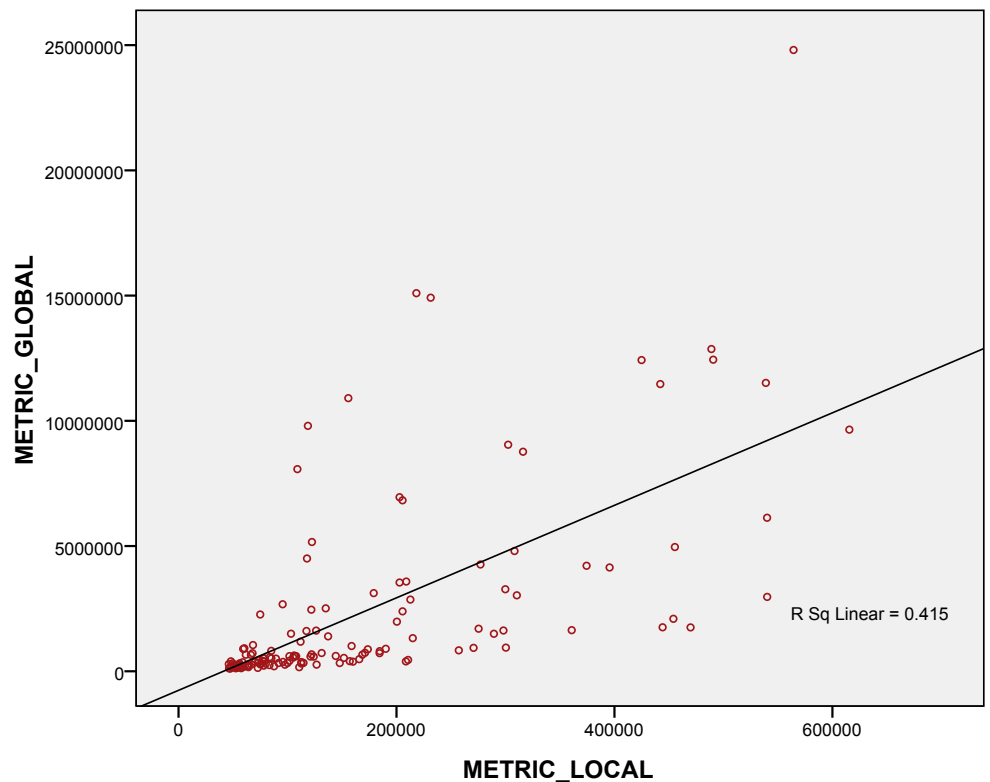


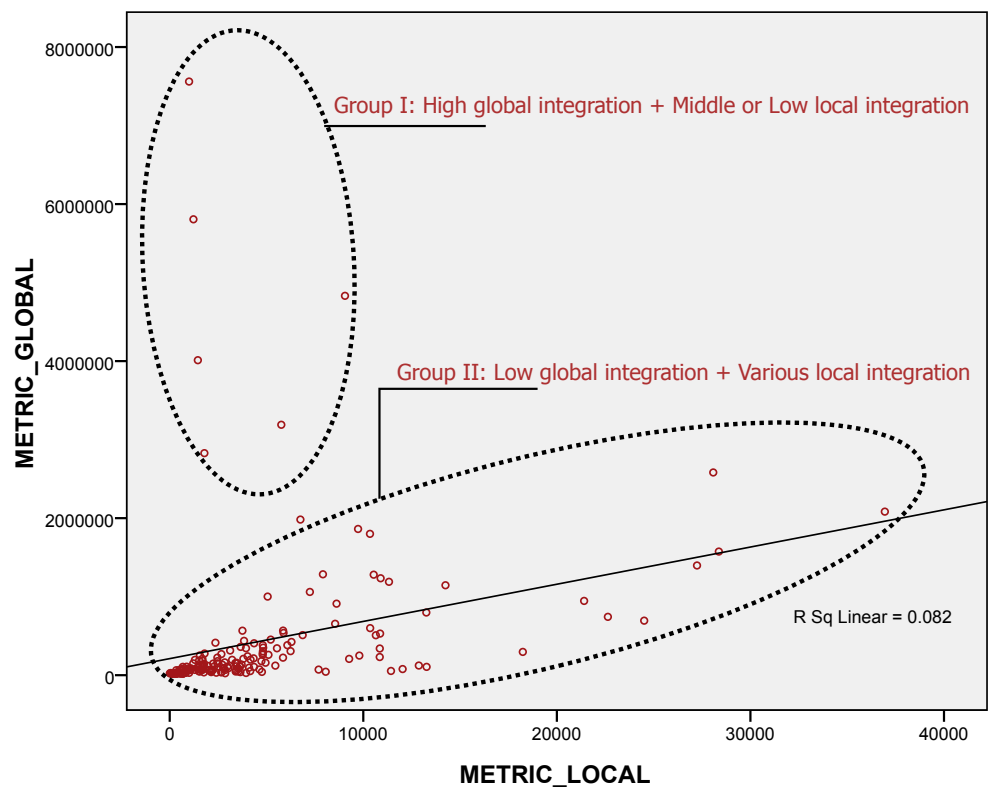
Figure 4.29
Regression analysis on
Scatter plots in Zoetermeer,
center area.

Figure 4.30
Regression analysis on
Scatter plots in Haarlem,
center area.



The similar result can be found in Songjiang center area. But this time the differences among Songjiang new town and Dutch new towns and old city are much smaller. Overall, in Songjiang new town, all the plots (lines) can be divided into two groups: 1) several plots have high global integration and middle or low local integration, 2) a larger number of plots have low global integration and various local integrations. Nevertheless, this kind of clear distinguish is not obvious in Dutch new towns and historical city.

Figure 4.31
Generalization of Scatter
plots analyses in Songjiang
new town



If we look at those results from Songjiang new town more carefully, through following those groups into the map, we can find that all plots in group I (high global integration and middle or low local integration) are the main roads shaping the blocks. The plots in group II (low global integration and various local integrations) are belonging to the local roads inside the blocks (Figure 4.31). It seems like Songjiang new town has well connected main roads but the local roads inside the blocks are poorly integrated with main roads outside. Nevertheless, this situation is not obvious in Dutch new towns and even cannot be found in Dutch old city. Therefore, we can suppose that the different local street networks between Songjiang new town and Dutch towns lead to this situation.

4.1.2 Step depth analyses

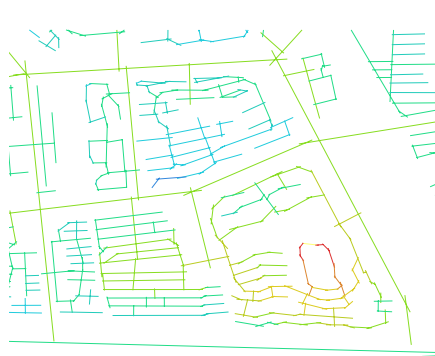
The assumption on local street network differences has been proposed by Scatter plot analyses. Then, step depth analyses will try to verify this assumption.

It is clear that all the cases in Songjiang new town have much higher step depth rates compared with Dutch new towns and historical city (Figure 4.32, 4.33, 4.34). Specifically, in Songjiang new town's residential areas, the max step depth from the inherent road to around main streets is around 14-17. In contrast, this number is about 6-8 in Dutch new towns and 3-4 in Dutch historical city.

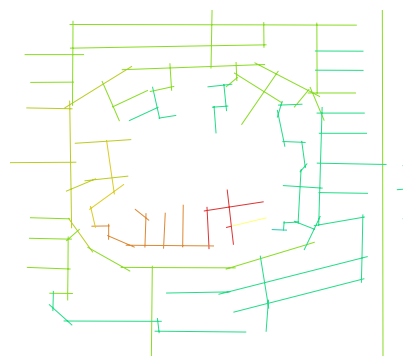
A similar situation can be found in the step depth calculation in town centers. In Songjiang new town, its maximum step depth to around main streets is about 5-7, while this number is lower in Dutch new towns (3-4). In historical city center (Haarlem), we can see the step depth is only 2-3.

Obviously, the much higher step depth in Songjiang new town leads to separation in scatter plot analyses. In Songjiang new town, local streets are poor connected; tree structure is widely used and the step depth from private to public is extremely high. Combing the analyses results, we can say this poor spatial feature should be one of the main reasons leading to the spatial integration problems.

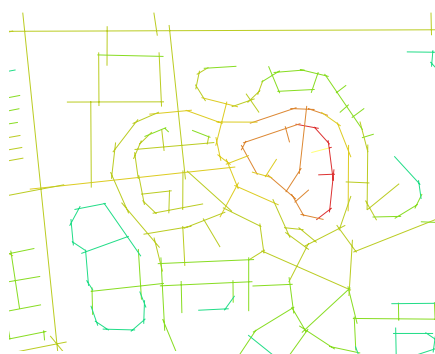
STEPS DEPTH ANALYSES IN SONGJIANG NEW TOWN



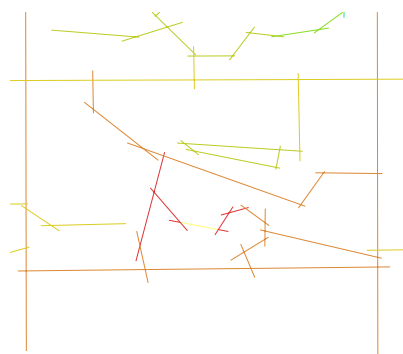
Residential areas I: Max Step depth 14-16



Residential areas II: Max Step depth 15-17



Residential areas III: Max Step depth 14-16



Town center: Max Step depth 5-7

Figure 4.32
Step depth analysis in
Songjiang new town.

STEP DEPTH ANALYSES IN DUTCH NEW TOWNS



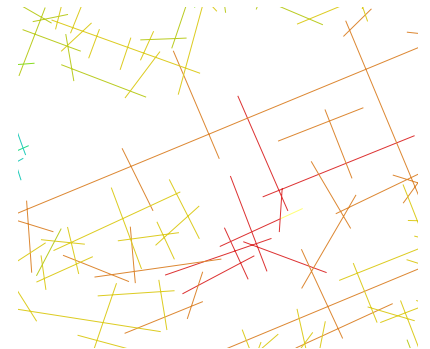
Residential areas (Zoetermeer I): Max Step depth 3-6



Residential areas (Zoetermeer II): Max Step depth 6-7



Residential areas (Almere): Max Step depth 6-8

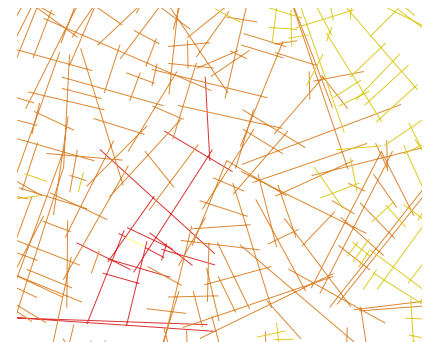


Town center (Zoetermeer III): Max Step depth 3-4

STEPS DEPTH ANALYSES IN HISTORICAL CITY HAARLEM



Residential areas I: Max Step depth 3-4



Town center: Max Step depth 2-3

4.1.3 Network density analyses

However, besides the high step depth, are there other reasons might lead to the poor spatial integration in Songjiang new town? Network density, as another indicator affecting street layout, should be checked as well. Therefore, Network Density in the Spacematrix analyses will be applied at here.

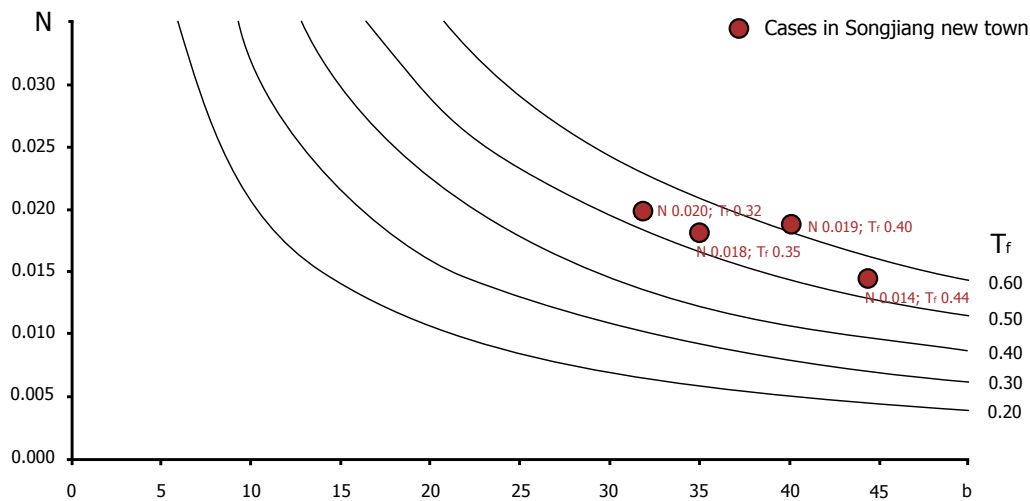


Figure 4.35
Network density analyses in Songjiang new town.

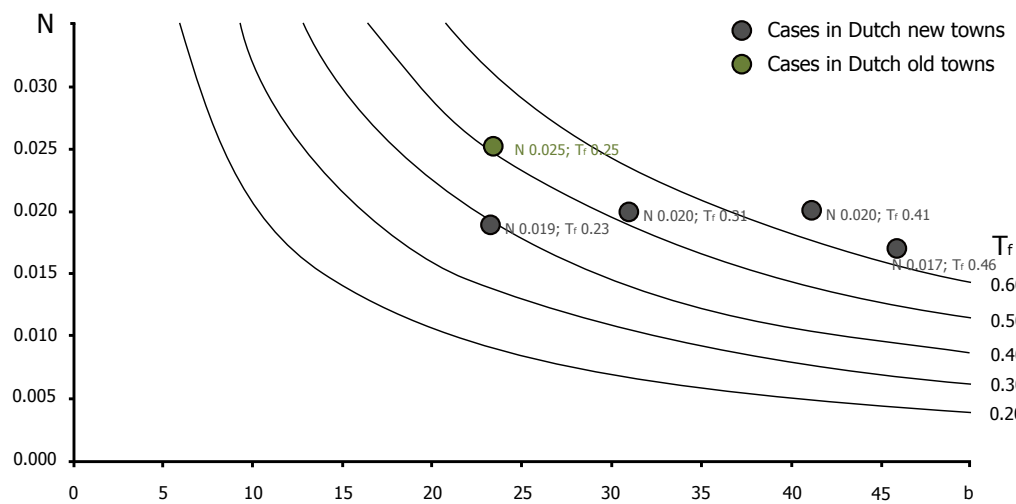


Figure 4.36
Network density analyses in Dutch new towns and a old town.

Because of the restriction of sunshine restrictions, Chinese cases show high similarity in N and Tf. The network density results in Chinese cases are close to each other: N is around 0.020 and Tf is between 0.32 and 0.44 (Figure 4.35). Compared with Chinese cases, Dutch cases show a little bit more scattering (Figure 4.36). Nevertheless, generally speaking, no obvious clue can be found through the comparison on network density in Spacematrix. Both Chinese and Dutch new towns' network density results are so close to each other, although Dutch historical city demonstrating small meaningless differences.

Thus, we can conclude that network density is not the reason leading to the spatial problems in Songjiang new town.

4.1.4 Conclusion

Overall, current spatial structure in Songjiang new town is poorly integrated. And we can say the main problems are inherent tree structure with huge number of direction changes from local roads to main streets and limited intersections with main roads. Thus, two kinds of interventions are needed: **1) improving the connectivity on the local roads, 2) adding urban block entrances between the local and main roads**

4.2 Problems in Ground floor / design level aspects

4.2.1 Problem analyses

Turning to the ground floor / design aspect, all the grids marked are studied. Generally speaking, the crucial interactions between buildings and streets are extremely limited, which only can be found in commercial areas. The widespread of big block size (500m x 500m) and gated communities lead to a common spatial feature: most residential areas are isolated with public streets by walls and linear green space (Figure 4.37).

In addition, restricted by the out-dated zone map, mono-functional areas can be seen everywhere (Figure 4.38). Not only residential blocks are lacking mixture, the large university areas are troubled by function monotony. **Therefore, promoting interactions and functional mixture are the two main tasks in urban design aspects.**

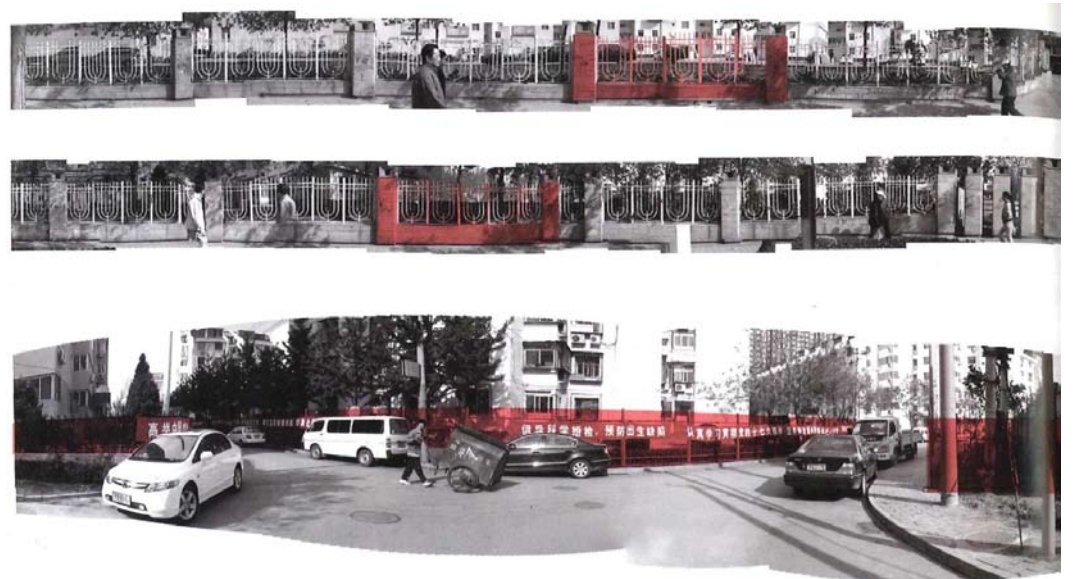


Figure 4.37
Walls obstacle intersections
between buildings and
streets, (source: Li, 2008).

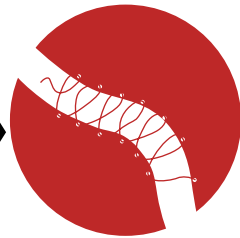


Figure 4.38
Mono-functional areas are
widely spread, (source: Mars,
2009).

5. The transformation rules in urban scale

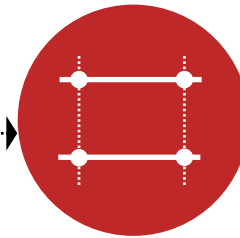
5.1 The corresponding rules in two aspects

THE
TRANSFORMATION
RULES
CORRESPONDING
TO SPATIAL
INTEGRATION
PROBLEMS

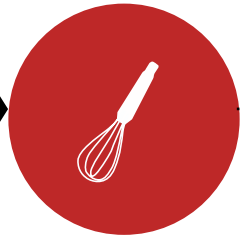


LINK

Adding roads & entrances

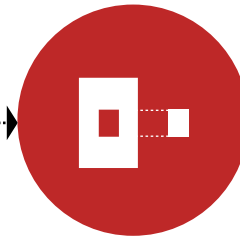


New roads & entrances

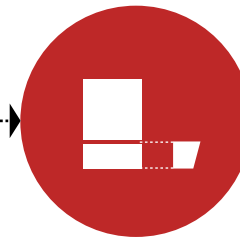


MIX

Encouraging functional mixture



Functional implantation



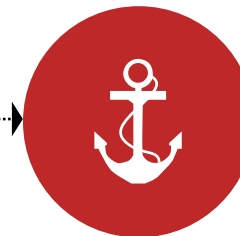
Ground floor functional changing

THE
TRANSFORMATION
RULES
CORRESPONDING
TO GROUND FLOOR
/ URBAN DESIGN
PROBLEMS

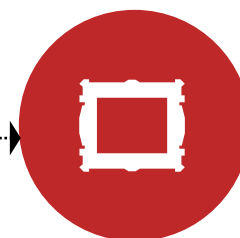


PATCH

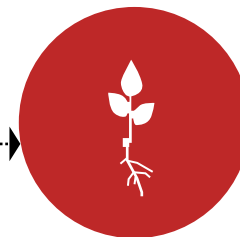
Improving interactions between buildings & streets



Strong functional improvement



Soft functional improvement



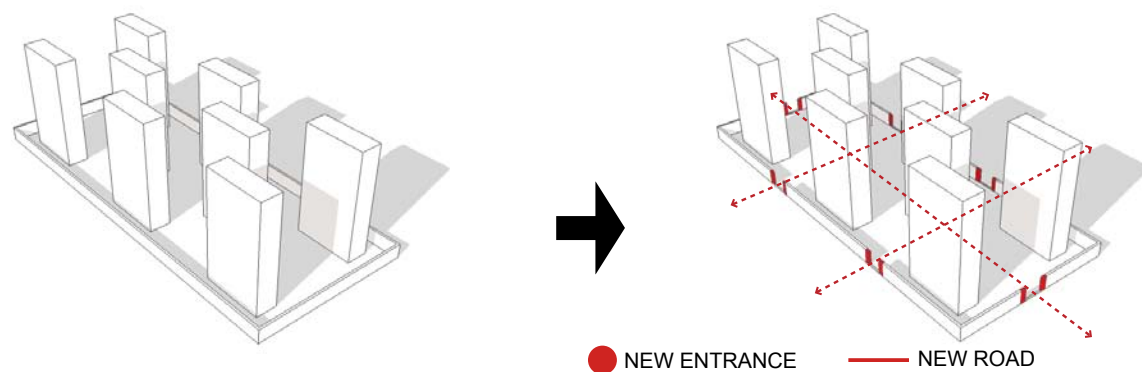
Slight functional improvement

The three main rules are defined here as tools to handle the problems found in both spatial integration and ground floor / urban design aspects. The rule: Link is proposed based on the demand of new roads and entrances to improve spatial integration. The rule: MIX is created according to the huge mono-functional areas, which contains two sub rules: encouraging functional implantation and ground floor functional changing. The last rule: Patch is aiming to improve interactions between streets and buildings via various interventions. It contains three sub rules from strong to soft and slow interventions. Through interventions based on the three rules, unbalanced areas will be transformed towards high balanced areas, meanwhile, Songjiang new town will develop toward a more complete city.

5.2 The explanations of transformation rules

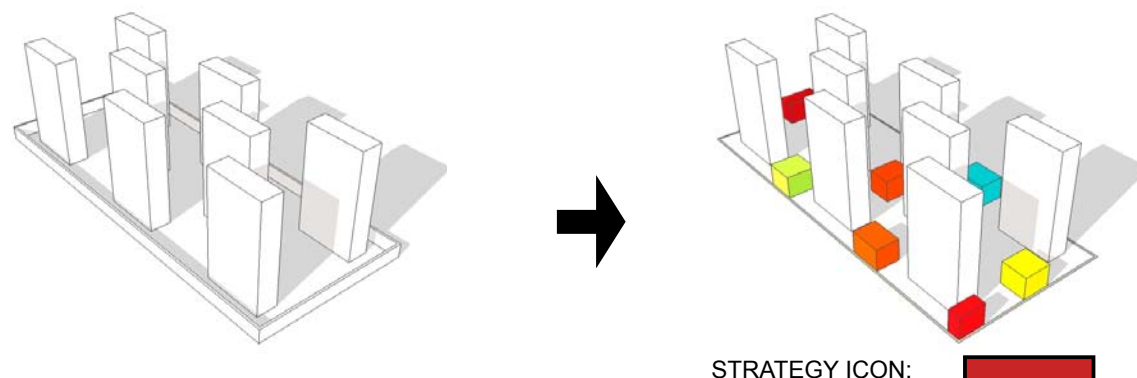
Sub rule I: New roads & entrances

Through adding new local roads and entrances to decrease step depth and increase the spatial integration in residential areas closing to city center.



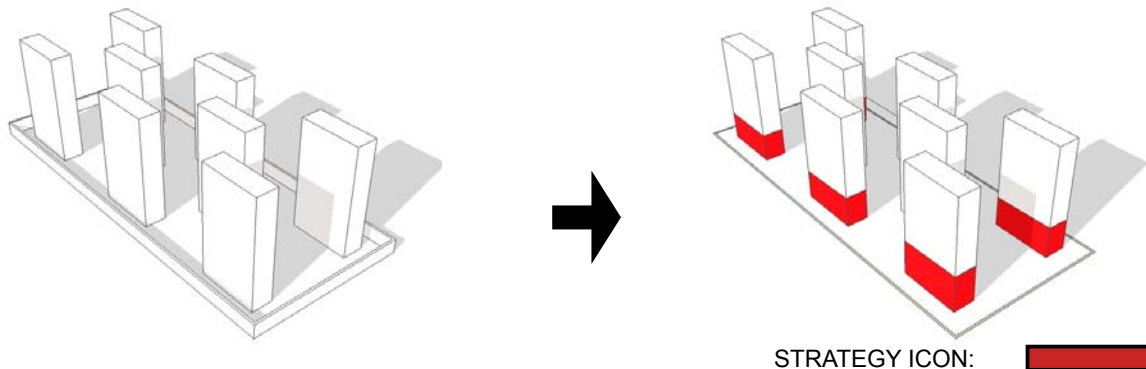
Sub rule II: functional implantation

Through adding new building complexes with dynamic functions to promote functional mixture



Sub rule III: ground floor functional changing

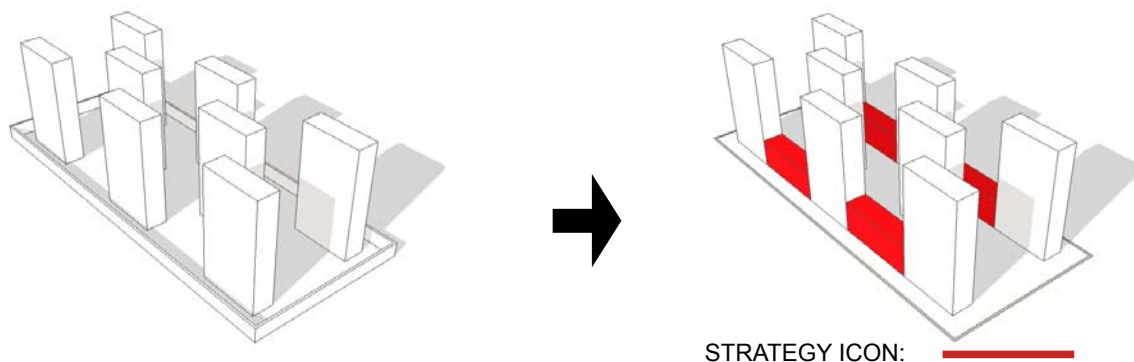
Through encouraging existing mono-functional ground floors been replaced by dynamic functions to promote functional mixture



Through design interventions to promote interactions between buildings and streets in residential areas are important as well. Because of the various building environment situations, three sub interactions are categorized at here. The choosing of sub interactions is decided by three criteria: geometric and typological locations; landownership and possible intervention space.

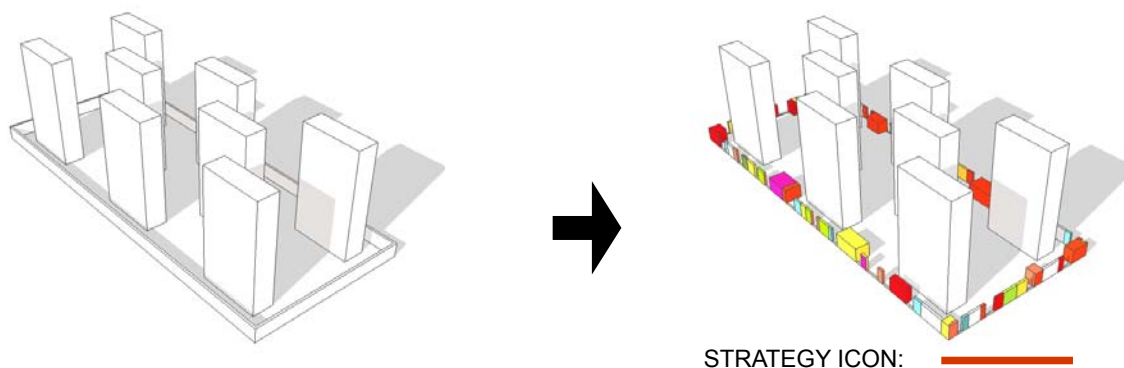
Sub rule IV: strong interaction improvement

When all the three criteria are high, strong interactions to change ground floor totally will be implemented via direct functional implantations and the wall removing.



Sub rule V: soft interaction improvement

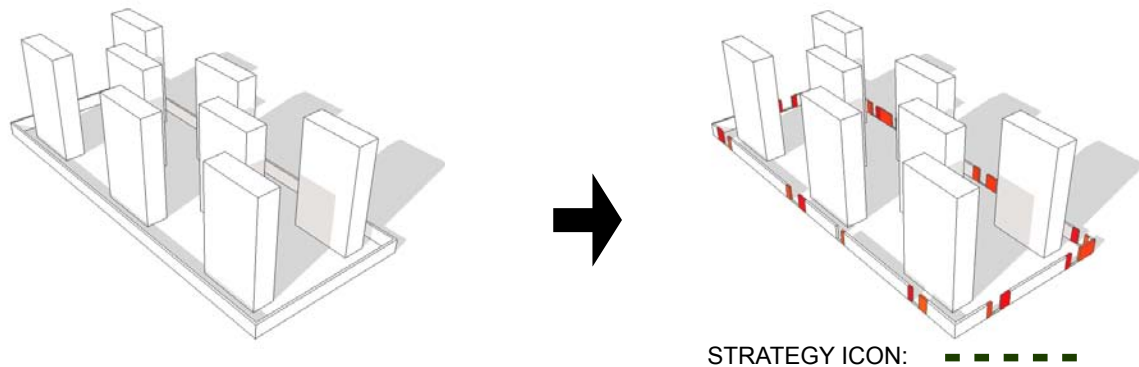
When the conditions are not very perfect, soften replacement will be considered. It is mainly focusing on replacing gated wall with small recreational space. Several other function implantations will be encouraged as well.





Sub rule VI: slight interaction improvement

When the conditions are poor, slight interaction improvements will be taken. Several replacements on the gated wall will be made to increase the interactions.



5.3 The strategies in Songjiang new town

Since rules have been proposed, we can turn to intervention aspects to transform the rules into strategies for Songjiang new town.

Strategy I: surrounding areas

In this direction, resolving spatial integration problem is the main task while several ground floor / design level problems should be considered as well (Figure 4.39).

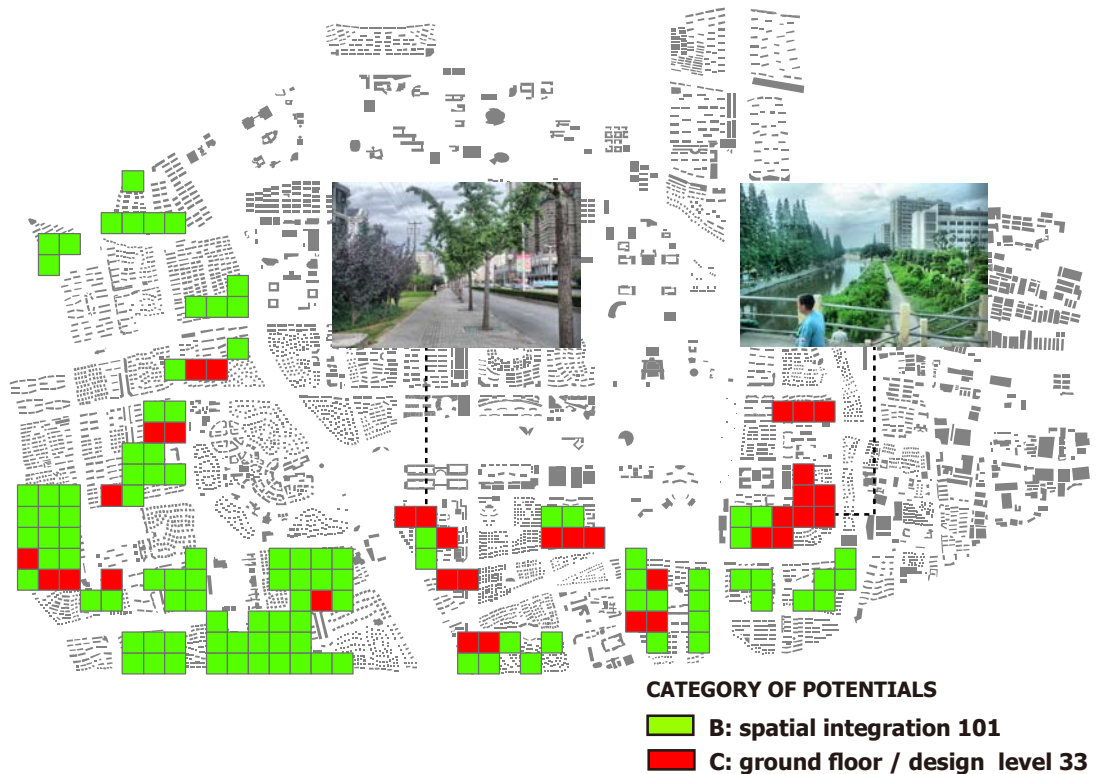


Figure 4.39
Problem demonstrations in
surrounding areas.

According to the pervious defined potential areas and the methods, strategy including both spatial integration and ground floor / urban design aspects can be proposed as follow (Figure 4.40, Figure 4.41). By now, the strategy in urban scale could be given. Nevertheless, how and where the exact intervnetions need to done will be decided by designers.

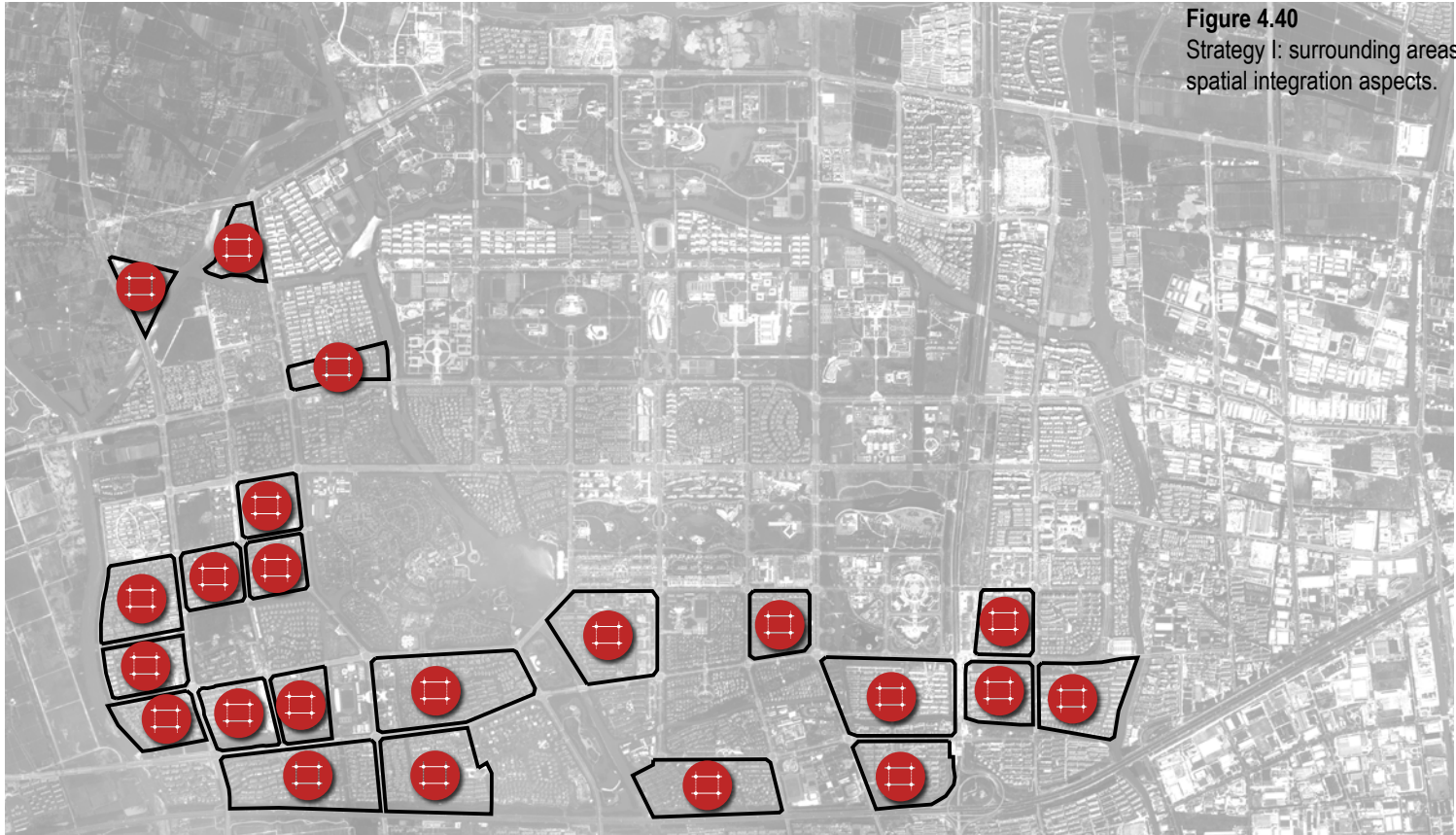


Figure 4.40
Strategy I: surrounding areas,
spatial integration aspects.

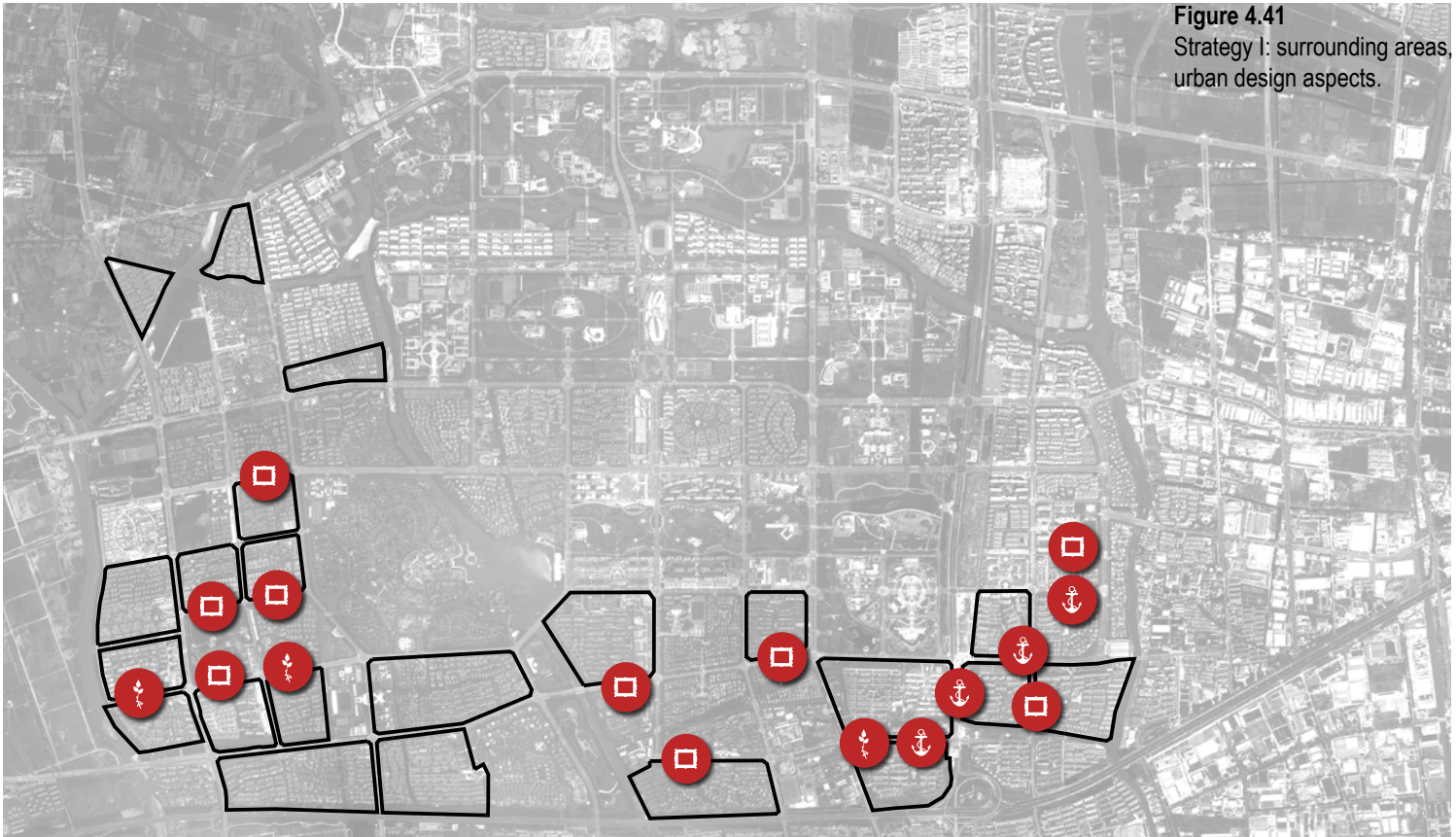


Figure 4.41
Strategy I: surrounding areas,
urban design aspects.

Strategy II: town center areas

In this direction, resolving ground floor / design level problem is the main task while several spatial integration developments are needed as well (Figure 4.42).



Figure 4.42
Problem demonstrations in town center areas.

CATEGORY OF POTENTIALS
■ B: spatial integration 13
■ C: ground floor / design level 64

The town center areas can be divided into two parts: northern university areas and southern residential areas closing to city center. From Figure 4.42, we can see that in the northern university areas, the ground floor / design problem is mainly reflected on over mono-functional mixture. In those residential areas closing to city center, the ground floor / design problem is reflected on the interactions between buildings and streets while spatial integration problems also appear in several grids. Based on the analyses above, strategy II can be given as follow (Figure 4.43).

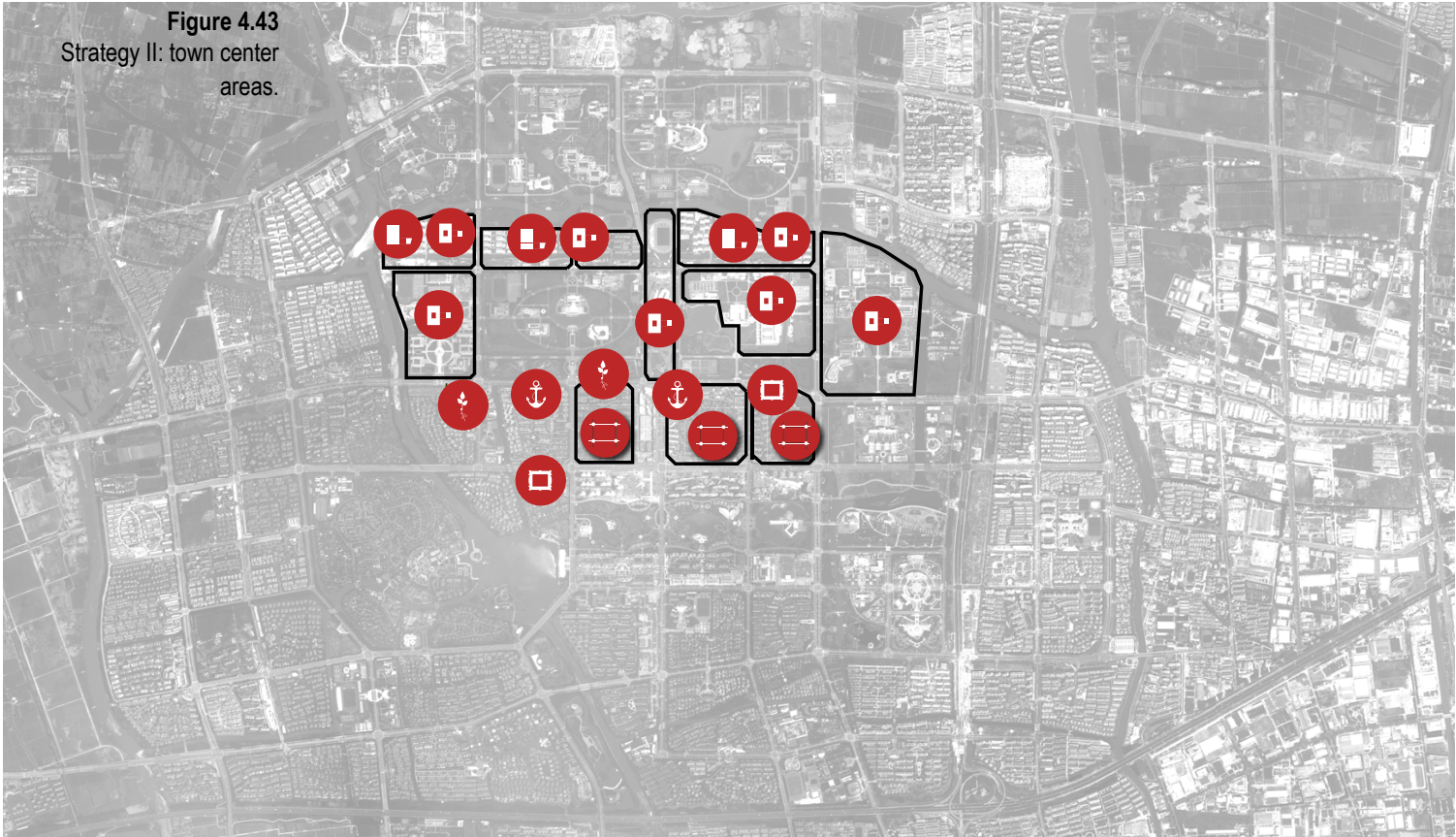
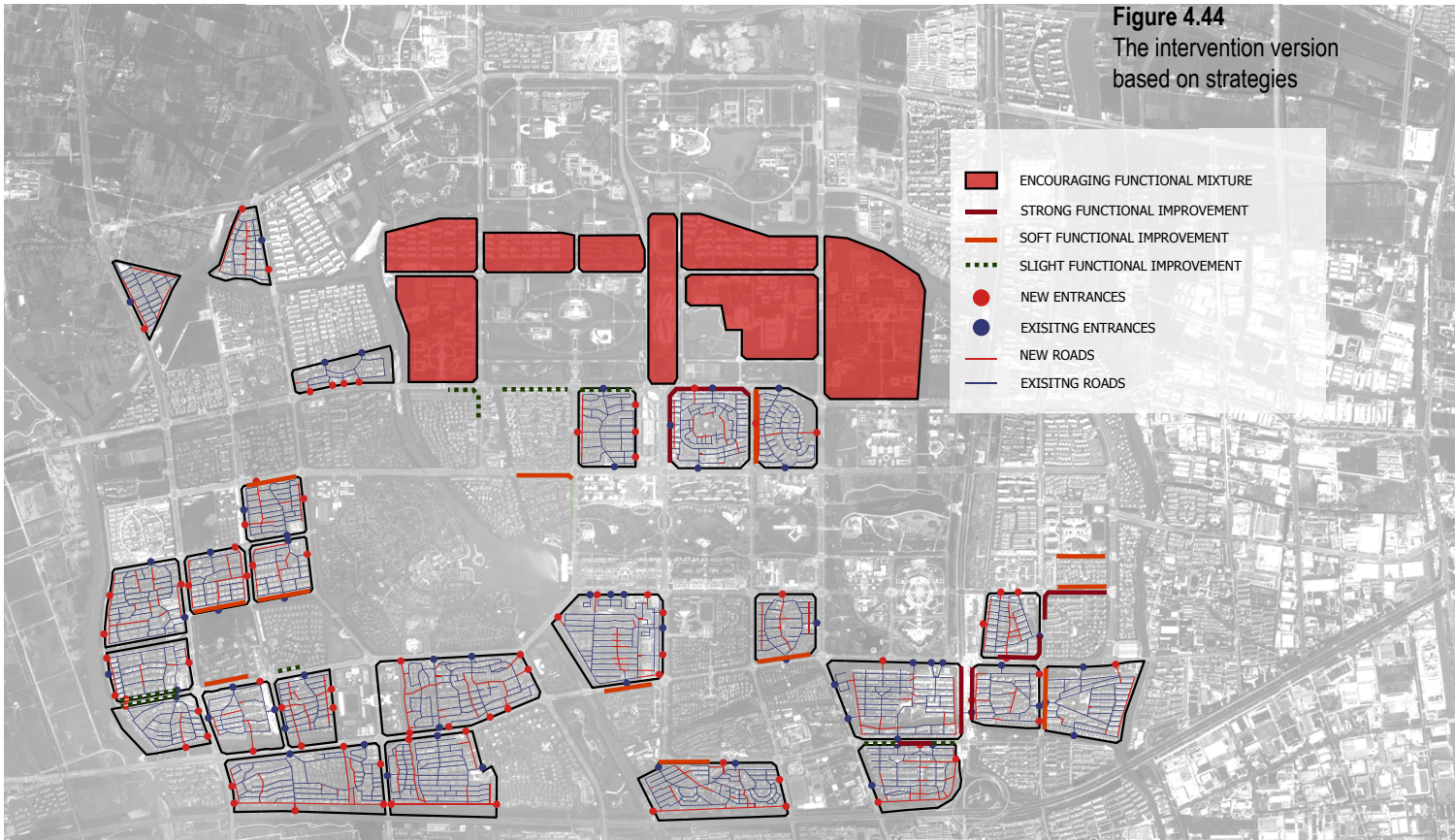


Figure 4.43
Strategy II: town center areas.

5.4 The version of interventions

According to the proposed strategies, now it is possible to demonstrate an intervention version (Figure 4.44). It shows a kind of possibility under the implementation of rules and strategies.



6. Evaluation of the strategies & interventions

Since the strategies and interventions in regional scale and urban scale in Songjiang new town have been given, it is time to evaluate the effect of regional strategy and urban interventions. First of all, the influence of regional strategy will be checked, and then followed by the checking in urban interventions.

6.1 Evaluation in the regional strategy & intervention

According to the strategy given in Section IV, its regional strategy should mainly focus on promoting connections with its surrounding areas. Specifically, three new roads should be added to improve Songjiang new town's intercity level integration. Just like the diagram shows, new road on the left is aiming to strengthen the connection to west built up areas. The other two roads are trying to strengthen Songjiang new town's connection with Shanghai city center (Figure 4.45).

Based on the strategy, new roads have been added and the new result has been calculated in Depthmap. Although this strategy is mainly aiming at intercity level, both regional and intercity levels are calculated. It seems like not only in intercity level but also in regional level, this strategy bring positive influences in spatial integration rate. Connections with surrounding intercity areas are improved (Figure 4.46, 4.47, 4.48). Two regional connections in Songjiang new town also been promoted (Figure 4.49). In conclusion, this regional strategy is successful.

Regional strategy

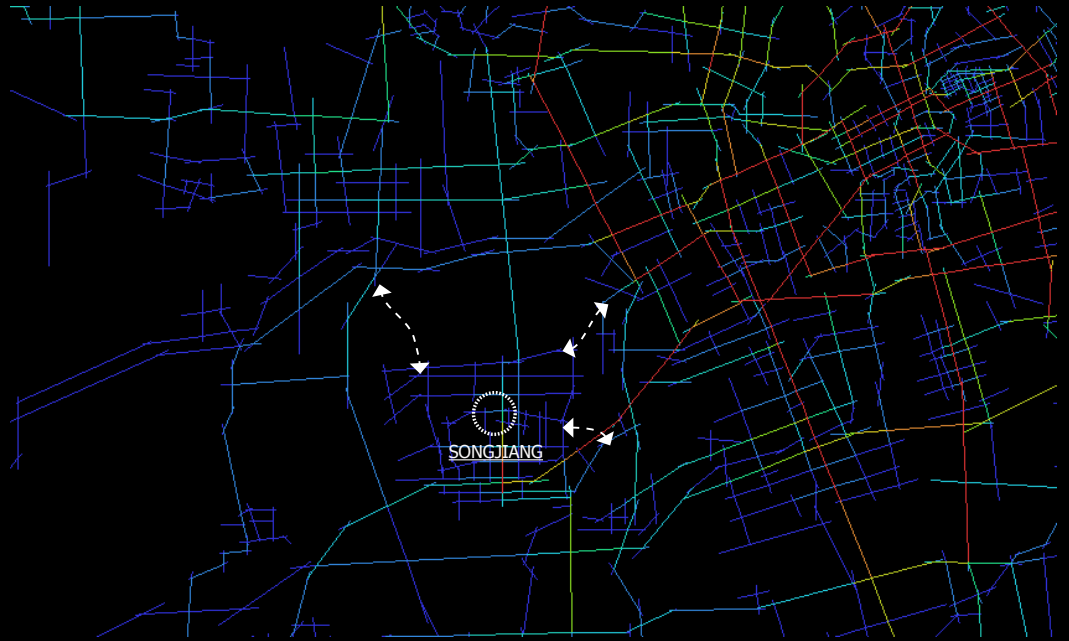


Figure 4.45
The strategy to improve
Songjiang new town's
intercity level connections.

Before Intervention

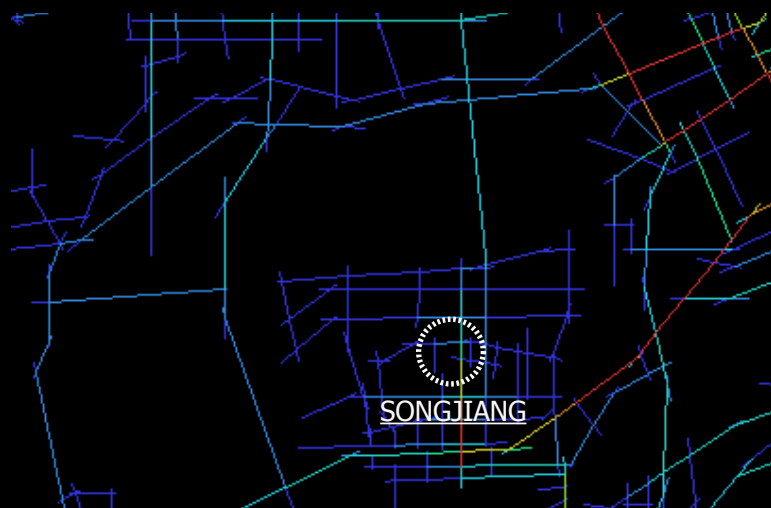
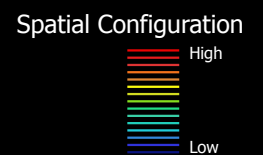


Figure 4.46
Typological and metric
analysis in intercity level,
interventions unimplemented.



After Intervention

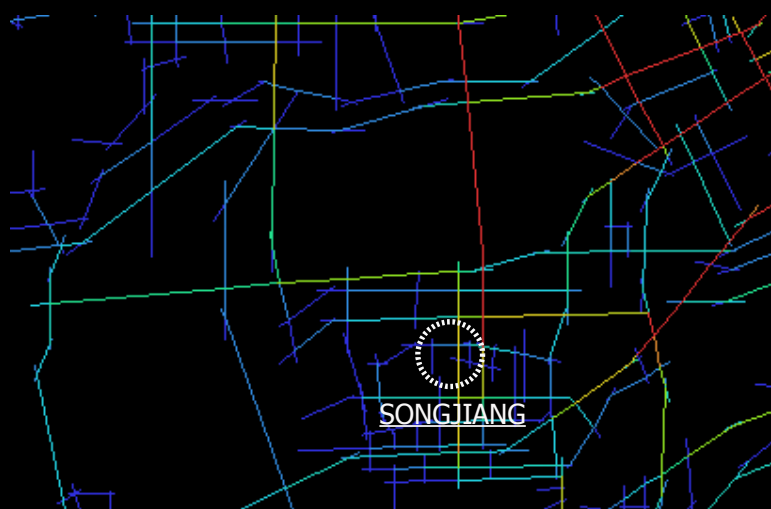


Figure 4.47
Typological and metric
analysis in intercity level,
interventions implemented.

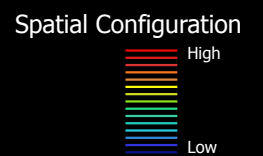


Figure 4.48

After intervention: Typological and metric analysis in Metropolitan area of Shanghai, Intercity level.

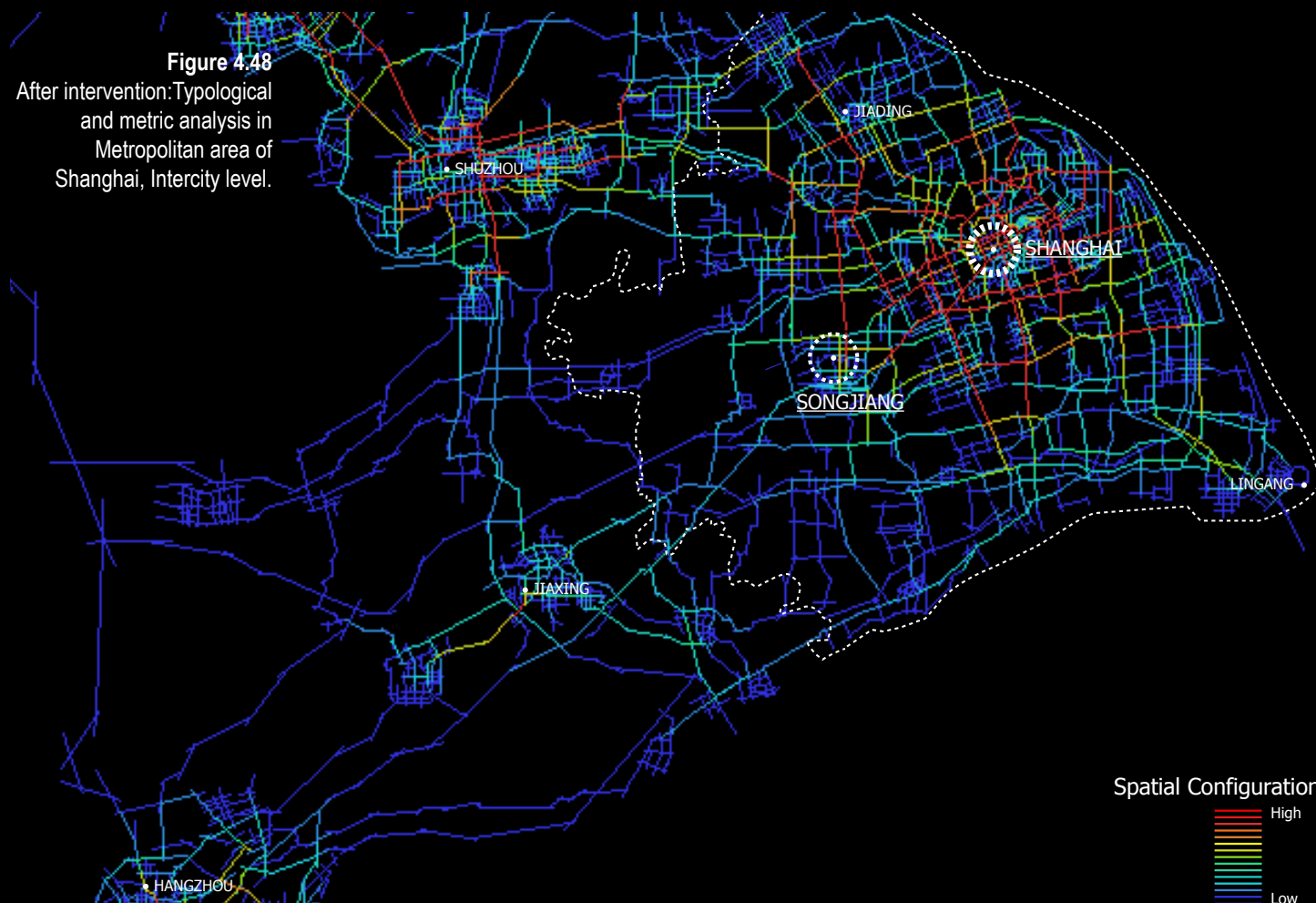
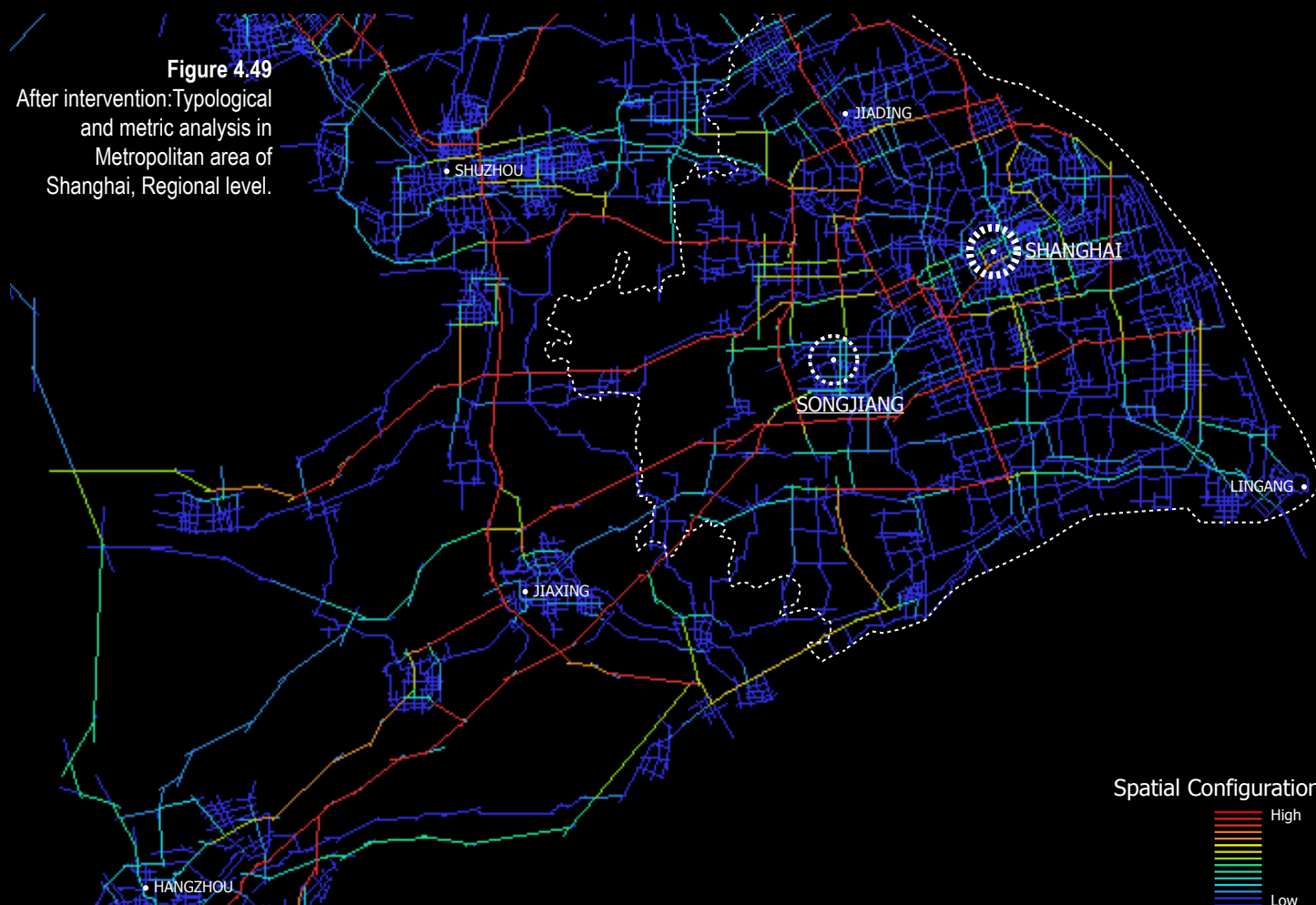


Figure 4.49

After intervention: Typological and metric analysis in Metropolitan area of Shanghai, Regional level.



6.2 The Evaluation of urban strategies & interventions

Just as mentioned above, the interventions in urban scale are mainly focusing on two directions: spatial integration (Space Syntax) and ground floor / urban design (Spacematrix and MXI) issues. Specifically, those interventions will change the three measurements at the same time. Therefore, all the three aspects need to be recalculated and finally we will get the final combination map demonstrating the influence of urban interventions.

6.2.1 Integration analyses with Space Syntax after interventions



Figure 4.50
The Space Syntax analysis
map after interventions in
Songjiang new town.

Spatial integration, as one of the main improving direction, will be changed a lot (Figure 4.50). Compared with the old integration map (Figure 4.7, P. 92), a great number of grids will be improved from low integration rate (shown in blue and green) to middle integration rate (yellow). Meanwhile, the number of high integrated grids would make an increase as well. Overall, the spatial integration in both center areas and surrounding areas will be improved a lot. The better spatial structure can provide foundation for a stronger urban network.

6.2.2 Morphology analyses with Spacematrix after interventions

Because of the high density in Songjiang new town, the existing density & building type is not the main focus of interventions. Only in several ground floor / urban design intervention areas, the existing density & building type will be changed during interventions. Therefore, the new map (Figure 4.51) will not show too much difference compared with the old one (Figure 4.9, p. 93).



Figure 4.51
The Spacematrix analysis map after interventions in Songjiang new town.

6.2.3 Functional mixture analyses with MXI after interventions

As the other main intervention direction, there will be a big improvement in functional mixture issue. According to the strategy I & II, the center area and university campus will be implanted dynamic functions and in many potential areas the dynamic mixture will be encouraged. As the result of those interventions, we can see more highly mixed areas will appear in center areas while university areas will be transferred from mono-functional areas into bi-functional areas. In addition, in appropriate residential areas pointed out by urban diagnosis, slight interventions will promote functional mixture as well. Therefore, a more dynamic new town is foreseeable (Figure 4.52) compared with the old mono-functional one (Figure 4.11, P. 94).

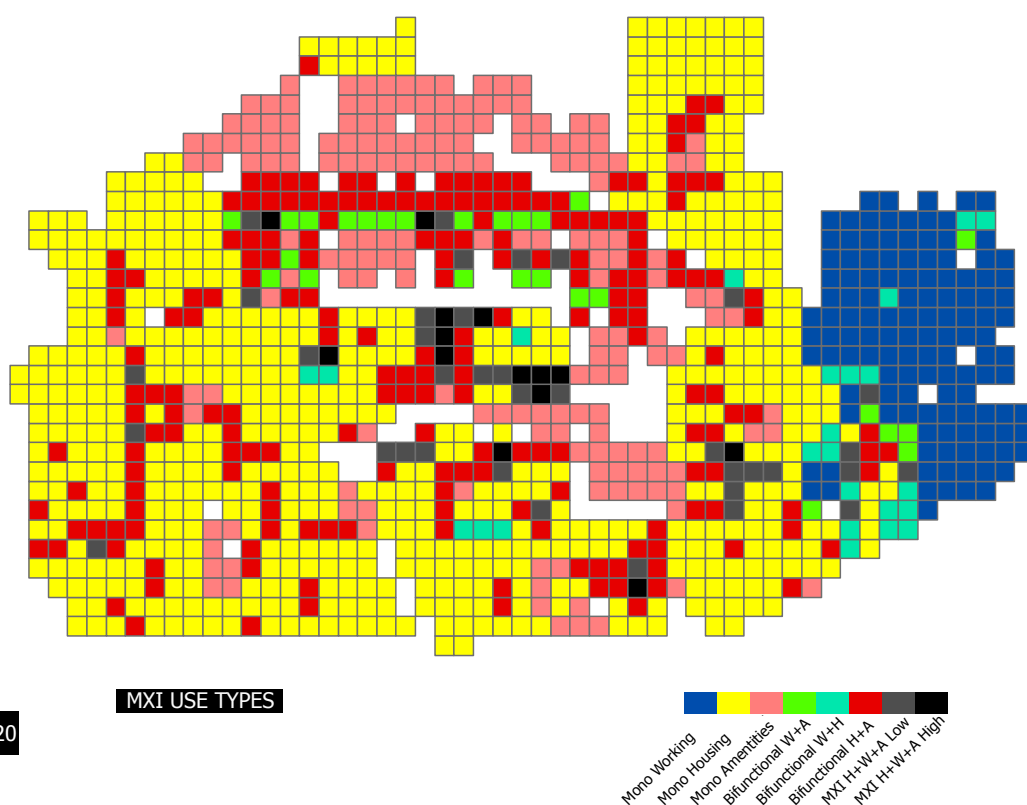


Figure 4.52
The MXI analysis map after interventions in Songjiang new town.

6.2.4 The combination of Space Syntax. Spacematrix and MXI after interventions

Through those interventions in three measurements, a more complex and dynamic new town can be foreseen (Figure 4.53). It seems like the suggested interventions would have a long-term positive effect on the city's spatial performance. In contrast to the old map (Figure 4.12, P. 94), a stronger and more dynamic city center will be cultivated and a well developed urban network based on highly integrated spatial structure could be developed. It seems like the two goals in the transformation process from new town to complete city will be fulfilled.

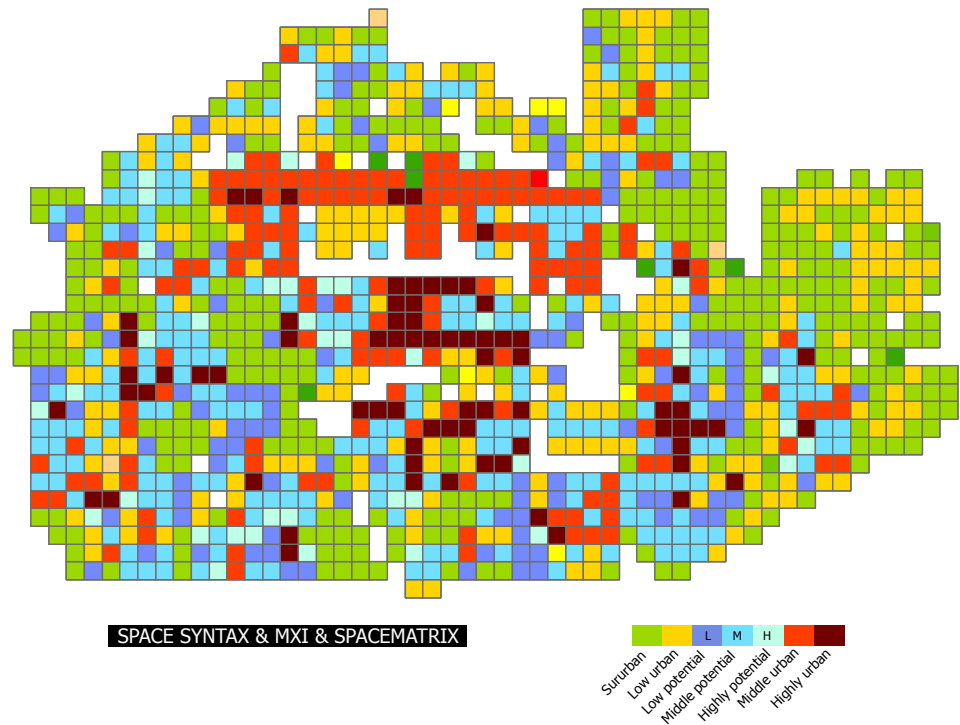


Figure 4.53
The combination of Space Syntax, Spacematrix and MXI in Songjiang new town after interventions.

City	Potential level	SpaceSyntax	MXI	Spacematrix
Songjiang new town (Before intervention)	High	100 (6.5%)	15 (1.3%)	424 (36.5%)
	Middle	453 (29.5%)	155 (13.4%)	515 (44.3%)
	Low	983 (64.0%)	991 (85.3%)	223 (19.2%)
City	Potential level	SpaceSyntax	MXI	Spacematrix
Songjiang new town (After intervention)	High	194 (12.6%)	50 (4.3%)	451 (38.7%)
	Middle	744 (48.4%)	257 (22.1%)	490 (42.3%)
	Low	598 (39.0%)	854 (73.6%)	221 (19.0%)

Figure 4.54
The comparison of data in the three measurements between before and after intervention.

The data comparison (Figure 4.54) proves the positive influence as well. It is obvious that the spatial integration has been improved a lot, meanwhile the other two measurements also been developed. High value in space syntax increases from 6.5% to 12.6% and high value in MXI increases from 1.3% to 4.3%.

In conclusion, the effects of quantitative spatial modeling and urban diagnosis method can be confirmed. Those urban interventions will bring great positive influences on spatial aspects of songjiang new town. Nevertheless, it is still meaningful to check the match rate after interventions (Figure 4.55).

Before intervention

City	N(h): Grids obtaining value \geq middle level in three measurements	N(s): Grids obtaining value \geq middle level in spatial integration	Match rate
Songjiang new town	93	553	16.8%

After intervention

City	N(h): Grids obtaining value \geq middle level in three measurements	N(s): Grids obtaining value \geq middle level in spatial integration	Match rate
Songjiang new town	243	938	25.9%

Figure 4.55

Thee comparison of Mact rate between before and after intervention.

It is clear that both spatial integration (938 vs. 553) and the well developed areas (243 vs. 93) are improved after interventions. Finally the match rate after intervention increase from 16.8% to 25.9%. That means the Songjiang new town moved from less developed new town with high match rate and low spatial integration to well developed new town with both high match rate and spatial integration (Figure 4.56).

Match rate	Spatial integration	City completeness	Examples
Low	Poor	Extremely less developed	unfounded
	Well	Less developed	Almere
High	Poor	Less developed	Songjiang new town (before)
	Well	Well developed	Haarlem
		Well developed	Songjiang new town (After)

Figure 4.56

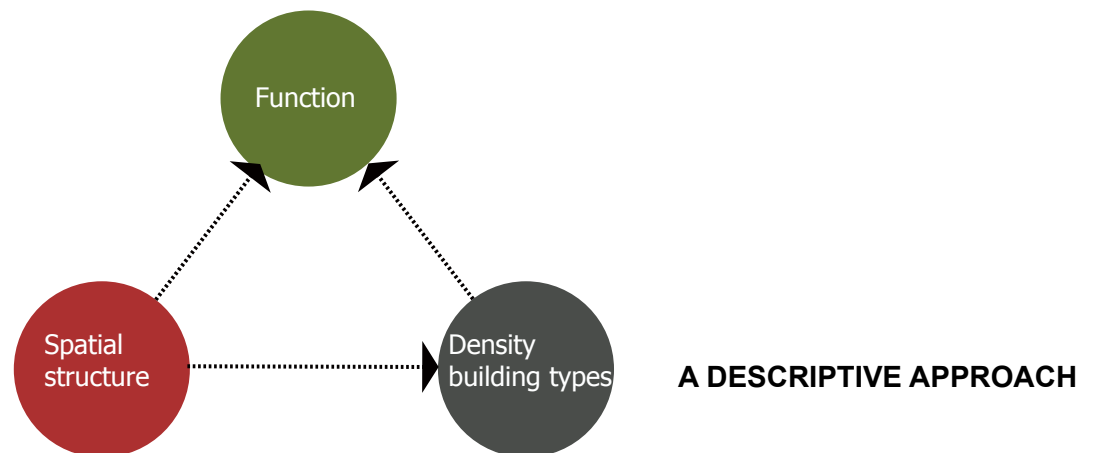
The changes brought by interventions

Moreover, another interesting finding from this final map should be mentioned. This visualized final map corresponds with the previous conclusion on the new town developing goals (Section IV, 4.4, p. 81): the complete city developing from new towns will have several differences with a complete city developing from history. Just as this conclusion pointed out, this after intervened new town simulation tends to show a relatively equal distribution rather than totally centralized spatial features.

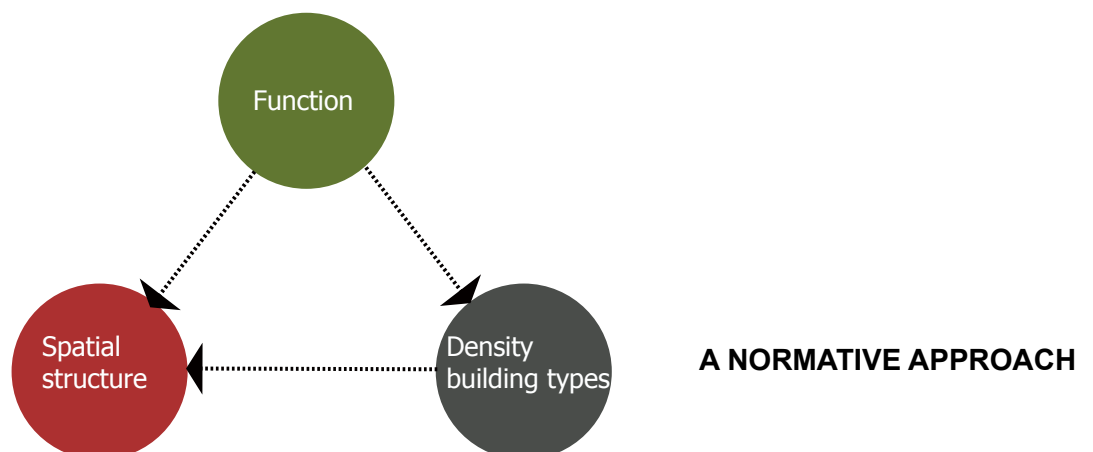
7. Natural paradigm or Planning paradigm? A new starting point

Based on all my work in this thesis, there are two paradigms can be proposed. Just as the diagram underneath shows, during the natural urban transformation process, spatial structure can be regarded as the foundation which will influence both density and function. Meanwhile, density issue will affect function as well. That is what happned spontaneously during time, which creates a great number of dynamic and attractive areas.

Nevertheless, in those planned areas, this triangle relationship is reversed. In normal planning process, because of the principle of form follows function, the function is the most important issue which will decide the density & building types and the spatial structure also follow the demand of function. The building types will affect spatial structure as well. It is this normative approach that creates many less dynamic postwar areas.



PRINCIPLES OF THE NATURAL URBAN TRANSFORMATION PROCESS



PRINCIPLES OF THE PLANNING PROCESS IN NEWLY DEVELOPED AREAS

However, the creating of less dynamic areas does not mean this paradigm is totally wrong. We need to consider that many areas, especially residential areas, are planned as less integrated places. It is unsuitable to say the second paradigm is not good enough compared with the first one.

Nevertheless, revising current planning paradigm and challenges for future strategic planning and future research are the works I should do. At present, it is not a mature idea, may be even naive. But it is still a good starting point for my future research.

SECTION V:

THE DESIGN EXAMPLE

THE SELECTION OF DESIGN EXAMPLE

THE DEMONSTRATION OF FIVE INTERVENTIONS



1. The selection of design example

Following the possible intervention version given from last section (P.115, Figure 4.42), a design example will be shown in order to explain how those interventions land in real situation. The design part will thus mainly focus on demonstrating interventions in real built environment. Considering this requirements, the design example is chosen in the center area which combining all the two strategies and five interventions (Figure 5.1). By this way, clear images about my project can be illustrated.

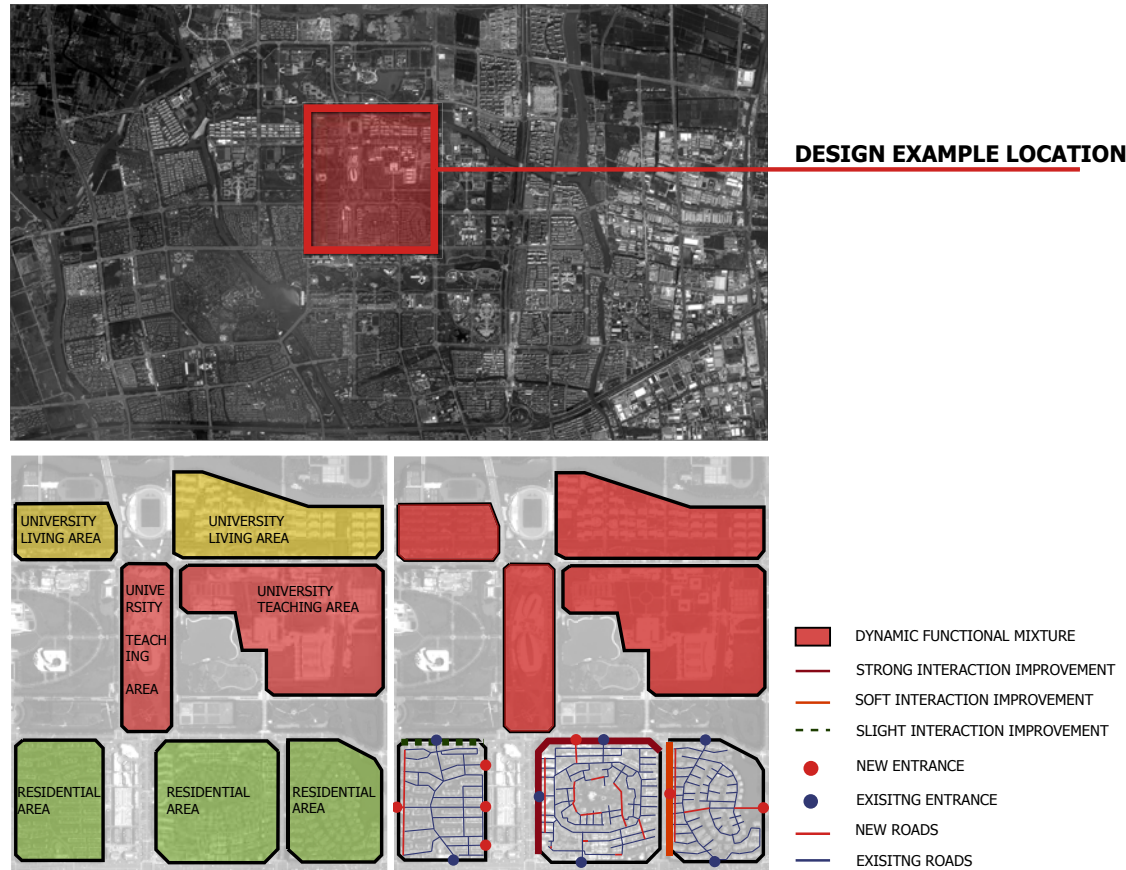
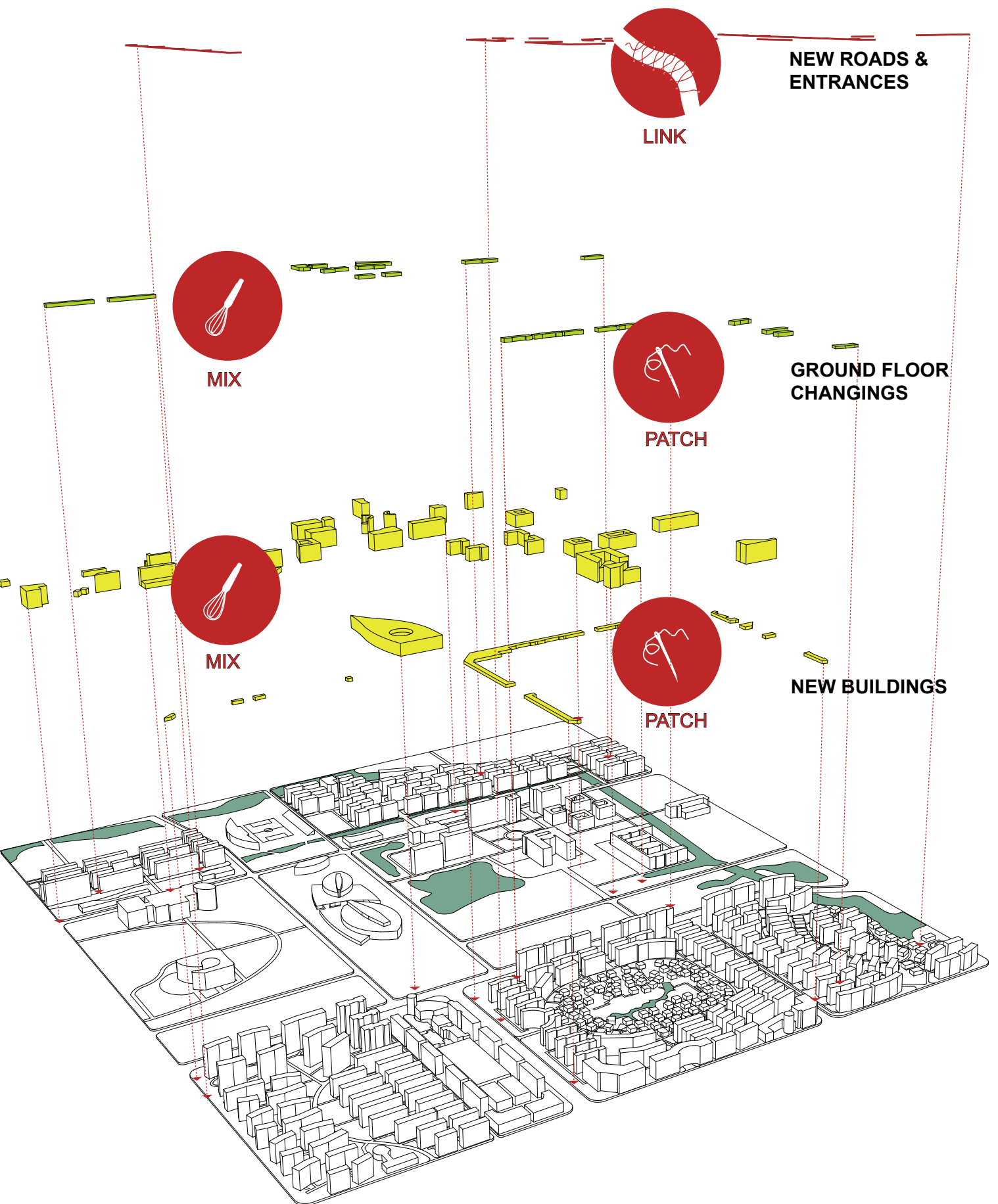


Figure 5.1
The location of design example

All three strategies: Link, Patch and MIX are applied in this example and there are five kinds of interventions. Specifically, MIX is applied northern university areas while Link and Patch are mainly focusing on developing residential areas in the southern part.

In the university areas, the existing functions are mono-functional: purely living for students and teaching amenities. Obviously, this kind of functional situation will bring negative influence, especially during student vacation period. Therefore, the Strategy: MIX will be used at here. New building complex with various dynamic functions will be implemented into this area. The functions in those building complex are diverse and their main function will be decided according to surroundings. For instance, new buildings in the student living area are mainly commercial shops or working studios, while new buildings in teaching amenities area are mainly living apartments. Meanwhile, several existing building will be encouraged to alternate its old function in ground floor to promote diversity. By those two ways, the aim of functional mixture can be fulfilled. This is demonstrated as Intervention II.

In the residential areas, the Strategy: Link will be implemented to improve spatial integration while the Strategy: Patch will be used to handle ground floor / urban design problems. Intervention I will add more entrances and new roads to promote spatial integration. The other interventions (III, IV, V) are aiming at handling ground floor / urban design problems by adding new buildings and strengthening interaction between buildings and streets. The version of design area is shown as follow.



2. The demonstration of interventions

2.1 The demonstration of Intervention II

The first demonstrated diagram underneath is an example of Intervention II: promoting functional mixture. In this university living area, residential space for students is dominant. Therefore, new building complex and ground floor functional changing are the main content. Commercial amenities and working spaces will be encouraged in this area in order to promote diversity (Figure 5.2).

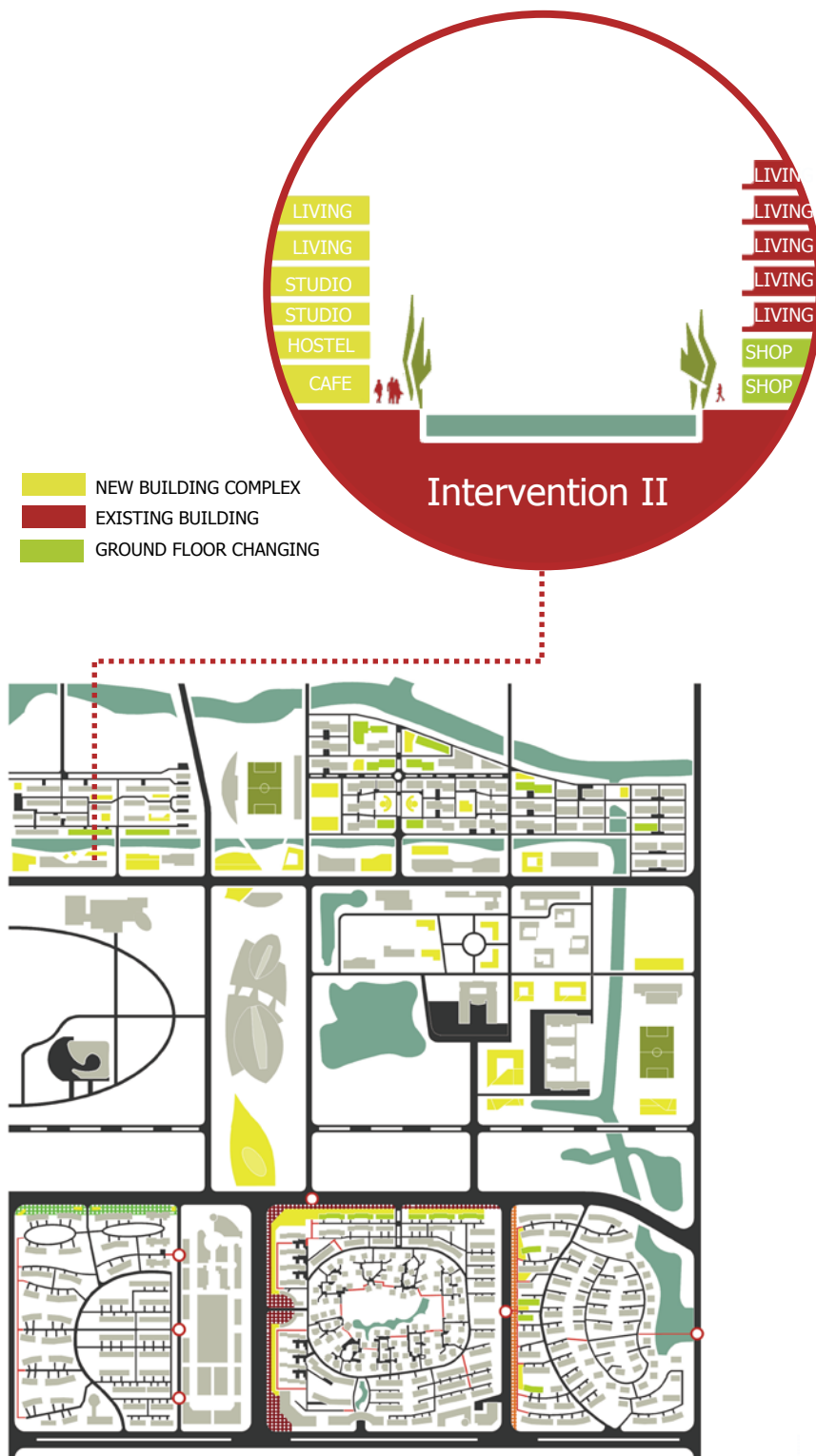


Figure 5.2
The section of Intervention II

Before Intervention

It is an obviously mono-functional area (Figure 5.3).



Figure 5.3

Photo showing current situation in the example area of Intervention II

After Intervention

Diversity and urbanity can be promoted (Figure 5.4).



Figure 5.4

Collage showing the situation after intervention in the example area of Intervention II

2.2 The demonstration of Intervention III

The second demonstrated diagram underneath is an example of Intervention III: strong interaction improvement. The strong improvement means, in the whole intervention area, new commercial buildings will be implanted into this area and a well pedestrian system will be built up. By this way, the interaction between residential blocks and streets can be improved in the highest way (Figure 5.5).

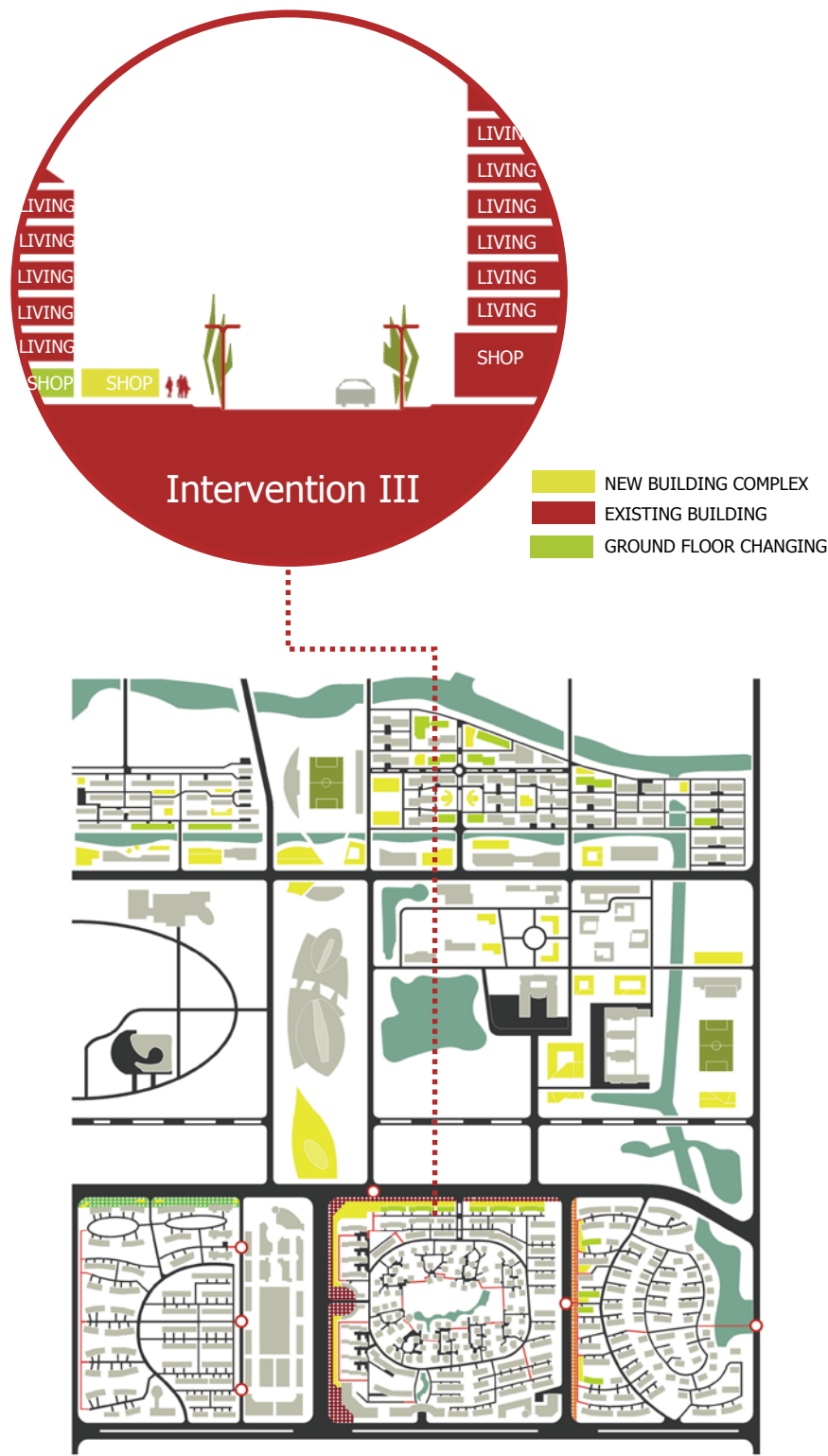


Figure 5.5
The section of Intervention III

Before Intervention

The street greens and walls block the necessary interaction between residential blocks and streets (Figure 5.6).



Figure 5.6
Photo showing current
situation in the example area
of Intervention III

After Intervention

A dynamic pedestrian friendly street can be created and a strong interaction between residential blocks and streets can finally be built (Figure 5.7).



Figure 5.7
Collage showing the situation
after intervention in the
example area of Intervention
III

2.3 The demonstration of Intervention I & IV

The third demonstrated diagram underneath is an example of Intervention I and IV together: new roads and entrances in residential blocks and soft interaction improvement. Just as the diagram shown, new entrances and roads (red lines and dots) will be added. In addition, the soft interaction means only in several appropriate places some new buildings will be built and the ground floor interaction will be improved. (Figure 5.8).



Before Intervention

The street greens and walls block the necessary interaction between residential blocks and streets, just like the situation in Figure 5.6. The lacking of entrances aggravates this situation (Figure 5.9).



Figure 5.9

Photo showing current situation in the example area of Intervention I & IV

After Intervention

In several places of intervention area, like the new entrance, new buildings and ground floor changing will be encouraged. Many pedestrian friendly areas will be built and a soft interaction can be set up (Figure 5.10).



Figure 5.10

Collage showing the situation after intervention in the example area of Intervention I & IV

2.4 The demonstration of Intervention V

The last demonstrated diagram underneath is an example of Intervention IV: slight interaction improvement. This intervention means only in important locations, like street corners, some small buildings with recreational or commercial functions will be added. This intervention is mainly focus on the creation of attractive pedestrian friendly interacted places rather than the implantation of new buildings and functions (Figure 5.11).

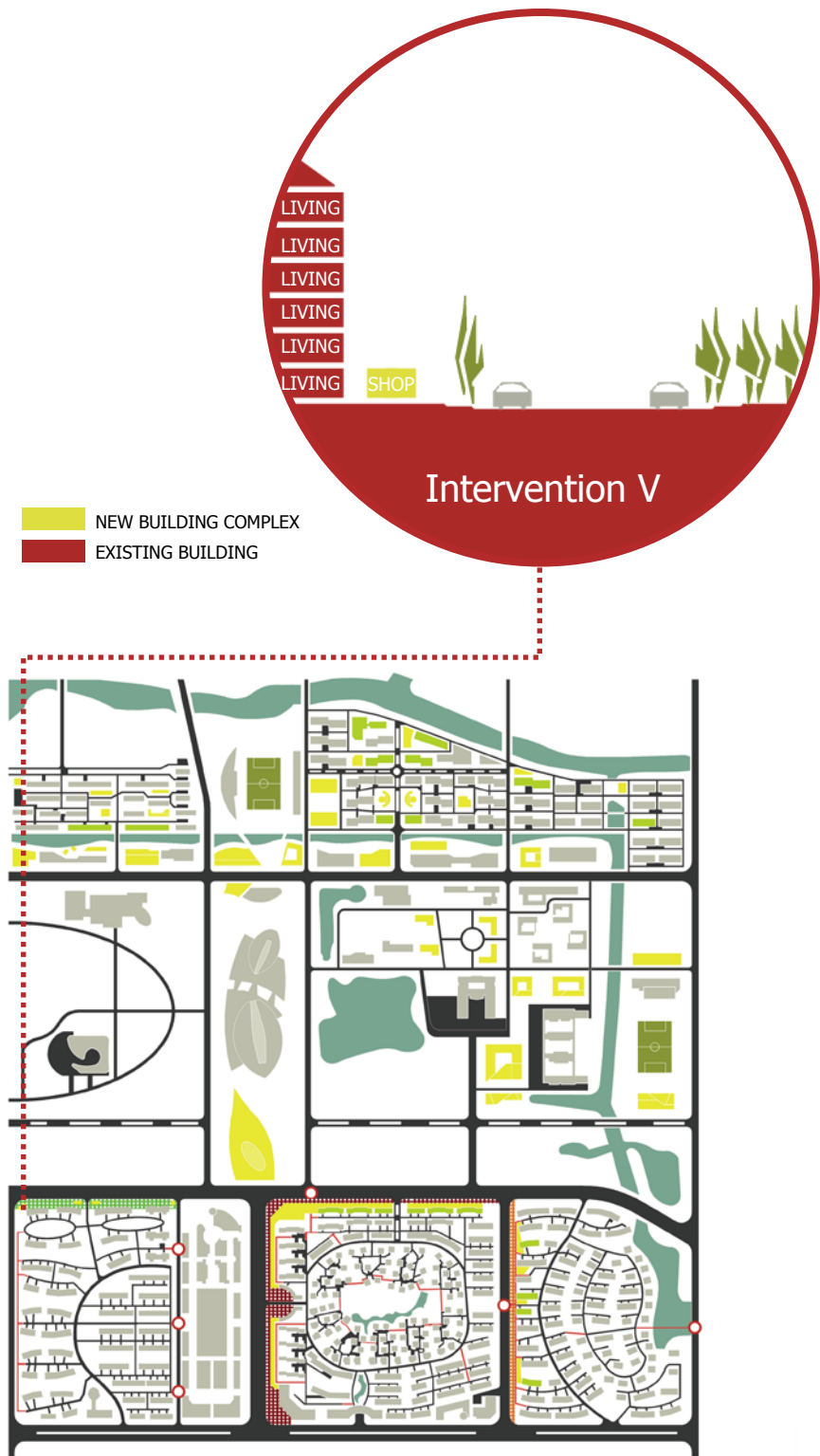


Figure 5.11
The section of Intervention V

Before Intervention

The existing interaction is poor but there is not enough space for large scale re-development and the surround areas are not suitable for strong interventions (Figure 5.12).



Figure 5.12

Photo showing current situation in the example area of Intervention V

After Intervention

Through several small interventions, a pedestrian friendly interacted place will be created (Figure 5.13).



Figure 5.13

Collage showing the situation after intervention in the example area of Intervention V

SECTION VI:

REFLECTIONS & RECOMMENDATIONS

REFLECTIONS FOR MY GRADUATION PROJECT

RECOMMENDATIONS FOR MY FUTURE RESEARCH



1. Reflections for my graduation project

1.1 The relationship between research and design

Generally speaking, the research is the foundation of my project and it will provide guiding for further strategic planning and urban design aspects. It implies that most of the time is used on researches and analyses compared with normal Msc thesis. However, strategic planning and urban design are still important aspects explaining my research results in the project.

1) Why I preceded the research a part of my study plan

I claim the research is the foundation is mainly because the lacking of existing research on my study direction. Large scale new towns are implemented on a fast speed but many of them are regarded as dull and monotonous places. How the spatial forces affect the development of more complete cities are seldom taken into consideration. Therefore, I have to make research first to seek possible methods and principles to provide a condition for well-functioning urban areas.

2) how the research provides guiding for design

Through a long term research, I can describe the new town quantitatively and understand the spatial changing trends visually via new spatial modeling method. Meanwhile, a new urban diagnosis has been raised with the help of GIS. Based on those results and applying them into my case, the design can be guided in correct direction.

1.2 The relationship between the theme of the studio and the subject/case study chosen by the student within this framework (location/object)

The study in my own graduation project is mainly focusing on two points: 1) the developing of new spatial modeling method and 2) applying this method into new town research to promote new town development. Both two points are well correspond to one of three themes of Complex City Studio: Urban form and Process. They are also highly related to the other two themes: Governance and Metropolitan & Regional.

1.3 The relationship between the methodical line of approach of the studio and the method chosen by the student

My graduation project is following one of the typical methodical lines of approach in Complex City Studio. This project is beginning from problem definition (Section I) and then conducting research via technique tools (Section II, Section III). Based on those results, the strategies and interventions will be formulated in Section IV. After that, a design example will be demonstrated to explain my interventions (Section V). Finally, the reflections and recommendations will be claimed (Section VI).

1.4 The relationship between the project and the wider social context

The methods and principles found from my project are a first step towards quantitative analysis method for diagnosing the spatial problems of new towns. It may be used to accelerate new town developments in China and it also possible to be applied in guiding urban regenerations in Europe. Those results may provide higher efficient and more accurate suggestions about new town development. It seems like can play an important role in understanding built environment quantitatively.

2. Recommendations for my further research

Through combining three measurements: Space Syntax, Spacematrix with MXI to study Dutch and Chinese new town developments, a new way of spatial modeling and urban diagnosis have been proposed. Researches via those methods achieve fruitful results, nevertheless, there are some limitations still existing in various aspects of my research methods. It is meaningful to point out those limitations and trying to handle them in my future deeper study.

2.1 Recommendations for improving the measurements

2.1.1 Spacematrix

The Spacematrix diagram applied in my research is defined based on floor numbers, FSI and GSI (Figure 6.1). Those numbers are defined according to Dutch built environment, in other words, they are not 100% suitable for other context, for instance, China. Therefore, when applying this diagram into other environments, we might need to revise it, especially the floor number and GSI.

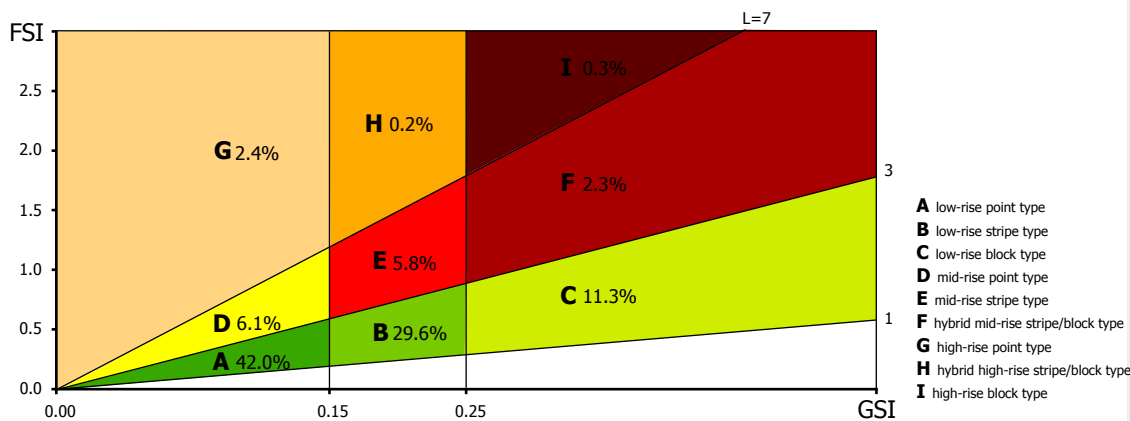


Figure 6.1
Spacematrix diagram in new town Zoetermeer.

In other words, the division of type A-I might need to be revised in the Chinese context. However, I think this is not an urgent problem, because the constitution of types will be rather similar. The other point I want to mention is I translate density into discrete variables (the nine types A-I, Figure 6.1), which is easier to do the calculation but might not very accurate. It would be more accurate to use continuous variables (Figure 6.2), but how to operate that is difficult. Further consideration in this direction is needed.

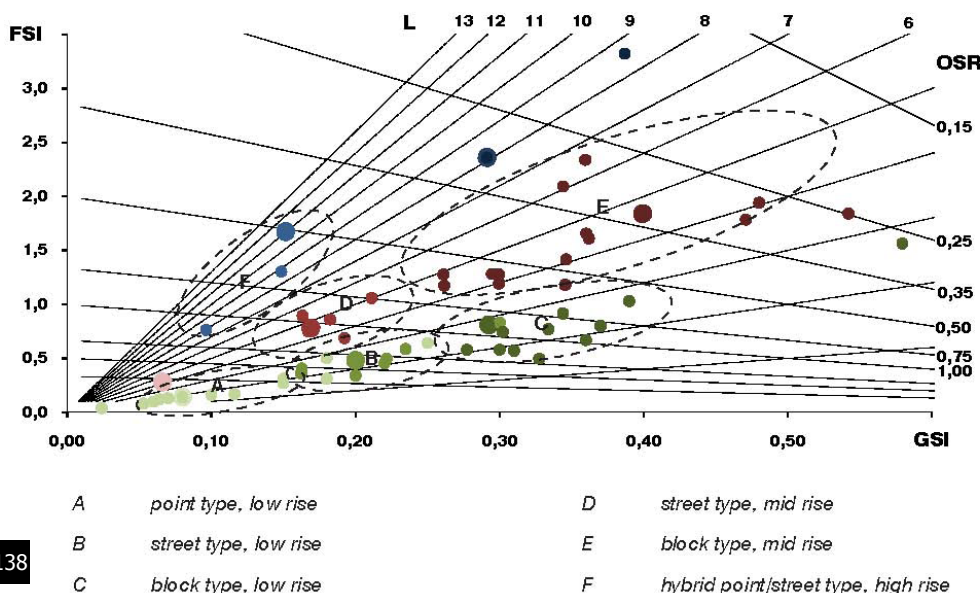


Figure 6.2
Continuous Spacematrix diagram

2.1.2 MXI

In my thesis, the definition of MXI is according to its old meaning: $MXI = (\%HOUSING / \%WORKING / \%AMENITIES)$. Housing includes various buildings for living, such as apartments, condominium and town houses etc. Working means a place to work; office, factory and laboratory for instance. Amenities contain all commercial, retail, societal, universities, cultural amenities (Figure 6.3). Mono-functional means purely Housing, Working or Amenities. Bi-functional means two kinds of functions mixture together: Housing+ Working; Housing+ Amenities and Working+ Amenities. Mix means the mixture of three functions.

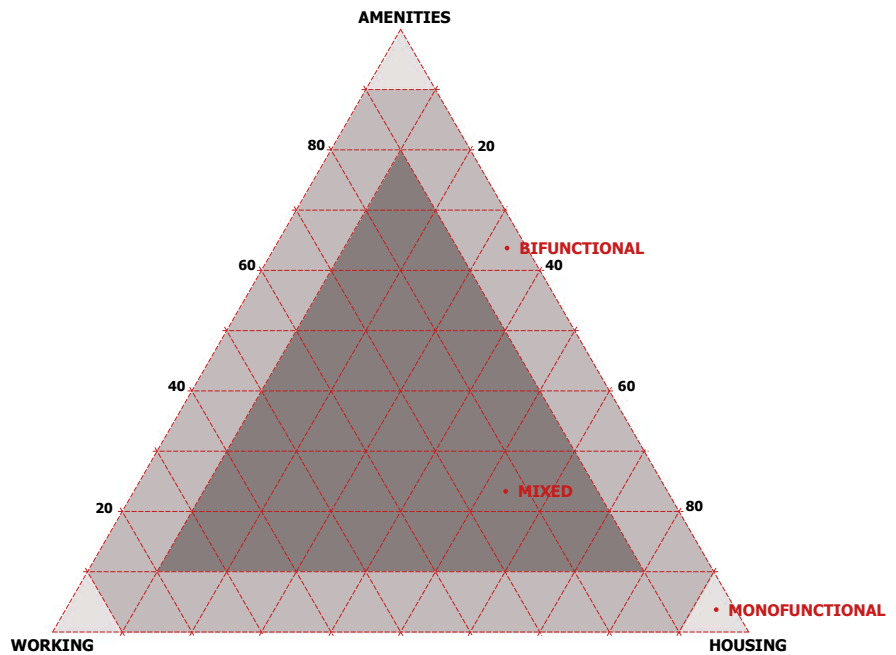


Figure 6.3
Ternary diagram:
monofunctional, bifunctional

However, the meaning of Working and Amenities are ambiguous and confused for researchers. The first problem is the 'working: a place of work' is not a clear definition of this category. For instance, those amenities also have many people working in it. Should those amenities be classified under the category of Working? Considering this point, using Industrial & Office park to replace 'working' would be better.

In addition, classifying all commercial, retail, societal, universities, cultural amenities into one category may not be appropriate. Because those amenities have various influences to surrounding built environment, especially those commercial amenities (shops & restaurants) and public service amenities (universities & hospitals). Therefore, Amenities should be divided into two new categories: Commercial Amenities contain all commercial, retail and leisure amenities and Public service Amenities contain all societal, cultural amenities and universities. According to those analyses, the new diagram can be proposed as follow (Figure 6.4).

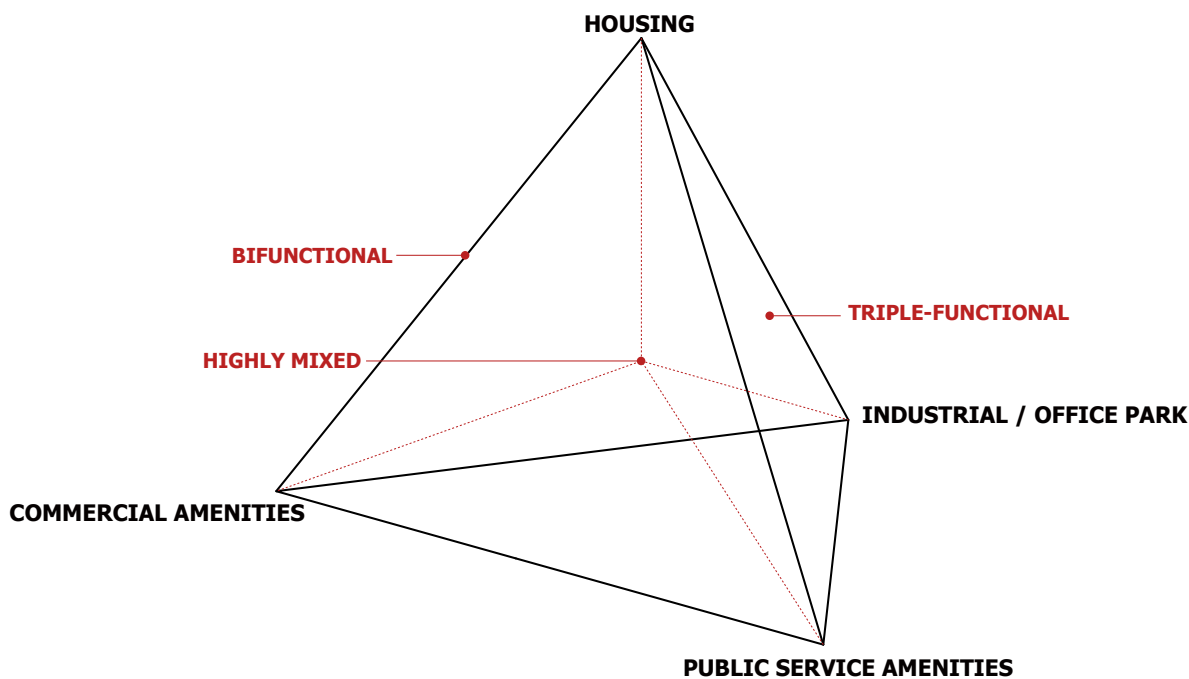


Figure 6.4
New diagram for MXI

Besides those problems in MXI itself, the value definition in MXI is also questionable (Figure 6.5). According to the old system, all bi-functional areas are clarified into middle value, which hides the different features between housing + amenities; housing + working and amenities + working. In addition, the MXI measurement is revised as well. Thus, in my future study, a new classification system in MXI will be proposed to reflect functional mixture more clearly.

category of MXI	Meaning
High degree of functional mix	mixture of three functions
Middle degree of functional mix	bifunctional areas
Low degree of functional mix	Monofunctional areas

Figure 6.5
The old definition of values in MXI.

Considering the new MXI diagram and my previous analyses, low value of MXI is still representing mono-functional areas, the two kinds of functional mixture is belonging to Middle value MXI and the four kinds of functional mixture should be classified into High value MXI. The difficulty is how to label three kinds of functional mixture.

The triple-functional mixture can be divided into 4 categories: Commercial + Public service + Housing; Public service + Housing + Industrial / Official park; Commercial + Housing + Industrial / Official park and Commercial + Public service + Industrial / Official park. According to empirical study, we can say the last one has an obvious distinguish in urbanity compared with the others. Therefore, the last one should be classified into Middle value while the others are belonging to High value. The new definition of values in MXI is shown underneath (Figure 6.6).

category of MXI	Meaning
High degree of functional mixture	The mixture of four kinds of functions Commercial + Public service + Housing Public service + Industrial / Official park + Housing Commercial + Industrial / Official park + Housing
Middle degree of functional mixture	Commercial + Public service + Industrial / Official park two kinds of functional mixture
Low degree of functional mixture	Monofunctional areas

Figure 6.6
The new definition of values in MXI

2.2 Recommendations for value definitions in those measurements

In order to be convenient for the final combination of Space Syntax, Spacematrix and MXI, all the three measurements are divided into three levels: high, middle and low. However, the validity of those value definitions is lacking strong support and need to be discussed.

The most important thing is to make sure the divisions of high, middle and low values in spatial integration (Space Syntax), density (Spacematrix) and functional mixture (MXI) are calibrated with the meaning it has in practice. For instance, the low degree of functional mixture defined by me through MXI is the same as what professionals and the general public defines as low mixture. This is a big research project in itself. But at least, in my future research, through questionnaires and interviews to verify my own divisions are important.

2.3 Recommendations for category definitions in combining Space Syntax, Spacematrix and MXI

In my thesis, the final category definition is made according to the values in three measurements (Figure 6.7). In this context, the validity of defining various categories from suburban to high urban is a troublesome issue. It is hard to find direct academic supporting for its validity because existing researches are rare.

Category of final combination	The value of space syntax, MXI and spacematrix	balance
1) Suburban	L/L/L, M/L/L, L/L/M, L/M/L	low balanced
2) Low urban	L/M/M, M/L/M, M/M/L	
3) Low potential	H/L/L, L/H/L, L/L/H	unbalanced
4) Middle potential	H/M/L, M/H/L, L/M/H, H/L/M, L/H/M, M/L/H	
5) high potential	H/H/L, H/L/H, L/H/H	
6) Middle urban	M/M/H, M/H/M, H/M/M, M/M/M	high balanced
7) high urban	H/H/H, H/M/H, M/H/H, H/H/M	

Figure 6.7
The definition of various categories in final combination

Thus, the validity of this classification can only become more sound after verifying it with dependent variables. The dependant variables could be the amount of people in the streets .etc, which is possible to be measured through GPS Tracking or fieldwork. And this should also prove that combining density, mix and space syntax gives a more accurate classification than only density or only MXI.

The GPS-experiments were set up to tackle questions about urban quality in the field of urbanism, i.e. the design and planning of urban areas and used as an instrument to analyse both individual routes and collective, aggregate patterns of use (Van der Spek, et al., 2009, p.5). Many institutions, like TU Delft, MIT have carried researches in improving city centers for pedestrians (Figure 6.8) and diagnosing spatial mechanism in new towns as well. A series of softwares, including GPSU batch utility, ArcGIS, Data Interoperability Tool (DIT) and SPSS are used to collect and analysis data.

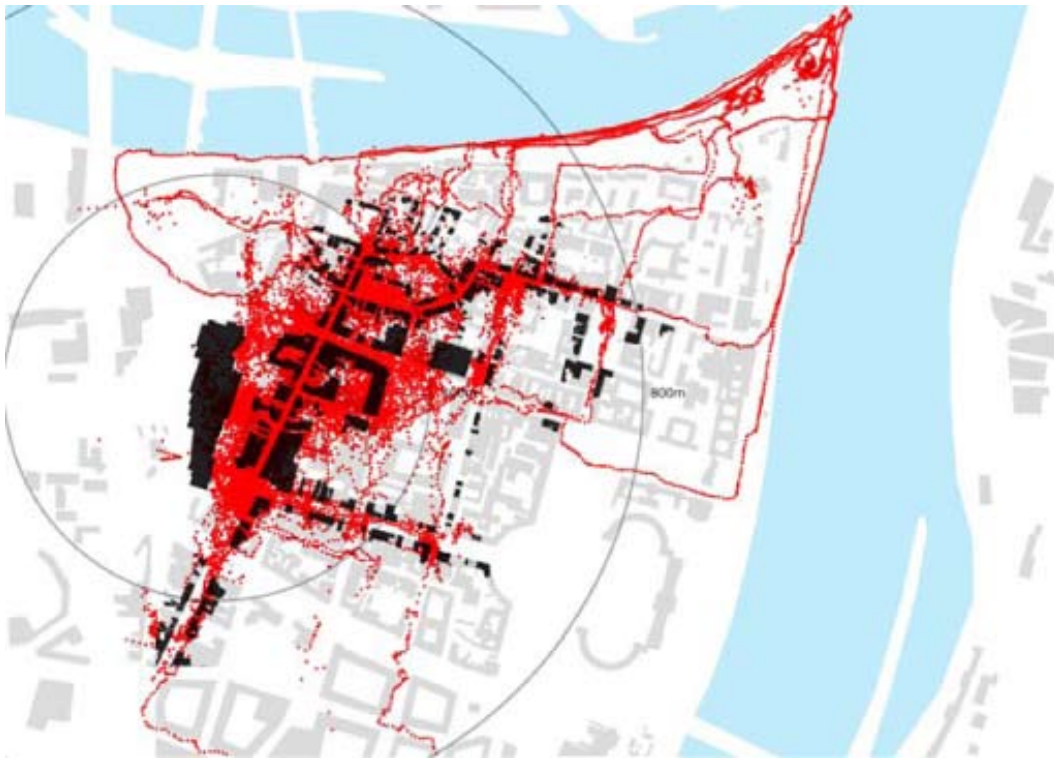


Figure 6.8
GPS tracking results from Koblenz superimposed on location of commercial function, (source: Van der Spek, et al., 2009, p.13)

GPS and GIS offer a new technique beyond traditional and low-tech researches, like work of Gehl (1971/1987) and Lynch (1960), to map and measure urban quality in new ways. Thus, it would be meaningful to verify and correct my classification system.

Applying GPS Tracking is one way, nevertheless, including expert knowledge to verify the classification system is also feasible. Generally speaking, through this way to include expert knowledge is to confront them with references and let them decide whether it is urban, suburban, etcetera. For instance, the definition of suburban I proposed can be converting to many definitions only based on Space Syntax, FSI and MXI, and then asking experts' help to revise it. After that, the results can be used to compare with various definitions using spatial measures to make sure the accuracy.

2.4 Recommendations for further development

At present, my research is mainly focusing on the spatial measurements and other variables in socio-economic aspects are missed. Although there is a relation between the city completeness development and the three spatial measures, this does not mean that the relation is causal enough. In other words, in real life, developing the spatial variables will not automatically generate more complete cities. Other non-spatial variables (e.g. policy, regional development direction) might be of more importance. Therefore, I should try to bring them into the model, or at least, combining those non-spatial variables with results from spatial model to give the final suggestions. In addition, more cases need to be included find out what the importance is of the spatial variables.

Besides the problem above, another research direction should be mentioned as well. At present, the various values of cells are the focusing point. However, it might be so that a clustering of cells with a high integration level is more important than those individual high integrated cells. A further research is needed in this kind of cluster and it can be done via the Place Syntax which simply includes the information of surrounding cells in the cell at stake (Stähle, et al, 2005). It could be done via the network and can be repeated with various radii. Alexander Stähle and Lars Marcus's research will be a great help for improving my research in this direction.

REFERENCES:

- Alexander, C. (1965). A City Is Not A Tree. Architectural Forum, Vol. 122, No.1
- Batten, F. D. (1995). Network Cities: Creative Urban Agglomerations for the 21st Century. Urban Studies, March 1995 vol. 32 no. 2 313-327.
- Batty, M. (2005), "Agents, cells, and cities: new representational models for simulating multiscale urban dynamics", Environment and Planning A 37, 1373-94.
- Berg, J., & Geluk, M., (Eds.). (2009). *Vernieuwing van de nieuwe stad: Groeikernen van slaapstad naar droomstad*. Almere, International New Town Institute.
- Berghauser Pont, M.Y., Haupt, P.(2010). *Spacematrix, Space, Density and Urban Form*. Rotterdam: NAI Publishers.
- Brömmelströet, M. T.& Stolk, E. (2007). New Town Simulation: An Introduction. In: Stolk, E. & Brömmelströet, M. T. (Eds.). *Model Town: Using Urban Simulation in New Town Planning*. Amsterdam: Sun Press, 8-15.
- Conzen, M. R. G. (1960). Alnwick, Northumberland: a study in town-plan analysis. Transactions of the Institute of British Geographers 27: 3-4.
- Chen, B. (2004). The Rapid Urbanization Mechanism in China. Acta Geographica Sinica, Vol. 65, No. 12, 1068-1075.
- Christaller, W. (1933) *Central Places in Southern Germany*. Translated by Carlisle W. Baskin. Pp. 230. Englewood Cliffs, N.J.: Prentice-Hall, 1966.
- Cullen, G. (1961). Townscape. Architectural Press, London.
- Den Hartog, H. (Ed.). (2010). *Shanghai New Towns: Searching for community and identity in a sprawling metropolis*, Rotterdam: 010 Publisher.
- De Bois, Peter. (1998). *STOA-Method for Urban Design and Analysis*, preliminary version; Delft University of Technology: Delft, the Netherlands.
- De Bois, P.and Buurmans, K. (2005). Genesis of Urban Frame. Case study New Town Almere; presented at Conference on Public Space in Contemporary City, Cracow University of Technology: Cracow, Poland.
- De Bois, P.and Buurmans, K. (2007). To know the Path is to Rule the System-case-study New Town Almere: The discrepancy between serial planning and vital city; European Urban Research Association (EURA) 10th Anniversary, University of Glasgow: Glasgow, Scotland, 12-14.
- De Bois, P. (2009) *Zoetermeer. Anchor Point research*. CIP-data, Royal Library, The Hague.
- Engel, G. (2004). China special-China's new towns. In: ZKG International 57, No. 10, 46-53.
- Soja, W. E. (1980). The Socio-Spatial Dialectic, Annals of the Association of American Geographers, Volume 70, Issue 2, pages 207-225, June 1980.
- Gehl, J (1971/1987) *Life Between Buildings: Using Public Space*, translated by Jo Koch, Van Nostrand Reinhold, New York.

Friedman, J. (1964). *Regional development and planning : a reader*. Cambridge, Massachussettes : M.I.T. Press.

Friedmann, J. and J. Miller (1965) The urban field, *Journal of American Institute of Planners* 31(4): 312-319.

Friedmann, J. (2005). *China's Urban Transition*, University of Minnesota Press.

Harvey, D. (1973). *Social Justice and the City*. Baltimore. The Johns Hopkins University Press, 1973, p. 306.

Harvey, D. (2006). *Divided cities: the Oxford Amnesty lectures 2003*, Oxford University Press, 2006, p.84.

Healy, P. (2007). *Urban Complexity and Spatial Strategies: Towards A Relational Planning For Our Times*, 3. London: Routledge.

Hillier, B. & Hanson, J. (1984). *The Social Logic of Space*. Cambridge University Press, p.6.

Hiller, B. (1996). *Space is the machine: A configurational theory of architecture*. The Press Syndicate of the University of Cambridge.

Hillier, B., Penn A., Banister D., and Xu, J., 1998, "Configurational modelling of urban movement network," *Environment and Planning B: Planning and Design*, 25:59–84.

Hillier, B. (1999). Centrality as a process: Accounting for attraction inequalities in deformed grids. In: *Urban Design International*, Volume 4, Issue 3-4, p.107-127.

Hillier, B. (2006). The Golden Age for Cities? How we design cities is how we understand them, *Urban Design, Visions of the Future*, Issue 100. Available at http://www.spacesyntax.com/Files/MediaFiles/1_multipart_xF8FF_2_hillier06--goldenagecities-urbdesign%201.pdf.

Howard, E. (1898). *Tomorrow; a peaceful path to real reform* (3rd ed). London. Routledge/Thoemmes Press

Jacobs, J. (1961). *The Death and Life of Great American Cities*, Vintage Books press, 1992.

Jiang, B., Claramunt, C., and Klarqvist, B. (2000). "An integration of space syntax into GIS for modelling urban spaces," *International Journal of Applied Earth Observation and Geoinformation*, 2:161–171.

Joosten, V. and Van Nes, A. (2005). How block types influences the natural movement economic process: Micro-spatial conditions on the dispersal of shops and Café in Berlin. 5th International Space Syntax Symposium, Delft, The Netherlands, 13 rd –17 th June 2005, Retrieved Nov 19, 2011. Available at <http://www.spacesyntax.tudelft.nl/media/Papers/225.pdf>

Karimi, K., Rose, A., Martinez, M, and Raford, N. (2007). New Towns of England: Understanding Failure with Space Syntax. In: Stolk, E. & Brömmelströet, M. T. (Eds.). *Model Town: Using Urban Simulation in New Town Planning*, Sun Press, 19-43.

Stanilov, K. (2008). *Urban Morphology*, 2008, Volume: 12, Issue: 1, Pages: 54-57. Available at http://www.urbanform.org/online_public/2008_1.shtml.

- Lefebvre, H. (1970). *La Revolution Urbaine*. Paris: Gallimard, 1970.
- Lefebvre, H. (1976). *The Survival of Capitalism*. New York: St. Martin's Press, 1976.
- Lynch, K. (1960). *The image of the City*. MIT Press, Cambridge.
- Lösch, A. (1945). *The Economics of Location*. Translated by William H. Woglom, New Haven: Yale University Press, 1954.
- Mashhoodi, B. and Berghauser Pont, M. (2011). Studying land-use distribution and mixed-use patterns in relation to density, accessibility and urban form. Retrieved Nov 11, 2011. Available at http://geography.ssc.uwo.ca/faculty/gilliland/ISUF%202011%20Full%20Papers/01051156%20Mashhoodi_paper.pdf.
- Marshall, S. (2005). *Streets and Patterns*. London, New York, Spon Press.
- National Bureau of Statistics of China. (2010). National Statistics Year Book 1978-2010, Retrieved Aug 3, 2011. Available at <http://www.stats.gov.cn/tjsj/ndsj/>
- Nio, A. (1997). *Groeten uit Zoetermeer: Stedebouw in discussie*. NAI Uitgevers.
- Oh, C. (2006). A Study of Spatial Analysis Using Space Syntax, ERSI user conference, 2006. Retrieved Dec 2011. Available at <http://www10.giscale.com/link/Esri-Users-Group-Conference-Study-Spatial-Analysis-Using-Space-Syntax/15483/view.html>.
- Parker, D. C., Manson, S. M., Jansen, M. A., Hoffmann, M. J. and Deadman, P. (2003). 'Multi-agent systems for the simulation of land-use and land-cover change: a review, *Annals of the Association of American Geographers* 93, 314-37.
- Provoost, M. (2010). New Towns for the 21st Century; the Planned vs the Unplanned City. In: Provoost, M. (Eds.). *New Towns for the 21st Century: the Planned vs the Unplanned city*, 8-27. Amsterdam: Sun Press.
- United Nations Population Division. (2009). World Urbanization Prospects :The 2009 Revision. Available at <http://esa.un.org/unpd/wup/index.htm>.
- Read, S. (2001). Neighborhood spatial processes: Notes on Public Space, 'Thick' Space, Scale and Centrality. Retrieved Nov 2, 2011. Available at <http://www.spacelab.tudelft.nl/Media/Papers/04.Neighbourhood.pdf>
- Read, S. (2005). Flat City; a space syntax derived urban movement network model. Retrieved Nov 4, 2011. Available at <http://www.spacesyntax.tudelft.nl/media/longpapers2/stephenread.pdf>
- Read, S. and Bruyns, G. (2007). THE FORM OF A METROPOLITAN TERRITORY: the case of Amsterdam and its periphery. Retrieved Nov 4, 2011, Available at <http://www.spacesyntax.tudelft.nl/media/longpapers2/stephenread.pdf>.
- Read, S. (2009). Another Form: From the 'Informational' to the 'Infrastructural' City. Available at http://repository.tudelft.nl/assets/uuid:9124271d-6373-4541-a5cd-54ba3e3373f4/FP5_Read1.pdf
- Reijndorp, A. (2006). Growing pains of new towns. In: Frieling D.H. (Ed.). Research on New Towns First International Seminar 2006, 121-129, Almere: PlantijnCasparie.
- Reijndorp, A. (2009). Vernieuwing van de nieuwe stad. INTI, 2009.

Roos, M. R. (2005). *THE MOBILE CITY: The planning and design of the Network City from a mobility point of view*, PhD thesis, Technische Universiteit Delft.

Selezneva, E. (2011). *Urban vitality: Exploring the centrality conditions*. Master thesis. TU Delft.

Southworth, M. and P. Owens (1993). "The Evolving Metropolis: studies of community, neighborhood and street form at the urban edge." *Journal of the American Planning Association* 59(3): 271-287.

Stanilov, K. and B. Case-Sheer, Eds. (2004). *Suburban Form: an international perspective*. New York and London, Routledge.

Ståhle, A., Marcus, L., and Karlström, A., 2005, "Place Syntax: Geographic accessibility with axial lines in GIS," In A. van Nes, editor, *Proceedings Space Syntax*. 5 th International Symposium, Delft.

Stanilov, K. (2008). *Urban Morphology*, 2008, Volume: 12, Issue: 1, Pages: 54-57, Available at http://www.urbanform.org/online_public/2008_1.shtml.

Taylor, N. (1998). *Urban planning theory since 1945*, London: Stage.

Van den Hoek, J. (2009). The Mixed Use Index (Mixed-use Index) as Planning Tool for (New) Towns in the 21st Century. In: Provoost, M. (Eds.). *New Towns for the 21st Century: the Planned vs. the Unplanned city*, Sun Press, 198-207.

Van der Spek, S. , Van Schaick, J. De Bois, P. and De Haan, R. (2009). *Sensing Human Activity: GPS Tracking*. Retrieved Sep 21, 2011. Available at *Sensors* (ISSN 1424-8220; CODEN: SENSC9), www.mdpi.com/journal/sensors.

Van Eck, J. R., Snellen, D. (2006). Is the Randstad a city network? Evidence from commuting patterns. *European Transportation Conference 2006*, Strasbourg, France, from 18th - 20th September.

Van Nes, A. (2002). *Road Building and Urban Change: A morphological and configurative explanation of how ring roads change the pattern of distribution of shops in city and town centres*. PhD thesis. Agricultural University of Norway.

Van Nes, A. and López, M. J. J.(2007). Micro scale spatial relationships in urban studies. the relationship between private and public space and its impact on street life. In A. S. Kubat, (Eds.). *Proceedings Space Syntax*. 6th International Symposium, Istanbul, 2007.

Van Nes, A. & López, M. J. J. (2010). Macro and Micro Scale Spatial Variables and the Distribution of Residential Burglaries and Theft from Cars: An investigation of space and crime in Dutch cities of Alkmaar and Gouda. *The Journal of Space Syntax*, Vol.1, No 2, 296-314. Retrieved Sep 21, 2011. Available at http://joss.bartlett.ucl.ac.uk/index.php/joss/article/viewFile/296/pdf_25.

Van Nes, A. (2011). (forthcoming). *Space syntax in urban studies – an introduction*. Delft University of Technology.

Van Nes, A., Berghauser Pont, M. and Mashhoodi, B. (2012). Combination of Space Syntax with Spacematrix and the Mixed Use Index :The Rotterdam South test case. *Proceeding in 8th International Space Syntax Symposium*, Chile.

Van der Spek, S. , Van Schaick, J. De Bois, P. and De Haan, R. (2009). Sensing Human Activity: GPS Tracking. Retrieved Sep 21, 2011, from Sensors (ISSN 1424-8220; CODEN: SENS9), www.mdpi.com/journal/sensors.

Zhang, J. (2003). Some consideration on new town planning and construction in China, City planning review, May, 71-75.

Zhou, J. (2008). Searching for good urban form from utopian cities to Chinese new towns. Urbanism PHD RESEARCH 2008-2012, IOS Press, 2009.

Zhou, J. (2010). Urban development and management in Songjiang new city. In: Den Hartog, H. (Ed.). *Shanghai New Towns: Searching for community and identity in a sprawling metropolis*, 273-290, Rotterdam: 010 Publisher.

Measuring Urban Space

Reviewing the contributions of spatial-analytical methods proposed in U-Lab, TU Delft, over the last decade

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Abstract –The question of how to design a perfect city, one of the “mantras in urban planning”, has been an alluring question for centuries because of its complexity. During the twentieth century, various temptations to design a universal model in urban making have become acknowledged failure. Therefore, in order to understand the complexity in spatial and socio-economic dynamics, planners are moving beyond the past oversimplified and fuzzy analytical methods. Based on the interrelations among spatial and socio-economic dimensions, several spatial-analytical methods were raised in the past decades with the contribution of researchers in various universities, including UCL, TUD, KTH, MIT, et al. Nevertheless, there are too many groups involving in this direction to mention at here and this review paper will mainly focus on the progress in U-Lab, TU Delft. The ULAB research-program is focusing on strengthening urban design as a technical-scientific discipline by the development of methods, tools and instruments which produce the possibilities for a fruitful and effective approach of the design of urban patterns.

The main focus of this paper is to review TU Delft’s recent contributions focusing on the socio-economic performance of urban form through various spatial analyses, and finally to provide theoretical underpinning for my research method in master thesis. Specifically, this paper will begin from reviewing the theory of urban movement network model and functional-spatial structure. After that, the paper contains researches about spatial analyses with quantitative approaches. Finally, the new trend integrating GIS and GPS will be mentioned as well.

The literature review on this topic can give a better insight in spatial mechanism and socio-economic performance via various new methods, and finally it will be used to guide my master thesis. By looking through Read (2001; 2005; 2007) and De Bois (1998; 2005; 2007)’s researches based on Hiller (1984,1996,1999); the theoretical underpinning for my spatial research in Master thesis can be found. Then, the reviewing of various analytical methods, including Berghauser Pont (2010); Van Nes (2006; 2010); Van den Hoek (2009); Mashhoodi (2011); Joosten (2005); Hausleitner (2010); Van Schaick and Van der Sperk (2008), will help to evaluate and choose appropriate spatial analytical methods for my future study.

Key words –analytical methods, spatial mechanism, socio-economic performance

1 Introduction: new breakthroughs in spatial analytical theories and methods

People once believed that the mechanical paradigm and separated distribution of functions, which was proposed by the CIAM, is the universal model for creating good spatial mechanism. Nevertheless, the implementations applying that ‘functional city’ paradigm as the universal model for spatial mechanism are unsuccessful because of urban complexity. Most urbanists have realized that a city is not a simple machine, but a complex mixture in both spatial and socio-economic dimensions. Actually, the shift in planning thinking occurred in the sixties, triggered by Jacobs (1961), Alexander

(1965) and Gehl (1971/1987). Scholars have realized the complexity of cities during decades review about the flaws of modern urbanism. Just as Healy (2007, p. 13) pointed out: “such socio-economic activities make use of the city in all kinds ways that are often difficult to imagine in advance; they are too dynamic”. The complex issue, especially the importance of these social-cultural and socio-economic dynamics for city-making demands the planners and designers should move beyond the oversimplified analyses and design exercise (Brömmelströet and Stolk, 2007).

Nowadays, two directions for improvements have been raised and discussed based on the complexity

of cities. One is asking more communicative process in urban planning and trying to involve more relevant stakeholders. The other direction is to gain more insight in positive spatial mechanism and the related socio-economic performances, which is one of the main research directions in Urbanism-Lab (U-Lab), TU Delft. Besides TUD, various universities and research groups are involved in this direction as well. For instance, Space Group leading by Bill Hillier in UCL is the initiator, which proposed Space Syntax as a set of techniques for the analysis of spatial configurations since 1980s (Hillier et al, 1984). Scholars in KTH developed knowledge in accessibility research via proposing Place Syntax (Ståhle et al, 2005) based on Space Syntax. Recently, the City Form Lab launched Urban Network Analysis which including buildings and their particular features into consideration. Tracking technologies also been applied in urban research by a series of people, including Ahas and Ular (2005), Shoval and Isaacson (2006), Shoval (2008) et al. However, there are too many groups involving in this direction to mention at here, thus, this review paper will mainly focus on the progress in U-Lab, TU Delft.

Over the last decade Faculty of Architecture, Delft University of Technology developed and applied several spatial-analytical theories and methods to understand the spatial mechanism and related socio-economic performance. This paper is aiming to review and evaluate the proposed theories and methods to seek for theoretical underpinning and appropriate spatial analytical methods. Spatial rules and mechanisms which can provide flexibility and changeability in urban level have been intensively studied. Read's (2001; 2005; 2007) research had revealed rules in the form of metropolitan territory based on Hillier's research (1999). In the meanwhile, a related theory of functional-spatial structure for vital city was developed by De Bois and Burmans (1998; 2005; 2007) based on Hillier (1999)'s research as well. Their researches will be used as theoretical foundation in my spatial researches. Meanwhile, new quantitative methods to measure density (Spacematrix) and function mix (The MXI model) were raised by Berghauser Pont (2010) and Van den Hoek (2009) separately. Van Nes's (2006; 2010) researches on the relationship between spatial configuration and crime in micro scale via Space Syntax was meaningful as well. During the last few years, a group of researchers, like Mashhoodi (2011); Joosten (2005), Hausleitner (2010); at the U-Lab, TU Delft had combined Space Syntax, Spacematrix, MXI with GIS to get a more comprehensive understanding of the role of the spatial parameters on socio-economic processes in a city. In addition, Van Schaick and his colleagues work with Urban Tracking (2008; 2009) have been used as a combined way of categorizing urbanity

and been regard as a useful tool to verify new theories. The methods mentioned above will be compared and evaluated for my future analyses.

2 New theories about spatial mechanism

2.1 Stephen Read: Movement layers and Place-region formations

The discussion of urban centrality and public space has continued for half a century since rethinking to modernism urbanism in 1960s. And the accelerated globalization recasts the question about the nature of the city – in both old centers and new emerged periphery. Arguments about the nature of centrality and the concept of generic city had an important role within discussions of postmodernism.

Read (2001) approach the problem of public space by talking about urban space as a mechanism. The hypothesis of scale rather than the programme is the vital issue in city organization. Read firstly mentioned that different scales are held in relation to each other in a way which supports intelligibility and coherence in his paper about public space, local and high scales and centrality. Through comparison research about urban typologies between inner city and the periphery (see illustration 1), he concluded that:

certain spatial layouts, characterised by openness and transparency at the local scale, combined with strong connection to their surroundings at the scale immediately above the local, offer the necessary spatial-structural qualities to support the sort of structured diversity, overlap and busyness characteristic of well-functioning central urban locations ... The particular social and cultural vitality of these environments is underpinned by a rich overlap of social and cultural meanings constructed within relational spaces ... (Read, 2001, p. 16)

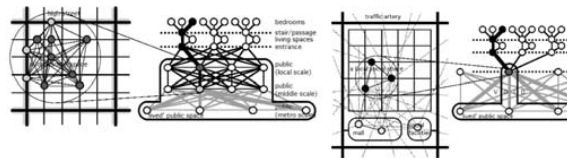


Illustration1 The comparison between inner city and the periphery.
(source: Read, 2001, p. 8-9)

Then, Read proposed that Flat City model, a space syntax derived urban movement network model in 2005. Space syntax is used to define different scale and demonstrate the relationship between

supercentrality and supergrid. He pointed out the emergence of peripherality is a condition created by the movement and communications network infrastructures. Centrality is something malleable rather than out of our control (see illustration 2).

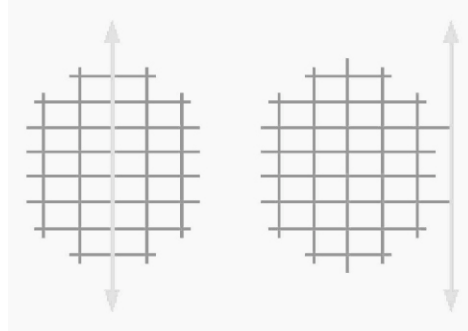


Illustration 2 Centred and de-centred neighbourhoods; (source: Read, 2005, p. 14)

Centrality and peripherality become not simply accidents of history over which we have no power, but products of particular definable movement and communications network infrastructures and their relationships, which we have the power, if the will be there, to establish or to change. (Read, 2005, p. 13)

This flat city model explained how this spatial model changes our view of the nature of the explosion of the city into the periphery. The urban liveliness and quality is creatable if we can well organized high-scale connections and low-scale grounding movement (Read, 2007). It can be used to deal with metropolitan area rather than only central urban fabrics. Amsterdam is studied as a case in 2007 and a series of formations (closed and open) are raised based on his results in 2005. He concludes that the lively places depends to lower speed and scale connective matrices while the relation between high-scaled connective and lower-scaled grounding networks are crucial as well (Read, 2007). Those results are meaningful to support viable and self-sustaining urban environments.

2.2 De Bois: Functional-spatial structure

The researches of De Bois and his colleagues (1998; 2005; 2006; 2007) try to ask how does the existing frame of the city (the system of public spaces) facilitate the necessary socio-economic dynamics of its use and users. Firstly, this theory explains how a city is constituted of. The structure of the urban frame of a city is a precondition for the way users of public space of the city have access to the city as a whole and to the interconnected neighbourhoods. The theory states that the completeness of the urban frame is in fact a precondition for the identity and

liveliness of the city as a whole (Van der Spek, Van Schaick, De Bois and De Haan, 2009).

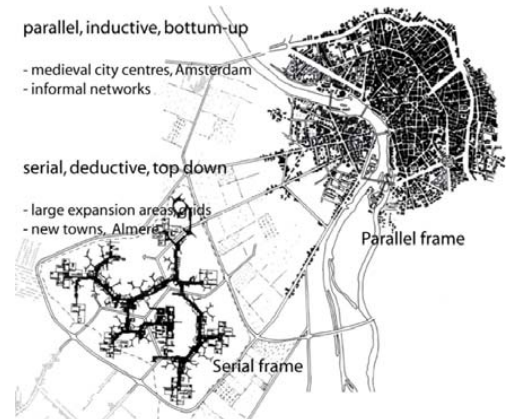


Illustration 3 The principal difference between a 'parallel' and 'serial' urban system, (source: De Bois and Buurmans, 2006, p. 8)

In addition, this theory explains how the process of planning and construction of cities can be related to the physical structure of the urban frame. Based on this theory, urban systems that are organized as a 'parallel' system or as a 'serial' system (De Bois, 1998; De Bois and Buurmans, 2007). (see illustration 3). The planning decision making in new town developments is a 'serial' process. Therefore, in contrast to the 'parallel' process of historically-involved cities, the instant city-making new towns are generally 'serial' in nature. And it is obvious that urbanity needs a 'parallel' urban frame.

3 New spatial analytic methods for urban form and its socio-economic relativity

3.1 Meta Berghauser Pont and Per Haupt : Spacematrix

The potential of urban density as a tool for urban planning and design is research in Berghauser Pont's study. The Spacematrix method has contributed to a clarification of the density. In Spacematrix, density is defined as a multi-variable phenomenon to be able to relate density and urban form. Spacematrix find the relationships among density, urban form and other performances (see illustration 4).

This spatial DNA of an area offers much data (absolute and relative) to analyse and make explicit certain spatial properties of the area. These can serve as input for the understanding of and speculation on other, non-spatial properties. (Berghauser Pont and Haupt, 2010, p. 116)

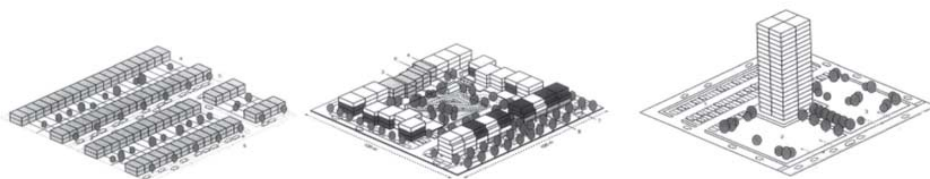


Illustration 4 Three different types of urban areas with 75 dwellings per hectare, (source: Berghauser Pont & Haupt, 2010, p. 13)

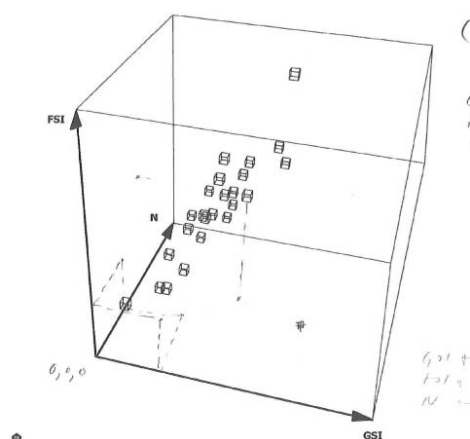


Illustration 5 Spacematrix diagram, (source: Berghauser Pont & Haupt, 2010, p. 116)

Spacematrix uses the following measures: floor space index (FSI), ground space index (GSI), and network density (N). These three measures are represented in a three-dimensional diagram, the Spacematrix. Measures such as open space ratio (OSR) or spaciousness, the average number of floors or layers (L) and the size of the urban blocks (w) can be derived from that (see illustration 5). Here FSI on the y-axis gives an indication of the built intensity in an area and GSI on the x-axis reflects the coverage, or compactness, of the development. The OSR and L are gradients that fan out over the diagram. OSR describes the spaciousness (or pressure on the non-built space), and L represents the average number of floors. Another diagram is constructed with N, b and T_f . The N on y-axis denotes the network density of the urban layout, and b on the x-axis the profile width of the street. The tare space (T_f) as a percentage of public space in a fabric is shown as gradients in the diagram (see illustration 6). Overall, Spacematrix begins the researches via multivariable approach to density to characterize a specific place. It is a contribution to the science of density and a great tool in urban analysis and governance.

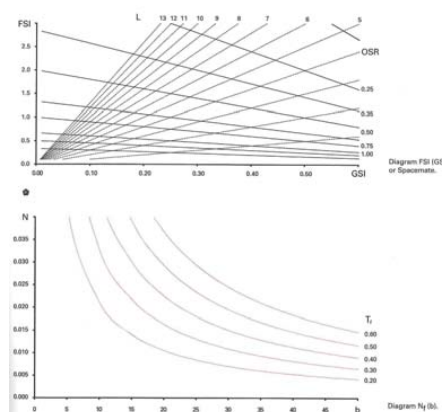


Illustration 6 The relationships between FSI, GSI, OSP, L and N, b, T_f , (source: Berghauser Pont & Haupt, 2010, p. 117)

3.2 Joost van der Hoek: Mixed-use Index

Mixed-use Index is conceived as a quantitative planning tool to measure the functional composition and the mix of uses, which is initiated by Van den Hoek (2008). With the help of GIS programs and well-kept urban datasets, he put forward the concept of 'MXI' to measure mixed-use urbanity of Amsterdam in real insights instead of old conceptual hypotheses. MXI is an inventory of the mixture situation. And the definition of MXI is $MXI = (\%HOUSING / \%WORKING / \%AMENITIES)$. Housing includes various buildings for living, such as apartments, condominium and town houses etc. Working means a place to work; office, factory and laboratory for instance. Amenities contain all commercial, retail, societal, universities, cultural amenities. Because the amount of activities generally correspond with the amount of floor space or land use, the balance of functions can make sure the appropriate proportion of diverse movements, and finally forge the urban vitality. If an area has highly mixture of three functions, a lively urban can be expected. Apparently, when an area has 100 percent of one function, the lack of identity and characterless built environment can be illustrated (see illustration 7).

This analysis aims to measuring urban mixture in numbers is certainly tells something about the character of urban area (Van den Hoek, 2009). It is an innovation analysis tool to define urban quality and character and it is also meaningful for urban planning and governance.

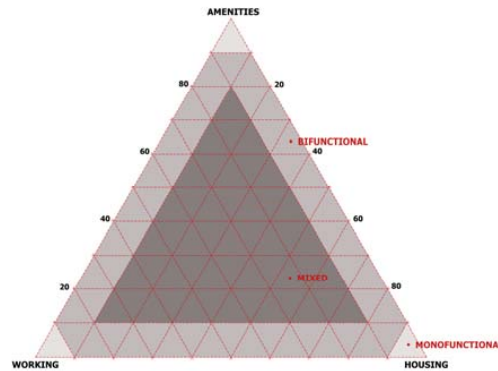


Illustration 7 Ternary diagram: monofunctional, bifunctional, (source: Van den Hoek, 2009, p. 203)

3.3 Akkelies van Nes: Space Syntax in micro scale

Space Syntax is a renowned set of theories and techniques for the analysis of spatial configuration. Through computer programs, such as Depthmap and Confeego, the network can be analyzed further and reveal a clear image of the hierarchy of urban spaces, and the patterns of movements in the cities. It is well acknowledged that the movement network decides the quality of urban areas (Hillier, 1996) and it has been widely used to get a deeper understanding in built environment.

During the past few years, the relationship between spatial configuration and crime is studied by Van Nes and her colleagues (see illustration 8). Various parameters affecting the crime rate were studied. Topological depth from private spaces, street's degree of constitutedness, inter-visibility and density of entrances and isovist field were regard as key parameters (see illustration 9)

The dominant factor that explained both the variation in the spatial variables and the difference in the distribution of criminal incidents was the topological depth of a street segment ... it showing a significant statistical correlation with the micro spatial parameters of targets and the distribution of residential burglaries and theft from cars (Van Nes and López, 2010).

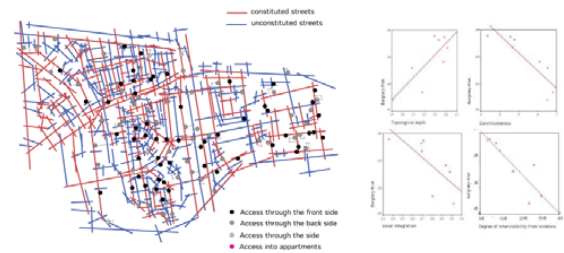


Illustration 8 Space integration and Statistical correlations in various spatial parameters, (source: Van Nes & López, 2010, p. 308,310)

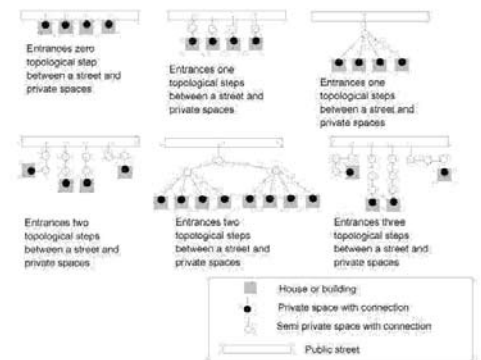


Illustration 9 Diagram showing the topological depth between private spaces inside buildings and the street., (source: Van Nes, 2011, p. 93)

It is important to point out that the statistic analysis was used to pinpoint the relationship and this kind of quantitative integration reveal has inspired further researchers. A quantitative approach applying statistics and scattergrams to visualise the registrations of human activities together with the spatial analyses bring a new direction in built environment.

4 GIS: Linking spatial analysis to socio-economic data

4.1 Bardia Mashhoodi: Quantitative researches on urban level based on GIS

Several spatial analyses, including Spacematrix, MXI and Space Syntax were raised for analyzing the spatial properties of the built environment in the past few years. And the results from these various spatial analyses tools can be integrated with social-economical data through GIS platform to get quantitative analyses.

During the past two years, U-Lab of TU Delft, a group of researchers leading by Van Nes and Berghauser Pont are using above-described methods in quantitative as well as qualitative ways of studies. In 2011, Van Nes, Berghauser Pont and Mashhoodi applied these different spatial analyses tools through

GIS in the southern part of Rotterdam to support the strategic planning of the municipality. The core of this research project was to bridge the gap among Space Syntax, Spacematrix, and the function Mix model and to make a tool through GIS to provide scientific based operational tools in strategic planning (Van Nes, 2011).

In this research, the city is divided into cells in order to fulfill the comparison research among the various abovementioned methods. To make a diagnosis of the current situation in Rotterdam South, the following analyses are made:

- 1) Spatial integration analysis using the Space Syntax method at various scale levels and in relationship with the whole city (see illustration 10, 11, 12);
- 2) Density analysis using Spacematrix (see illustration 13);
- 3) Analysis of the degree of mix using the MXI model (see illustration 14);
- 4) Analysis of the correlations between spatial integration, density and mix of use by overlaying the results from the Space Syntax, Spacematrix and MXI analyses in GIS (Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 9) (see illustration 15).

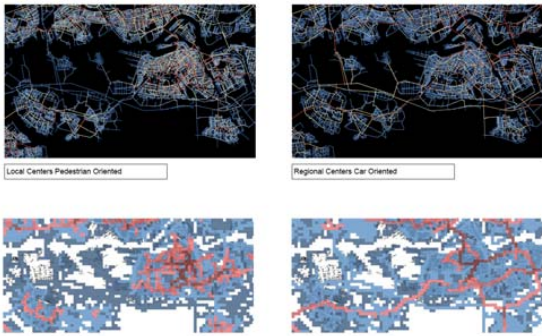


Illustration 11 Angular analyses of Rotterdam with low (left) and high (right) metrical radius, (source: Van Nes, Berghauser Pont and Mashhoodi 2011, p. 11)

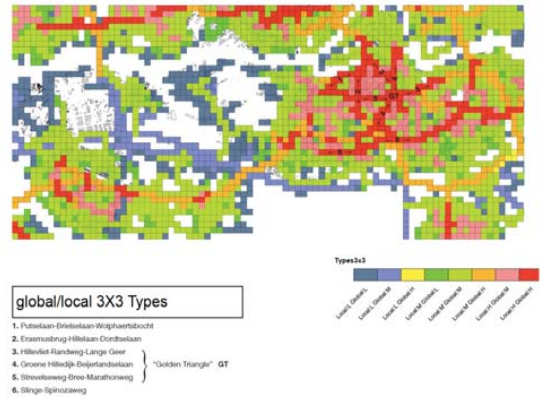


Illustration 12 The combination of angular integration analyses with high and low metrical radii, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 13)

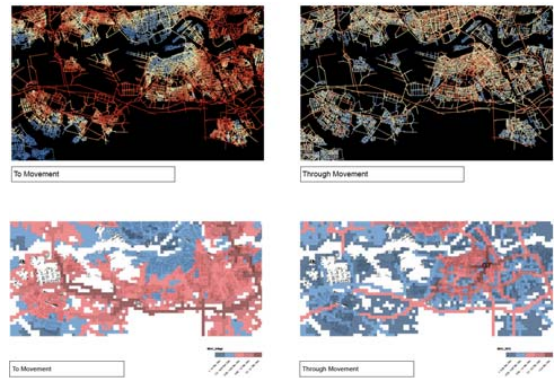


Illustration 10 Global integration analyses (left) and local angular analysis (right) of Rotterdam, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 10)

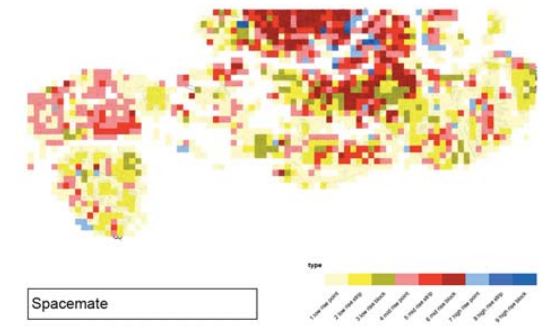


Illustration 13 The location of the 9 different environmental types in Rotterdam South as defined with Spacematrix, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 14)

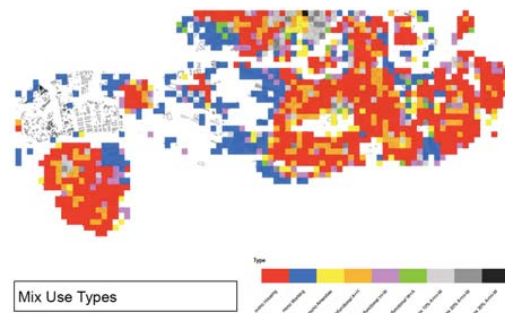


Illustration 14 The degree of function mix in Rotterdam South, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 14)

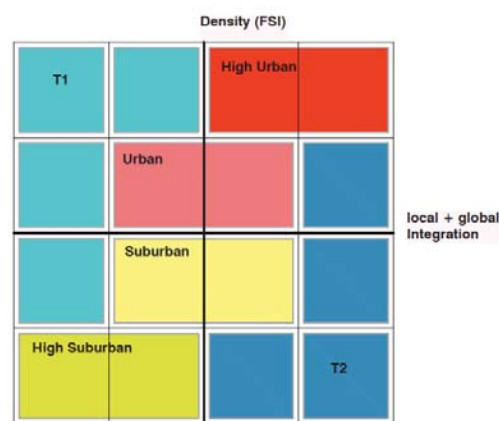


Illustration 15 The Matrix with colour codes used for aggregating the Space Syntax and Spacematrix data in GIS, (source: Van Nes, Berghauser Pont and Mashhoodi, 2011, p. 19)

The research starts from angular and metric analysis in Space Syntax, Depthmap and the calculation results are transformed into cells in GIS in order to facilitate the further integration. It is a further development in searching the way to identify the correlations between the various spatial and socio-economic parameters quantitatively. The relationships among spatial integration, density and functional mixture have been firmly claimed. The higher local as well as global integration on the street and road net and the higher density, in terms of both FSI and GSI, the more multi-functional the areas tend to be. This research method is the first to systematic analysis in urban form quantitatively. It is a great breakthrough and can be used in numerous researches needing to combine spatial and socio-economic dimensions together.

4.2 Victor Joosten: Block types and street-edge commercial functions in micro-level

It is generally acknowledged that street-edge commercial functions contribute to urban diversity

in terms of street life and quality (Jacobs, 1961). Therefore, the analysis in micro spatial conditions always choose street-edge functions as the main indicator in researches.



Illustration 16 Map showing shop and catering enterprises on a block typology map in Berlin, (source: Joosten and Van Nes, 2005, p. 9)

Joosten and Van Nes's empirical research (2005) compares the correlation among the spatial distribution of street-edge commerce among block typology, population densities, block sizes and public transport hubs and street configuration to explain the dispersal pattern of shops and enterprises (see illustration 16).

The result shows that block typology has a strong influence on the dispersal of shops and catering enterprises whereby filled-in blocks facilitate most enterprises, hollow blocks facilitate enterprises less well and non block typologies serve enterprises very poorly....Analyses of street configuration seem not to provide good correlations with the dispersal of shops and catering enterprises in Berlin (Joosten and Van Nes, 2005, p. 1).

Joosten's research aims to find key micro-spatial conditions determining the dispersal of shops, cafes and restaurants in urban environment. Although his conclusions ignoring the effects of historical-evolution in block types, it is still an innovation in micro-spatial conditions. Moreover, the shortcoming of Space Syntax is exposed in this empirical research: Space Syntax always treat the urban object as a homogeneous thing while overlooking the density and fabric's influences.

4.3 Birgit Hausleitner: Urban form and scopes of action for people in micro-level

As I mentioned above, micro-business is always regarded as the main indicator for micro spatial

qualification researches. Hausleitner applied Spacematrix and GIS to seek for related morphological properties of the urban tissue enhancing the conditions for scopes of action in terms of micro-businesses.

Firstly, a series of parameters are analyzed based on amount of facilities and the 'natural breaks' is used as categorizing method. The preliminary diagrams can show first results in the ranges of values. Someone have better correlations to the performance than others. Then, the diagrams relate the parameters to each other while searching for exceptions and their reasons. The question was why a case study showed only few micro-businesses, even though it was in the range of high performance in certain parameters (Hausleitner, 2010, p.9). Through the searching of exceptions and reasons, the key parameters can be drawn.

Based on the research, the first level and second level parameters have different importance in the amount of facilities and only topology centrality, entrances, amount of plots and density belong to the first level (see illustration 17).

...four properties of the urban tissue are crucial to provide conditions for scopes of action. Density of built form, plot-division, entrances as well as vicinity to centralities...a group of properties has a higher relevance than others, but the four main morphological parameters only jointly provide the urban condition for micro-economy as people's scope of action, each on its own performing well is not sufficient...The other parameters tested were in general also of importance, but within the whole group of the second level up to four parameters could be out of the range of high performance values(Hausleitner, 2010, p.11).

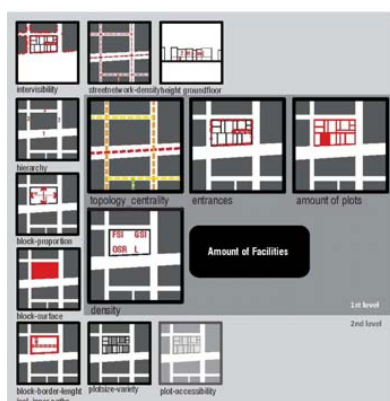


Illustration 17 Importance and relation of the morphological parameters, (source: Hausleitner, 2010, p. 12)

This quantification research of urban form is a necessary to understand the morphological conditions for the facilities for micro-business and finally lead to design guidelines concerning lively spaces based on local existent urban rules (Hausleitner, 2010). The result partly corresponds with Joosten's research about block type and this developed method of abstraction is applicable for other spatial-social researches in micro-level.

5 GPS Tracking: New tool to integrate spatial & socio-economic data

The enhancement of GPS technology enables the use of GPS devices not only as navigation and orientation tools, but also as instruments used to capture travel routes: Van Schaick and Van der Spek (2008) developed a process and database for collecting data on pedestrian movement quantitatively.

The GPS-experiments were set up to tackle questions about urban quality in the field of urbanism, i.e. the design and planning of urban areas and used as an instrument to analyse both individual routes and collective, aggregate patterns of use (Van der Spek, et al., 2009, p.5). TU Delft has carried researches in improving city centers for pedestrians (see illustration 18) and diagnosing spatial mechanism in new towns as well. A series of softwares, including GPSU batch utility, ArcGIS, Data Interoperability Tool (DIT) and SPSS are used to collect and analysis data.

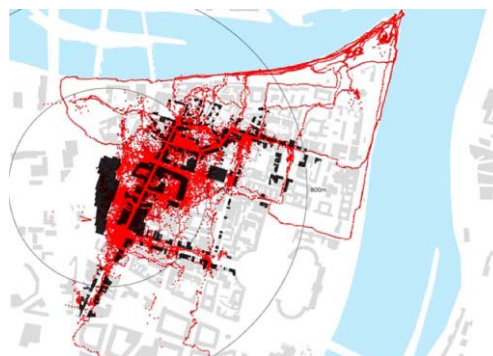


Illustration 18 GPS tracking results from Koblenz superimposed on location of commercial function, (source: Van der Spek, et al., 2009, p.13)

GPS and GIS offer a new technique beyond traditional and low-tech researches, like work of Gehl (1971/1987) and Lynch (1960), to map and measure urban quality in new ways. It is also useful to verify new hypothesis about spatial mechanism. Moreover, it has the potential to evaluate the influence of interventions.

6 Comparison & Discussion

In order to choose the suitable theories and methods to support my master research, all of them will be classified and judged based on the criterion below:

- **degree of operationability**
criteria: clear definitions/model (+); easy to get data(+); having softwares to help the research (+);
- **degree of consideration**
criteria: only considering pure physical or social aspect (+), focusing on physical or social but also partly considering the other side (++), integrating two part perfectly (+++);
- **empirical and theoretical supports**
criteria: only empirical or theoretical aspect (+), focusing on empirical or theoretical but also partly considering the other side (++), gaining well supports from two sides(+++);
- **degree of applicability**
criteria: give inspiration for my hypothesis or whole research (+), inspired and valued for my research (++), regarding as the key analytical methods (+++);

on physical aspect while getting partly empirical and theoretical supports. But his understanding about parallel and serial urban frame do not have software supporting research and hard to get data.

Overall, Read's theory inspired my research because he pointed out that centrality and peripherality are something we can control. That is a strong support for my master thesis. The idea of de-centred neighborhoods are products of particular definable movements (Read, 2005) are important as well. Specifically, isolated neighborhoods in new towns are common situation because the residents do not want and do not need to go to other parts of new town areas, especially in the beginning period of new towns. That corresponds with De Bois's concept of 'serial frame' in new towns and 'parallel frame' in traditional cities. Therefore, I suppose spatial structure in new towns has a high potential to be changed during the maturation process. And that would be one spatial hypothesis in urban scale, which I will try to verify it in my master thesis.

Criterion Name	Degree of operationability	Degree of consideration	Empirical and theoretical supports	Degree of applicability
Read	+	+	+	+
De Bois	+	+	++	+
Berghauser Pont	++	+	++	++
Van der Hoek	+	+	+	++
Van Nes	+++	++	++	++
Mashhoodi	+++	+++	+	+++
Joosten	+	+	+	+
Hausleitner	+	++	+	++
Van Schaick & Van der Spek	++	++	++	+

Illustration 19 Comparison among various theories and methods, the positive evaluation is proportional to the plus numbers.)

Based on the theories and methods introduced before, an evaluation is made (see illustration 19). Firstly, Read's contribution focusing on physical aspect, including Movement layers and Place-region formations, which can explain the contemporary peripherality and centrality well. And he pointed out that centrality is something makable, which is an important inspiration for my new town research. Moreover, he also mentioned the shortcomings of only using Space Syntax to research urban form: 1) treating the urban object as a homogeneous thing while ignoring the density and function difference. 2) treating all movement spaces equally, which means Space Syntax should not be used alone in spatial researches. His conclusion corresponds with Marcus (2007)'s conception of spatial capital. Then, De Bois's theory on public space and urban frame is inspiring for me as well. His theory mainly focuses

Besides spatial theories, in various spatial analytical methods, both Spacematrix (Berghauser Pont) and MXI (Van der Hoek) are important analytical methods focusing on density and functional mixture separately. In the degree of operationability, both of them have a clear model; but Spacematrix are easier to get the data compared with MXI. In the degree of consideration, MXI is focusing on social aspects while Spacematrix is a physical analytical method. Moreover, Spacematrix has getting higher empirical and theoretical supports and has been used in guiding zoning in Amsterdam. Both of them are inspired and valued for my research. Meanwhile, Van Nes's research applying Space Syntax, statistics and scattergrams into spatial and social dimensions is vital for studying spatial mechanism in micro scale. With the help of existing software, her researches have higher operationability. Because of the adding of social data and the using of statistic software, the degrees of consideration and empirical and theoretical supports

The most important analytic method is created by Van Nes, Berghauser Pont and Mashhoodi via integrating Space Syntax, Spacematrix and MXI in GIS. They are inspired by Marcus (2007)’s idea of considering density and diversity issues in research and combine Spacematrix, MXI with Space Syntax, which is creating a quantitative and objective analytic method in urban level. It has highest operationability and consideration, thus, it is highly applicable for my reviewing study for spatial structure transformations in Dutch new towns.

In addition, the quantitative researches in local level made by Joosten and Hausleitner are also meaningful. Joosten’s research in Berlin found the low correlation rate between pure Space Syntax analyses with the street-edge commercial functions, which corresponds with Read’s conclusion about Space Syntax’s flaws. And his discovery about block typology’s effects in street-edge commercial functions should be taken into consideration. However, he didn’t realize that block typology itself contain a series of factor’s (time, location, integration) influences. Thus, it is incorrect to say block type is the vital factor affecting the location of shops. However, his research is still an significant

applicability is low because it is impossible to use this method during my master study.

7 Conclusion

It is important to point out that the linear evolution process does not exist in those various works. Those theories and methods are different in nature. Specifically, their works can be separated into spatial theories, single analytical methods and combined analytical methods, therefore, it is crucial to understand that they have different focusing points (see illustration 20). For instance, Spacematrix and Space Syntax are mainly focusing on physical part while GPS tracking (Van Schaicl & Van der Spek) is purely behavior mapping. Mashhoodi’s focusing is integrating methods together. Obviously, there is a kind of overlapping as well, but I believe it is important to mention the differences.

It is also meaningful to mention that although single analytical methods in physical or social aspects may not have high grade in the comparison in Illustration 19. But they are the foundations of more accurate combination researches made by PhD students (Mashhoodi and Hausleitner). Only by further

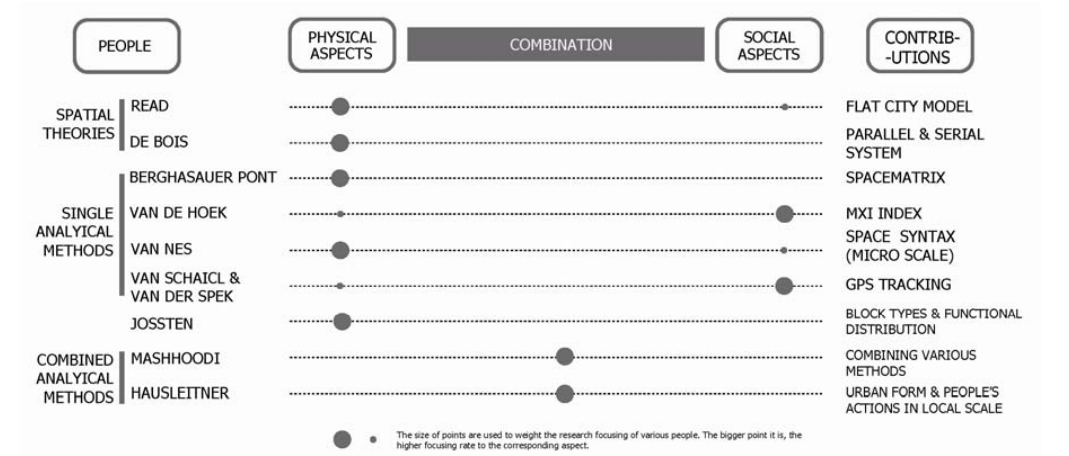


Illustration20 The various focusing points of theories & methods

inspiration for me. Compared with Joosten’s work in 2005, Hausleitner’s research (2010) is more systematic organized based on Spacematrix and GIS, thus, she has wider consideration. The results are more convincing. Finally, Van Schaick and Van der Spek’s tracking research demonstrates a new measurable way to understand urban quality, which has a border prospects. Their works can reflect people’s movements accurate and easy to operate with the help of sets of software. But its

developing the methods in physical and socio directions, an objective understanding on built environment can be found via the combination researches.

To sum up, their contributions will support my future master thesis in three aspects. Firstly, in theoretical part, Read and De Bois’s contributions give me a strong inspiration. Based on their ideas, I can suppose a hypothesis of spatial construction

changing from new towns to historically-evolved towns. Then, the integration of Space Syntax, Spacematrix and MXI in GIS is a universal research method which will be the spatial-analytical method in my master research in urban level. In addition, the researches made by Joosten and Hausleitner will be taken into consideration in my local scale study, especially their research methods. This review paper will be a strong support for the theoretical framework in my master thesis.

Bibliography

- Ahas, R.; Ular, M. (2005). Location services - new challenges for planning and public administration? *Futures* 2005, 37, 547-561.
- Aldridge, M. (1979) *The British New Towns: A Programme Without a Policy*. London: Routledge.
- Alexander, C. (1965). A City Is Not A Tree. *Architectural Forum*, Vol. 122. No. 1.
- Berghauser Pont, M.Y., Haupt, P. (2010). *Spacematrix, Space, Density and Urban Form*. Rotterdam: NAI Publishers.
- Brömmelströet, M. T. and Stolk, E. (2007). New Town Simulation: An Introduction. In: Stolk, E. and Brömmelströet, M. T. (Eds.). *Model Town: Using Urban Simulation in New Town Planning*. Amsterdam: Sun Press, 8-15.
- De Bois, Peter. (1998). *STOA-Method for Urban Design and Analysis*, preliminary version; Delft University of Technology: Delft, the Netherlands.
- De Bois, P. and Buurmans, K. (2005). Genesis of Urban Frame. Case study New Town Almere; presented at *Conference on Public Space in Contemporary City*, Cracow University of Technology: Cracow, Poland.
- De Bois, P. and Buurmans, K. (2007). To know the Path is to Rule the System- case-study New Town Almere: The discrepancy between serial planning and vital city; European Urban Research Association (EURA) 10th Anniversary, University of Glasgow: Glasgow, Scotland, 12-14.
- Gehl, J. (1971/1987) *Life Between Buildings: Using Public Space*, translated by Jo Koch, Van Nostrand Reinhold, New York.
- Hausleitner, B. (2010). Urban Form and its Impact on Scopes of Action for People. Investigations on Urban Blocks in Paris. In: ISUF (International Seminar on Urban Form), 17th Conference on "Formation and Persistence of Townscape", Hamburg and Lübeck, Germany, 20th -23rd August 2010. Retrieved Nov 14, 2011, from http://www.isuf2010.de/Papers/Hausleitner_Birgit.pdf.
- Healy, P. (2007). *Urban Complexity and Spatial Strategies: Towards A Relational Planning For Our Times*, 3. London: Routledge, P.1.
- Hillier, B., Hanson, J. and Peponis, J. (1984). "What do we mean by building function?", in Powell, J., A., Cooper, I. & Lera, S., (eds.), *Designing for building utilisation*, London.
- Hillier, B. (1996). *Space is the machine: A configurational theory of architecture*. The Press Syndicate of the University of Cambridge.
- Hillier, B. (1999). Centrality as a process: Accounting for attraction inequalities in deformed grids. In: *Urban Design International*, Volume 4, Issue 3-4, 107-127.
- Jacobs, J. (1961). *The Death and Life of Great American Cities*, Vintage Books press, 1992.
- Joosten, V. and Van Nes, A. (2005). How block types influences the natural movement economic process: Micro-spatial conditions on the dispersal of shops and Café in Berlin. 5th International Space Syntax Symposium, Delft, The Netherlands, 13rd -17th June 2005. Retrieved Nov 19, 2011, from <http://www.spacesyntax.tudelft.nl/media/Papers/225.pdf>.
- Lynch, K. (1960). *The image of the City*. MIT Press, Cambridge.
- Mashhoodi, B. and Berghauser Pont, M. (2011). Studying land-use distribution and mixed-use patterns in relation to density, accessibility and urban form. Retrieved Nov 11, 2011, from http://geography.ssc.uwo.ca/faculty/gilliland/ISUF%202011%20Full%20Papers/01051156%20Mashhoodi_paper.pdf.
- Marcus, L. (2007). Spatial Capital and How to Measure it: an outline of an analytical theory of the social performativity of urban form. Proceeding in 6th International Space Syntax Symposium, Istanbul, 2007. Retrieved Nov 22, 2011, from <http://www.spacesyntaxistanbul.itu.edu.tr/papers%5Clongpapers%5C005%20-%20Marcus.pdf>.
- Read, S. (2001). Neighborhood spatial processes: Notes on Public Space, 'Thick' Space, Scale and Centrality. Retrieved Nov 2, 2011, from <http://www.spacelab.tudelft.nl/Media/Papers/04.Neighbourhood.pdf>.
- Read, S. (2005). Flat City; a space syntax derived urban movement network model. Retrieved Nov 4, 2011, from <http://www.spacesyntax.tudelft.nl/media/longpapers2/stephenread.pdf>.
- Read, S. and Bruyns, G. (2007). THE FORM OF A METROPOLITAN TERRITORY: the case of Amsterdam and its periphery. Retrieved Nov 4, 2011, from

- <http://www.spacesyntax.tudelft.nl/media/longpapers2/stephenread.pdf>.
- Ståhle, A., Marcus, L. and Karlström, A. (2005). Place Syntax- Geographic Accessibility with Axial Lines in GIS. Retrieved Nov 21, 2011, from http://www.spacescape.se/pdf/Place%20syntax%20paper_Stahle_Marcus_2005.pdf.
- Shoval, N. (2008). Tracking technologies and urban analysis. *Cities* 2008, 25, 21-28.
- Shoval, N. and Isaacson, M. (2006). The application of tracking technologies to the study of pedestrian spatial behaviour. *Prof. Geogr.* 2006, 58, 172-183.
- Van den Hoek, J. (2009). The Mixed Use Index (Mixed-use Index) as Planning Tool for (New) Towns in the 21st Century. In: Provoost, M. (Eds.). *New Towns for the 21st Century: the Planned vs. the Unplanned city*, Sun Press, 198-207.
- Van der Spek, S., Van Schaick, J. De Bois, P. and De Haan, R. (2009). Sensing Human Activity: GPS Tracking. Retrieved Sep 21, 2011, from *Sensors* (ISSN 1424-8220; CODEN: SENS9), www.mdpi.com/journal/sensors.
- Van Schaick, J. and Van der Spek, S. (2008). *Urbanism on Track: Application of tracking technologies on Urbanism*, Delft University Press.
- Van Nes, A. and López, M. J. J. (2007) Micro scale spatial relationships in urban studies. the relationship between private and public space and its impact on street life. In A. S. Kubat, (Eds.). *Proceedings Space Syntax*. 6th International Symposium, Istanbul, 2007.
- Van Nes, A. and López, M. J. J. (2010). Macro and Micro Scale Spatial Variables and the Distribution of Residential Burglaries and Theft from Cars: An investigation of space and crime in Dutch cities of Alkmaar and Gouda. *The Journal of Space Syntax*, Vol.1, No 2, 296-314. Retrieved Sep 21, 2011, from http://joss.bartlett.ucl.ac.uk/index.php/joss/article/viewFile/296/pdf_25.
- Van Nes, A. (2011). (forthcoming). *Space syntax in urban studies – an introduction*. Delft University of Technology.
- Van Nes, A., Berghauser Pont, M. and Mashhoodi, B. (2011). (forthcoming). Combination of Space Syntax with Spacematrix and the Mixed Use Index :The Rotterdam South test case. Proceeding in 8th International Space Syntax Symposium, Chile.