Doctoral Thesis

博士論文

Diversification and Localization in Transformation Process of Urban Morphology in Major Cities of China

（中国の大都市における都市形態の変容過程にみる多様化と地域化に関する研究）

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Abstract

China is an ancient urban civilization that embraces historical continuity, but with an unprecedented modern urbanization process. As the urban form is a result of planning concepts, aesthetic and techniques of the particular times, the dual aspects of China's urbanization process have brought drastic changes to the transformation process of urban morphology. Various spatial patterns coexist in one city, at the same time. The complexity and uniqueness of Chinese urban form, require clarification.

Some Chinese cities are facing with a problem of "becoming 'placeless', with 'international-style' architectures and characterless urban spaces", as a result of the high-speed urbanization in similar techniques and aesthetic. Hence, clarifying the connections between the old and the new forms contributes to solving the "monotone" and "a loss of identity" in urban morphology.

China adopts a relatively united and continuous history, mainly rooting in domestic and traditional culture. Meanwhile, cultural interaction with other countries happened for some times, actively or passively. Internal forces and external influence can be found in shaping Chinese urban form, causing a unique transformation process with "diversification" and "localization". Hence, to clarify the mechanism of Diversification and Localization process of urban morphology is efficient in reading Chinese cities. It will guide the future application of traditional inherent patterns and foreign imported patterns critically.

The city can be 'read' via the medium of its physical form, within which urban structural elements are the foundation, for their high unchangeability once being constructed. Streets, as the 'skeleton' of urban structure, is the frame for creating urban form. While, blocks, as the 'basic unit' making up urban form, can be called a city's DNA. They shaped urban form through two dimensions: 1) diversify cities through initial planning 2) differentiate in long-term transformation. Moreover, as a bridge connecting the macro and microscope, street/block-scale analysis is potential for analysis on both human level and city level. Hence, street/block patterns have a pivotal role as the concrete clues to visualize the urban morphological transformation process, by means of both diachronic and synchronic analysis.

This research aims to investigate the transformation process and current conditions of urban physical form in major Chinese cities, from the view of diversification and localization, to clarify: 1) The origin, influential relationship and current significance of the inherent urban pattern and the imported urban pattern. 2) How the inherent urban pattern from traditional Chinese culture diversified in the long-term process of urbanization and globalization. 3)How the imported urban pattern from foreign culture localized into different Chinese urban context, diversely developed in different cities and shaped these cities in different ways. 4) Connections, potentials and limitations of the above processes in current urban planning and design.

Hence, the mechanism of diversification and localization in transformation process of urban morphology in major cities of China is clarified. It provides a concrete angle in street-block scale by time-and-space-dimensional

reading of representative cities, to make the urban morphological transformation more legible. It contributes to solving the monotone in city images in the flow of industrialization and globalization, as well as sustaining local traditions as an essential part of urban identity.

The overall structure of the research takes the form of seven chapters.

Chapter 1 introduces the research background, research objectives, definitions, research framework and previous research.

Chapter 2 begins with the multiple sources of Chinese urban forms, sorting out the representative patterns, and clarifies their inheriting relationship, time sequence, and current issues, from the view of culture inheritance and importation. The investigation is not limited in Chinese urban context, but also in the world, proposing a whole view of specific patterns as prerequisites for clarifying their “diversification” and “localization”. The grid plan of dualism or hierarchy, which has been inherited through ancient times and the unprecedented urbanization, can be considered as the inherent pattern. Its inheritance tends to be a "game" between "hierarchy" and "homogeneity." Its diversification process and dynamics were clarified in Chapter3 and Chapter4. The Baroque ring-radial space, as a totally “exotic” from foreign culture, results from passive urbanization with colonial background. Its form and functions changed constantly with urban development worldwide, making them still irreplaceable in current urban context. It was imported into China when its symbolism was endowed with more practical functions, adding a tendency of pragmatism in the Chinese cases. Its localization in Chinese cities was clarified in Chapter5.

Chapter 3 focuses on the representative inherent pattern, grid blocks, investigating their formation and the relevant urban planning principles that directly influence block form, at national and local level, with a case study of Beijing, China. The possible influence is revealed, contributing to addressing the mechanism and dynamics of morphological diversification in Chapter 4. Grid blocks were initially constructed in ancient times, but were hardly inherited completely, giving Beijing an impression of "massive uprooting and demolition." As the urbanization in Socialist planned period was rapid but rough, the blocks were mainly completed in 1982-2004 under social marketing economy. In addition, block boundary and inner subdivision were not constructed orderly or within a certain period of time. Their formation covered a long-time span, complying with principles of different periods. Moreover, principles at national level addressing realistic health and safety issues more than physical shape and spatial perception, are lacking in clear definition of "block" for a long time, resulting in few quantitative regulations. While, the ones at the local level in Beijing have changed substantially according to urban development stages influenced by regime, social structure and foreign theories etc. Principles lack continuity to some degree, and some of them contradicted previous versions.

Chapter 4 continues the analysis on grid blocks in Beijing, targeting at revealing their current conditions and transformation, to clarify how and why the grid blocks diversified from the inherent archetypal pattern, from two layers: the primary block-boundary layer, and the detailed inner-space layer. First, five morphological clusters in grid blocks were classified based on 7 indicators. Grid blocks with high variety co-exist in limited liner-shape distribution in Beijing, showing an incredible sense of contrast. Second, the diversification process in the block-boundary layer related to block size and shape regularity. Block-boundary layer in Beijing shows large difference from the regular grid network in western cities. It adopts large size and lower regularity, which inherited the network from traditional Chinese grid. Block size related to urban planning principles' transition, while, block shape regularity corresponded more to its location in Beijing. Both indicators adopt large variation, reflecting the spatial contrast. What's more, when the large size resulted in more diversification in the inner-space layer, smaller size correlated with higher density in inner-space layer especially in commercial areas. Third, the diversification process in the inner-space layer, related to road network density, building density and subdivision pattern. The building intensity connected with road density following planning principles' transition, but had a rather reversed tendency with building compactness. Subdivision pattern strengthened the spatial contrast in block boundary layer, and the re-subdivision process stimulated the diversification inside blocks, because that the existing irregular inner pattern would increase complexity in spatial arrangement. Multiple factors and dynamics in time and spatial dimension resulted in the diversification.

Chapter 5 investigates the transformation process and current conditions of Ring-radial Spaces and Rotaries (RS&Rs) as representative imported pattern. It clarifies how the RS&Rs localized with Chinese urban context and diversely developed in different cities, by comparative analysis between Dalian and Changchun, China. First, by investigating the urban planning timelines, with natural and social conditions, it revealed that different natural conditions, city positioning, and the application of multiple modern urban planning theories led to landscape-oriented RS&Rs with random distribution in Dalian, and monument-oriented ones with ordered arrangement in Changchun. Second, RS&Rs correspond to the urban sprawl process and are continually implemented as a planning icon. It is suitable as a clue for understanding the urban development process from the perspective of both time and space. Third, cities showed different preference in morphological types with respective functions according to locality. However, their transformation lacks unity and identity inheritance, which manifests as the lack of connective relationships between the RS&Rs in Dalian, and as the loss of activity function in Changchun. Moreover, both cities transformed with original building fabric changing around RS&Rs. It can be considered as a procedure of localization adapting to local conditions, but it can also be considered as a loss of conceptual inheritance of imported pattern. Therefore, exploiting distinctive characteristics and emphasizing the inheritance of RS&Rs critically must be considered in future.

Chapter 6 redefines the “Diversification” and “Localization” in Chinese urban morphological transformation, based on the analysis in Chapter 2, 3, 4 and 5. The inherent block pattern and the imported street pattern in this research were treated as concrete clues for understanding the transformation process of Chinese cities. The mechanism of both processes is clarified and compared.

Diversification refers to: the time differences of urban construction and the subsequent changes appeared after construction, in time dimension; and the simultaneous spatial distribution of “time difference” in urban construction, and the unexpected differentiation in similar construction periods, in spatial dimension.

Localization refers to: a continuity in urban construction from the view of time dimension, and also a continuity in urban sprawl from the view of spatial dimension. It includes the initial integration with local context, as well as its long-term changes in form and functions so as to adapt to cities’ updating requirements.

“Diversification” process and “Localization” process are not separated with each other. They may transform into each other according to the different ranges or resolutions. Their continuous transformation in both time and spatial dimension, were influenced by Internal Forces and External Forces at different time, with different proportion. It leads to a Constancy of Conceptual Inheritance in the Inherent Pattern, but Variability of the Imported Pattern in the transformation process of Chinese urban.

The conclusions and suggestions can be referred by the other cities with similar patterns and background. For cities with traditional grid blocks, strategies need to be proposed hierarchically according to the positioning of block typologies, balancing the inherent spatial configuration and the newly emerging patterns. For cities originating from foreign urban forms, changes in physical form, functions and planning objective require critical examination, avoiding the complete separation between the previous and the new, as well as dogmatic inheritance. The conclusions also help to endow the “Indices-oriented” detailed plans with more social and cultural consideration, optimizing the connection between statutory planning and practical implementation in China.

Chapter 7 summarizes the conclusions and proposals of the research. This research provides new insights on understanding the transformation process of Chinese urban morphology basing on the mechanism of “Diversification” and “Localization”. The inherent pattern shows stronger inheritance in conceptual features, while the imported pattern persists uncertain preferring tendency, with vital changes in forms, functions as well as interact connections. Eventually, 1) a reading approach from diversification and localization is proposed in understanding Chinese urban form transformation; 2) Corresponding proposals are suggested to cities with similar urban patterns; 3) Effectiveness of detailed plan and urban design in guiding practical implementation is possibly improved.

Content

Chapter 1 Introduction

1.1 Research Background

(1) Complexity of Chinese urban form and the dual aspects of China's urbanization process

China is an ancient urban civilization that embraces historical continuity, but with an unprecedented modern urbanization process (Friedmann, J., 2006). On one hand, it is considered as the only survivor of the few ancient civilizations (Morris, A., 1972), and the North China Plain is treated as one of the handful of regions of primary urbanization in the world (Wheatley, P., 1971). Hence, numbers of historic cities in China, with a history of thousands of years, ceaselessly transformed and developed throughout an extensive stretch of time. Although evolutions and changes may take place during the transformation process, either enduring or short-lived, the millennial urban tradition in China is inherited till now, leading to certain patterns persisting with differentiation to some extent.

One the other hand, the urbanization process in China only started a short while ago, although Chinese cities are of great antiquity. Urban population in China in 1820 amounted only about 6.5% of the total, and increased to about 9.8% at the beginning of 20th century. The rate was about 10.6% at the start of the People's Republic of China in 1949. At that time, China was still a predominantly rural society. During 1949-1978, the rate rose with some ups and downs and reached 17.9%. However, the statistics grew by leaps to 36.22% in 2000 and 60.60% at the end of 2019. Compared with European countries, the end of the eighteenth century, the urban proportion of total population for western and central Europe ranged between 20% and 25% (Braudel, F., 1973), and the rate of the whole Europe reached 74.3% in 2019. Thus, in one century, China's hyper-urbanization almost compressed what would have taken the world two more centuries to achieve.

As the urban form is a result of planning concepts, aesthetic and construction techniques of the particular times, the dual aspects of China's urbanization have brought drastic changes to the transformation process of urban morphology. Spatial patterns may have changed considerably in a short time, and the representative patterns of different phases may be compressed and coexist in one city, at the same time. The above adds complexity and uniqueness to the Chinese urban form, which needs further clarification. (Fig.1-1)

(2) "Monotone" and "Placelessness" appearing in some Chinese cities

The high-speed urbanization process may consequently cause monotonous images among places constructed in same period of time, because of similar techniques and aesthetic in urban planning. Hence, some Chinese cities are facing with a vital problem of "becoming 'placeless' – congested with 'international-style' architecture and characterless urban spaces" (Chen, F. et al., 2009). The prevailing urban design languages are dominated more by power and economy in priority, rather than socio-cultural relations, collective belongings and aesthetic achievements. This may ultimately weaken the sense of urban identity.

The identity of a city is closely related to the personal and social identity of its residents. It is recorded and expressed in the conventional built forms, as a reflect of specific culture (Watson, G.B. et al.,2007). As the co-existence of urban forms from both previous and current, matching the modern with the old is crucial in order to create cohesive city entities and legible city images. Therefore, clarifying the urban morphological transformation examine the connections and limitations between the old and the new, so as to propose urban design suggestions for urban designers and policy makers to solve the "monotone" and "placelessness" in urban morphology.

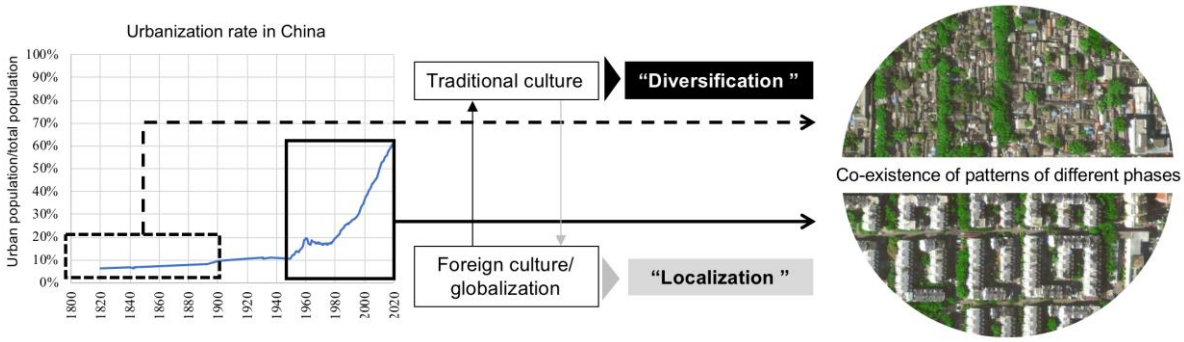

Fig. 1-1 Complexity of Chinese urban form

(By author, based on data from National Bureau of Statistics of China, https://data.stats.gov.cn, figure from Baidu satellite map, https://map.baidu.com)

(3) Internal forces and external influence in urban morphological transformation in Chinese major cities

China adopts a relatively united and continuous history, mainly rooting in domestic and traditional culture. Meanwhile, cultural interaction and exchange with other countries also happened for some times, either actively or passively. Therefore, inherent patterns, such as the planning of imperial cities, are inherited based on traditional Chinese culture as internal force, while, imported planning theories and concepts from the Western countries and the globalization tendency, as external influence, result in cross-cultural patterns, such as previous concessions.

For the inherent patterns, they were not immutable. Not only the urban planning theories, construction techniques, but also the existed urban form have been redeveloped accordingly to the updating requirements of industrialization and globalization. The original urban patterns following strict construction principles in ancient times have been diversified with more flexibility.

For imported patterns, although some physical imitation may appear at the beginning, localism was integrated, creating a process of localization. It is a process of recreation instead of copy, directing to cross-cultural urban images with local identity.

Internal forces and external influence can be found in shaping Chinese urban form, causing a unique transformation process with "diversification" and "localization". Accompanying the pace that China has started to catch up and engage with the remainder of the world, "Chinese cities are evolving in their own ways, and will end up as cities embodying a Chinese form of modernity, regardless of how many office towers and luxury hotels built

in Shanghai are designed by western architects" (Friedmann, J., 2006). As a result, to clarify the mechanism of Diversification and Localization in transformation process of urban morphology is efficient in reading the Chinese cities. It will also guide the future application of inherent patterns and foreign imported patterns critically.

(4) Roles and significance of urban structural elements and the scale in shaping urban form

The city can be 'read' and analyzed via the medium of its physical form (Moudon, A. V.,1997). Among the factors in shaping urban physical form, urban structural elements are the foundation, because it cannot be changed easily once being constructed. For instance, streets, as the 'skeleton' of urban structure, is the integral frame for creating urban form, leading to various spatial characteristics. While, blocks, as the 'basic unit' making up urban form, can also be called a city's DNA, and it is a media for Plot/Building to realize street publicity, accessibility and livability. In addition, urban structural elements shaped urban form through two dimensions:

1) They may diversify cities at the beginning of planning, by the implementation of Homogeneous network, Centrality, Multi-focus, Axiality etc.;
2) They can differentiate into various patterns in long-term transformation, that the similar street and block pattern changes through subdivision or mergence, either on purpose or spontaneously. (Fig.1-2)

Moreover, resolution is another factor that require consideration. Commonly, four levels of resolution are recognized in analyzing urban physical form: building/lot, street/block, city, and region (Moudon, A. V.,1997). This research focuses on the street/block scale, that can be regarded as a bridge connecting the macro and micro scope. It is potential for both analysis on human level, and being as a unit in understanding the whole city. (Fig.1-3)

Last but not least, socially sustainable cities are chronological records of social factors made manifest through the dynamic, changing and adaptable nature of their physical and spatial order (Chen, F. et al., 2013). So, urban physical form need to be read as a result of an evolutionary process, according to the idea of Typo-morphology (Muratori, S., 1959; Leite, J.et al, 2017), which includes a static process of the decomposition and classification of urban elements, and a dynamic process related to the action of time on the urban elements.

As a result, street and block patterns have a pivotal role as the concrete clues that visualize the urban morphological transformation process. By means of both diachronic and synchronic analysis, "diversification" and "localization" process in transformation of urban morphology in major cities of China are more possible to be understood.

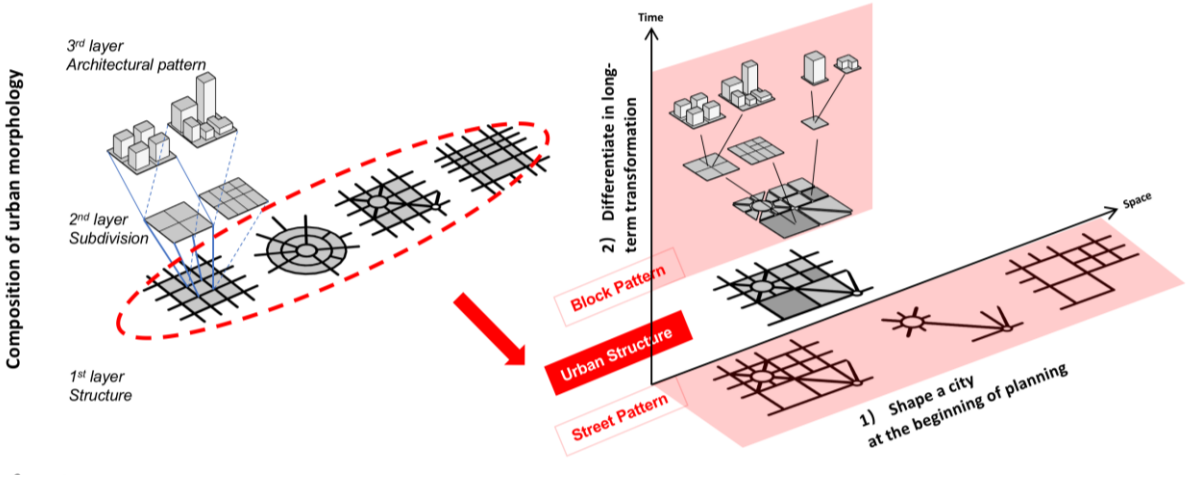

Fig.1-2 Roles and significance of urban structural elements in shaping urban form (By author)

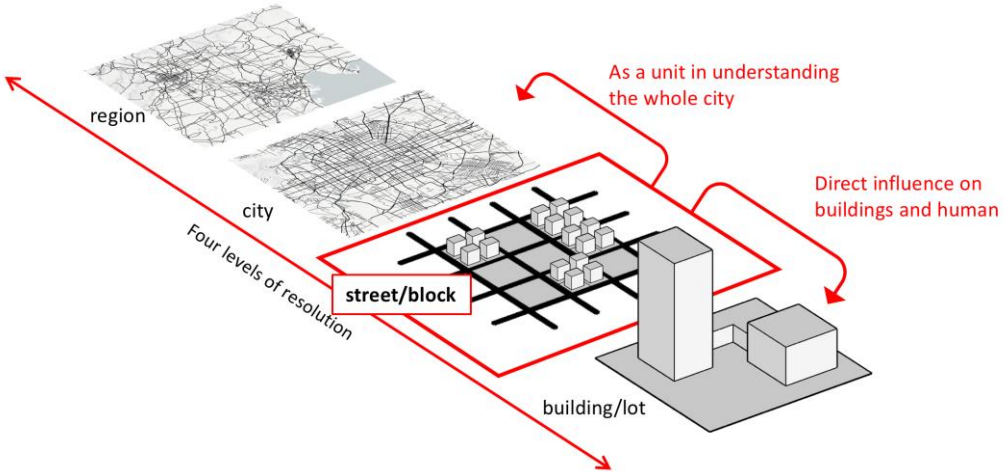

Fig. 1-3 Four levels of resolution in analyzing urban physical form (By author)

1.2 Research Objectives

The objective of this research is to investigate the transformation process and current conditions of urban physical form in major Chinese cities, in order to provide a concrete angle in street-block scale by time-and-space-dimension reading of urban physical form, from the view of diversification and localization, aiming to make the urban morphological transformation more legible.

It contributes to establish a new viewpoint for scholars in reading urban morphological transformation. Also, it is benefit for offering suggestions for urban designers and policy-makers on solving the monotone in city images in the flow of industrialization and globalization, and inheriting local traditions to evolve and sustain as an essential part of urban identity.

The aforementioned will be achieved by further clarifying:

1) The origin, influential relationship and current significance of the inherent urban pattern from traditional Chinese culture and the imported urban pattern from foreign culture that have been implemented in Chinese cities, world-widely.
2) How the inherent urban pattern from traditional Chinese culture diversified in the long-term process of urbanization and globalization.
3) How the imported urban pattern from foreign culture localized into different Chinese urban context, diversely developed in different cities and shaped these cities in different ways.
4) The mechanism of diversification and localization in transformation process of urban morphology in major cities of China, as well as the connection, potentials and limitations, of the above processes in current urban planning and design.

1.3 Definitions of Keywords in the Research

1.3.1 Diversification and Localization

(1) Diversification in the transformation process of urban morphology

Diversification mainly refers to the processes that an archetype transforms diversely in the long-term development and evolves into patterns with differentiations. In the transformation process of urban morphology, the diversification is not only diachronic but also synchronic. Diachronically, first, the archetype transforms into identical typologies resulted from technique and aesthetics of every phases; Second, each typology subsequently evolves variously, intendedly or unexpectedly. Synchronically, first, identical typologies of each phase sustain and co-exist at the same time in the same city, leading a morphological diversity in current urban space; Second, although guided by similar technique and aesthetics, differentiation also happened inevitably, as a part of natural emerging.

(2) Localization in the transformation process of urban morphology

Localization mainly refers to the processes that an archetype transforms with specific tendency to adapt to local conditions and requirements. In the transformation process of urban morphology, the localization process can also be decomposed diachronically and synchronically. Synchronic process triggers the localization initially, when new the new archetype integrates with local context in a new city. While, the diachronic process refers to the following evolution, that is the continuous adaptation to local requirements. Each one of the above processes can be a part of localization, but there is another condition that contributes to a more comprehensive understanding of localization. That is the continuity in urban construction, either timely or spatially.

(3) Connections between Diversification and Localization

The two processes of Diversification and Localization, are not independent or totally separated from each other. Dialectical relations can be identified in the two processes. According to the different ranges or resolutions and different evolving phases, there is possibilities for them to transform into each other.

Urban form diversification in a single city is inevitably a localization process of the larger scale (e.g., nationally or world-widely), because of the influence by the city's conditions. However, urban form diversification in a single city is composed of localization processes of the smaller scale (e.g., in district scale or block scale), resulting from the positioning of different areas and local attachment. It can be regarded as a sum or result of numbers of localization processes.

Similarly, the urban form localization in a single city can be considered as an approach of morphological diversification world-wide. Its long-term adaptation can be treated as a diversification of the initial localized pattern.

As a result, depending on different resolutions, diversification and localization adopts different explanation. The cross-relation and possible mutual transformation between them are not conducive to distinguishing their formation mechanism and dynamics. Hence, more necessary conditions require consideration in clarifying urban form transformation. Cultural origins can be helpful in the analysis.

1.3.2 Diversification and Localization of Inherent Pattern and Imported Pattern

(1) Inherent Pattern and Imported Pattern

Based on the origins of urban pattern, the concept of "inherent pattern" and "imported pattern" was introduced in the research.

Inherent Pattern (of Chinese cities) in the research refers to the urban patterns based on the urban planning concepts that originates from the traditional cosmology and social system in domestic Chinese culture.

Imported Pattern in the research refers to the urban patterns based on the urban planning concepts that originates from the foreign cosmology and social system in foreign culture, but has been introduced and implemented in Chinese cities.

(2) Diversification as domination with localization as subordinate for inherent pattern

Taking the cultural origin or the origin of urban planning concept as prerequisite, the inherent pattern may evolve into different concrete pattern when implemented in various cities, which can also be called its "localization". But, the implementation of archetypal inherent pattern in specific cities in China does not adopt drastic changes in cultural background. Although the archetypal inherent pattern needs to be localized into a specific city initially, it is not the main reason causing the following transformation. Instead, the following transformation emerged under similar urban background, which requires clarification so as to reveal the transformation mechanism. Hence, diversification is considered as domination in urban form transformation of inherent pattern. It represents that the urban pattern (inherent pattern) originating from domestic urban planning concepts and traditional culture, follows the same urban background but transformed diversely into different patterns(diversification), influenced by multiple factors.

(3) Localization as the main characteristic and diversification as a result for imported pattern

For the imported pattern, it originates from foreign urban planning concepts and foreign culture, and was introduced into China and differentiated into patterns that better adapt to the local context of each Chinese city. Drastic changes in cultural background triggered the initial transformation and stimulated the subsequent evolution. It endows the following long-term diversification process with particular tendency in adaptation to local necessities. Moreover, when focusing on the global scale, its localization into Chinese cities can be considered as one of the diversification processes of the urban pattern worldwide, but when focusing in the Chinese urban context, it is the change of cultural background and urban conditions triggered the transformation. Hence, localization is considered as the main characteristic in urban form transformation of imported pattern. It represents that the urban pattern (imported pattern) originating from foreign urban planning concepts and foreign culture, was introduced into China and differentiated into patterns that better adapts to the local context of each Chinese city.

(4) "Diversification of Inherent Pattern" and "Localization of Imported Pattern" as efficient perspectives in understanding the Chinese urban form transformation

Diversification and Localization both exist in urban form transformation in Chinese cities, no matter for inherent pattern or imported pattern. However, their proportions in leading the transformation process differ vitally. In addition, the ambiguity between the two process needs to be avoided in the research by regulating the resolutions and definitions. Therefore, though patterns in block-street scale are targeted at, it aims to understand the whole city. Their cultural origins result in the main distinctions in transformation. In that case, "Diversification of Inherent Pattern" and "Localization of Imported Pattern" were proposed as two efficient perspectives. They are based on the cultural origin, aiming to reveal the basic characteristic of transformation, so as to distinguish the dynamics and reveal a clearer causation logic in the transformation of urban morphology in Chinese cities.

1.4 Research Framework

The overall structure of the research takes the form of seven chapters, including the introductory chapter and conclusion chapter. (Fig.1-4)

Chapter1 is the Introduction, including research background, research objectives, keywords' definition, research framework and the review of previous research.

Chapter2 targets at the original patterns that were implemented to shape urban form in major cities in China, aiming to clarify the factors resulting to the original patterns, their influential relationship with cities in other countries, as well as their current morphology and functions after a gradual transformation process.

First, it reviews the typical patterns in Chinese urban form, abstracting the geometric archetypes and cultural factors hidden behind, from the view of traditional culture inheritance and foreign culture import. Second, it focuses on the grid plan as the representative inherent pattern, which is resulted from the ancient China. Not only investigate its transformation tendency within China but also reviews its influence and differentiation in neighbor countries. Third, it pays attention to the ring-radial space as the representative imported pattern, which is traced back to classical Baroque Style. Its concrete physical pattern is further categorized worldwide and its import into Chinese colonial cities is clarified. Moreover, compared with the grid plan which is still commonly implemented, the current significance of the classical ring-radial space is also discussed world-widely as a reference for the case redevelopment in Chinese cities.

Chapter 3 targets at the inherent pattern of grid blocks, aiming to investigate their formation process and the related principles, which directly influence block form, at both national and local level, with the case study of Beijing(Chinese: 北京, Japanese:北京), China. Their potential effect on the subsequent transformation was clarified. The proposed method and results of this chapter contribute to further study of the mechanism and dynamics of morphological diversification in Beijing in Chapter 4.

First, the formation process of blocks was decomposed and correspond to the urban development stages of Beijing. The overlayered urban construction process are clarified and the typologies of block formation process were classified. Second, it introduces the urban planning system in China, extracting the contents that directly influence urban block design. The transition of Legislation system, Standard system about blocks at the national level are arranged. Then, the characteristics of principles are concluded. Third, shows the transition of urban planning principles and city plans that influenced the block form in Beijing at the local level. The characteristics of each stage and the overall transition tendency are clarified.

Chapter 4 targets at the inherent pattern of grid blocks in Beijing, China. It aims to clarify their diversification process under a united urban planning background and set up an archive of its current patterns for future issues.

First, it investigates the process of grid block transformation in Beijing referring to western typology and morphology theories, based on historic maps. The overlayered urban construction process, the geometric characteristics and subdivision patterns of grid blocks are clarified. Second, it reviews the urban planning system and arranges the urban planning principles related to block and street design in different periods, to clarify their influence on the geometric characteristics of blocks in each period. Third, the typological process and its multiple dynamics in diversification are clarified in time and space dimension. Finally, based on the mechanism of grid block pattern diversification in Beijing, it contributes to make Beijing's urban fabric more legible. Also, clarifying the inner gene which is persisted in the evolving prosses, is beneficial in future redevelopment from the view of preserving urban identity.

Chapter 5 targets at the imported pattern of ring-radial spaces and rotaries (RS&Rs) in cities with colonial background in China. Comparative analysis is carried out between Dalian (Chinese: 大连, Japanese:大連) and Changchun (Chinese: 长春, Japanese:長春), to clarify how the Baroque-style RS&Rs were localized into Chinese urban context, and how the similar geometric prototype, diversely developed in different cities and shaped these cities in different ways.

First, it investigates the initial background for the implementation of the RS&Rs, which reveals the first step for the foreign pattern inserted into local conditions, causing the first differentiation between Dalian and Changchun. Second, the connective relationship between the RS&R construction process and the urban development process is clarified from the viewpoint of both time and space. Third, it describes the RS&Rs in terms of spatial morphology and functions to clarify their current conditions, transformation process, and multiple dynamics. Based on the analysis above, the localization process of RS&Rs from a kind of exotic to a symbolic urban pattern is clarified. It may contribute to future renovations both morphologically and functionally as well.

Chapter 6, based on the clarification in each chapter, Chapter 6 proposes an effective approach in reading urban form transformation in Chinese cities. The "diversification of inherent urban pattern" and "localization" of imported urban pattern" are redefined. The mechanism of "diversification" and "localization" are built up and compared, as the distinctiveness, in the transformation process of urban morphology in major cities of China, in order to identify their potentials and limitation in future plan critically. Issues and possible strategies are proposed as a reference for the other cities with similar urban patterns and background. Its contributions to current urban planning system are proposed as well.

Chapter 7 comes to the conclusions of the research. Conclusions and proposals of the research, as well as the issues that require further discussion are clarified.

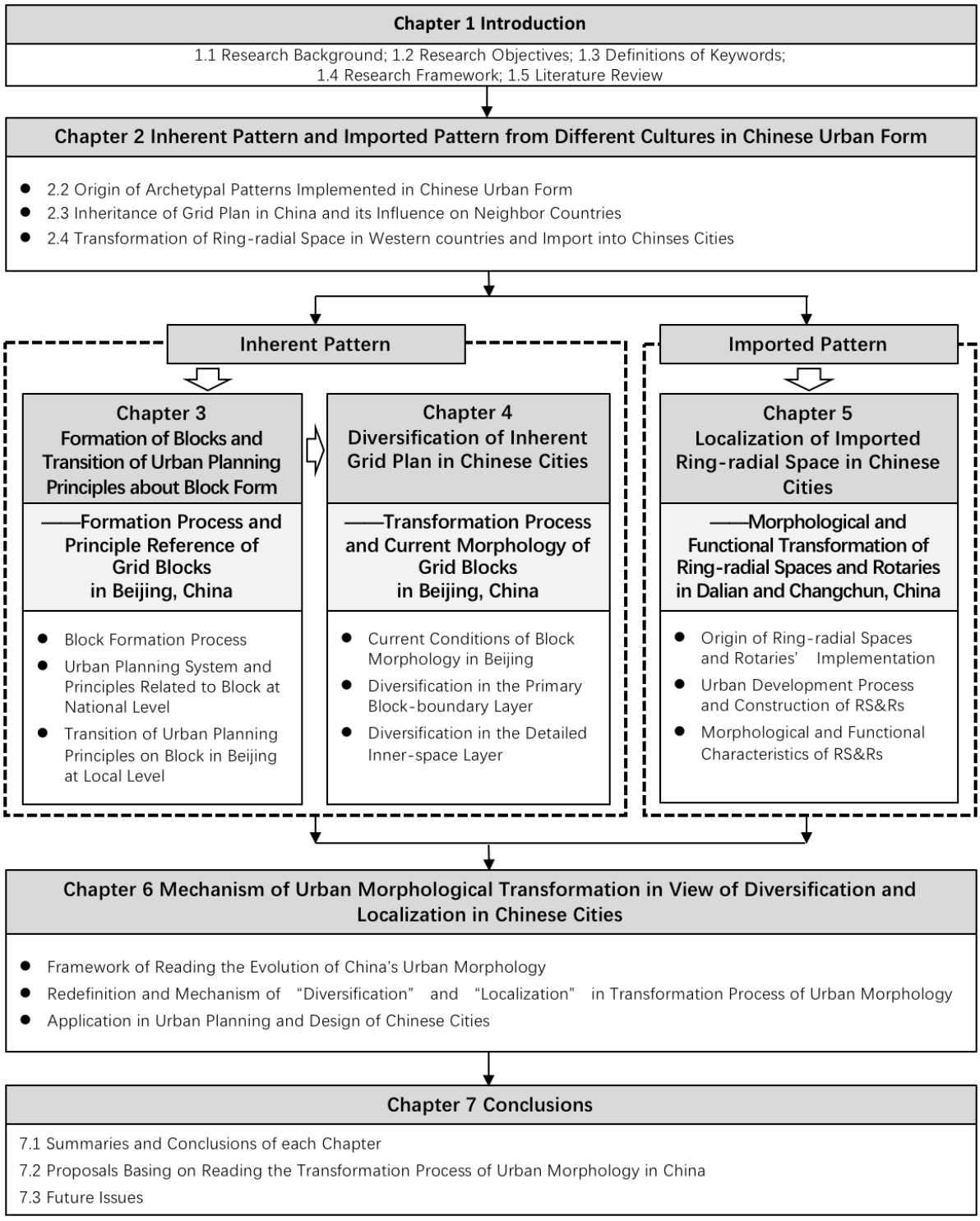

Fig.1-4 Research framework (By author)

1.5 Literature Review

1.5.1 Previous Research

Research on urban form started late in China, from about 1980s. The research on urban morphology, on the other hand, has started to attract the attention since the 1990s (Liang, J. et al., 2007). More scholars have realized the importance of urban morphology research to urban development. In a short time, around 2000, the experiences and methods of foreign scholars and other disciplines were introduced and referred in the research on Chinese urban form(Gu, K., 2001;Wang, H. et al., 2014), which broadens the research ideas and promotes the development of urban morphology.

The following literature review mainly focus on the ones concentrating the transformation of urban morphology in China, excluding the ones that are the static analysis on description the physical urban form of specific time, and do not involve any historical evolution, and the ones that only discuss about immaterial space, such as social, psychological, cultural, meaning, spiritual phenomena and patterns, etc., without analysis on physical form and elements.

(1) Transformation Process of Urban Morphology in Chinese Cities in City-scale

Urban researchers with a geographic background tend to interpret urban form from the perspective of internal/external structural patterns, discussing morphological issues from the view of distribution and connection of spatial elements, internal/external structure of physical space, formation mechanisms and evolutionary processes (Wang, H. et al., 2014).

Overview exploration of Chinese urban morphology

There are not so many researches giving the overall description of Chinese urban morphology, but they set up the foundation of further studies about Chinese urban form. Chinese urban construction in ancient time was first focused on (Dong, J.,1982; Ye, X., 1988). The book "The morphology of Chinese cities: structure, characteristics, and growth" started the study of domestic urban morphology about modern and contemporary Chinese cities (Wu J. 1990), followed by the book “Chinese cities: Their evolution and patterns” (Hu, J., 1995). "Urban Morphology", "Historical Features and Evolution of Urban Morphology", "Internal Structure", "External Form" are summarized based on the whole Chinese urban context.

Research on specific cities and specific issues

Most of the case studies focus on the spatial pattern of a particular city or issues, tracking its historical evolution, and conduct observation and analysis from a longitudinal perspective to explore the influencing factors and driving mechanisms of urban development.

The urban form is the accumulation of the development of material and spiritual civilization in different stages of the city, and it changes as the city continues to develop. Changes in urban morphology was explained by analysis of historical development processes in cities such as Suzhou city, Changshu city, and northeast district (Chen, Y.,

2006; Wang, J., 1994; Chen, L. et al., 2011). Urban formation and development were connected with other factors like geographical environment, culture, traffic etc., by reviewing the urban form related to particular elements, such as water system, religion (Fu, S., 2011; Zou, Z.& Yang, J., 2003; Xu. M., 2011; Xu, M.,2011; Zhang, Y. et al., 2016; Zhao J., 2008).

Moreover, existing studies have concentrated on the study of "dynamics of development" of urban form. Most of the research studies indicate that the "policy forces" represented mainly by state administrative power, the "economic forces" represented mainly by changes in economic, industrial and wealth, and the "social forces" represented by changes in individuals, customs and society" are the key driving force behind the evolution of morphology (Chen, Q., 2000; Chen, W., 2001; Wang, H. et al., 2014). "Geographic environment", "social culture", and "urban road and traffic system" are often the key elements in interpreting morphological evolution (Zheng, X, et al., 2002).

The study of urban form on city-scale started relatively early and the analysis of morphologically influential elements remains the key focus. However, they were conducted in a macroscope way which has little connections with the concrete daily urban space.

(2) Transformation Process of Urban Morphology in Chinese Cities in Block-scale

Among the research in block-scale, qualitative research was conducted earlier than the quantitative research. Some scholars focused on the development of commercial land form in the city center. Using the analysis method of economic geography, the location, development and evolution, constituent elements, and design principles of the business center area of a specific city are discussed (Wu, M., 1999; Han, J., 1998). Some focuses on the spatial design and planning of building groups, the urban texture and spatial patterns of buildings, so as to emphasize the guiding role of research results in planning and design, especially in the traditional residential area and historical district (Wu, L., 1999a; Wu, L., 1999b; Li, B. et al., 2000).

After 2000, the quantitative research attracted more attention, and the analysis on block-scale became more popular due to the introduction of methods of Urban Morphology. Many of them focus on the study of ancient cities and towns, such as the analysis on block sizes, modulus relationship between the overall city scale and the distance between roads, from Tang Chang'an to Beijing in Ming and Qing Dynasty (Fu, X., 2001; Sun, H. et al., 2003; Guan, J. et al., 2002; Tao, W. 2012; Funo, 2015). The fabric transformation of the old town in cities with long history, like Beijing, Nanjing etc., is also discussed (Liu, H., 2018; Han J., 1998; Li, B., 2017). Some paid attention to concession areas. The current urban form of Tianjin's former British, French, and Japanese concessions was analyzed (Wang, N., 2010; Song, J., 2010; Xu, M., 2010; Xue, S., 2013; Li, T., 2015; Deng, J.,2016). From the perspective of block size, it is proposed that the difference in block scale is more complicatedly affected by many factors than the country of the concession (Zheng, Y., 2014). Using the research method of urban

morphology, Liang systematically study the morphological evolution process, driving forces and laws of urban centers, and thus propose the principles of urban center morphological planning (Liang, J.et al., 2007). However, the previous study was mostly concentrating on specific areas, such as historical districts, concessions and urban centers. They revealed the mechanism in urban morphological transformation but mainly for the small limited range of area. The conclusions may not be able to suit other parts of the city.

(3) The time-space dimension in Urban Morphology

Existing research has focused on the analysis of the "development dynamics" and "evolutionary dynamics" of urban form for most (Wang, H. et al., 2014; Zheng, X, et al., 2002). The process of urban form transformation is concluded to be the evolution of the city's external form to adapt to functional requirements, and is the result of the struggle between the new form and the old form (Wu, J., 1990). From the perspective of this historical materialism, the change of urban form is seen as a passive process of urban space replacement caused by economic-social material foundations, and environmental conflicts, making it seem to be an inevitable, reasonable and legitimate way to break down the old and establish the new. Therefore, this morphological evolutionary perspective has, to a certain extent, contributed to the loss of history and confusion in the development of domestic cities. Historical forms that could have been preserved and respected are abandoned (Wang, H. et al., 2014). Based on the above-mentioned status quo and problems, it is necessary to seek a more sustainable perspective from the existing theoretical knowledge to revise the dynamic process of urban form transformation. Urban form is the crystallization of space in time, and the discussion on the transformation and development of urban form needs ultimately fall into the two dimensions of "time-space".

From the aforementioned views, in spite that there have been a few measures proposed for understanding urban form in Chinese cities, there is no well-developed or generally accepted methods for urban morphology analysis in China, considering time-space dimension. The introduction of Typology theory (Shen, K., 1988), Morphology theory (Gu, K., 2001) from the Europe received increasing attention in China over the last few years, along with the active participation of scholars in the cross-cultural methodology to be implemented in China.

In the spatial dimension, although there were a few papers considering typology in the urban context (Kang, H., 2003; Zhang, L., 1997), the majority of papers showed limited comprehension of typology, which was only at the building stage (Wang, L. et al.,2001; Zhang, J., 2003). Studies at that time ignored the transformation process of types or typological processes (Chen, F. et al., 2013). Later, comprehensive studies like Conzenian methodology on urban morphology was introduced (Gu, K., 2001; Whitehand, J. et al., 2006) and applied in analyzing some parts of Beijing, Guangzhou, Pingyao, Hankou, Suzhou and other cities in China, and applied the theoretical methods to the planning and design practice of Chinese cities and towns in relation to urban conservation (Whitehand, J. et al., 2007; Whitehand, J. et al., 2011; Zhang, D., 2011; Chen, F., 2012; Yao, S. et al., 2013). Time dimension began to be more considered. By exploring the typological process of Chinese houses (Chen, F., 2008b,

Gu, K. et al. 2008), the traditional boundary between typology and morphology were crossed. Further, a Typomorphological approach was established by decomposing Chinese cities into seven elements (general plan, silhouettes, street networks, urban blocks /plots, public spaces, public buildings and houses) and investigated how they were influenced by typological processes, aiming to preserve the cultural identity of Chinese cities (Chen, F. et al., 2013).

However, the studies considering dimensions of "time-space" are more likely to analyzing all cities in China equally, by abstracting the concrete urban form in each epoch and arranging their sequences, in order to find suitable patterns guiding future design from the view of preserve the cultural identity of Chinese cities. They were arranging the transforming process in a “linear way”, ignoring how the various concrete forms were originally created from the cultural archetypal pattern, which played important roles in reading a city.

1.5.2 The Perspectives of the Research

Referring to western methods for understanding urban morphology and its transformation mechanism, cities are decomposed into distinguishable but related elements at different scale levels, and the relationship between the different elements has been investigated in order to read the city comprehensively. Although, in this way, the complicated urban issues were simplified to a certain degree, it is still hard to grasp a clear view of a single urban element, especially the ones in the block-street scale, which act as a media in connecting macro and micro scope.

In addition, the previous studies about urban morphology in Chinese cities in the so-called “block-scale” were mainly referring to the analysis limited in small areas within the scale of numbers of blocks. “Block”, in other words, the structural element, is not always considered as a media in the analyzing process. As a result, this research is going to take the street and block pattern as an urban structural element and also a “reading clue”, trying to propose a simplified but efficient way of reading urban morphological transformation.

Moreover, compared with the analysis on abstracting the messy and constantly changing urban form into concise and abstract typologies, the process of how the diverse patterns were generated from the original archetype were investigated in limitation. The transformation of urban form is not a linear process that connecting different typologies of each epoch sequentially. On the contrary, there is a “thickness” in time dimension. Hence, the research tries to clarify how the urban form was becoming complicated accompanying urban development. In other word, the process of how similar original archetypal pattern transformed diversely in both time and spatial dimension is investigated.

Finally, because of the complexity of Chinese urban form resulted from internal forces and external influence, the cultural origins require to be considered from the initial phase of reading the transformation process. Therefore, the research regards the cultural origin as the prerequisites for the reading process, so as to provide a clearer causation logic in understanding the transformation.

1.5.3 The Position of the Research

Based on the focusing points, the previous research on urban morphology could be mainly divided into two parts: 1) Research on urban form history: it focuses on the emergence of new urban pattern caused by big event in history; 2) Research on urban planning theory: it focuses on how the intended planned pattern responses to city's necessity and requirement, functionally, as a rational approach.

This research tries to provide an in-between approach between 1) and 2). It is the secondary process of urban form history research. That is, after the new pattern was introduced in the history, how it naturally adapts to the new urban requirements and problems. This process is qualified positively in the process of enriching urban morphology in this research. The purified form is more discussed functionally and rationally in urban planning research, and its configuration is highlighted in urban form history research. This research helps us to identify that although a city can be planned intentionally with the pure forms, it will naturally emerge into diverse human settlements.

The position of this research can also be understood from the view of Modernism and Post-modernism theories about urban planning and urban design. On one hand, Modernism with theory like Radiant City and Garden City related to Functionalism, Mechanical Determinism and Simplicity. The simplified top-down geometric pattern was more emphasized, instead of city's self-organization. On the other hand, theories such as "Urban Diversity" by J. Jacobs, "Complexity and Contradiction" by R. Venturi, "A city is not a tree" by C. Alexander, "Collage City" by C. Rowe were proposed as Post-modernism, criticizing the functionalist thinking and Utopian planning in Post-modernism (Laurence, P., 2006). R. Venturi mocked the banal simplicity of post-war modernist architecture and urban development projects with the unforgettable adage "less is a bore," (Venturi, R., 1966) while, Jacobs also derided the "great blight of dullness" in architectural and urban design as a result of the "Radiant Garden City Planning" theory (Jacobs, J., 1961; Laurence, P., 2006). Instead, they analyzed the city from the view of System Approach, underlining its organism and complexity.

However, the two approach co-exist and cooperate in shaping the current city form. The purified pattern as the approach of artificial planning shapes a city initially, but it is also the start of the following self-organizing evolution, accompanying the "'diverse' and 'intricate' influences of context, experience, and the elements of daily life" (Laurence, P., 2006). The complex evolution will be easier to be understood by decomposing and simplifying into elements and models. Hence, this research hopes to clarify the complicated urban form transformation process with spontaneity by tracing back its connection with the original pure pattern. It focused more on the morphological perspective, which is the foundation for further analysis about its relationship with more social factors.

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Chapter 2 Inherent Pattern and Imported Pattern from Different Cultures in Chinese Urban Form

2.1 Introduction

2.1.1 Research Background and Research Objectives

China has a continuous history of thousands of years accompanying wide spread of Chinese culture to nearby countries, as well as the absorption of foreign countries either actively or passively. As the physical expression of socio-cultural environment, urban form can be considered as a concrete clue in understanding not only the inheritance of Chinese culture, but also their connection with other countries in the world. Hence, tracing back to the origin of urban forms in Chinese cities, contributes to build up the foundation of understanding their transformation process.

The objective of this chapter is to sort out the multiple sources of urban forms in major Chinese cities, and clarify their inheriting relationship, time sequence, and current issues, from the view of culture inheritance and importation. The investigation is not limited in Chinese urban context, but also in the range of the world, so as to give a whole view of the position of specific patterns, before further clarifying the "diversification" and "localization" process in urban morphological transformation.

2.1.2 Research Methodology and Framework

(1) Research framework

This chapter gives an overall review of the original patterns that were implemented in urban form in major cities in China, as well as their roles worldwide, aiming to clarify the factors resulting to the original patterns, their influential relationship with cities in other countries, as well as their current significance after a gradual transformation process, both morphologically and functionally.

First, it reviews the typical patterns in Chinese urban form, as products of social, cultural and political conditions that have shaped the evolution of Chinese cities, either logically or abruptly. Categories are classified based on the abstract geometric archetypes and the multiple factors hidden behind, from the view of traditional culture inheritance and foreign culture import. (Chapter 2.2)

Second, grid plan, especially the grid block, is focused on as the representative inherent pattern, which is resulted from the imperial urban form in ancient China. Its geometric features' evolution, together with its roles in routine daily living, management and governance is investigated through literature review and historical maps. In addition, its influence and differentiation in neighbor countries are also investigated, so as to clarify the potential of grid blocks in adapting to different cultures and updating requirements. (Chapter 2.3)

Third, ring-radial space, particularly the ring-radial spaces and rotaries (RS&Rs) is focused on as the representative imported pattern, which is traced back to classical Baroque Style. Its concrete physical pattern is further categorized worldwide. By arranging their original implementation background and timelines of

construction, the influential flow of RS&Rs in different areas is clarified. So is its import into Chinese colonial cities. Moreover, compared with the grid plan which is still commonly implemented, the current significance of the classical ring-radial space is examined world-widely, as a reference for the case redevelopment in Chinese cities. (Chapter 2.4)

(2) Definitions

"Culture" in this research was tended to be referred as the origin of urban planning and urban pattern. It represents the background or tradition with some circumstances. In ancient urban planning, culture refers to the cosmology applied in Chinese and foreign city plans. After modern urbanization, culture may also refer to new urban planning theories, and new aesthetic or technical tendency emerging in different civilizations.

Grid Plan: The grid plan, or gridiron plan is a type of city plan in which streets run at right angles to each other, forming a grid. The grid plan in this research refers to the pattern that the main framework is in grid network but do not need to form right angles everywhere.

Ring-radial Space: The ring-radial space in this research refer to the type of city plan that adopt focal spaces with roads radiating from the center, especially in district scale. It is also called ring-radial space and rotary in the following analysis.

Homogeneity in grid plan (Homogeneous grid plan): It refers to the grid plan where there are not so many differences in the classification of urban roads functionally or morphologically.

Hierarchy in grid plan (Hierarchical grid plan): It refers to the grid plan where there is relatively obvious classification of urban roads functionally or morphologically, which may lead to spatial contrast in and out of the blocks shaped by urban road network.

2.1.3 Previous Research

Previous research on Grid Plan, especially in Chinese cities, are mainly focusing on static conditions of specific periods, especially the exploration of the layout of ancient capital cities (Funo, S., 2003; Dong, J., 2004; Zhu, J. et al., 2013). When considering the block scale, historical analysis or comparative study of historic periods takes up the most part (Wang, H. et al., 2007; Sun, H. et al., 2003). But only a few paid attentions to the dynamic process of its transformation from previous to current (Sun, H. & Liang, J.,2003). Moreover, some research focuses on the comparison between Chinese grid pattern and western grid pattern, conducting objective description (Kostof, S., 1991) or aiming to improve the current form implemented in China (Zhao, G., 2008). But in spite of the changes in transformation, the inner tendency and the inheritance also require clarification. Hence this chapter identifies

not only the changing tendency but also the characteristics in inheriting the traditional Chinese grid plan, in order to establish a background for clarifying its diversification.

Previous research on RS&Rs usually focuses on history, like their roles in Baroque city planning (Horst, D., 1960; Sun, H., et al., 2003; Li, Y., 2007; Jiany, Y., 2013). Some take them as one type of city square, analyzing their functions and renovation for specific cities (Zhou, Y., 2009; Hou, C.,2013). More analyze simply from a traffic perspective, classify their types from traffic functions (Tollazzi, T., 2015), taking traffic capability and safety as priority, paying little attention to other functions like landscape (Pratelli, A. et al., 2018; Gates, T.J. et al., 2000; Brilon, W., 2011). Except for the cases implemented in Baroque planning, limited research out of traffic field focused on the trend that this kind of spaces continued appearing in modern urban planning, even until now, as a type of essential urban structure. It implies that the "old fashioned" form has been found more potential and has been endowed with new functions to meet the updating needs in urban space. But their transition tendency has not been clearly extracted. As a result, the potential and newly given functions of RS&R, from the view of urban structure, need to be clarified.

2.2 Origin of Archetypal Patterns Implemented in Chinese Urban Form

2.2.1 Patterns of Three "Normative Models" of Urban Form by Kevin Lynch

Kevin Lynch set up an organizing scheme that examine the urban form with three categories called three "Normative Models", which includes "cosmic model", "practical model", and "organic model". They have less to do with political or economic order than the prime motivation of the city or its self-perception (Kostof, S., 1991; Lynch, K., 1981). Typical patterns are selected based on their geometric features to become the physical expression of the symbolic meaning. (Fig. 2-1)

The cosmic model, or holy city, is a spatial diagram of social hierarchy. It takes the plan to be an interpretation of the universe and of the gods (Kostof, S., 1991; Lynch, K., 1981). Patterns such as monumental axis, encircling enclosure, the regular grid for establishing pervasive order, symmetry, and landmark at strategic points, are considered as common form concepts of cosmic city.

The practical model, or the city as machine, is a functional construct of interrelated parts. It is made up of "small, autonomous, undifferentiated parts, linked up into a great machine which in contrast has clearly differentiated functions and motions" (Lynch, K., 1981). It motivated many of the colonial cities and company towns, and patterns such as the speculative towns in the United States, Le Corbusier's Radiant City.

The organic model, or the biological city, is an indivisible, living creature rather than a machine. It has a definite boundary and an optimum size. It is self-regulating and self-organizing that it adopts indivisible structure and dynamic behavior to maintain the balanced state, when facing inevitable changes. It is the only model with non-geometric urban pattern (Kostof, S., 1991).

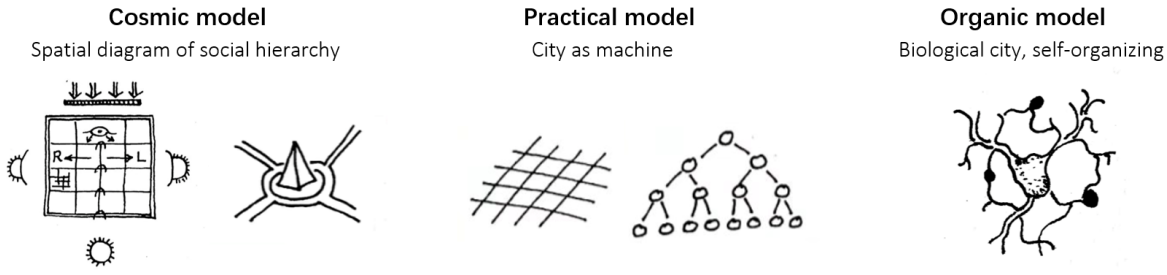


Fig. 2-1 Three "Normative Models" and representative diagrams by Kevin Lynch
(By author, based on figures from Lynch, K., 1981)

2.2.2 Four Chronological Morphological Models in City Centers in China

According to the construction sequence in time and spatial characters, urban form in city centers in China were classified into four morphological categories, at the scale of street and block: "Feudal traditional model", "Modern colonial model", "Planned economy model", and "Modern new district model" (Liang, J. et al.,2007).

Ancient feudal model is derived from Lifang System, composed of rough super-block network and spontaneous small lanes (Sun, H. et al.,2003). The road network is divided into two hierarchies: arterial road system (including trunk roads and secondary trunk roads) of 15 meters' wide at the maximum, and small lanes for daily service of 2 meters' wide. With the modern vehicle traffic got on the stage, functions along arterial roads were strengthened for their higher accessibility, which highlighted the difference in economic benefits between arterial road space and inner lane space. Hence, the tree-shape pattern has been continually strengthened.

Modern colonial model includes two types, the Colonial Cities with large-scale construction from small habitats, and the Concessions which were gradually expanded co-existing with the former urban fabric. Both types adopted exotic urban pattern, such as the homogenous chessboard-like network which is totally different from the Ancient feudal model in China. However, urban plans in Colonial Cities own higher subjective initiative with long-term scope, so that geometric patterns with symbolic meaning were also implemented, while Concessions pursued higher speed and quicker payback preferring the dense grid network.

Planned economy model was generated within a relative short time between 1950 to 1980, usually outside the old town. Similar with Ancient feudal model, public functions like administration and business were concentrated along arterial roads, leaving the back-land as large-scale of residential, factory or office area. However, as they were more likely to be constructed based on different Work-unit, though they used regular rectangular boundaries, it is rather unordered and enclosed inside.

Modern new district model refers to either the newly-built districts or development zones, or the redeveloped zones with original fabric totally changed. In seek of quick construction and convenient management, grid network was preferred. But unlike the strict and homogenous gridiron of Modern colonial model, irregular geometry and hierarchical traffic are still left over. It can be regarded as a transferring state from Planned economy model to pursue social market economy. (Liang, J. et al.,2007)

2.2.3 Comprehensive Process for Understanding the Urban Patterns and Their Symbolic Meanings in Chinese Urbanization

By combining the three "Normative Models" of Urban Form by Kevin Lynch and the four Morphological Models based on the construction sequence in time and spatial characters, a comprehensive understanding of urban patterns in Chinese urbanization process is set up. (Fig. 2-2)

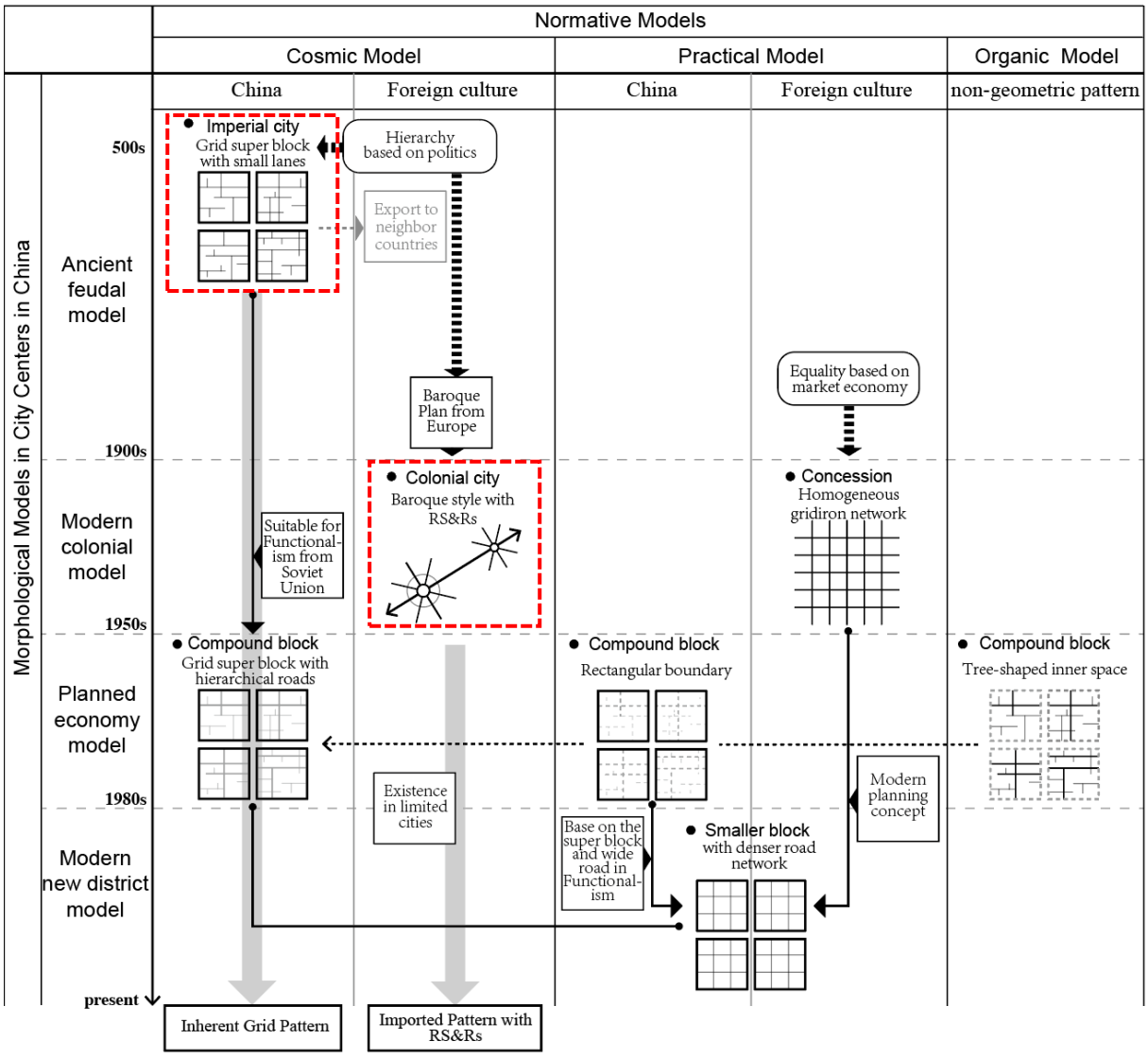


Fig. 2-2 Typical urban patterns in Chinese urbanization process (By author)

The urban pattern with the longest history in China (for cities after urban planning), is the grid network, which was implemented as an expression of Centralism. However, convinced by experience that the same urban form does not inevitably express the same or even equivalent human content and, conversely, a similar social, political and economic context may not result in an invariable design matrix (Kostof, S., 1991), the grid network represents distinctive urban context different from that in western countries, although they can be considered as two variants of rectangular archetype.

Western countries prefer homogeneous gridiron network. On one hand, it was used to celebrate the centralized political structure, for example in Greek colonies. “It was far from being a democratic device, but was the approach of perpetuating the privileges of property-possessing class descent from the original settlers” (Kostof, S., 1991). On the other hand, it is conveying an opposite idea and objective in current implementation, as a means of equality,

pursuing efficient land allocation or land speculation, and it corresponds well to the hypergrowth of vehicle traffic. Hence, the basic pattern persists, but with symbolism transformed.

On the contrary, the grid plan in ancient China represented Centralism by the dominance of up versus down, and of big versus small. The super grid block with small spontaneous lanes reflects the dualism in the traditional pattern. However, disadvantages of the traditional pattern appeared when the market economy requires higher equality in land use and the exploded traffic advocates higher accessibility for the inner space. As a result, transformation and integration with patterns from foreign culture appeared, leading to a process of diversification. The transformation process will be investigated based on regional differences and time differences in Chapter 2.3, including the geometric characters and the dynamics.

Another pattern was also implemented in China, expressing political symbolism. It is the ring-radial space, which was commonly used in the European Baroque city plan of 16th century. It is said to be a phenomenon of capital cities and serves the representational needs of absolutism (Kostof, S., 1991). But in China, it is implemented in colonial cities, replacing the homogeneous gridiron network in concessions. It reveals that colonial government invested largely in urban planning with relative long-term scope, instead of pursuing short-view resources.

As a complete exotic, it appeared in China abruptly and shows no continuity when focusing on the whole Chinese urbanization process. It is similar in the world that after modern urban planning advocating the gridiron network, the ring-radial space seems to be a record of specific period, that is “out-of-date” to some degree. Moreover, the complex colonial background in China makes it difficult to clearly conclude the inheriting relationship with European Baroque. As a result, in order to clarify how the imported pattern was localized into Chinese urban context, it is necessary to put it in a global context, to clarify its connection with cases in foreign culture and its potential in meeting the current urban requirements. (Chapter 2.4)

2.3 Inheritance of Grid Plan in China and its Influence on Neighbor Countries

2.3.1 Chronological Transformation of Grid Plan in Ancient Chinese Cities

According to the Cosmology ideal in the capital city theory of Shuji Funo (Funo, S., 2015), the urban form of major cities in South Asia, Southeast Asia and East Asia, is a miniature cosmos, imitating the structure of the universe in their culture. Among these cities, the ancient capital cities in China were believed as the origin of this urban planning concept, and they greatly influenced the nearby countries in history. Hence, the ancient cities in China adopted similar urban forms: rectangular and regular shapes, with symmetrical central axis, central palace, temple in left and altar in right, administration in front and market in back, three gates along each city wall and the road system is a regular grid network, forming a set of strict planning system. Most of them can be regarded as variants of Chinese Grid Plan, reflecting the patriarchal system of supremacy of imperial power and strict hierarchy.

This section focuses on the major ancient cities in China with the typical Grid Plan, to clarify how and why the grid plan were transformed chronologically in the similar Chinese social context. Representative cities in different historical dynasties and different city levels were selected and compared at the block scale, namely: 1) Chang'an City(長安), the capital city of Sui and Tang Dynasty; 2)Kaifeng City(開封), of North Song Dynasty; 3) Pingjiang City(平江, current Suzhou, 蘇州) of South Song Dynasty ;4) Yuan Dadu City(元大都) of Yuan Dynasty and Beijing City of Ming and Qing Dynasty. The comparison was conducted from three views: street hierarchy, block size, and block pattern.

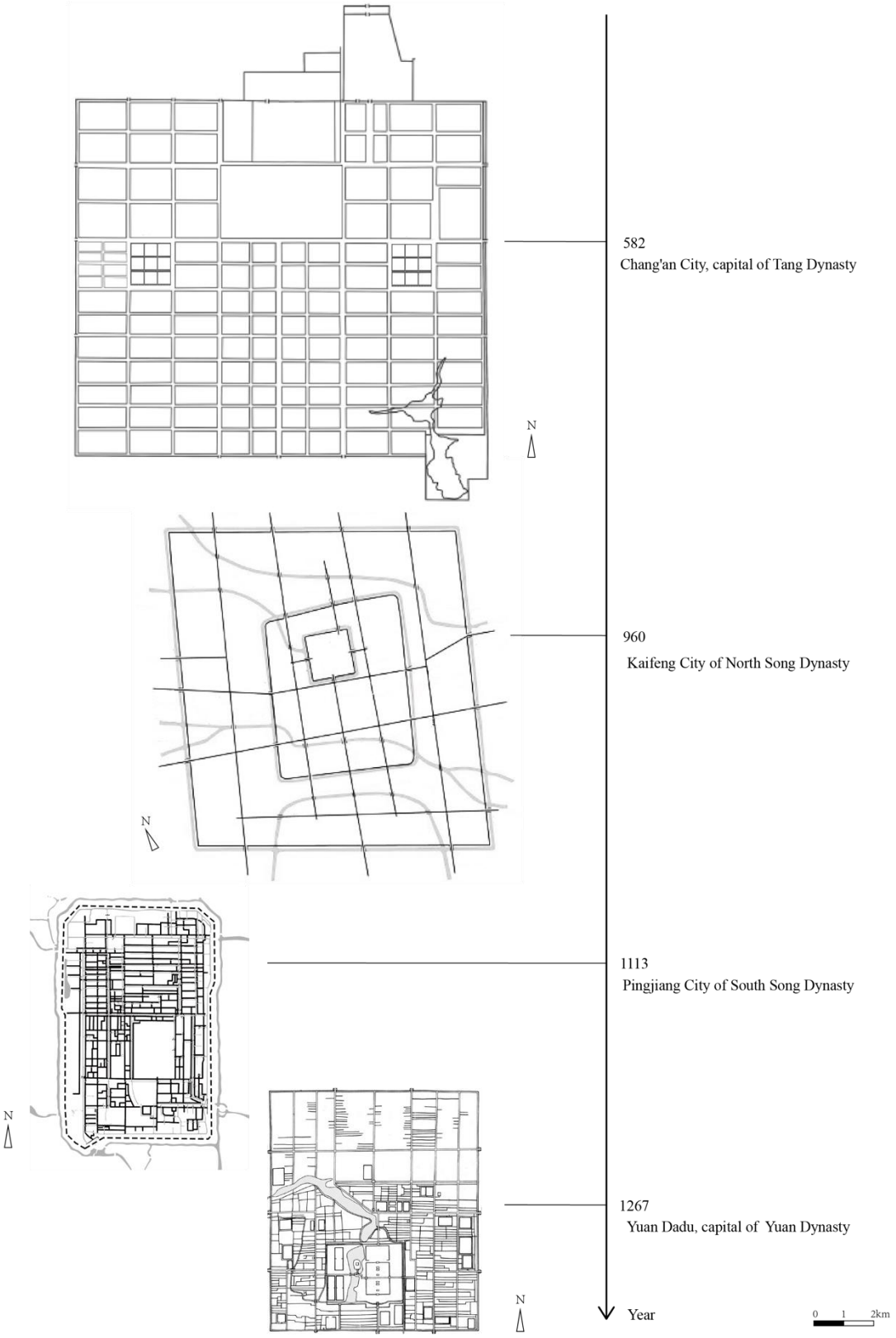


Fig. 2-3 Four representative cities in ancient China

(By author, based on Wang, H. et al., 2007; Li, R., 2005; Dong, J. 2004)

(1) Road hierarchy

Hierarchical road system is the fundamental structure of urban form and the framework for dividing blocks.

A. Chang'an City, the capital city of Sui and Tang Dynasty

Road network in Chang'an followed a strict hierarchy with specific geometric pattern in each level.

First grade: Zhuque street as the north-south symmetrical central axis, which is 150m wide.

Second grade: the general main road of the city. Three N-S roads and three E-W roads connecting the three city gates in each edge of the city walls. They were between 130m-40m, mainly in 130m, 120m, 110m, 70m, 60m, 50m, 40m.

Third grade: the main road inside Lifang with "1" shape or "+" shape, and can be considered as local-scale roads, mainly for pedestrians. They are far narrower than the city-scale roads, and are about 15m wide.

Fourth grade: the Fangqu road inside Lifang in irregular shape. They are the lowest-level roads, only in 2m's wide. They connect every building inside the Lifang.

B. Kaifeng City, of North Song Dynasty

Although road network in Kaifeng persisted clear hierarchy, but they were no longer in the strict orthogonal gridiron. Distinctive oblique streets were constructed as an active element. The spatial sequence was more variable.

First grade: There is one central street, located on the central axis, in 40 meters' wide. From Nanxun gate in the south to Xuande gate in the north, it passes through Nanxun menli street and Yujie street, crosses Longjin bridge, and enters ZhuQueMen gate. After that, it is called Tianjie, and then goes north to cross the State Bridge to Xuande gate.

Second grade: There are four secondary trunk roads in 25 meters' wide. There are two streets in the north-south direction. One is from Xuanhua gate to Chenqiao gate in the east city, and the other is from Dailou gate to Anshu gate in the west city. The other two streets are in the east-west direction, which are Xinzheng gate in the South City leading to Xinsong gate and Wansheng gate in Beicheng city to Xincao gate.

Third grade: the other general street of different width, but they cannot run through the whole city.

Fourth grade: the small lanes that cannot be clearly marked on the map.

C. Pingjiang City of South Song Dynasty

Pingjiang is the representative of the general region-level "Fu" City in Song Dynasty. It adopted a parallel double checkerboard pattern, combining both road network and waterway network. The road system consisted three grades. The first grade is the several roads facing the city gate are the main roads of the city, intersecting in the "+" shape or "T" shape, in about 40-50 meters' wide; the second grade of urban roads are other roads go throughout the city, which divide the blocks, in about 20-30 meters' wide. Between the streets, there are the third grade of small lanes, mostly in the east-west direction.

D. Yuan Dadu City of Yuan Dynasty

The road network in Yuan Dadu can be seen as a return to the strict gridiron network, and it followed the idea of "Kao Gong Ji" even more strictly (Ancient Chinese Encyclopedia of Technology: Translation and Annotation of the 'Kaogong Ji' (The Artificers Record). The urban road system is divided into three grades. The central axis roads leading to the imperial city is the first grade, the other trunk roads are the second grade, and the hutong is the third grade. There are 11 gates in the whole city, and a straight trunk road is built between each gate. Except for a few exceptions, there is also an additional trunk road between the two gates. In this way, there are nine north-south trunk roads and nine east-west trunk roads in the whole city, with the north-south trunk road dominating. Within the area divided by these trunk roads, there are small lanes arranged horizontally, mainly in the east-west direction, known as Hutong, which is the third grade of urban roads. They were mostly constructed to prevent the spread of fire originally, and is end-grade framework in arranging the buildings.

First grade: "Big Streets" in the width of about 36.96m.

Second grade: "Small Streets" in the width of about 18.84m.

Third grade: "Hutong" in the width of about 9.24m.

Summary

The urban roads in ancient Chinese cities were arranged hierarchically, usually taking the roads connecting with city gates as the main roads. The width of urban roads in ancient China corresponds to the road's grade. The higher the road's grade is, the wider it is. Moreover, there were huge differences between road widths of different grades, which strengthen the hierarchy of urban road system. Compared with western cities, the road width in ancient Chinese grid model is surprisingly wide and the hierarchical pattern is rather obvious.

However, when considering the chronological transformation within China, there were a decreasing tendency, especially the big gap between Tang Dynasty and Song Dynasty. It is also a reflection of the change of social system: from the closed Lifang System to the open Shijie System(market-street). Main roads in Tang Dynasty also acted as isolation zones between the closed blocks("Fang") with block walls and block gates managing the citizens in the "Fang" block (Sun, H. et al., 2003). Activities were strictly limited outside of the blocks. Hence, the wide streets were more a symbolic elements and political requirements, than functional space. On the contrary, during 1010-1063 in Song Dynasty, the population density of Kaifeng City was more than three times that of Chang'an city of Tang Dynasty in Kaiyuan Tianbao period (Zhu, J., et al., 2013) (Table 2-1). Under such a high-density circumstance, the land use of Kaifeng City became more tense. The large population and compact urban space not only promote the communication between people, but also promote the emergence of street markets and the rise of various commercial facilities. With the rapid development of urban economy, the demand for commercial space expansion is increasingly urgent, so the old system is abolished. Block walls were no longer implemented and the commercial space gradually penetrates into the streets and alleys and spreads all over the city. Furthermore, a phenomenon called "street invasion" also appeared. It refers to the construction of illegal structures along the street.

Commercial facilities were setting entrances along the streets (Wang. J., 2006), endowing the buildings with strong extroversion. A variety of awnings were built along the street, and tables and chairs were placed on the street. It extended the commercial space into the street space. Although it reduced the width of the roads, but it created a vitalized streetscape.

Table 2-1 Comparison of population density between Kaifeng in North Song Dynasty and Chang'an in Tang Dynasty (By author, data from Seo, T. et al., 1994)

City	Time	Population	Area	Population density
Tang Chang'an	First half of 8th century	700000	84.1	8200
Song Kaifeng	Year 1102-1106	1500000	57.58	26000

(2) Block size

Blocks in ancient Chinese cities were defined by the main roads in the city, excluding the lower grade streets and small lanes. Hence, large distance between main roads creates large-scale blocks.

A. Chang'an City, the capital city of Sui and Tang Dynasty

The road network density of Chang'an is about 4.4km/km^2 (Zhao, G., 2008). The sparse and strict urban road network system resulted in five categories of block model("Fang") as follows.

Block A: 515m×515m (350 steps× 350 steps), 26.7 ha;

Block B: 515m×662m (350 steps× 450 steps), 34 ha;

Block C: 515m×955m (350 steps× 630 steps), 49.2 ha;

Block D: 588m×955m (350 steps× 350 steps), 52.2 ha;

Block E: 797m×955m (550 steps× 650 steps), 76.1ha.

In addition, the blocks in Chang'an are not only a physical form of urban pattern, but is also the administration unit. Citizens were limited inside the blocks, so it is more convenient for the governor to manage smaller numbers of blocks with large-scale.

B. Kaifeng City, of North Song Dynasty

Urban form of Kaifeng was not in a regular grid pattern. And because of the change from closed Lifang System to the open Shijie System, the physical boundary of block was not strengthened as before. Moreover, new administration system was proposed in North Song Dynasty, taking "Xiang" as the basic unit for maintaining safety and preventing fires. The sizes of "Xiang" differed largely, as a single of them may consisted several to more than twenty "Fangs".

C. Pingjiang City of South Song Dynasty

Blocks in Pingjiang City also adopted the Shijie System, taking “Fang” as simply an administration unit. Their size ranged from about 10ha to 30ha (Zhao, G., 2008).

D. Yuan Dadu City of Yuan Dynasty

The distance between “Big Street” and “Small Street” in Yuan Dadu is about 672m (440 steps) and the distance between Hutong is about 67.2m(44steps). As a result, block size of Yuan Dadu can be taken as 672m×672m, 45.16ha. It needs to be emphasized that, inside the blocks of Yuan Dadu, the areas defined by Hutong can also be considered as sub-blocks to some degree. Because, different form the small lanes in the previous dynasties that were almost generated spontaneously without any top-down planning, Hutong was planned as a part of urban road system, but only focusing on daily life functions instead of traffic function.

Summary

The word “block” did not actually exist in ancient China, but it has some similar meanings with the Chinese word “Fang”. However, the Chinese word “Fang” consists of more comprehensive meaning, that it may not only refer to the physical form of urban space, but also may refer to an administration unit. When focusing on the block size, no exact tendency can be safely drawn in the cases cities, but it can be clarified that the analysis of block form in China requires considering the administration system simultaneously. Though the administration system may not have direct impact on the block pattern, it may affect their transforming in an internal way.

(3) Block pattern

The accuracy and depth of urban planning in ancient China was relatively shallow, which only touched upon urban roads that serve the whole city. The lower-grade streets and small lanes which were most frequently used by urban residents were not involved, at least not involved in the initial planning. In other words, the planning roads of ancient Chinese cities generally do not include lower-grade streets and small lanes (Zhao, G., 2008). So, they were mostly formed spontaneously based on the daily life of residents. On the one hand, these streets and lanes show the sense of irregular, uneven and strong randomness in morphology and texture; on the other hand, they take the pedestrian traffic as the precondition. Therefore, their scale is pleasant, and they are in harmony with people's perception and activities, providing the best living space for people's common communication and daily life, which almost has nothing to do with the feudal imperial thought.

For example, in the initial phase of city construction of Chang'an City, only the Lifang block with few “+” shape or “1” shape small streets were divided, and the land inside was allocated to each family for their own construction (Dong, J., 2004). The winding lanes connecting houses were formed spontaneously, and the layout inside the Lifang block was quite disordered. In other words, the government organized human and financial resources to focus on the planning and construction of block walls, block gates and rammed earth cross streets, while the parts

limited by the cross streets were left to the residents themselves. As a result, the urban form of Chang'an shows a great sense of contradictory with the large-scale strait grid plan and the small-scale disordered life space. The block pattern therefore is more introvert.

For the blocks in Kaifeng of North Song Dynasty, though there were not proper blocks resembling Lifang block in Chang'an, the significant change was the relationship between backland inside blocks and the street space. Without the limitation of block walls and block gates, the blocks developed the extroverted tendency. Daily life became to be concentrated on the main urban streets instead of the inner small lanes. The top-down planned urban road system was added with spontaneity through independent construction of illegal structures.

The rough urban planning system is progressed a little in Yuan Dadu, as explained in 2.3.1(2). The Hutong system is included in the top-down plan, together with the main urban system. It reflects that the urban planning began to consider the daily life of citizens, rather than only focused on the formatted urban framework. Therefore, the block pattern of Yuan Dadu is supposed to be more regular. Nevertheless, from the maps of Beijing in Ming and Qing Dynasty, which is mainly constructed based on Yuan Dadu, the Hutong pattern inside blocks are still unordered, even though the traditional building "Siheyuan" (courtyard house) had their own modular system. It can be related to another kind of "street invasion", motivated by the feudal bureaucracy. Bureaucrats and nobility took advantage of their power and social relations, neglecting the law in varying degrees. In the process of expansion of bureaucrat's residence and large-scale temples, merging the surrounding land, occupying and closing the surrounding roads were very common (Liang, J. et al.,2007).

(4) Characteristics of chronological transformation of grid plan in ancient China

Chronological transformation of grid plan in ancient China, shows continuity with partial changes.

First, the grid plan in China shows a big contrary of 1) the city-scale regularity, and 2) the human-scale spontaneity. Only structural framework of a city followed the rough top-down planning, leaving the microscale spaces constructed randomly. It is because that in the feudal society, the traditional urban planning system was served for the imperial power, so it was out of touch with the individuals and daily life.

Second, neighborhood space was distinctive and maintained continuously. The contrary above makes the grid plan in China identical from western countries, not only in the morphological view, but also in a socio-cultural view. Public facilities and residential spaces were separately established within urban blocks rooted in standardized gridiron-type road networks. As the microscale spaces were constructed by residents, it resembles the process of community development with residents' participation. A semi-private space was created and improved according to the locals. On the one hand, it is potential to achieve place-making with local identities. On the other hand, it led to a close relationship among neighborhood.

Third, both the road network and blocks have transformed into the patterns considering more about details and citizens' need. For the road network, there was a decreasing tendency. It reveals that the function of road network

changed from simply symbolizing ceremony ideology (such as in Chang'an), to considering more about actual traffic requirements and commercial requirements. For the block pattern, block size decreased when marketing and commerce were encouraged, and even spontaneous reconstruction was added to the strictly planned road network, improving the spatial perception from human's view. Similarly, detailed plans on Hutong aimed to provide better service for individuals, but unfortunately, the space was still under a big influence of the feudal bureaucracy.

Last, the transformation of grid plan in China cannot be totally separated from social system, such as administration. Urban form is sometimes a concrete expression of social systems. Urban form can be strengthened when it has accordance with administration system and can also be weakened when the administration system is re-arranged.

2.3.2 Export of Traditional Grid Plan of China and Its Transformation in Local Context

In the late fifth century and early sixth century, regimes in ancient China were unified for the second time in Sui and Tang Dynasty, after the first unification in Qin Dynasty (221-206/207 B.C.). Daxing City(大興城, year 583AD, the origin of Chang'an City in Tang Dynasty), Luoyang City(洛陽, year 605AD) were constructed as the capital cities sequentially. It led a period of capital construction in the East Asian countries. It is because that the sprawl of Tang Dynasty gave heavy pressure to the nearby countries, so in order to resist the Tang Dynasty and also keep balance with other countries, series of capital cities were built up (TAMAI Tetsuo, 2013). For example, Fujiwarakyo (藤原京, 694AD), Heijokyo(平城京, 710AD), Nagaokakyo(長岡京, 784AD), Heiankyo(平安京, 794AD) in Japan; Seorabeol (金城, present-day Gyeongju 慶州市, 676AD) of Silla(新羅) in Korean Peninsula; Shangjing/Sanggyong(上京, 755AD) of Balhae(渤海国). Influenced by the capital construction in China, these cities were applying similar pattern originating from ancient China, but differentiated and improved following their local context.

Take the four representative cities in Japan, Fujiwarakyo, Heijokyo, Nagaokakyo, and Heiankyo, which followed the capital pattern from China, as examples, in order to clarify how the traditional grid plan in China exported and rooted in foreign countries, and clarify the reason of both inheritance and differentiation form the origin, especially at the block scale. (Fig. 2-4)

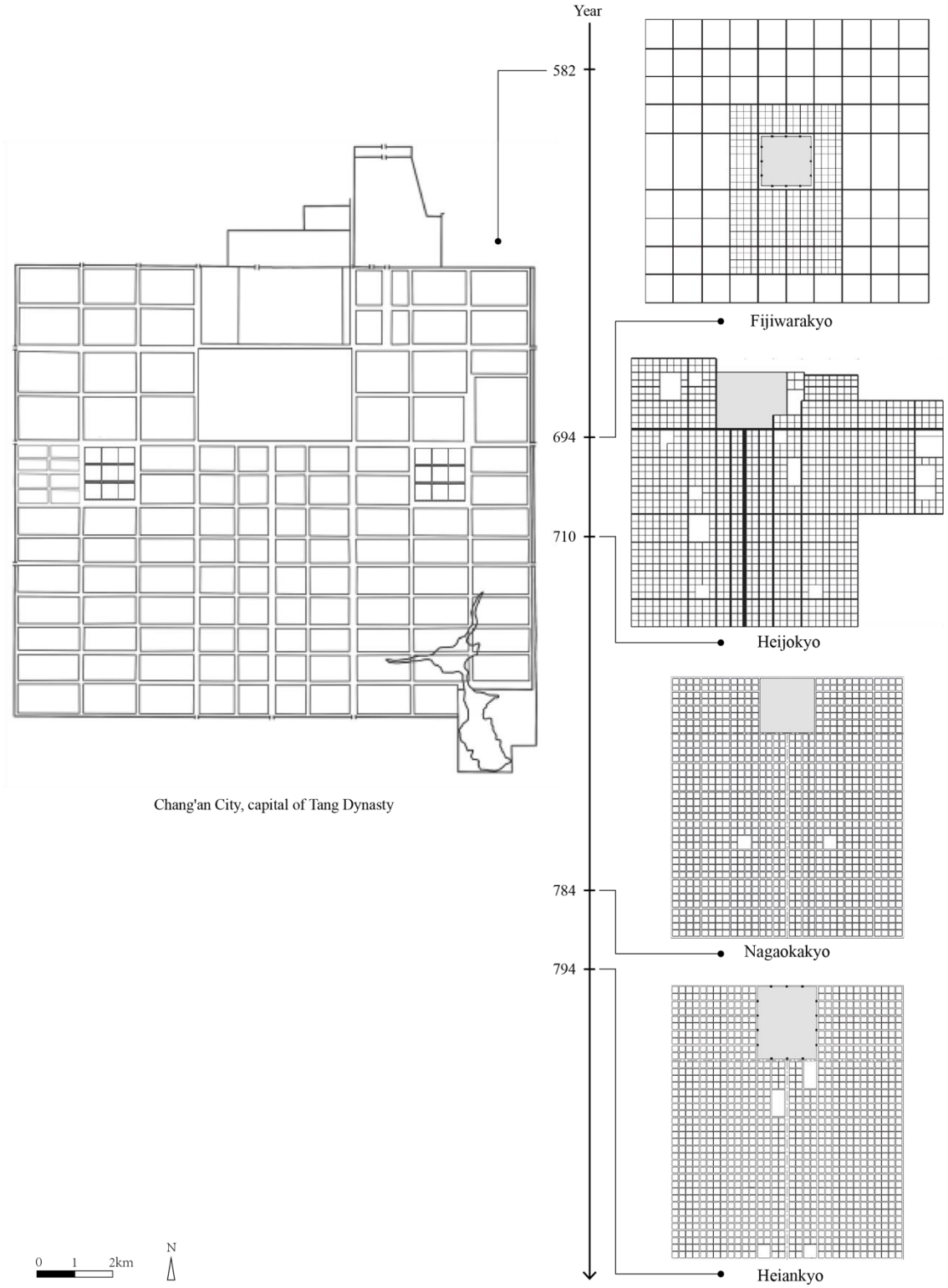


Fig. 2-4 Maps of Fujiwarakyo, Heijokyo, Nagaokakyo, Heiankyo in Japan, compared with Chang'an in China (By author, based on Wang, H., 2007; Wang, H. et al., 2007)

(1) Characteristics in the transformation process about the block system in Japan

Fujiwarakyo is considered to be the earliest formal capital in Japan and it first carried out complete block space planning. The block space system in the ancient capital of Japan was called " Joubou (条坊)" system, imitating the ancient Chinese Lifang(里坊) system. In the above four capitals, the Joubou system has both inheritance and continuous innovation and development. The migration process from Fujiwarakyo to Heiankyo is also a process of maturity and perfection of the Joubou system. There were two characteristics in the transformation process about the block system, that differed from China largely.

A. From "axial planning" to "boundary planning", that is from the priority of "street" to the priority of "block" in urban planning

Fujiwara Kyo's plan uses the axial planning method (心々制) of the main road. First, the central line of the urban road is determined on a 1500-square-foot grid, and then half width of the road is drawn equidistantly on both sides. Then ditches are dug out along the street and the remaining area is the Joubou block, so the size of Joubou blocks varies with the width of the roads. The construction of street-side ditches and block walls took up some of the area of block, leaving the actual block area less than 1500-square-foot (about 533m×533m). It was similar in Heijokyo, block sizes were not all the same in order to guarantee the width of several main streets. There is a large difference between a small homestead facing Suzaku Avenue and a large homestead facing an alley (Wang, H., 2007). Hence, the whole city plan is based on the street structure as priority, leaving the remaining space as "block". (Fig.2-5)

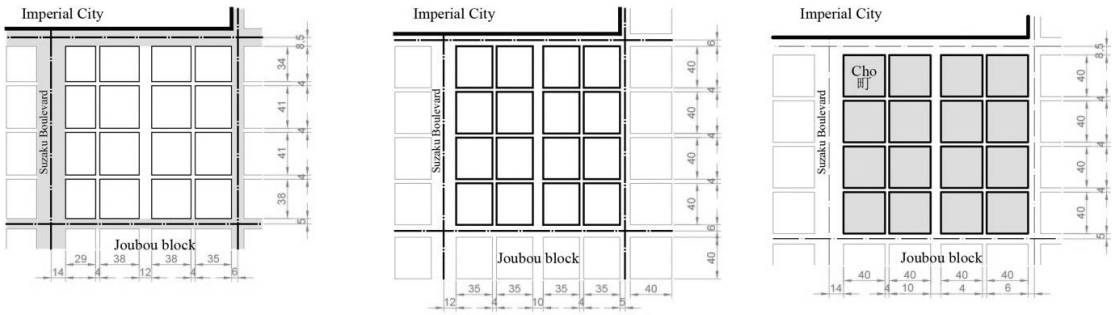


Fig. 2-5 Transformation of Joubou block (Unit: Take 丈, 1 Take=about 30meter)

(By author, based on Wang, H., 2007)

The "axial planning" to "boundary planning (内法制)" in Nagaokakyo. This change caused a fundamental change in planning methods, in order to more accurately control the area of the homestead. Fujiwarakyo was divided under a preset large 1,500 feet (180 Take 丈, 533m)-grid; while Nagaokakyo is the basic method of dividing all big roads, small roads and Cho. After the sizes were set, the sum-up operation is carried out from the inside to the outside, from the part to the whole, so the size of the Cho is basically an integer (40 or 35 Take 丈,120m or 105m), and the distance between the central lines of the road depends on the result of the sum-up, not

necessarily an integer. “Boundary planning” method was not thoroughly implemented in Nagaokakyo, for there was still some differences in block size along the axial street. It is until Heiankyo, that guaranteed all the Cho in a 40-take(120m) grid pattern.

B. Urban planning reaches the level of homestead subdivision, with planning unit becoming smaller and more homogeneous

In Fujiwarakyo, Joubou block is first divided into 4 parts by the block subdivision roads, then, further divided into 16 parts (坪, tsubo). While in Heiankyo, the Joubou block is directly divided into 16 “Cho” , and 4 “Cho” compose one Ho(保), but only as an administrative unit. As a result of “boundary planning” method, compared with the Joubou block in Fujiwarakyo as the basic unit for urban planning, “Cho” block in Heiankyo is more likely to take up the role of basic unit in urban planning. So, the planning unit became smaller and homogenous in the transformation process. (Fig.2-6, Fig.2-7)

Moreover, the transformation process maintained the continuity in considering homestead subdivision, avoiding the irregularity pattern inside the block. These traditions have been inherited in Japan till now, that blocks are defined in a small size, with homestead subdivision clearly regulated in the relevant principles (Kawai, T., 2016).

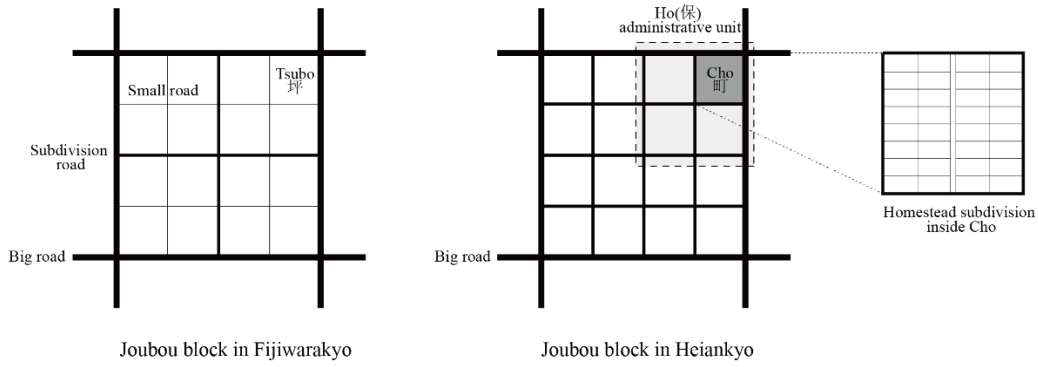


Fig. 2-6 Transformation of Joubou block subdivision in Japan (By author)

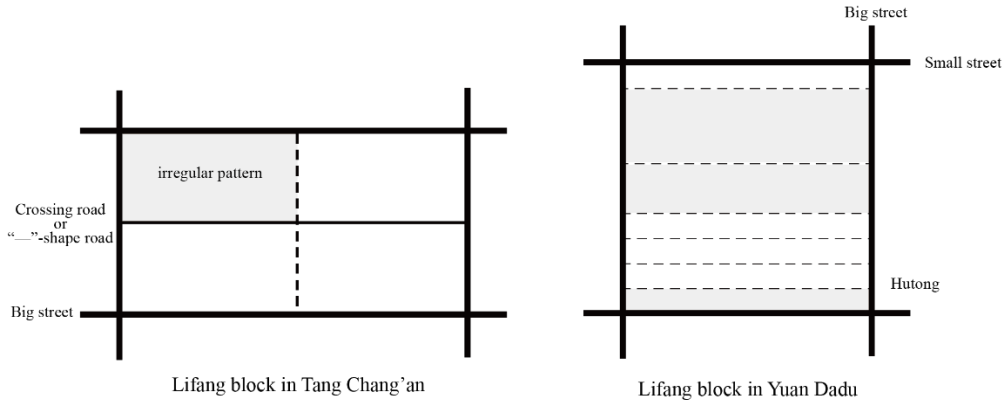


Fig. 2-7 Lifang block subdivision in Tang Chang’an(left) and Yuan Dadu(left), China (By author)

(2) Divergence between the grid plan in Japan and the traditional one in China

From the above analysis about the grid block transformation in Japanese cities that originates from the main concept from ancient China, the divergence between the two countries can be concluded into two points.

Firstly, the dualism of traditional grid plan in China with rough but regular road network and spontaneous block pattern was transformed into a homogeneous way in Japan. The homogenization of the block space is mainly manifested in two aspects: the first is that the size of Joubou block and Cho-unit tends to be unified, which is the result of the above-mentioned changes in the planning benchmark method; the second is the division of the Joubou block. The subdivision way with double-grade crossing roads was changed to a three-vertical and three-horizontal method, which changed the hierarchy of the road in the area from two grades to one grade. It also led to the planning unit changed from the big Joubou block into Cho-unit, which is only 1/16 of the former one. Hence the planning concepts adopted a sense of bottom-up when the city is considered as a result of Cho-units' combination, instead of a dividing prosses with road network.

Secondly, homestead/plot subdivision was always considered in Japan, while it was not clearly recorded or regulated in China, and scholars are still having different opinions in the block pattern of Tang Chang'an. Hence, block pattern in Japan was more ordered, while that in China varied a lot.

Naturally, the change in the allocation of homestead can be cited as the background to such changes in the Joubou system. At the time when Fujiwara-kyo and Heijo-kyo were planned, it seems that the uniformity of the residential land was not so important, as the common people were not allocated with residential land, and only officials were targeted. However, in the latter of the Nara period, a large number of farmers were gathered into capital for the large amount of construction projects. So, 1 tsubo was started to be divided from 32 parts to 64 parts for more allocation. As the population continued to increase, consideration was given to homestead, and as a result, the Joubou system was forced to change in Nagaokakyo (Funo, S.,1995).

For Japanese cities, initial application of Joubou system form Chinese Lifang system is the external factor that influenced urban planning, but the attention to homestead allocation became the internal factor, rooted in domestic context. The divergence in Japanese cities shows another potential of traditional grid plan in China. But based in Chinese urban context, the traditional grid plan evolved in a totally different way in China in the long history, until the foreign culture was imported after 1840.

2.3.3 Reversed Import of Grid Plan and its transformation in Modern Chinese Cities

(1) Grid plans related to colonial background

Before the Opium War in 1840, Chinese cities followed the system of feudal society, with simple urban functions, slow economic development, and little change in urban and architectural form.

In 1919, due to the invasion of foreign powers and the signing of unequal treaties, more than 80 cities along China's coast and along the river opened as trade ports, such as Shanghai, Tianjin, Guangzhou, Wuhan, etc. The

specific forms of occupying China's land by the foreign powers include concession areas(Tianjin 天津, Shanghai 上海), leased cities(Dalian 大連, Qingdao 青島), foreigners' residences(Ningbo 寧波, Fuzhou 福州, they were still in the governance of Qing Dynasty/China) and railway affiliated areas(Shenyang 瀋陽，Ha'erbin 哈爾浜ハルビン). These lands are colonial or semi colonial in nature. One of the main purposes of their large-scale construction is to meet the needs of trade, industry and commerce, administration and residence. As a result, they have become the places of raw material export, processing, and trade dumping for western industrial products, and the economic functions of cities have been obviously strengthened. Due to the adoption of modern western urban planning concept and construction technology, these cities were implemented with western style blocks which are quite different from the traditional Chinese grid plan.

As is shown in Fig.2-8, Fig.2-9, Fig.2-10, the grid blocks planned with colonial background were more homogeneous and denser. Though the gird pattern constructed by different concessions may have differences between each other, they do not have huge gaps, for example the concessions in Tianjin.

A. Block size and road width

According to the map, the block length in the French Concession of Tianjin is about 80m-240m, and the block depth is about 50-130m, with road width of about 15m (Wang, N., 2010). The block length in the center of the area planned by Japan, is about 80-120m, with the road width about 15-20m (Song. J., 2010). The road width is similar with the roads which were one grade upper than the lanes in traditional Chinese grid plan. But, differently, there is not obvious hierarchy in the road network. As for the block size, it is far smaller than the super blocks in ancient Chinese cities.

B. Block pattern

From the comparison of Old Town and colonial area in Tianjin (Fig.2-8) and Shenyang (Fig.2-11), the differences between colonial grid pattern and traditional Chinese grid pattern, become more evident. As the block were already regulated into relatively small scale, there is no sub-blocks inside the colonial block, giving the whole area a sense of order. On the contrary, the old town maintains the sense of spontaneity as the ancient time.

The small block, homogeneous road network and regular block pattern due to two main reasons:

First it is the geometric feature of dense block that can be more efficient in construction and land allocation, and offers more equality in land marketing, which meet the requirements of marketing economy.

Second, the depth of urban planning also contributes to the final block form. As in Fig.2-10, the affiliated area in Shenyang, not only the small block, but also the further subdivision of each block was regulated in the plan. Hence, all the urban space is decided by the government without the self-depend construction by citizens. Without citizens' participation, the sense of belonging like the one generated in Lifang block in China, can be lacking of.

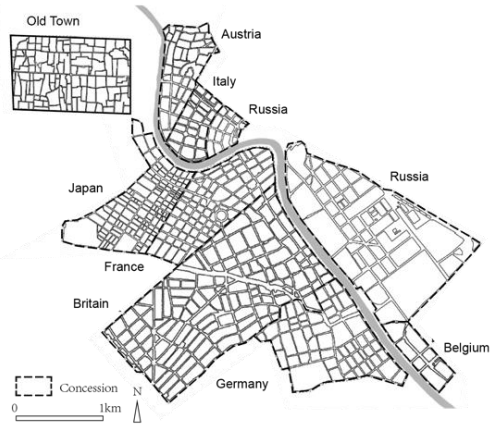


Fig. 2-8 Old Town and concessions in Tianjin (By author, based on Zheng, Y., & Xue, S. 2014)

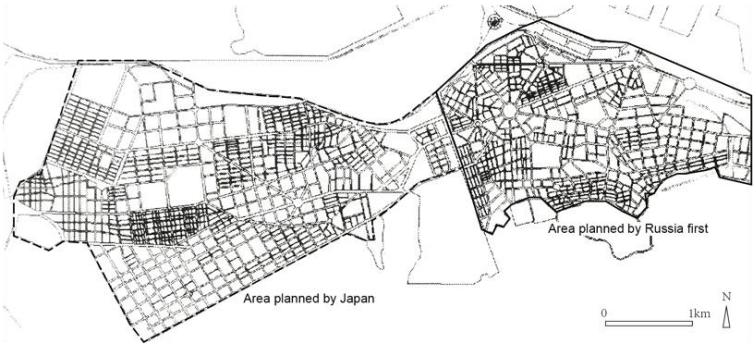


Fig. 2-9 Areas planned by foreign governance in Dalian
(By author, based on Sun, H. & Liang, J.,2003)

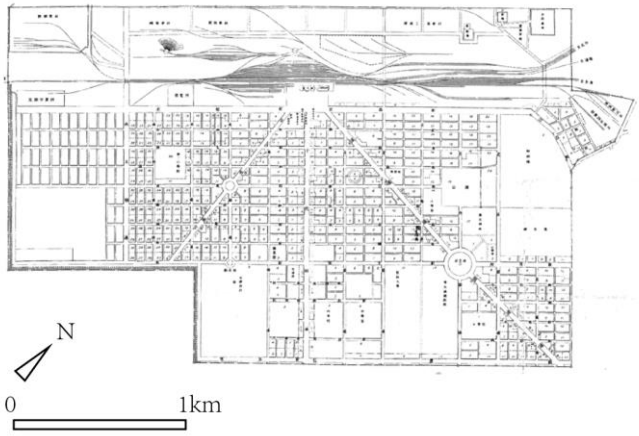


Fig. 2-10 City map of railway affiliated area in Fengtian (Shenyang), 1925 (Based on “實測最新奉天市街附近地圖”1925, https://www.oldmapsonline.org/map/harvard/014622053_1)

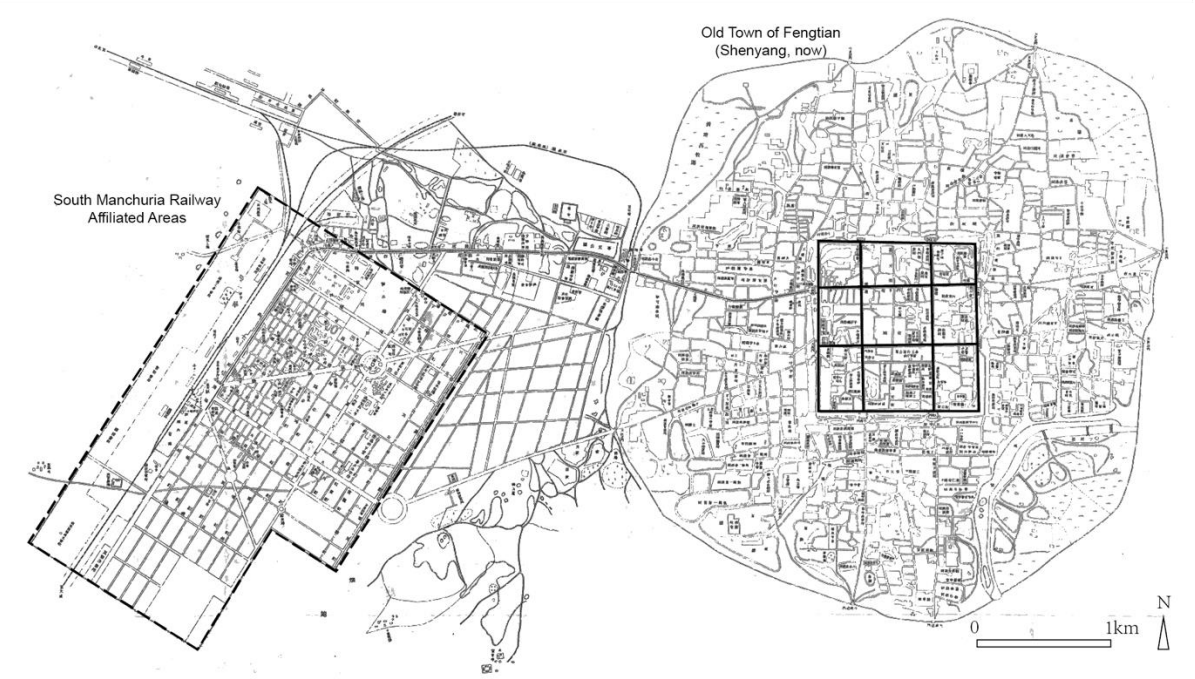


Fig. 2-11 City map of Fengtian (Shenyang), 1925 (By author, based on “實測最新奉天市街附近地圖” 1925, https://www.oldmapsonline.org/map/harvard/014622053_2)

(2) Grid plans related to modern new districts

With the rapid development after 1978’s economic reform, in the 1990s, many cities proposed new urban plans on new district development of administrative, cultural and financial centers (Table 2-2). They were either developed in suburban area that had not been built yet, or reconstructed the existing urban center thoroughly. As a result, it was a chance for those cities to attempt to apply new urban planning concepts and new urban patterns. With the rapid cultural exchange, technology development in recent decades, more and more cities are facing similar conditions, problems and requirements. Hence, the urban planning concepts that comfort current urban desire spread quickly worldwide. A tendency of convergence in urban form is inevitable as a result of current globalization background. Modern new districts in China plays a role as a ground for the global urban pattern. Fig.2-12 lists 6 cases of modern new districts constructed in the 1990s, in two different scale.

Table 2-2 Some plans of new district development in 1990s

City	Time	Plan
Beijing	1992	Development of Financial Street and Beijing Central Business District, proposed in "Beijing City Plan 1992"
Shanghai	1993	Plan of Lujiazui Central District
	1995	Urban design for Lujiazui Central District
Shenzhen	1992	Detailed planning of Futian central district
	1994	Urban design of Futian central district
	1994	Regulatory detailed planning of Bao'an new Central District of Shenzhen city
Tianjin	1994	Urban master plan of Tianjin Binhai New Area (1994 – 2010)
Guangzhou	1993	Comprehensive Planning of Zhujiang New Town
Hangzhou	1993	Reply of the State Council on the Establishment of Hangzhou Economic and Technological Development Zone

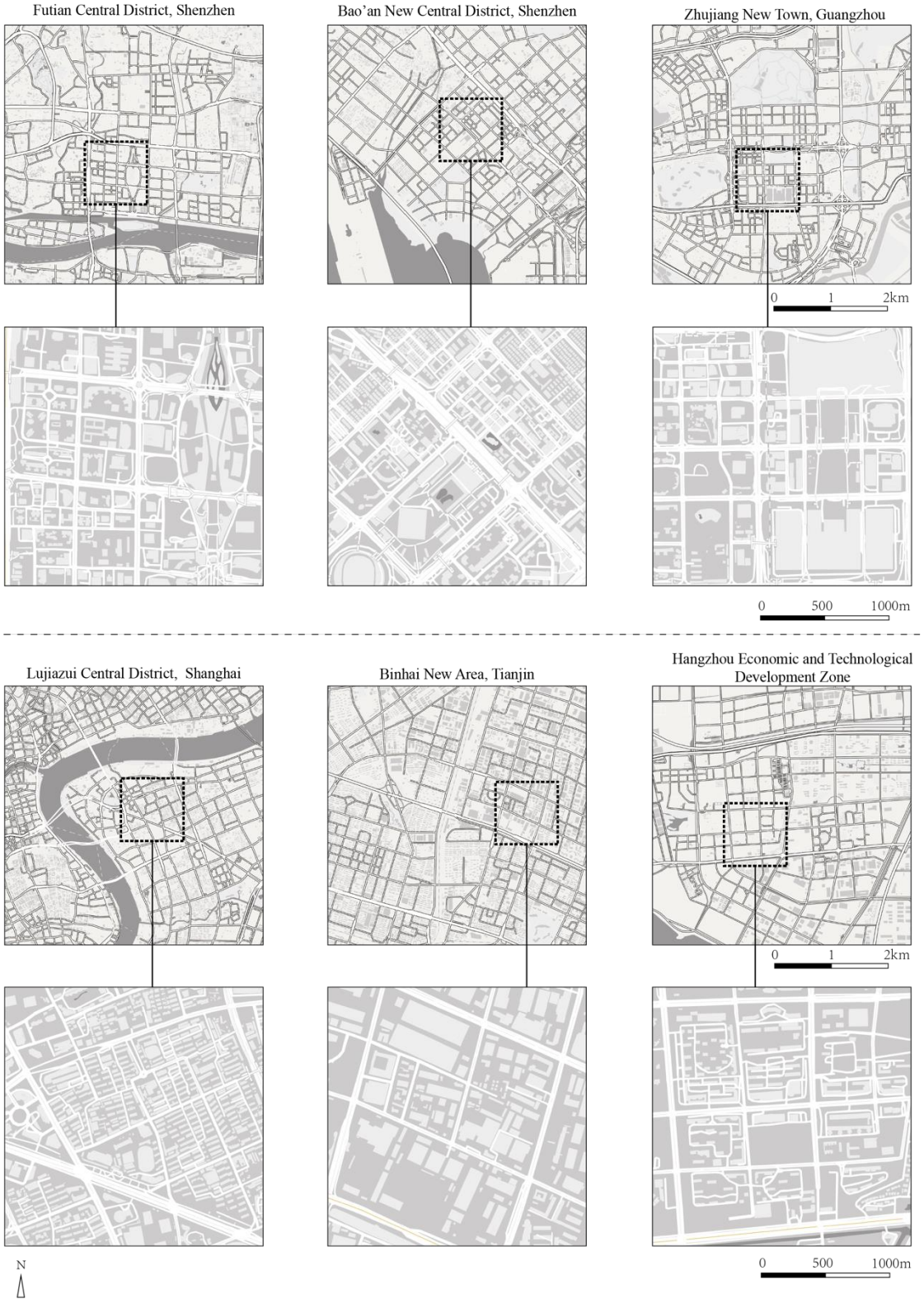


Fig. 2-12 Cases of modern new districts in China in different scales

(By author, based on the data of Baidu Map, https://map.baidu.com)

Fig. 2-13 Traditional grid pattern in Xi'an Old Town

(By author, based on the data of Baidu Map, https://map.baidu.com)

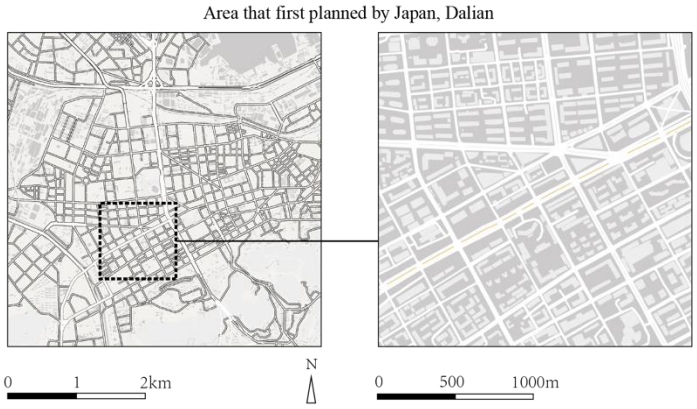


Fig. 2-14 Area with Japanese colonial background in Dalian

(By author, based on the data of Baidu Map, https://map.baidu.com)

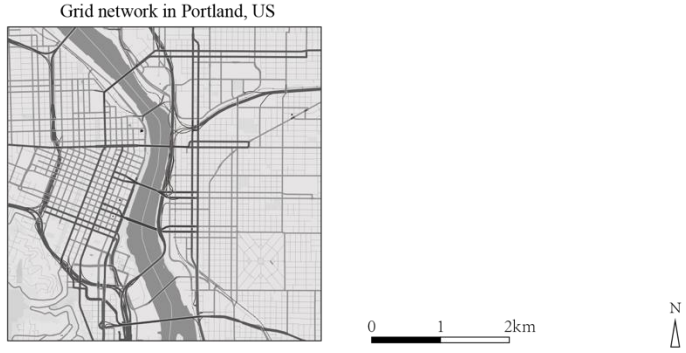


Fig. 2-15 Dense grid network in Portland, US

(By author, based on the data of https://www.mapbox.com)

Their grid network resembles the dense gridiron in western countries (Fig. 2-15) and colonial areas (Fig. 2-14) to some extent. From the district scale, they were planned with higher road network density compared with the traditional one in ancient China (Fig. 2-13). Correspondingly, the block size decreased a lot. From the block scale, their block patterns became more regular compared with the tree-shaped super block in ancient China. It related to an urban plan system with higher accuracy and depth, so that streets and roads of lower grade can be regulated in an integral way, creating a neater streetscape.

However, they still got big differences from the dense gridiron in western countries and colonial areas. From the district scale, they are not exactly gridiron network. Curved roads and irregular pattern can be found, and the roads are not always evenly distributed. Moreover, some “diagram” like painting also appeared (such as Futian central district in Shenzhen), because they are usually endowed with the duty of showing the symbolism and the identity of the city, or the imposing manner in city development. This can be considered as an inheritance and differentiation of the cosmic and imperial concept in ancient China, which is driven by the top-down idea and dominance. From the block scale, modern new districts considered less about the land coverage and the street wall. In ancient Chinese block, although the small lanes were unorderly distributed, the buildings were constructed from the edge of street, without large street-front setback. So, the continuity of street space was shaped by the buildings on both sides, even it is sometimes “deckle-edged”. And it left the backland inside in a more irregular shape. In the western dense grid network, buildings are always following the shape of small block or the subdivided plots, increasing the coverages as high as possible to get more frontage along the streets. However, the building arrangement in modern new districts is more random. Public buildings may stand in the center of block or plots, for an identical model consideration as landmarks. For residential buildings, as a result of residential community system, estate developers have strong decision-making power, so the inner pattern of residential community may show high level of difference. It is similar with the large area of buildings owned by on company.

Therefore, the grid pattern in modern new districts in China, can be seen as a neutralization of the globalized dense gridiron network and the inherent pattern from ancient China.

2.3.4 Characteristics in the Process Inheriting Grid Plan in China

The transformation of Grid Plan in China, is like a “Game” between the “hierarchical” traditional pattern, and “homogeneous” western pattern. (Fig.2-16)

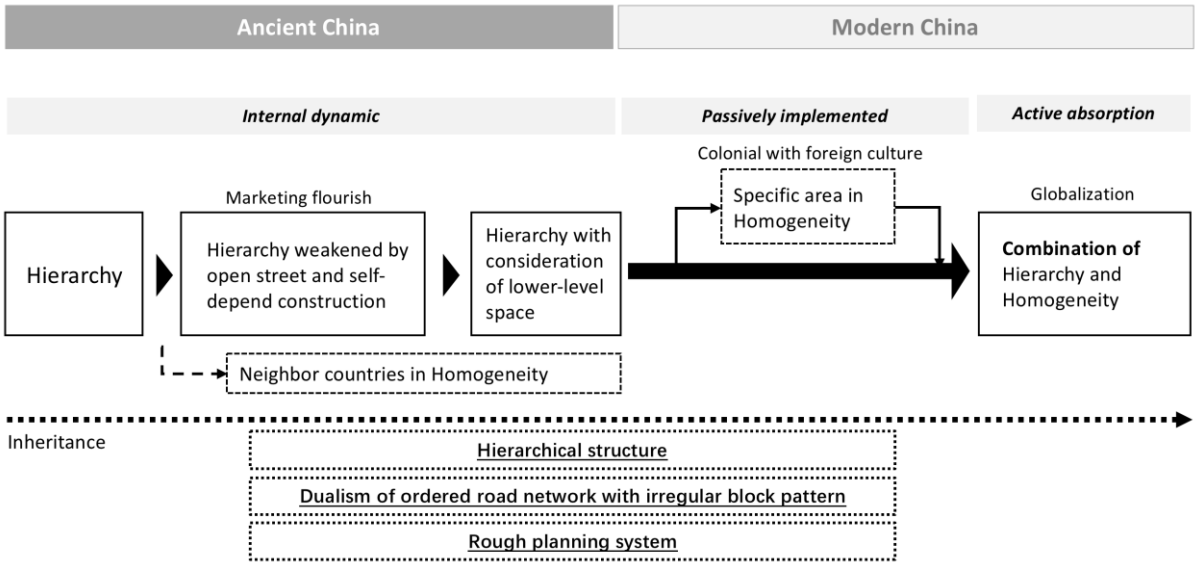


Fig. 2-16 Process of inheriting grid plan in China (By author)

The traditional grid plan in China was first generated as a physical expression of cosmology, so it was strictly arranged in gridiron network. In order to symbolize the imperial power for political needs, both the street and block adopted large scale. Simultaneously, the gridiron was also endowed with administrative functions, so that the large scale offered more convenience in management. The coincidence of physical function and administrative function made the urban form being strengthened, structural elements such as block walls were built. Moreover, the official urban planning is totally top-down, aiming to serve politics. Hence, strict hierarchy was limited in both street and block. However, unexpectedly, in the highly Centralized society, the strict regulation did not reach every detail space, that the inner space of the huge blocks was left to be constructed spontaneously. The phenomenon reveals the rough social management to some degree, that the governor paid more attention on the overall stability, leaving much flexibility in arranging daily life space by citizens themselves. For a good aspect, local community can be established with local belongings, while for a bad aspect, it is difficult to maintain a high-quality environment without the support of governmental management.

The traditional pattern was exported to nearby countries, and differentiated into their domestic pattern. The hierarchical form was initially adopted in Japan but latterly, transformed into a homogeneous variant. The top-down pattern was endowed with a sense of bottom-up, for considering more about the homestead allocation in the microscope.

However, the hierarchical structure, dualism of ordered road network with irregular block pattern, and the rough planning system were highly inherited in China. But it was once upon weakened in the period when marketing

flourished. The spontaneity extended out from the inner block to the public streets, abandoning the dogmatic block walls and decreasing the scale of both street and block. After regime changed, political significance of the grid plan may be emphasized again, with the long-term development until the final dynasties in ancient China, the rough planning system was eventually improved, reaching as detailed as the Hutong scale, due to the focus on citizens' daily life space from the view of governance. Block pattern became relatively ordered and homogeneous. But in the feudal society, the powerful class took privileges inevitably, neglecting the rules to achieve their own goals. As a result, homogeneity did not take the place of hierarchy in the transformation process.

After the modern urbanization, new types of grid pattern were imported into Chinese cities. The dense gridiron network form western countries, which resembles the domestic one in Japan, was passively implemented as colonial measures. Strong homogeneity became another way of showing governance power, rather than respecting individuals and pursuing equality. But it was happened only in several cities, that did not lead any tendency all over the country.

On the contrary, the homogeneity appeared again in the recent decades, in the pattern of new district construction. This time, it is in a proactive way facing marketing economy and globalization. But it is more a diversified version of the inherent grid pattern other than simply import or imitating the western style. Because in the process of network densification, some commanding form or structure with symbolism are maintained. Both block and street scale decreased compared with the super ones in previous, but it cannot be called a subversion. Moreover, local patterns inside block also exist, offering the potential for creating local communities and identities, which is distinct in Chinese social culture, avoiding monotony. Nevertheless, as it is a national tendency, cities may ignore the inherent urban form and their historical background, in the process of construction. Consequently, cities resemble each other to different degrees. It may be an inevitable process in pursuing higher benefit but is also an essential issue that current Chinese cities need to face and solve.

2.4 Transformation of Ring-radial Space in Western countries and Import into Chinese Cities

This section focuses on the imported ring-radial space. It is defined as Ring-radial Spaces and Rotaries (RS&Rs, in this research).

Rotary (also called traffic circle, roundabout) is a road junction in which traffic streams circulate around a central island (Collins English Dictionary, 2012). It is usually built for the purposes of traffic calming or aesthetics (Victoria Transport Policy Institute, VTPI, 2018), until modern roundabout was first standardized in the UK in 1966 (Laurence, C. J. D.,1980) which promote the traffic sufficiency.

Ring-radial spaces in this research refer to the focal public urban spaces, which usually exist at the intersection points of urban structures, with roads radiating from the center, but not necessarily adopt central islands.

This section aims to clarify the original and current roles of RS&Rs in urban development to find the transformation tendency, as well as the interactive relationship between their implementations in various areas in urbanization, by reviewing their morphological and functional transition, avoiding simply from traffic perspective.

2.4.1 Classification from the view of Urban Structures

The classification is based on the geometric form of urban structures. Radial Plan and Grid Plan are two of the specific urban forms in city scale. Their geometric pattern can also be adopted, when scaling-down to districts. In the transformation from the only radial pattern, to the coexistence of both patterns and then to the only grid pattern, different urban structures lead to different types of RS&Rs. (Fig.2-17)

Cases are collected based on the above classification in the following three categories: ①traditional baroque city: Paris in France; ②areas with grid pattern: Washington D.C, New York, Seattle in the US, Denenchofu in Tokyo, Japan; ③colonial cities that not only in grid pattern: Dalian and Changchun in China. The three categories represent the original implementation in Europe and the sorts of areas that unexpectedly adopt RS&Rs in the US, China, and Japan.

Type1: Concentric Type

It has a main circular shape in center with concentric circular shapes around. Similar with radial plan in city scale, cases of this type focus on single circular space as a center, dominating a limited area in district scale.

Examples: Denenchofu Station (Tokyo)； Renmin Square (Changchun).

Type2: Diagonal Type

RS&Rs are set up at intersections with significant functions or location, such as the station, symbol, palace, highland etc. Diagonals connect intersections, forming main street network. RS&Rs are dominant, compared with the street network.

Examples: Place Charles de Gaulle, Rond-point des Champs-Elysees, Place de la Nation etc. (Paris); Zhongshan Square, Gangwan Square, Minzhu Square etc. (Dalian).

Type3: Diagonal + grid Type

The diagonal avenues intersect with the orthogonal streets at circle plazas. RS&Rs, and street network are of equal importance in forming urban structure.

Examples: Dupont Circle, Logan Circle etc. (Washington D.C.); West Square, South Square (Changchun).

Type4: Grid Type

The street network is laid out in grid plan. But considering traffic or public space, circles are implemented, replacing the common crossroads. RS&Rs are subordinate to the grid street network.

Examples: Columbus Circle, Frederick Douglass Circle etc. (New York City), Communities' mini-roundabouts (Seattle); Saide Square etc. (Changchun), Huanan Square (Dalian).

Further, colonial cities like Dalian and Changchun in China, which have more complicated urban planning background and were constructed by different governors in various stages, adopt more than one type. Collage city image was created.

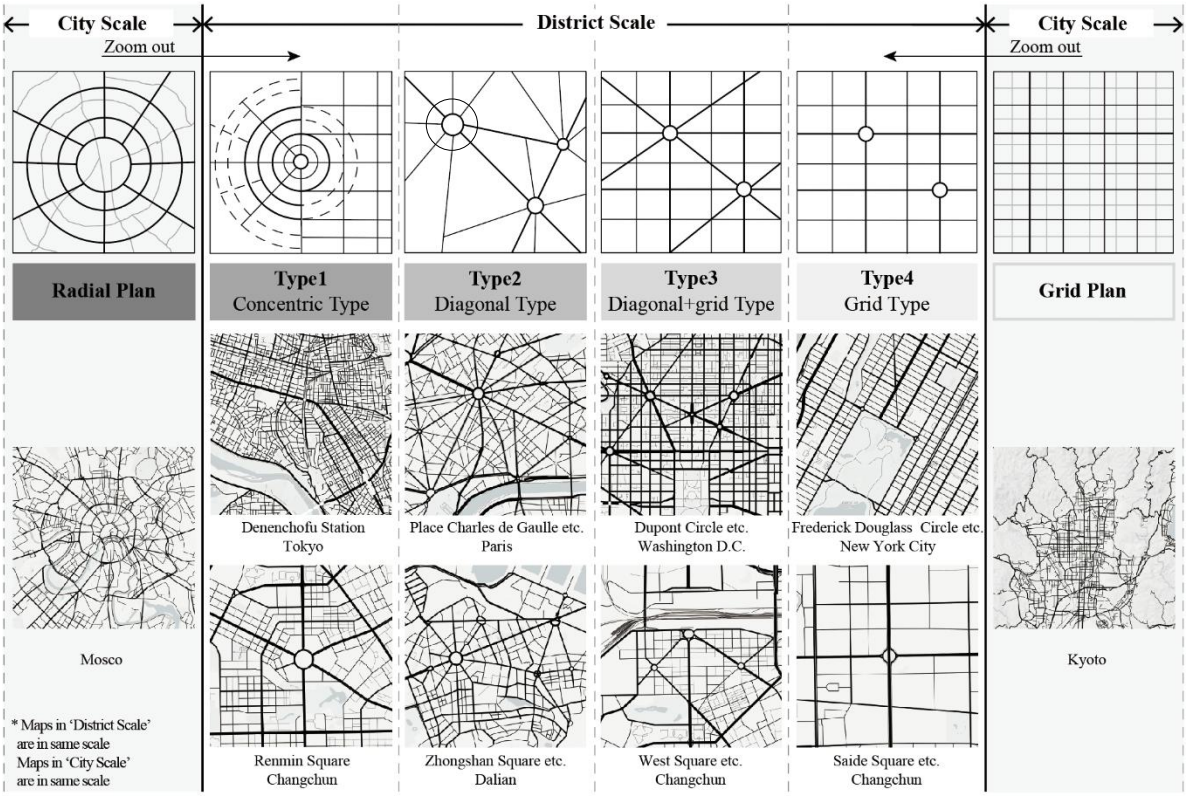


Fig. 2-17 Classification of Ring-radial Spaces and Rotaries

(By author, based on the map of Mapbox, https://www.mapbox.com)

2.4.2 Purpose of Original Implementation

Different places implemented the 4 types of RS&Rs for different purposes. Take examples in different cities of each type as case study, to clarify why RS&R were first planned, by methods of reviewing historical literature from both scholars and governments, as well as the historical maps.

(1) Type1: Concentric Type

Type1 usually relates to Ebenezer Howard (1850-1928)'s Garden City Theory. (Fig.2-18)

Howard's concept entered Japan and was promoted as garden suburban living by means of suburban train (Fujimori, T., 1984). It was thought to be an attractive and viable solution to rampant overcrowding and growth in Tokyo during the Meiji period, by taking advantage of Japan's rapidly developing and increasingly electrified railway network (Tokyo Metropolitan Government, 1994). Realizing Howard's planning ideal in the Japanese physical context[*1)] lead to the unique station-centered ring-radial spaces created in Denenchofu.

The morphology of Denenchofu was based on Howard's diagram, as well as the interpretation of Hideo Shibusawa's[*2)] observations in Europe and America[*3)] (Shibusawa, H., 1971; Oshima, K., 1996). The concentric road pattern around the Arch of Triumph in Paris impressed him and "A street with a curve has no perspectival vanishing point, and consequently engenders a sense of curiosity and embraces one's dreams"(Fujimori, T., 1984). Different from the self-contained communities of garden city, which are surrounded by "greenbelts", containing proportionate areas of residences, industry, and agriculture. The semicircular etoile pattern on the western side of Denenchofu only imitated the geometric form, creating high-quality residential for the Middle Class.

City center in Changchun, around Renmin Square, is also an imitation of the geometric form of Garden City. Green space, as green belt, alternates with functional space originally (Liang, J. et al., 2006).

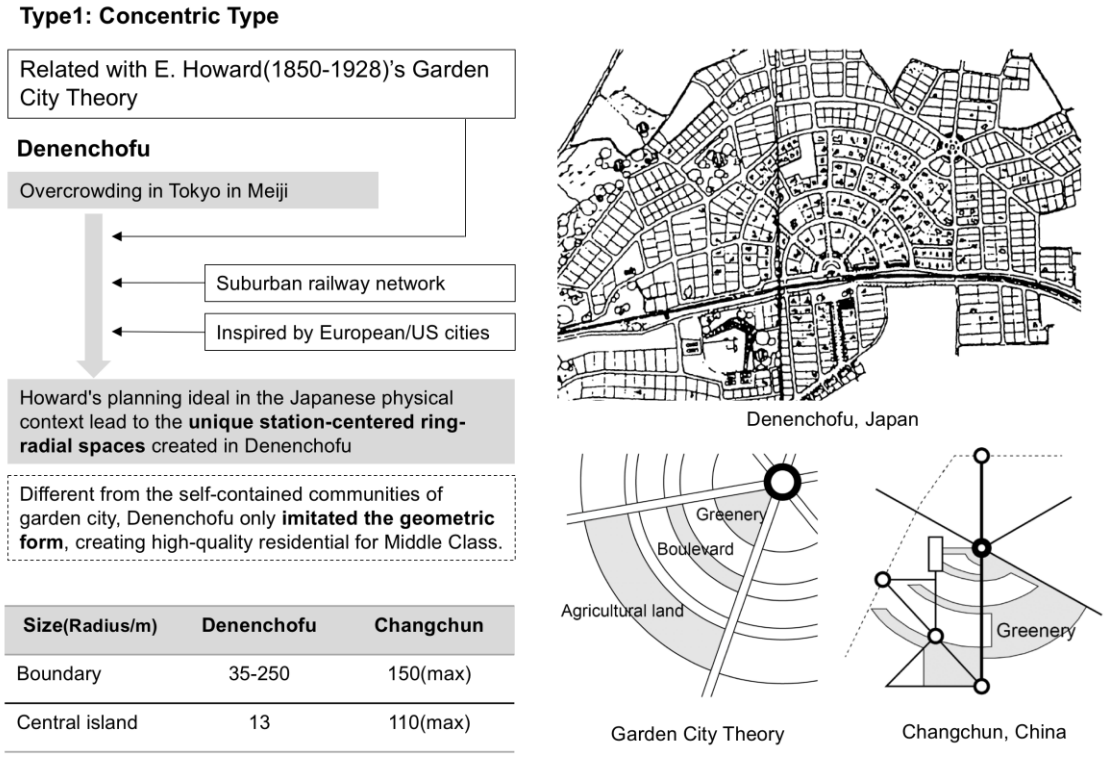


Fig. 2-18 Purpose of original implementation of cases in Type1: Concentric Type
(By author, based on Oshima, K., 1996; Liang, J. et al., 2006)

(2) Type2: Diagonal Type

Type2 is considered to be a typical Baroque Style. Apart from symbolic and aesthetic consideration, more functions were also gradually considered. (Fig.2-19)

In Paris of Feudal society, ring-radial spaces began to be used extensively from Absolute Monarchy Time, as a representation of Classicalism. Louis XIV connected geometrical plazas to show off personal achievements and nation's power. In the Napoleonic era, monuments were placed in the center of plaza, to enhance centrality (Shen, Y., 2007). After the Industrial Revolution, Civil Society appeared instead. Bourgeois came to the stage and Functionalism was emphasized. Centripetal and isotropic features of ring-radial space and rotaries make them easy to be connected in different directions, adapting to the complicated environment. So, Georges-Eugène Haussmann (1809-1891) used them to form sub-centers with significant city functions like station etc. in the Renovation of Paris. Then, use diagonal avenues as connection, creating a network of social life for citizens.

The original plan of Dalian by Russia also took advantages of geometric merits of ring-radial space and rotaries. Chose higher site as ring-radial space and rotaries and connected them with street network, in order to 1) view the natural sea and hills directly, creating beautiful city scenery; 2) follow the natural topography, reducing construction cost. (Jiang, Y., 2013)

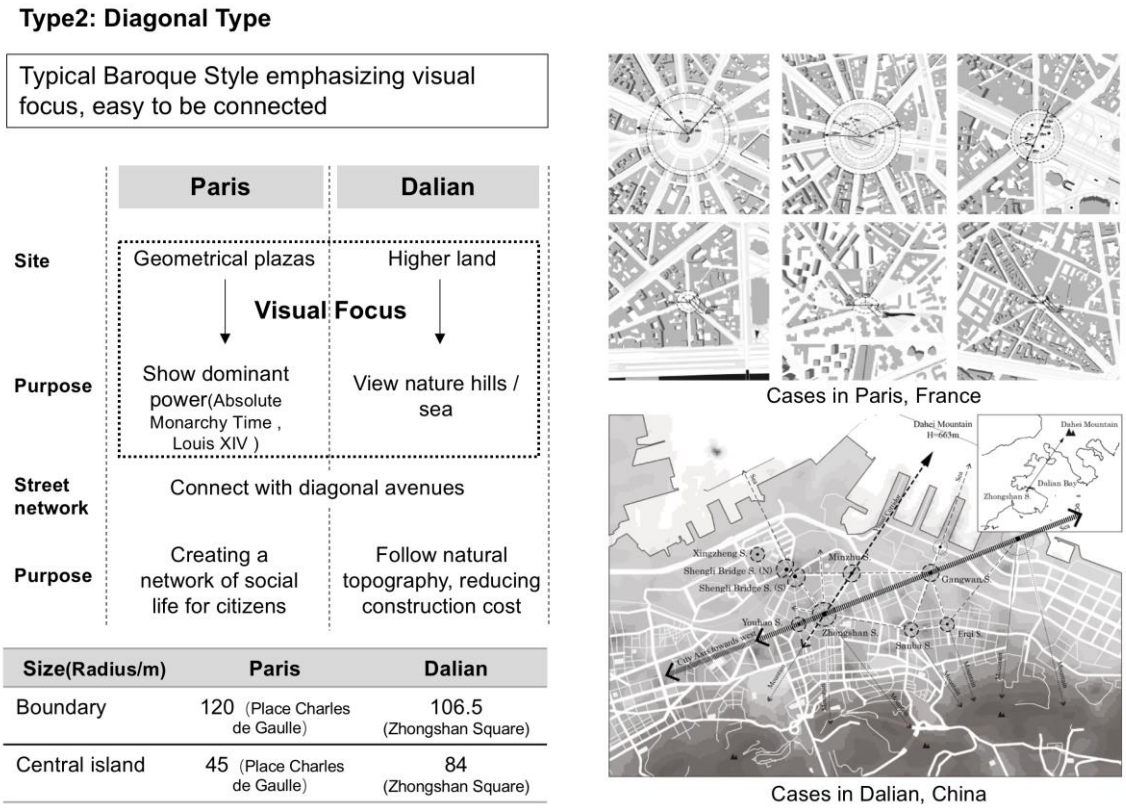


Fig. 2-19 Purpose of original implementation of cases in Type2: Diagonal Type (By author)

(3) Type3: Diagonal + grid Type

Type3 coexists with grid pattern, which plays an important role in urban structures. (Fig.2-20)

Washington D.C. is the sole American example of a comprehensive Baroque city plan with a coordinated system of radiating avenues, parks and vistas laid over an orthogonal system. It is influenced by the plan of several European cities and eighteenth-century gardens such as France's Palace of Versailles, as well as the existing colonial towns of the US. The plan was symbolic and innovative for the new nation (Historic American Buildings Survey, C. documentation compiled after 1933). Orthogonal streets with intersecting diagonal avenues radiating from two of the highest points in the city, was manipulated. Visually connect ideal topographical sites throughout the city where were envisioned important structures, monuments, and fountains.

Type3 also appeared in colonial cities constructed by Japan, especially in the railway affiliated area in grid pattern. In Changchun, they first appeared in South Manchuria Railway Affiliated Areas (SMRAA), in front of Changchun Station. SMRAA was in grid plan, because it met the flat terrain and the rectangle shape of the affiliated area. But Rotaries with diagonal roads were introduced for 3 reasons: 1) Preventing monotonous townscape. 2)Relieving traffic. 3)Attracting public participation with public facilities around (Koshizawa, 1988). In 1908, five rotaries were planned and four of which were implemented. Subsequently, in 1909, Business District to the southeast of SMRAA was planned by the Chinese government, imitating the pattern of SMRAA as well. Another five rotaries were planned but only one was implemented and conserved.

Type3: Diagonal + grid Type

Coexists with grid pattern, adding features

Washington D.C.:

European cities and 1700s' gardens such as France's Palace of Versailles

Existing colonial towns of the US

Coordinated system

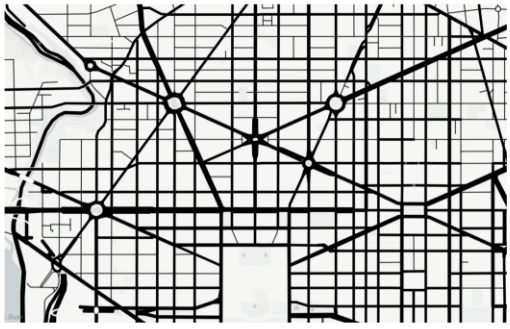
Radiating avenues, parks and vistas

Orthogonal system

Symbolic and innovative for the new nation

Changchun: (Koshizawa A. 1988).
1)Preventing monotonous townscape;
2)Relieving traffic;
3)Attracting public participation.

Size(Radius/m)	Washington DC	Changchun
Boundary	77.5(max)	91(max)
Central island	55(max)	72(max)



Washington D.C.

Changchun Station(South Manchuria Railway Affiliated Areas)

Fig. 2-20 Purpose of original implementation of cases in Type3: Diagonal + grid Type

(By author, based on the map of Mapbox, https://www.mapbox.com)

(4) Type4: Grid Type

Type4 usually subordinates to grid urban structure, and is relatively independent compared with Type2 and Type3, with traffic function. (Fig.2-21)

They were planned as part of the transportation system in the United States since 1905 when the Columbus Circle redesigned by William Phelps Eno (1858-1945) opened in New York City (Petroski, 2016). Subsequently, many large ones were built in the US. The prevailing designs enabled high-speed merging and weaving of vehicles. Priority was given to entering vehicles, facilitating high-speed entries. High accident rates and congestion problems following blooming traffic flow, led to rotaries falling out of favor in the US after the mid-1950s (National Academies of Sciences, Engineering, and Medicine, 2010). Things happened internationally with many countries experiencing circles being locked up as traffic volumes increased. Similarly, in Changchun, 8 cases were implemented since the 1930s to organize traffic flow, and 6 were deconstructed aiming to relieve the increasing traffic volume. But the result does not seem to be effective. (based on Hou, C., 2013)

Type4: Grid Type

Subordinate to grid urban structure, independent, with traffic function

New York:

As part of transportation system in the US **since 1905**, when Columbus Circle redesigned by William Phelps Eno(1858-1945) opened in New York City

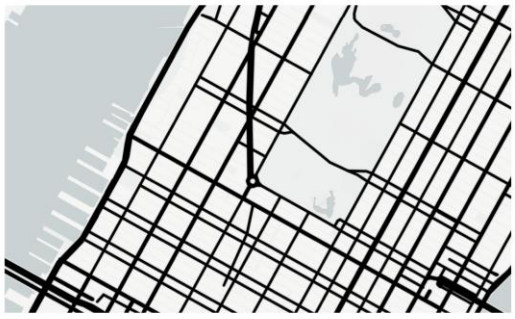
- Blooming traffic flow
- High accident rates
- Congestion problems

Rotaries falling out of favor in the US after the **mid-1950s**

Changchun:

- 8 cases were implemented since the 1930s to organize traffic flow,
- 6 were deconstructed to relieve increasing traffic volume. (Chapter 5)
- But the result does not seem to be effective.

Size(Radius/m)	New York	Changchun
Boundary	60(Columbus Circle)	150(max)
Central island	30(Columbus Circle)	120(max)



Columbus Circle, New York, US

Weixing Square, Changchun, China

Fig. 2-21 Purpose of original implementation of cases in Type4: Grid Type

(By author, based on the map of Mapbox, https://www.mapbox.com)

2.4.3 Original Roles and Significance of RS&Rs and its Import into Chinese Cities

(1) Original Roles and Significance

Based on the existence of RS&Rs in Europe, US, Japan, and China, their original roles and significance can be summarized.

1) Being Elements of the Baroque System as an Emblem of Symbolism or Nature

Type2 and Type3 mostly origin from Baroque City Plan, using axis network to connect significant intersections. The sequence of rotaries lined along wide avenues stressing the governance power, which did not change with the transition from Feudal Society to Capitalist Society. In Paris, Monarch used them for showing centralization, while in Washington D.C. and Changchun, planners used them underlining the position of brand-new capitals for the newborn nations. But Dalian is an exception for adapting to nature, showing the beauty of natural landscape.

2) Being Center of Garden City Model as an Archetype for a Better Environment

Garden City theory spread from Britain to Asia in the early 1900s, compared to the whole mechanism, the diagram of Garden City, which consists of several concentric circles and six radial roads, dividing the city into equal areas and linking other garden cities, was more referred to, aiming to obtain better scenery and environment.

3) Being as Temporary Traffic Calming Method.

Eugene Henard (1849-1923) invented traffic circle as early as 1877. The first test of his concept was with New York's Columbus Circle (1905), and then being introduced to Paris' the Place de l'Étoile and Place de la Nation (1907). They were subsequently built in Britain and Germany soon after, to organize increasing traffic. (Lay, M.G., 1992)

(2) Influential Relation Between Areas and its import into Chinese cities

RS&Rs occurred in different areas worldwide not just by accident, but had an influential relationship between each other (Fig.2-22). (Liu, J. et al., 2020)

Traditional Baroque City Planning origins from Europe. Original plans of Washington D.C. (by Pierre Charles L'Enfant,1754-1825), Denenchofu (by Kintaro Yabe, with Hideo Shibusawa's idea), and Dalian (by Kazimierz Skolimowski, 1862-1923) were inspired by European cities like Paris to some extent (based on Historic American Buildings Survey, C. 1933; Oshima, K., 1996; Koshizawa, A., 1988). While, Changchun, chosen as the "capital of Manchukuo" (Xinjing) during Japanese colonial period in 1931, was influenced by the concept in L'Enfant Plan (Liang, J. et al., 2006), being intended for the permanent seat of the government.

In colonial cities in northern China, Japanese government and companies absorbed classic and modern urban planning from Europe and US, together with domestic characteristics, trying to create improved city plan. Conversely, they gained more experience for city planning within Japan. As a result of a combination of advanced urban planning concepts, colonial cities, like Changchun, adopted more than one type of RS&Rs and were considered to be advanced that time (Koshizawa, A., 1988).

Although, originating from Baroque Style with Symbolism as the initial function, the ring-radial space is inherited with unique adaptation in the cities worldwide. More concrete functions such as improving environment and traffic calming gradually appeared in ring-radial spaces in the late 19th century and early 20th century. It was also at that time that the Baroque urban pattern was begun to be introduced into some Chinese cities, such as Dalian, Changchun, Shenyang and Ha'erbin. As a result, Baroque ring-radial spaces was imported into China when its symbolism was endowed with more concrete functions, adding a tendency of Pragmatism in the cases in China.

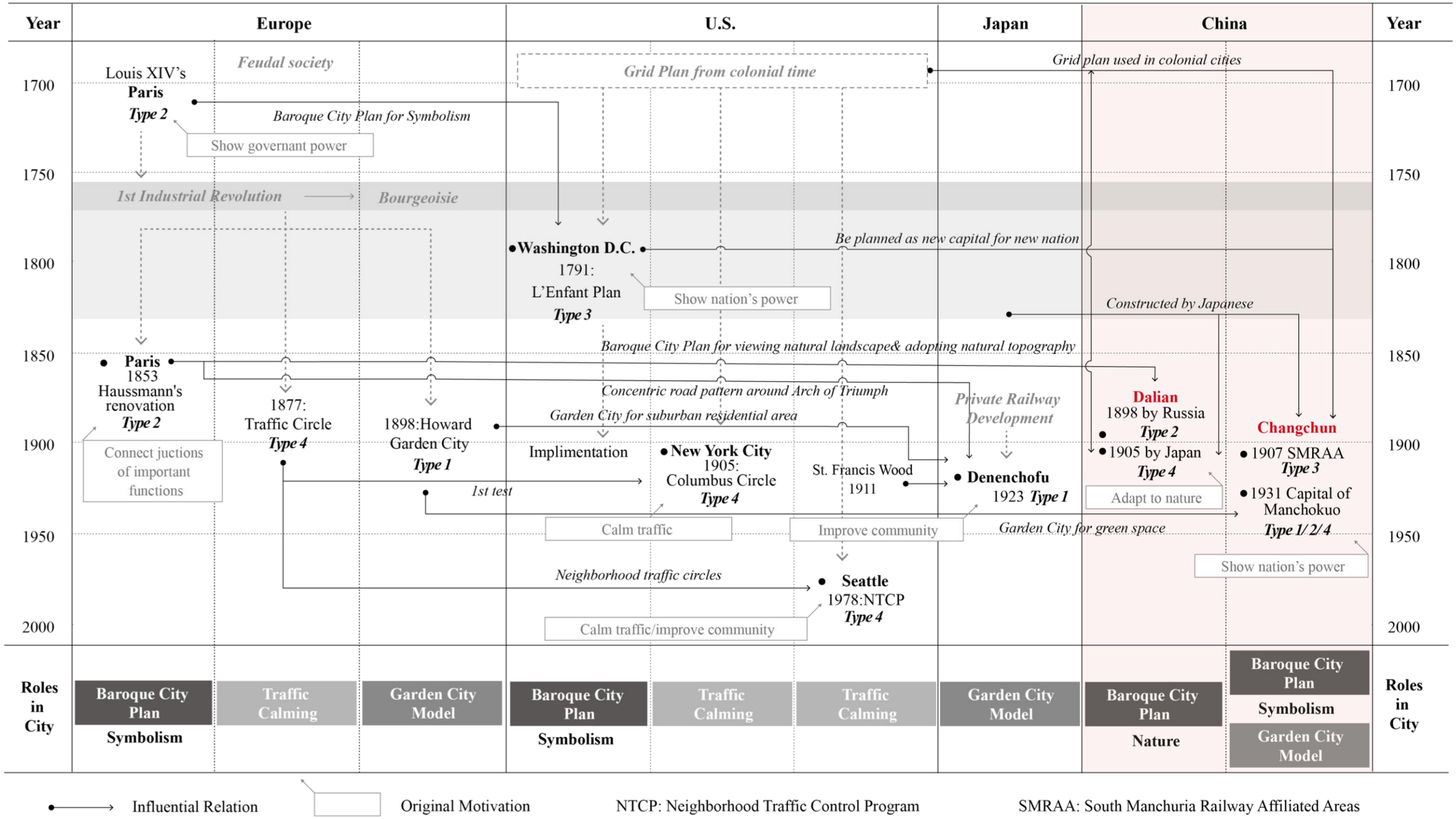


Fig. 2-22 Influential relation between different areas

(By author, based on Historic American Buildings Survey, C. 1933; Oshima, K., 1996; Koshizawa, A., 1988; Liang, J. et al., 2006 etc.)

2.4.4 Roles and Significance in Current Context

Transformation and renovation of RS&Rs accompanied with urban development. Their roles and significance changed according to the current social context, and the focusing aspect may differ from cities and areas. In this section, roles and significance in current social context are clarified, by referring to literatures, government documents and field research. (Fig.2-23)

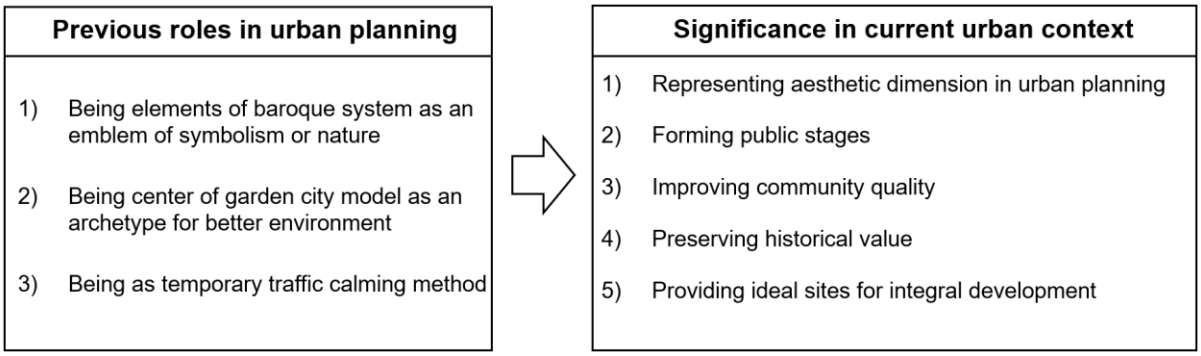


Fig. 2-23 Previous roles and current significance of RS&Rs (By author)

(1) Representing Aesthetic Dimension in Urban Planning

First, it represents the application of Baroque Art in urban planning. The age of the Baroque is a time when great strides were made in science and mathematics (Hersey, G. L., 2001). In Baroque city planning, it features more geometric order and measure, and less elaborate decoration. Urban space, was considered equally with the solid architectural volumes, through applying Gestalt Psychology. RS&Rs show the geometrical aesthetic of Classicism in the current modern world.

Second, it represents the earlier ideas about the art of city planning in connecting with life and nature. It is argued that the integration of art and planning has been inadequately developed since the mid-20th century, when modernist spatial ideas took hold. Modernism, seeks universal, utopian forms that are free from tradition and history, whereas the earlier ideas about the art of city planning often require contextualization (Talen, E. et al., 2004). RS&Rs are considered to be a symbol of Traditionalism or Classicism, usually implying autocracy, absolutism and the misuse of power. But, conversely, cases in Paris and Dalian show the aesthetic of collective decision making. One for social functions in daily life, the other for natural scenery. The planner's task is to "illuminate, clarify and explain the order of cities" (Jacobs, J., 1961). Instead of the top-down blueprint by some specific planners, RS&Rs, to some degree, can be seen as great collective works of art unfolding through time.

(2) Forming Public Stages

Geometric features of RS&Rs ensure visibility and accessibility from different directions, leading to higher safety. The spaces have become the focus of different neighborhoods, and the avenues that connect them are the

major thoroughfares for ceremonial and day-to-day use, forming a network of public stages.

First, it is a forum for voicing. In Washington D.C., as urban renewal and changing transportation modes brought revisions to L'Enfant's plan in the mid-20th century, drastic social movements altered the public perceptions of city's RS&R, as well as streets, avenues, and parks (Historic American Buildings Survey, C. 1993). In a nation of democracy, visibility on federal property in the national capital offers a perfect public forum for demonstrating dissenting views and could help spread messages around the nation and the world. Even Secretary of the Interior officially proclaimed the legality for peaceful using the spaces (Olszewski, G. J., 1968).

Second, it is a sharing space for neighborhoods. After the "streets for people" concept introduced in the late 1960s, in the late 20th century, landscape and entertainment, like music performance, in RS&Rs began to be pursued by citizens and visitors. Moreover, aiming to get a voice in space design, use, and maintenance, private organizations formed by merchants and occupants of neighboring buildings, cooperated with National Park Service, offered funds for reconstruction and renovation. Each space has a distinctive character defined by the neighborhood around and the people who use it.

Dupont Circle owns a central park with fountain, chairs, curved benches and stone chessboards for neighborhood gathering. It is also a location of political rallies, such as those supporting gay rights and those protesting the 2003 invasion of Iraq. Similarly, the recent renovation of Columbus Circle (NYC) (Fig.2-24) completed in 2005, not only made a beautiful and eye-catching place, but also improved pedestrian circulation, as a critical connector between Mid-town and Up-town Manhattan (Richard, W., 2007).

More abstract, buildings, whether federal, municipal, or commercial, are bounded and ordered by coherent streets and avenues, visibly, reinforcing the form of the federal government.

Fig. 2-24 Columbus Circle (NYC)

(Photo from the Official Website of the City of New York. http://www.nyc.gov/html/dot/downloads/pdf/columbus-circle-8th-ave-june2018.pdf, last review in 2021/1/29)

(3) Improving Community Quality

RS&Rs designed specifically for residential areas usually take up the duty for improving community quality, not only in safety, but in the environment as well.

Seattle's Neighborhood Traffic Control Program (NTCP) got its start to assist and improve deteriorating neighborhoods. In NCTP, Traffic Circle Program is the most popular and successful one, being proven to be the most effective at solving neighborhood concerns about speeding and traffic accidents with a minimum of controversy (James, E. et al., 1997). Over the last 30 years, the City of Seattle has installed over 1,000 traffic circles on city streets (www.seattle.gov). Landscaping is encouraged by Seattle Department of Transportation (SDOT) (Fig.2-25) in all traffic circles of sufficient size, for 1) making the circle more attractive to the neighborhood residents and 2) changing the character of the street making it less appealing for high-speed driving (James, E. et al., 1997). The public-private partnership is also applied. Circles are designed and constructed normally by SDOT. But the ongoing maintenance is the community's responsibility. If the larger scale restoration is needed, funds can be applied from the Neighborhood Matching Fund. So, it is welcomed for both traffic safety and unique neighborhood landscape.

Fig. 2-25 Seattle's neighborhood traffic circle

(Photo from the homepage of "Seattle.gov". Traffic Circles - Transportation | seattle.gov, https://www.seattle.gov/transportation/projects-and-programs/safety-first/traffic-operations/traffic-circles, last review in 2021/1/29)

The ring-radial space system in Denenchofu was maintained from 1923 till now, inheriting the original concept of Garden City. Radiating from Denenchofu Station makes it a neighborhood center, leading the way-finding action easier. Curved paths add more variability and charms for streetscape. Similar to Seattle, though constructed by private Denen-toshi Co., some community charters are contracted by many residents, and illegitimate constructions are monitored by residents (Domen, T. et al., 2004). The area is now managed by cooperation with administration, private organization and residents themselves.

(4) Preserving Historical Value

Construction trend of RS&Rs were reduced after modern urban planning, but they can be a record for the history of specific periods, which characterize a city and should not be erased in ongoing development.

Dalian and Changchun own a long history of RS&Rs, but until recent years they began drawing up integral plans for preservation and renovation, focusing on historical value. In Dalian, three out of 19 cases were included in different Historical and Cultural Blocks[*4)]: Zhongshan Square Historical and Cultural Blocks (2009, with Zhongshan Square in center), North of Shengli Bridge Historical and Cultural Blocks (2006, with Xingzheng Square and Shengli Bridge Square at both ends). Previous reconstruction targeted at either a part of the space or only historical architectures, instead of the whole area. Thus, collage images were created, as a special phenomenon in Dalian streetscape.

Conditions go alike in Changchun, six of 21 cases are included in the area of three Historical and Cultural Blocks (proposed in 2010) [*5)]: Renmin Street Historical and Cultural Block (Changchun Station Square, Renmin Square, Gongnong Square, Weixing Square), South Square Historical and Cultural Blocks, and Xinmin Street Historical and Cultural Block (Xinmin Square). They are mostly renovated by architecture. In 2016, "Changchun Renmin Square City Center Urban Design" was proposed, as the first district renovation plan for ring-radial spaces in Changchun.

(5) Providing Ideal Sites for Integral Development

Locating the rail lines under established structures was one of the main guidelines for subway system planners. RS&Rs with connecting streets would form the above-ground framework for the underground network. RS&Rs were intended to become points of reference throughout the city. In addition, the property was already owned by the government (Historic American Buildings Survey, C. 1993), which made them practical sites for Metro stations. Rotaries provide enough space for station construction without disturbing the existing buildings, and offer a chance for redefining the entrances that pedestrians would use to approach the underground rails, integrally. Apart from providing ideal sites for integral development of public transportation, RS&Rs also have potential in providing spaces for other creative functions. For instance, in 2010, the District of Columbia, US, issued a Request for Proposals inviting qualified development teams to propose their vision and plan for redeveloping the historic Dupont Trolley Station located underneath the Dupont Circle. The District sought a creative, yet sustainable use that would turn this vacant, 75,000-square-foot former trolley station into a destination for District residents. Then, the nonprofit Arts Coalition for the Dupont Underground (ACDU) [*6)] was founded. It planned to redevelop 23,000 square feet of the site through art and design events, public performances and temporary commercial uses. It aims at transforming a public work, the subterranean streetcar station in Dupont Circle, into a new public infrastructure to support creative exchange, contemporary arts practice, and an ongoing conversation about the city.

2.4.5 Characteristics in the transformation of Ring-radial spaces worldwide

Ring-radial spaces and rotaries are one of the typical patterns of urban public space. They have been used for long history and been considered as Classicism. But their “old fashion” and insufficiency in traffic safety make their significance be questioned. This section classified RS&Rs into 4 types based on urban structural pattern, and summarized their previous roles in urban planning:1) being elements of Baroque system as an emblem of Symbolism or Nature; 2) being center of Garden City Model as an archetype for better environment; 3) being as temporary traffic calming method. Then by reviewing and analyzing the examples of different areas, their significance in current social context was clarified: 1) representing aesthetic dimension in urban planning; 2) forming public stages; 3) improving community quality 4) preserve historical value 5) providing ideal sites for integral development.

Although compared with the modern grid pattern, RS&Rs are sometimes not economical enough in construction and land use, but they contain more flexibility and is nonmonotonic in streetscape creation. And when considering traffic safety, RS&Rs, on one hand, have the potential in transforming into modern roundabout (Gates, T. J. et al., 2000). But on the other hand, social network, public space or landscape of a city can be more important, so applying other methods for improving safety, like setting signals (Tollazzi, T., 2015), is also accepted. As a result, ring-radial spaces and rotaries are irreplaceable and appealing in creating unique city image and characteristics.

2.5 Conclusions

This chapter gives an overall review of the original patterns that were implemented in urban form in major cities in China, based on their cultural origins. It summarizes the following contents.

First, by combining the three "Normative Models" of Urban Form by Kevin Lynch and the four Morphological Models based on the construction sequence in time and spatial characters, a comprehensive understanding and the sequence of urban patterns in Chinese urbanization process is set up. (Chapter 2.2)

Second, resulted from the imperial urban form in ancient China, grid plan, is selected as the representative pattern based on the traditional Chinese culture. Its evolution was investigated in the whole Chinese urban context. Its inheritance and characteristics were concluded. (Chapter 2.3)

Third, ring-radial space, is focused on as the representative pattern from foreign culture, particularly from the classical Baroque culture. The influential flow between different categories of ring-radial spaces worldwide is clarified. So is its import into Chinese colonial cities. Moreover, compared with the grid plan which is still commonly implemented, the current significance of the classical ring-radial space is examined world-widely, as a reference for the case redevelopment in Chinese cities. (Chapter 2.4)

From the above summary, conclusions can be drawn that:

(1) Culture exchange appeared in different epochs in China. The advance and flourish in ancient China, such as Tang Dynasty, led to culture export to neighbor countries, while in the modern time, China went through a colonial and chaotic period with western culture imported passively. And currently, rapid urbanization and globalization background make Chinese cities absorbing advanced foreign concepts actively and integrate into domestic context. Therefore, in order to understand the transformation process of urban morphology in Chinese cities, original cultural source cannot be neglected.

(2) The comprehensive culture exchange in history was reflected in the urban form. Different urban pattern conveys various ideologies. Among the cities with top-down planning in China, they can be categorized according to the original cultural source they were based on in planning. The first group is the ones that were planned based on the traditional Chinese cosmology, represented by the grid plan of dualism, such as Xin'an and Beijing. The second group is the ones that were on the basis of western symbolism, represented by the Baroque ring-radial spaces, such as Dalian and Changchun.

(3) The grid plan of dualism or hierarchy, is the physical expression of traditional Chinese cosmology and hierarchical feudal society. It has been inherited through the thousands of years of ancient times and the unprecedented urbanization in the past century. Hence, it can be considered as the inherent pattern existing in Chinese urban form. According to the investigation in Chapter 2.3, the inheritance of grid plan seems like a "game" between "hierarchy" and "homogeneity". The homogeneity was underlined when marketing flourished with less prohibition, and was weakened when the management system required. The homogeneity took dominance once in

the colonial background as another measure showing hierarchy and political power, as well as pursuing higher land benefits. But it only appeared in specific time and place, and finally the homogeneous grid pattern has been integrated with the traditional hierarchical one, being implemented as the unique Chinese result in globalization. The inherent grid plan has high potential of transformation, which is also proved in the homogeneous divergence evolved in Japan after export. As a result, its inheritance in China is a constant adaptation to updating social requirements, as well as a process of diversification.

(4) The Baroque ring-radial spaces, as a totally "exotic" from foreign culture, is a result of passive urbanization in colonial background. It has no foundation in Chinese civilization, even if there was once a Baroque tendency in traditional Chinese grid plan (Funo, S., 2003) in different geometric pattern. So, to clarify the transformation of Baroque ring-radial spaces in the worldwide context is the prerequisite of understanding its import into China. According to the investigation in Chapter 2.4, Baroque ring-radial spaces originated from the symbolism of power in 17th century, but accompanying the development of Functionalism and Modernism in the late 19th century, they started to be endowed with more concrete functions, such as calming traffic. Meanwhile, Baroque ring-radial spaces differentiated into diverse concrete forms to fit the local context, so were the ones implemented in China. As a result, Baroque ring-radial spaces was imported into China when its symbolism was endowed with more concrete function, adding a tendency of Pragmatism in the cases in China. Moreover, the transformation of morphology and function of ring-radial spaces in the world set up a frame of reference for understanding how the "exotic" pattern adapted to the local conditions in Chinese cities.

From the above, it can be concluded that it is necessary to: 1) read the transformation process of urban morphology in Chinese cities from two perspective, the diversification of inherent pattern and the localization of imported pattern; 2) take grid pattern as representative inherent pattern to clarify how it diversified accompanying urban development; 3) take ring-radial spaces as particular imported pattern to clarify how they changed to adapt to local context; and 4) finally clarify the mechanism, similarities and differences of the above processes, so as to propose suggestions for future urban design .

Notes

*1) Urban historian Hideo Jinnai has argued that the railway terminal is, in fact, the center of the modem urban structure in Japan. Based on a lecture by Hidenobu Jinnai for the Edo/Tokyo Forum, Tokyo, November 1995. Refer to “Oshima, K., 1996”.

*2) Hideo Shibusawa (1892-1984), son of Shibusawa Eiichi (1840-1931), who first planned the development of Denenchofu.

*3) To develop a physical plan for parceling out the Garden City Corporation's land, Hideo Shibusawa visited Europe and America in 1919 for seven months. Refer to “Shibusawa, H., 1971”.

*4) Refer to “Comprehensive Urban Plan of Dalian City (2009-2010)”. Five Historical and Cultural Blocks in Dalian were listed. http://www.dl.gov.cn.

*5) Refer to Changchun Planning Bureau: http://www.ccghj.gov.cn.

*6) Refer to: Dupont Trolley Stations | dmped (dc.gov), https://dmped.dc.gov/page/dupont-trolley-stations; https://www.dupontunderground.org.

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Chapter 3 Formation of Blocks and Transition of Urban Planning Principles about Block Form

——Formation Process and Principle Reference of Grid Blocks in Beijing, China

3.1 Introduction

3.1.1 Background and Objectives

As the “basic unit” making up a city, blocks, are defined by street pattern which is the “skeleton” of a city and are highly unchangeable. The transformation of block arrangement reflects social change and economic development, and its physical form has been profoundly influenced by regulatory control (Ding, W., 2007). Simultaneously, it was the “practical issues in everyday lives through which citizens shaped urban forms collectively” (Chen, F. et al., 2013). Hence, its transformation process is possibly a physical clue of urban development process.

As a kind of inherent patterns of Chinese civilization, grid blocks have been implemented in numbers of Chinese cities, especially the ones with continuity in history. Beijing (Chinese: 北京; Japanese: 北京), the capital city and traditional city of China, has been constructed in grid plan. It originates from uniform urban planning and its construction is continuous in history. It is planned basing on uniform planning concepts and principles, but transformed diversely in microscope, either on purpose or spontaneously. As a result, Beijing is an appropriate case which represents the group of cities with inherent grid blocks, to understand their transformation process.

As urban blocks can be considered as a product of the combined influence of social, economic, historical, political, and environmental factors in a given geographical environment and historical period, thereby, reviewing the formation of blocks and their background at the specific time is the precondition for understanding the following transformation. In addition, the influence of economic dynamics, historical context, geographic environment, and the regional and religious concepts in the formation and development of urban form is not based on people's will, while, the regulatory guidance is the main factor that people can directly manipulate urban construction, so the regulatory control has a deep influence in the evolution of urban form. In China, the system of centralized government management from ancient times to the present (Wu, J., 1990) makes the factor of planning regulations and planning control quite important. Especially since the 1980s, with the unprecedented development of urban economy and urban construction, the dominant role of industry on urban form has been replaced by the mainstream development of commercialization, and a large number of mixed-function complexes have appeared in the city. Problems of urban morphology that need to be urgently solved, such as the disorderly organization of urban space and building forms, and the blurring texture, are generally controlled by urban development policies, urban planning and construction regulations and plans (Gao, C., 2018). The control of policies and regulations and the human manipulation of planning management have been intensified, and the control of relevant regulations has played a very important role in the development of China's urban form.

Hence, the objective of this chapter was to investigate the formation process of grid blocks in Beijing, and the relevant principles on blocks at both national level and local level, in order to clarify their possible influence on the subsequent transformation process of grid blocks. The proposed approach and findings of this chapter

contributes to further analyzing the process and dynamics of morphological diversification in Beijing in Chapter 4.

3.1.2 Previous Research

Among the studies about urban morphology of Beijing, the developing process is fully discussed, in ancient times (Fu, 2001; Li, J. et al., 2006; Li, J., 2009, Li, J., 2010; Deng, Y. 2003; Funo, S., 2015), Republic of China (Wang, Y., 2008; Wang, X., 2014), and modern time (Liu, X., 2009). For urban space analysis, the Old Town is usually focused, either on spatial transformation (Jinnai et al., 1996; Wang, J., 2003; Meyer, M., 2010) or conservation and renewal strategies (Chen, S., 2014). In recent years, more quantitative analysis with space syntax were conducted mainly on the Old Town (Zhang, J. et al., 2002; Dong, M. et al., 2007; Zhou, L. et al., 2018) or partial areas (Sheng, Q., 2012).

Limited research has taken block as the basic unit to clarify how similar grid blocks transformed diversely either on purpose or spontaneously. Among the few research on urban blocks, the current morphology of limited indicators was investigated, but their formation process together with the relevant principles that may influence the transformation have not drawn enough attention. Hence the clarification of grid block formation and the transition of relevant principles establish the foundation for clarifying the mechanism of diversification in the transformation process of urban morphology in Beijing.

3.1.3 Outline of Beijing's Urban Form and Block Pattern

Beijing is a planned imperial city over hundreds of years. It can be traced back to capital Yuan Dadu in 1274 (Yuan Dynasty, 1271–1368 CE), following closely an ancient Chinese planning model based upon concepts like the centrality of the city plan, concentricity of city walls, dominance of a north-south axis, a gridded street plan, and a square-shaped plan for the whole city (Zhu, J. 2004). Beijing was remodeled with new constructions under the Ming dynasty (1368–1644 CE), finalizing the prototype of the current Beijing. It is mostly inherited in Qing Dynasty (1644–1911 CE) and became the foundation of the new era of urban development after the establishment of the People's republic of China in 1949.

(1) Beijing 's urban form being unified but fragmental

Beijing has implemented a centralized government management system since ancient times, in continuity with top-down urban planning. Urban planning depends more on national investment and policies. And in different times, policies and plans have encouraged or hindered the evolution of urban forms to varying degrees (Wu, J.,1990). Therefore, principles became particularly significant in regulating block morphology (Gao, C., 2018). However, it is the changes of principles in different epochs that make Beijing also a city of fragments. Three models could be identified in Beijing, but not one of them has managed to get the upper hand. (Pierre-Alain. C,

2014): 1) The imperial city model, based on classical cosmology and the representational layout stated in Zhou Li, "The Rites of the Zhou Dynasty" (Wright, A. 1977; He, Y., 1985); 2) the socialist city model, as the product of socialist ideology, when cities were intentionally converted from consumption to production; 3) the neo-liberal city model, led by the rule of the market and the force of globalization. “For a capital that has been monocentric throughout its history, this characteristic has great potential from an urban viewpoint, to look towards future scenarios of indispensable polycentrism in the face of territorial and demographic growth” (Pierre-Alain. C, 2014), as well as creating local identities.

(2) Adoption of both off-scale super blocks and local-scale subdivisions

Beijing is sometimes viewed as a city of irreconcilable contrasts: between the old and the new, particularly, between traditional human-scale spaces and alien off-scale models. (Anne-Marie Broudehoux, 2004, 2007; Greco, C. et al., 2008; Marvin, C., 2008). Or it is described as a city that grows only via radical changes, where massive uprooting occurs and demolition becomes the main action of the urban planner (Thomas J. Campanella, 2008). However, the critique to some degree has missed a point. The large initial blocks in Beijing can also be called superblocks, their layout is changed by the insertion of small streets and alleys, creating smaller blocks and sub-blocks (Siksna, A.,1997). It builds up a bridge between “off-scale” and “human scale”, creating a resolution of “local-scale”. The space inside superblocks owns more closedness and inwardness in place making. It is more self-organized in local-scale, creating self-identity and then connects with urban conditions (Sheng, Q., 2012). Superblocks and their subdivision are unique in Beijing and they provide a transitionary level in creating block morphological diversity. (Fig.3-1)

Fig. 3-1 Fragmental images in Beijing, with both local-scale subdivisions and off-scale super blocks, constructed in different periods (Photos by author)

3.1.4 Definitions and Case Collection

(1) Functional classification of urban roads and streets

The urban road and street system can be classified into 4 categories in middle class: Expressway, arterial(trunk) road, secondary trunk road, and branch road (Ministry of Housing and Urban-Rural Construction of the People's Republic of China, “Standard for urban comprehensive transport system planning GB/T 51328-2018”, 2018).

Expressway, arterial(trunk) road and secondary trunk road are included in Arterial road system, and branch road mainly serves for local activities. As the scale descended, there are also Jiexiang Road and Hutong in "The detailed plan for the core area of the capital city of Beijing for the 2018-2035 period". The data of Arterial road system is based on the "Beijing City Master Plan (2016-2035)" (Fig.3-2) excluding the ones that have not been constructed yet.

Arterial(trunk) roads/ Secondary trunk roads are more likely to be inherited, but inside the blocks, especially the ones in large scale or tree-shaped, branch roads/alleys (subdivision) are more spontaneous and unordered (Liang, J., 2007).

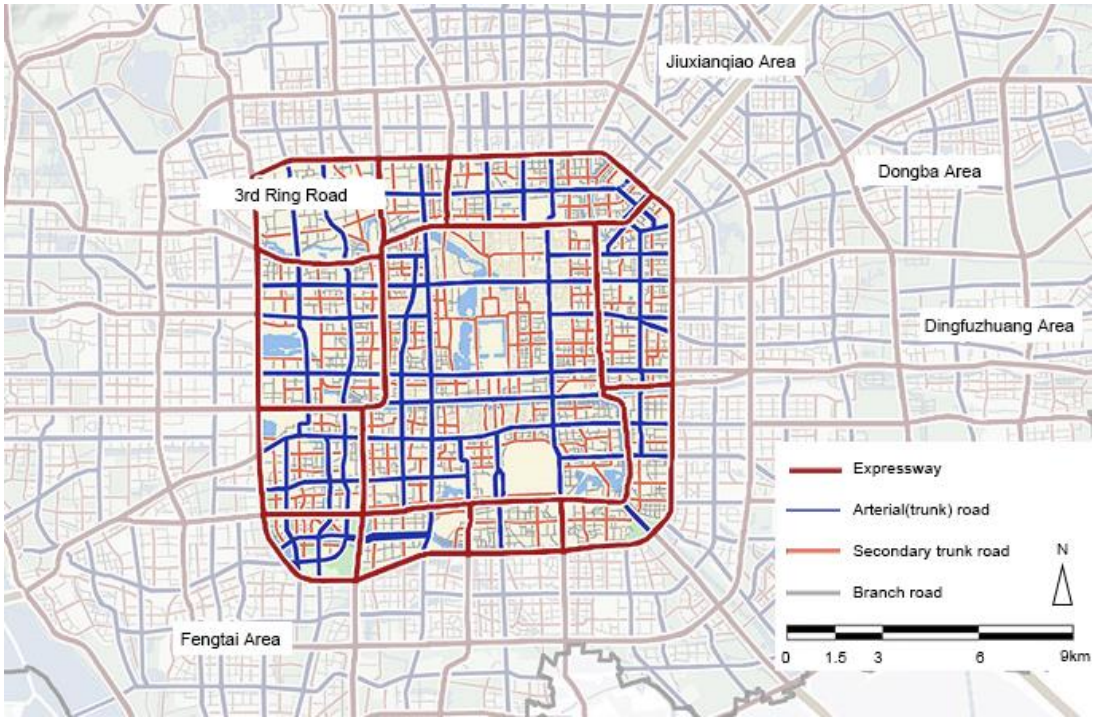


Fig. 3-2 Arterial road system within the 3rd Ring Road in Beijing

(By author, based on the Urban Road System Plan in the Central Area of Beijing, Beijing City Master Plan 2016-2035, Beijing Municipal Commission of Planning and Natural Resources, http://ghzrzyw.beijing.gov.cn/)

(2) Definition of Block

According to 3.1.4(1), expressway, arterial(trunk) road and secondary trunk road are included in Arterial road system, which defines the block boundary. Branch roads are used for inner space subdivision. Therefore, blocks considered in this research represent the areas bounded by expressway, arterial(trunk) roads or secondary trunk roads, and may be further subdivided by branch roads inside into sub-blocks. (Fig.3-3)

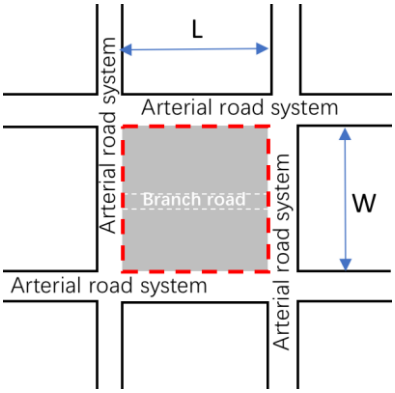


Fig. 3-3 Definition of Block in this research (By author)

(3) Definition of Grid Block

Although the road network in the central area of Beijing can be abstracted as grid plan, it is not as strict and pure as the gridiron pattern and checkerboard pattern (Kostof, S., 1991) in the United States. So, apart from the ones completely in rectangular shape, those contributes to grid pattern when combined with each other were also included (Fig. 3-4). Hence, gird blocks in the research refers to not only the Rectangle ones in 3.1.4(2), but also the ones that adopt at least 3 of the 4 sides being orthogonal to each other.

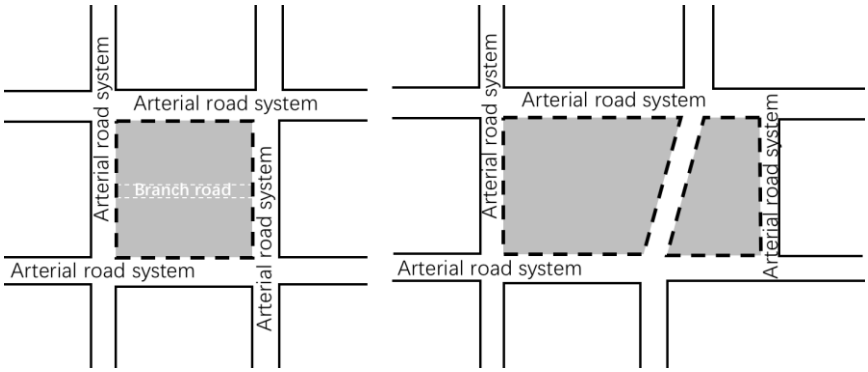


Fig. 3-4 Definition of Grid Block in this research (By author)

(4) Conditions of case collection

The cases were collected based on the above definitions, excluding those with large part of unconstructed areas or irregular river, lake, forest etc. inside. Moreover, cases were limited within the 3rd Ring Road of Beijing which covers most of the Core Area of Beijing (Fig.3-5). And, as the study focused mainly on physical form, so the range of grid block case collection is based on physical fringe, instead of administrative division. The distribution of branch roads is also marked on the map. It is mainly based on the “Beijing City Master Plan (2016-2035)”. But the current branch roads are not in the same width as regulated: some are of the same width as the Jiexiang road and Hutong, which is of lower level, and some have not been constructed yet. Hence, according to the Street View of Baidu Map, only the existed branch roads with at least round-way vehicle lanes were collected and marked on the following map.

In total, 194 cases were collected for further analysis. (Fig.3-6)

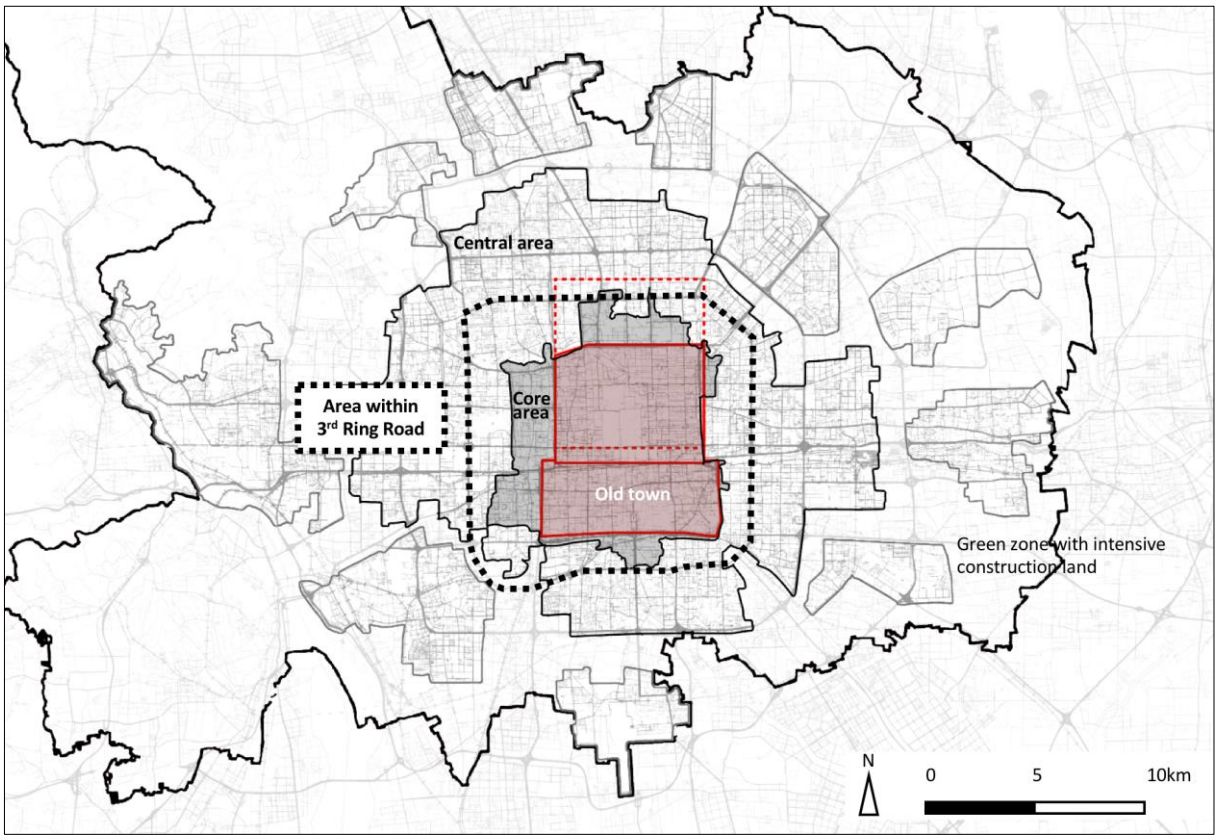


Fig. 3-5 Location of the Old Town, Core Area, 3rd Ring Road and Central Area of Beijing (By author)

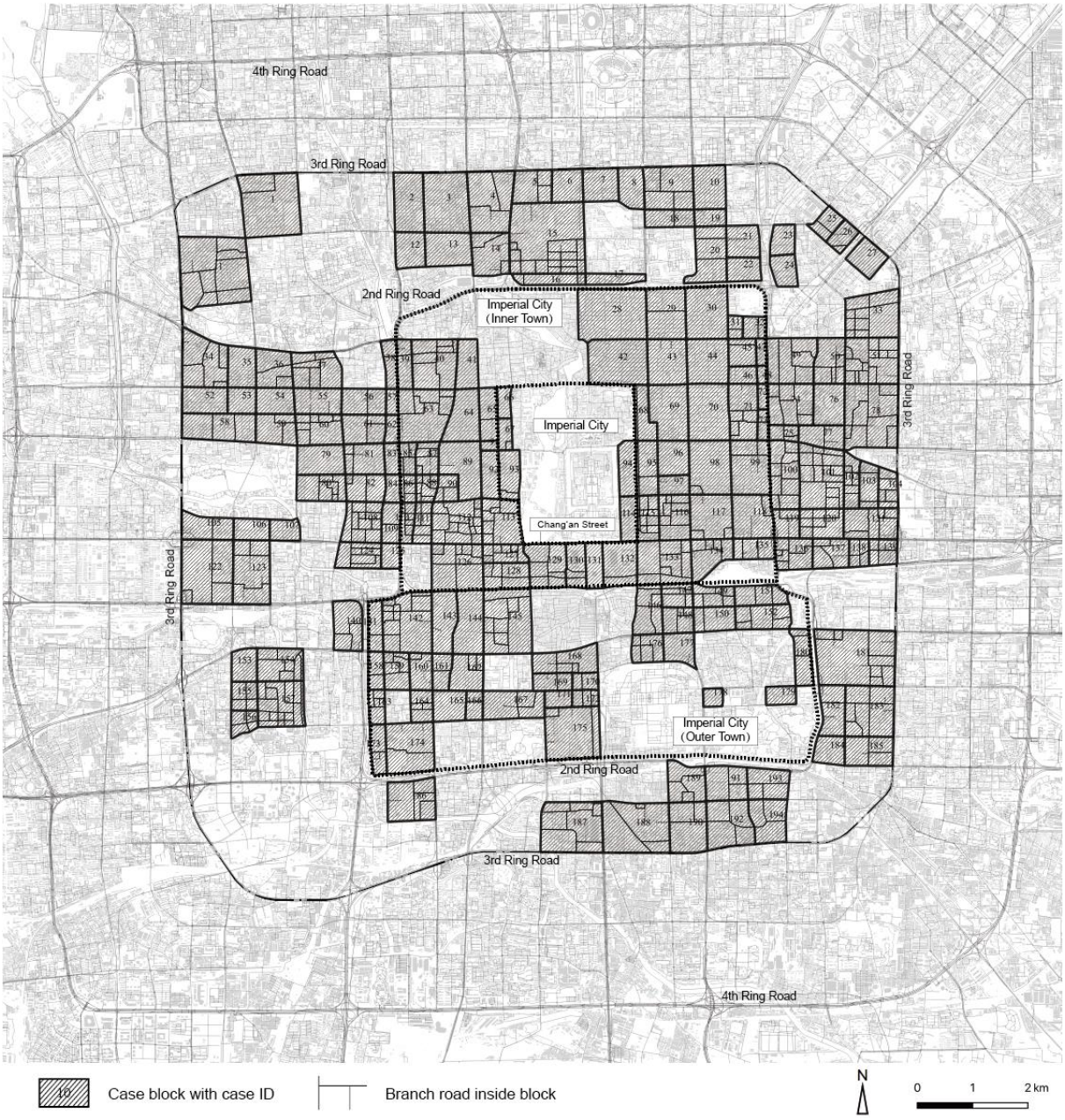


Fig. 3-6 Case grid blocks within the 3rd Ring Road of Beijing

(By author, base map from Baidu Map, https://map.baidu.com)

3.1.5 Research Methodology and Framework

Chapter 3.2 introduces the urban development stages of Beijing and investigates the formation process of the 194 grid blocks in Beijing based on historic maps. The formation process has been divided into 4 steps. Then, the time of each step was confirmed and corresponded to the urban development stages of Beijing. The urban development phases and the overlayered urban construction process are clarified with blocks as a clue. Moreover, the typologies of block formation process were classified based on the order of the above 4 steps, giving an overview of how the blocks in Beijing were constructed.

Chapter 3.3 introduces the urban planning system in China, extracting the contents that directly influence urban block design. The transition of Legislation system, Standard system about blocks at the national level were arranged. Then, the characteristics of principles were concluded.

Chapter 3.4 shows the transition of urban planning principles and city plans that influenced the block form in Beijing at the local level. According to the urban development stages divided in Chapter 3.2, the characteristics of each stage and the overall transition tendency were clarified.

Chapter 3.5 summarizes the conclusions about the formation and principles related to grid blocks. It established the background and principles' reference for the analysis of diversification in Chapter 4.

3.2 Block Formation Process

3.2.1 Four Time Points in the Process of Block Formation

The process of block formation can be decomposed and described by four important time points: the time of initial construction, the time of block boundary being defined, the time of current subdivision (branch roads) being formed, and the time of current block pattern being finished. They are defined as following in this research (Fig.3-7):

1) **The time of initial construction.**

   The target area has begun to be constructed and has covered over half of the area, but it has not formed a clear block yet.

2) **The time of block boundary being defined.**

   The grid block was clearly defined as a separated and independent area with urban roads as boundaries.

3) **The time of current subdivision (branch roads) being formed.**

   All the branch roads within the block have been constructed and have not changed significantly until now.

4) **The time of current block pattern being finished.**

   As there are some cases that had their boundaries defined first, subdivision finished second, while, some had the branch roads constructed first and boundaries defined later. This indicator refers to the time that both boundary and branch road subdivision were finished.

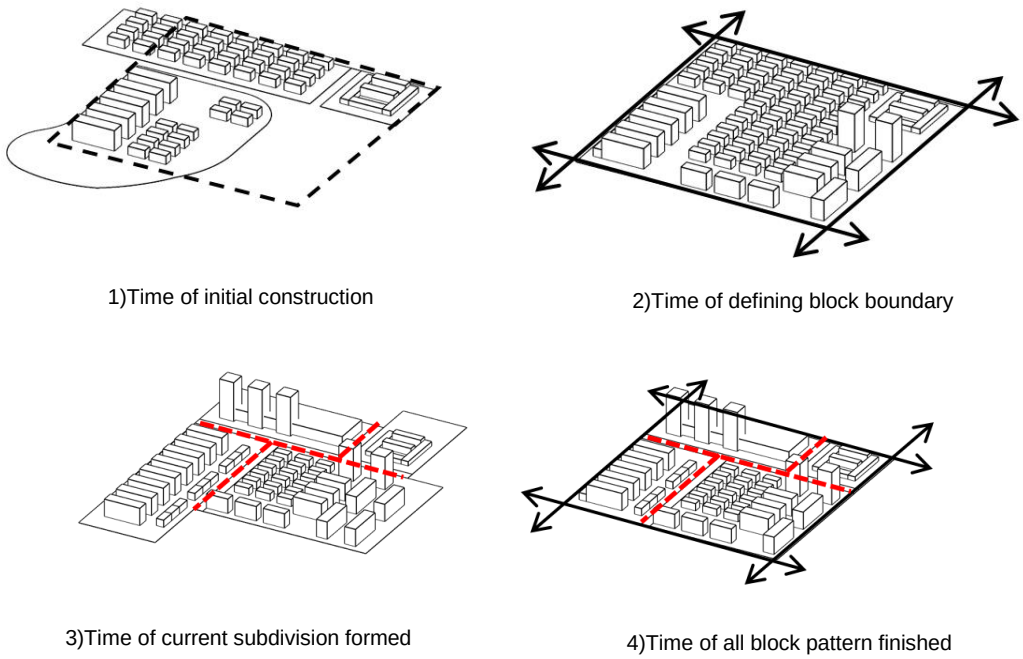


Fig. 3-7 Four steps in the process of block formation (By author)

3.2.2 Urban Development Stages of Beijing

The development of Beijing is divided into five periods according to the most dramatic changes of the city forms throughout its history (Table 3-1). Ⅰ. The imperial city period (1153~1911), Ⅱ. The initial modernization period (1911-1949), Ⅲ. Socialist planned period (1949-1982), Ⅳ. Socialist marketing period with rapid urban development (1982-2003), Ⅴ. Internationalization period with urban development and redevelopment (2004-present).

Table 3-1 Urban development stages of Beijing

I. Capital city in ancient period (1153-1911)	1153-1267: Capital of Jin Dynasty
	1267-1369: Capital of Yuan Dynasty
	1369-1900: Capital of Ming&Qing Dynasty
	1900-1911: New policy in late Qing Dynasty
II. The initial modernization period (1911-1949)	1911-1928: Municipal Office of Beiping (now Beijng) ***1911 Revolution(Xinhai Revolution, 辛亥革命), ended up Qing Dynasty and began the modern time***
	1928-1937: Beiping (now Beijng) Municipal government
	1937-1945: Japanese occupation
	1945-1949: The independent exploration period of Beiping (now Beijng) government
III. Socialist planned period (1949-1982) With the preliminary formation and repeated exploration period	1949-1957: Early New China and Soviet Assistance ***The foundation of People' Republic of China in 1949***
	1958-1965: Great Leap Forward" period
	1966-1982:"Cultural Revolution" period and later time
Ⅳ. Socialist marketing period with rapid urban development (1982-2003)	1982-1992: The first stage of reform and opening up ***Beijing Master Plan (1982)*** 1993-2003: The deep stage of reform and opening up ***Beijing Master Plan (1993)***
Ⅴ. Internationalization period with urban development and redevelopment (2004-present)	***Beijing Master Plan (2004)***

3.2.3 Time of the Formation Process of Grid Blocks and its Corresponding Urban Development Stages

Based on the satellite maps and city maps of Beijing from 1750 to present, the approximate time of the above four time points in block formation were confirmed. Then, the corresponding stages of Beijing's urban development stages were recorded and shown in Fig.3-8. (Map sources: Beijing City Lab,

http://www.beijingcitylab.com; Satellite maps of year 1961, 1967, 1972: U.S. Geological Survey, https://earthexplorer.usgs.gov.; Satellite maps after 2000: Google earth.)

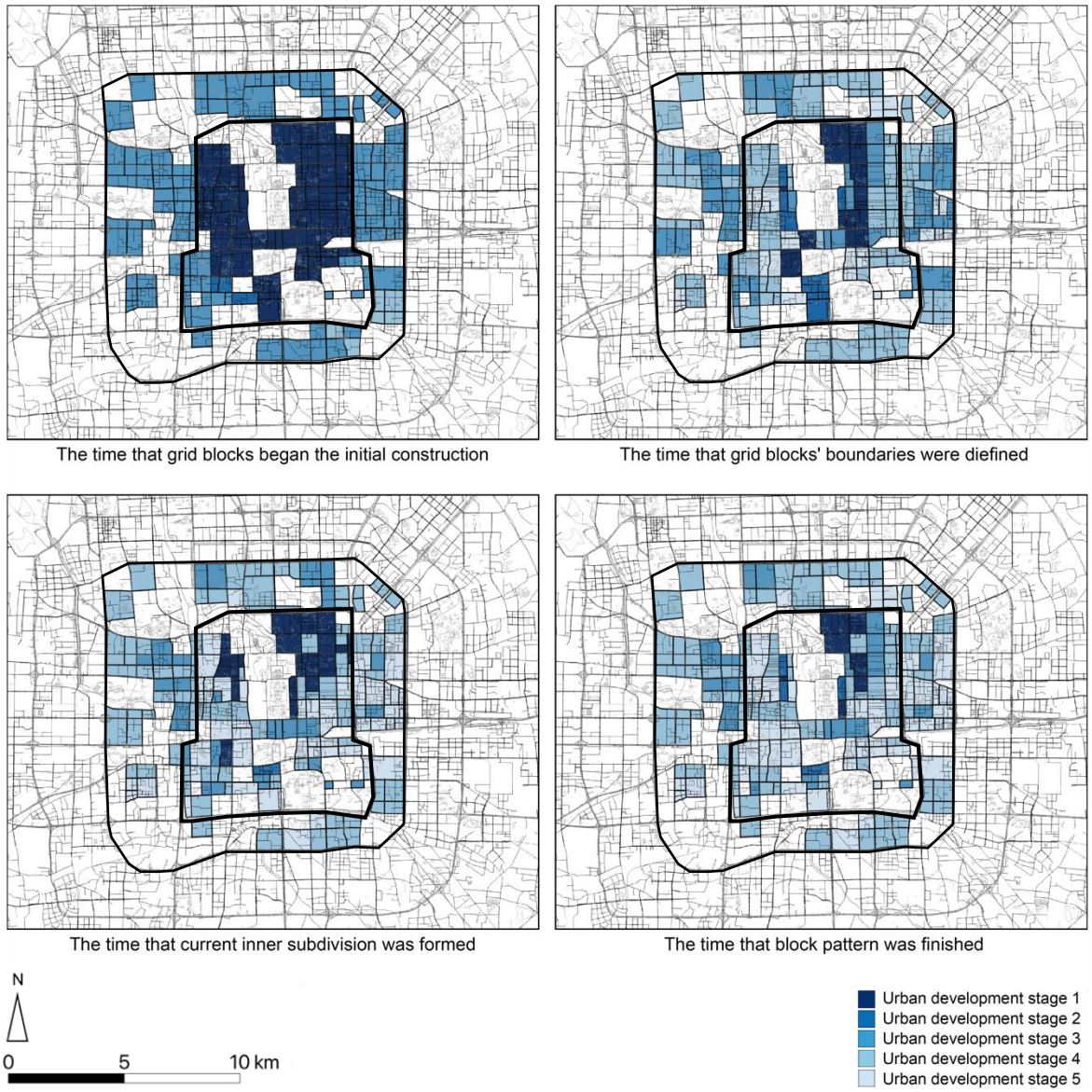


Fig. 3-8 The time (corresponding urban development stages) of the four steps in block formation process (By author)

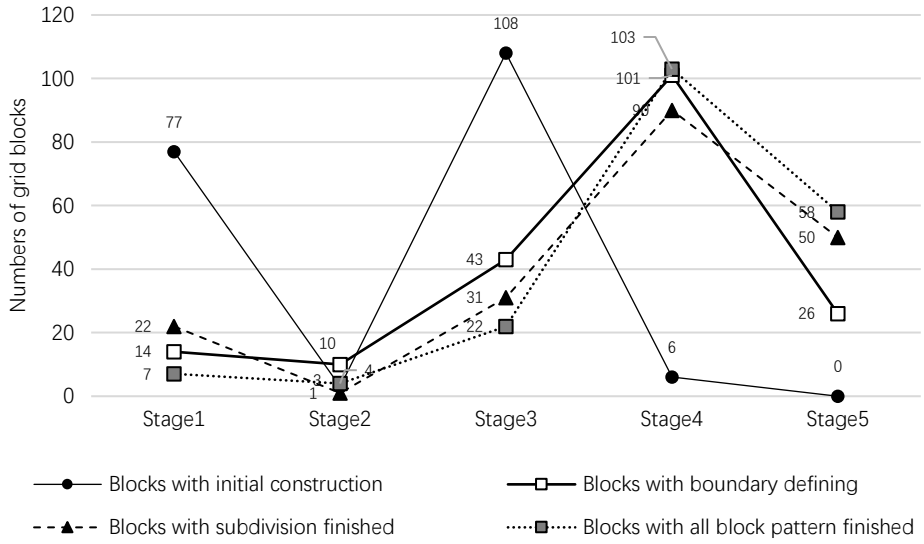


Fig. 3-9 Numbers of cases in each stage based on different formation process (By author)

Although the Old Town of Beijing originates from ancient times, the changes and reconstructions were disruptive. Only 14 grid blocks are inherited from the initial boundaries before 1911(Fig.3-9), and they are mostly closed to the Palace City, near the central city axis. Furthermore, only 7 of these ones inherited the original subdivision. In other words, only seven of 194 grid blocks inside the Old Town of Beijing persist their original urban patterns. If considering the building replacement, the change would be more surprising.

The outer town of the Old Town was not completely constructed before 1911, which offered a chance for implementing the western modern urban planning concept there. So, a few grid blocks were generated during 1911-1949 in the outer town and the embassy area near Dongjiaomin Lane. But affected by the 2nd World War, the urban modernization process was stopped.

Grid blocks which were started construction in Stage 3 Socialist planned period (1949-1982) adopted the largest number (108 cases), but less than half of them were clearly defined as a “block” (43 cases). It implies a rather rough sprawl tendency in every direction based on the Old Town. The clearly defined blocks were mainly formed towards the west and the east out of the Old Town, which reveals a relative precise sprawl in these two directions. The sprawl was supposed to be following the grid network inside the Old Town, but as a consequence of the social stagnant in the late 1960s and 1970s, many built-up areas remained undefined during Stage 3.

Stage 4 encountered the trend of redevelopment. The huge changes from Socialist planned economy to Socialist marketing economy resulted in new land-use demand. Hence, urban patterns were changed correspondingly to meet new requirements. Not only the cases that had not been completed in Stage 3 were defined and subdivided, but some cases in the Old Town were re-defined or re-subdivided. As the Fig.3-7 shows, 103/194 cases had their block pattern finished, which reached the peak of block construction.

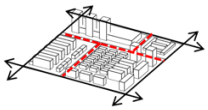
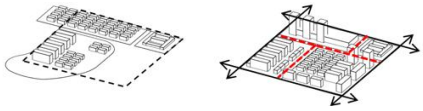
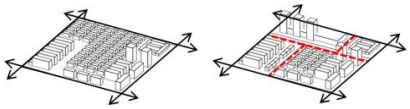
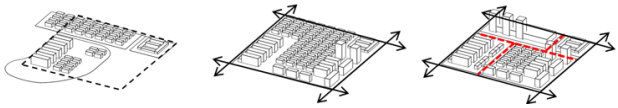
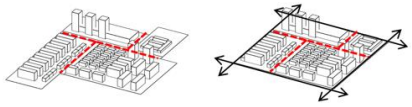
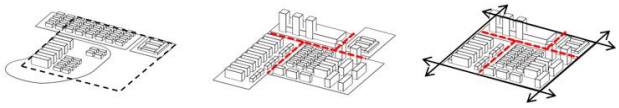
Last but not least, there is no block that is firstly constructed in Stage5 within the 3rd Ring Road, and only 26 cases had their boundaries defined in Stage5. However, 50 cases, that is more than 1/4 of the 194 blocks, have their inner patterns being re-subdivided. It is a continuity of redevelopment of the built-up areas of Beijing from Stage 4.

As a result, over 1/3 of the cases within the 3rd Ring Road of Beijing were initially constructed in ancient times but few patterns were inherited, which can be an important factor that endowed Beijing with an image of "massive uprooting and demolition". Most of the areas started the construction process during 1949-1982, reflecting a period of rough urban sprawl, while the redevelopment process got on stage and reached the peak during 1982-2004. The tendency continues but in a weaker degree after 2004.

3.2.4 Typologies of Formation Process of Grid Blocks

According to the time points and corresponding urban development stages confirmed in 3.2.3, the formation process of grid blocks in Beijing can be classified into 6 typologies based on the order of initial construction, boundary defining, and subdivision (Table 3-2).

Table 3-2 Typologies of formation process (By author)

	Type		Number of cases	Diagram
Block boundary and subdivision formed at same stage	**Type A1**	□● Original pattern	28	
	Type A2	▲—□● Initially constructed without forming block; then re-define & re-subdivide	81	
Boundary was defined first, then subdivided	**Type B1**	□●—● Original boundary, then re- subdivide	29	
	Type B2	▲—□—● Initially constructed without forming block; then re-define; finally re-subdivide	25	
Subdivision formed first, then boundary formed	**Type C1**	●—□ Original subdivision, then re-define	24	
	Type C2	▲—●—□ Initially constructed without forming block; then re-subdivide; finally re-define	7	
▲: Initial construction without forming block; □: Boundary defined; ●: Subdivision formed				

More than half of the blocks have their boundaries defined and inner space subdivided in the same period (Type A1, Type A2), and they were mostly a measure of re-arranging the urban spaces that were roughly constructed previously (Type A2).

There are 54 cases (Type B1, Type B2) that were subdivided after the block boundaries were defined, among which 7/14 of Stage 1 and 22/43 of Stage 3 (Type B1) changed the original subdivision patterns (Fig.3-10). As the branch roads in Beijing are mainly for service functions that have close relationship with place-making and daily life in urban spaces, the high rate of re-subdivision may lead to loss of local identity. It is not only in urban morphology, but in human belongings as well.

The cases that maintain the existed subdivision with boundaries being defined later(Type C1, Type C2) take up less than 1/6 of all. The subdivision were not planned based on the boundaries, but from the view of urban road network and traffic. As a result, it may lead to a weaker connection between the inner patterns and the block boundaries. The inner patterns are cut off suddenly by the arterial road system, leaving the blocks and adjacent blocks separated from each other.

Moreover, from the numbers of each process type based on the time the block was defined (Fig.3-10), blocks defined in urban development Stage 1, Stage 2, and Stage 3 are mostly in Type B (B1 or B2). It means that they were re-subdivided in the later periods. The distinctive urban forms that may maintain the social identities of specific time were probably lost during the re-subdivision process. On the contrary, cases defined in Stage 4 mainly had their boundaries and inner patterns constructed simultaneously. Large numbers of new blocks were built up, but whether they were planned in a brand-new way or implemented with inherent patterns from the previous, need to be further investigated.

Hence, although Beijing has a continuous history and a rather unified urban planning process from antiquity, its process of forming the current demarcative urban pattern had twists and turns. Some patterns were constructed integrally, and some were developed in a serial order, while some others were formed in a more passive way without enough consideration for the connection inside and outside the block. The uncertain order of formation process endowed the traditional grid blocks with higher possibilities in diversifying into more patterns.(Fig.3-11)

According to the typologies of block formation process classified above, grid blocks in Beijing were not constructed in a certain order or integrally within specific urban development stages. Their formation covers a large time span. Consequently, their construction may be required to comply the principles of different periods, lacking in continuity and integrity. Moreover, the uncertain order of boundary defining and inner space subdivision increases the separation between the two elements.

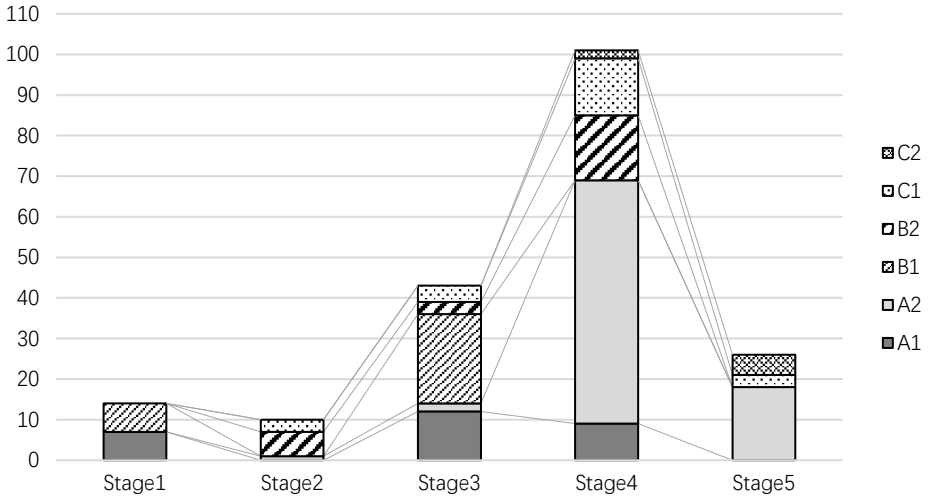


Fig. 3-10 Numbers of each pro-type based on the time the block was defined (By author)

Fig. 3-11 Distribution of each formation process type (By author)

3.3 Urban Planning System and Principles Related to Block at National Level

3.3.1 Urban Planning System in China

Principles that may have influences on urban block form can be extracted from the urban planning system in China (founded in 2008). They are divided into 3 categories: (National Urban Planning Practice System Management Committee, 2011)

1) Legal and regulatory system, that influences urban form in a macroscopic and implicit way;

2) Standard system, that regulates urban form with some of the quantitative index;

3) City plans, that shape the urban form directly and intuitively. (Fig.3-12)

(1) Legal and regulatory system

The hierarchy of the urban and rural planning legal and regulatory system includes Laws, Administrative Regulations, Local Regulations, Autonomous Regulations, Separate Regulations and Rules (Legislation Law of the People's Republic of China). It is decided by People's Congresses and People's Governments at All Levels from the national to the local based on the Law of the People's Republic of China on Urban and Rural Planning. It is also called the “vertical system”.

Moreover, apart from the “vertical system”, urban planning should also be restricted by the “horizontal system”, which includes relevant laws, administrative regulations and relevant departmental rules, such as Land Administration Law, Cultural Relics Protection Law and Construction Law.

(2) Technical standard system

Technical standard system refers to the technical and management requirements to achieve the goals related to quality, safety, health, environmental protection and public interest. It includes basic standards, general standards, and specialized standards.

(3) City plans

The implementation of city plans, especially statutory plans including mandatory content, result in the most direct and significant impact on the urban form (Xu, J., 2010). As the City Master Plan regulates arterial road network, it becomes the basic principle that affects block form intuitively.

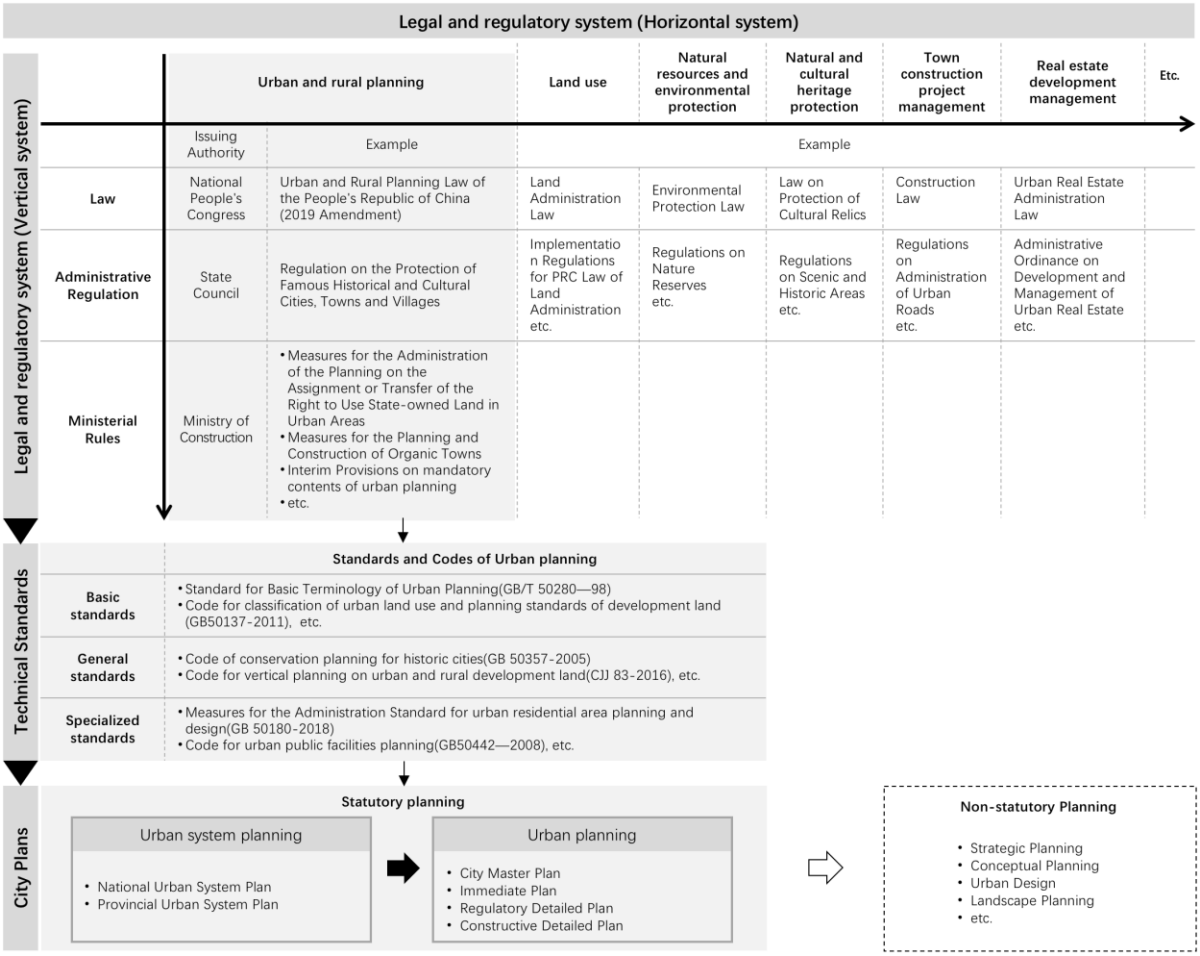
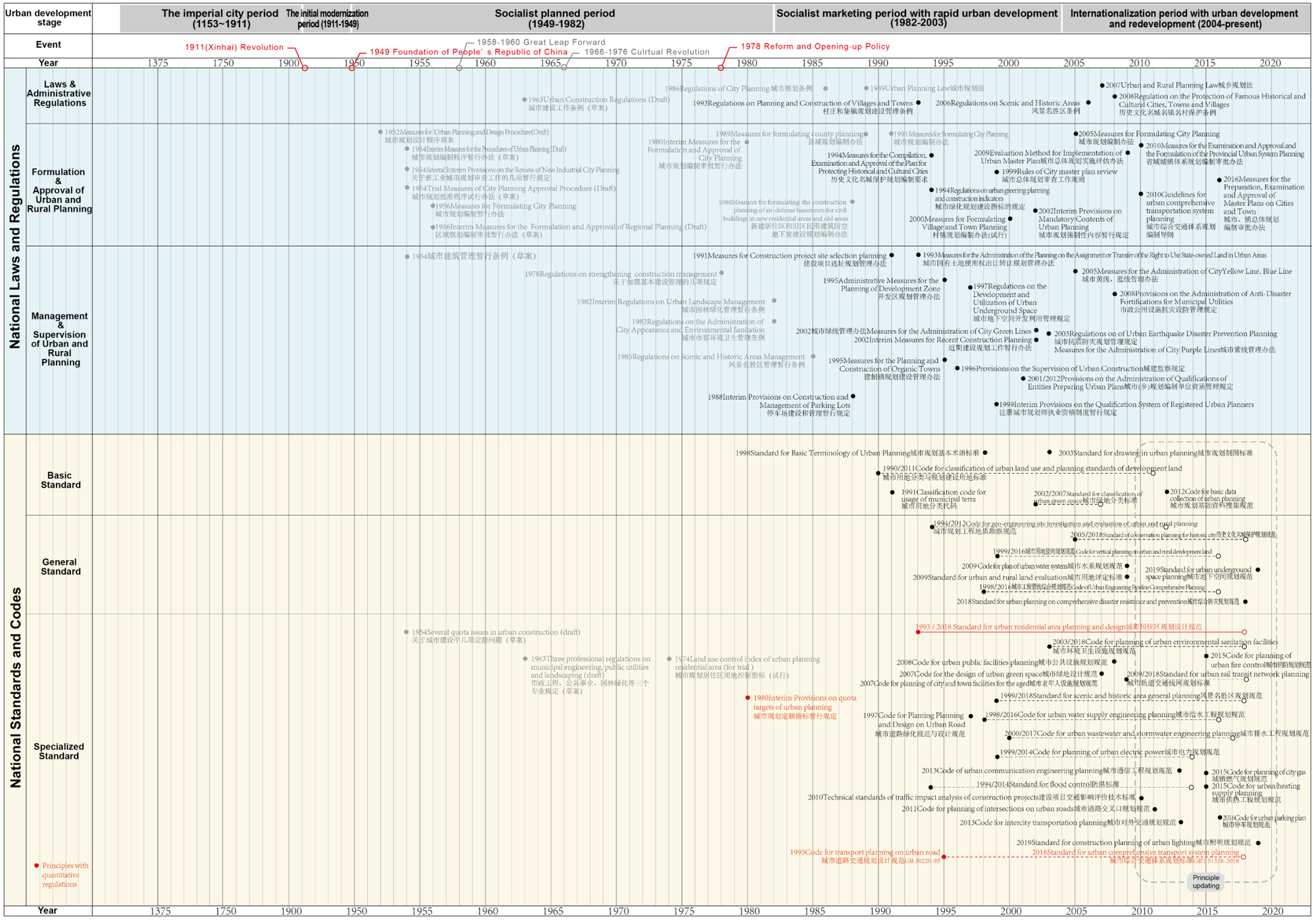


Fig. 3-12 Urban Planning System (2008) in China (By author)

3.3.2 Transformation of National Principles related to Block

At the national level, the legal and regulatory system, and the standard system of urban planning after the foundation of PRC (People's Republic of China) are listed in Table 3-3. Among them, the ones with quantitative indictors about block form are marked in red. Current system on Urban Planning was begun to be set up from 1988. Most of the standards were first proposed between 1990 and 2005, and have been renewed once after 2005. Although standards and codes usually regulate urban planning in a quantitative view, they are mainly targeting at solving the functional problems on health and safety, such as fire prevention, earthquake, lighting, ventilation, transportation and sanitation. Until now there have been only 5 standards (one was abolished without renewal) that have mentioned quantitative indicators about block morphology. In addition, Quantitative Indicators about blocks are from the view of 1) residential area, and 2) transport system.

Table 3-3 Transition of urban planning principles on block and street at national level (By author)



National Commission of construction, Interim Provisions on quota targets of urban planning, (1980)

[Contents]

Quota indicators for master plan and quota indicators for detailed planning of residential areas.

[Quantitative Indicators on Block and Street]

Table 3-4 Relevant regulations in Interim Provisions on quota targets of urban planning, (1980)

	Urban size	1st-class road	2nd-class road	3rd-class road	4th -class road
Road width		40-70m	30-60m	20-40m	16-30m
Vehicle lanes		⩾4	⩾4	⩾2	⩾2
Corresponding classification of urban roads and streets	Mega cities (Beijing)	Arterial road	Secondary trunk road	Branch road	
	Big/ Mid-sized cities		Arterial road	Secondary trunk road	Branch road
	Small-sized cities			Arterial road	Secondary trunk road
Density of road network	Arterial road and Secondary trunk road: 2-3 km/km²				
Block size	Distance between Arterial roads or secondary trunk roads: 800-1200m				

The Ministry of Construction, Code of Urban Residential District Planning & Design GB50180-93, (1993/2002/2016)

[Contents]

Standards and quota indicators on 3 levels of residential district: urban residential area (defined by urban arterial road network or natural boundary), residential quarter (defined by urban road network or natural boundary), residential group (defined by roads of residential quarter level).

[Quantitative Indicators on Block and Street]

Table 3-5 Relevant regulations in Code of Urban Residential District Planning & Design GB50180-93

	Urban residential area			Residential quarter			Residential group		
Year	1993	2002	2016	1993	2002	2016	1993	2002	2016
Number of residences	30000-50000	30000-50000	30000-50000	7000-15000	10000-15000	10000-15000	1000-3000	1000-3000	1000-3000
Land per capita (㎡, based on building storey)	12.5-21	17-47	17-47	10-25	10-43	10-43	7-20	8-35	8-35
Total land use area(ha)	37.5-105	51-235	51-235	7-37.5	10-64.5	10-64.5	0.7-6	0.8-10.5	0.8-10.5
Road width	⩾20m	⩾20m	⩾20m, 30m if possible	5-8m	6-9m	6-9m	3-5m	3-5m	3-5m
	Same level with urban branch road						Paths connecting buildings ⩾2.5m		

The Ministry of Construction, Code for transport planning on urban road GB 50220-95 (1995)

[Contents]

Standards on urban public transport, cycle transport, pedestrian transport, freight transport and road system, to carry out urban road traffic planning and design scientifically and rationally.

[Quantitative Indicators on Block and Street]

Table 3-6 Relevant regulations in Code for transport planning on urban road GB 50220-95 (1995)

	Urban size and population（10000）		Expressway	Arterial road	Secondary trunk road	Branch road	City center with FAR ＞8	Commercial area
Density of road network	Big cities	＞200 (Beijing)	0.4-0.5	0.8-1.2	1.2-1.4	3-4	Branch road network 12-16	Branch road network 10-12
		≤200	0.3-0.4	0.8-1.2	1.2-1.4	3-4		
	Mid-sized Cities	—	1.0-1.2	1.2-1.4	3-4			
Block size	Proportion of block defined by Secondary trunk road and Branch road is 1：2~1：4							

The Ministry of Housing and Urban-Rural Development, Standard for Urban Residential Area Planning and Design GB50180-2018, (2018)

[Contents]

The standard is based on the principle of “small block and dense road network”. The quota indicators are regulated on 4 levels of urban residential area (residential district):

1) 15-min pedestrian-scale neighborhood: Residents can walk for 15 minutes to meet their material, life and cultural needs; It is generally enclosed by urban arterial road network or land use boundary; It usually includes three or four 10-min pedestrian-scale neighborhoods.
2) 10-min pedestrian-scale neighborhood: Residents can walk for 10 minutes to meet their basic material, life and cultural needs; It is generally enclosed by urban arterial road network, branch roads or land use boundary; It usually includes three or four 5-min pedestrian-scale neighborhoods.
3) 5-min pedestrian-scale neighborhood: Residents can walk for 5 minutes to meet their basic living needs; It is generally enclosed by branch roads and higher-level urban roads or land use boundary; It usually includes 3-4 neighborhood blocks.
4) Neighborhood block: Residential land enclosed by branch roads or other urban roads or land use boundary. It is the basic residential unit formed by the combination of residential buildings.

[Quantitative Indicators on Block and Street]

Table 3-7 Relevant regulations in Standard for Urban Residential Area Planning and Design GB50180-2018, (2018)

	15-min pedestrian-scale neighborhood	10-min pedestrian-scale neighborhood	5-min pedestrian-scale neighborhood	Neighborhood block (Residential group in GB50180-93)
Walking distance	800-1000m	500m	300m	——
Number of residences	50000-100000	15000-20000	5000-12000	1000-3000
Land per capita (㎡, based on building storey)	27-51	22-51	19-47	⩽36
Total land use area(ha)	About 130-200	About 32-50	About 8-18	2-4
Road width	Urban road network 14-20m			Main path⩾4m, others⩾2.5m
Density of road network	8 km/km²			
Block size	Distance between urban road network: ⩽300m, the size of neighborhood block is better between 150-250m			

<u>The Ministry of Housing and Urban-Rural Development, Standard for urban comprehensive transport system planning GB/T 51328-2018, (2018)</u>

[Contents]

It proposes new classification of urban roads in detail. Specific and detailed standards are regulated according to the functions of different urban areas, and road classification.

[Quantitative Indicators on Block and Street]

Table 3-8 Relevant regulations in Standard for urban comprehensive transport system planning GB/T 51328-2018, (2018)

Function zoning		**Residential area**		**Business districts and central areas with dense employment**			**Industrial area / Logistics area**		
Block size	**Length (m)**	⩽300m		100-200m			⩽600m		
	Width (m)	⩽300m		100-200m			⩽600m		
Density of road network (km/km²)	**Urban road network**	8 km/km²		10-20 km/km²			4 km/km²		
	Arterial road	1.5-1.9 km/km²; distance between arterial roads: 0.9-1.5km							
Classification of urban roads		**Arterial road**					**Collector road**	**Branch road**	
		Expressway (excluding frontage road or serviced road)		Arterial road (III includes the constructed secondary trunk roads that mainly afford traffic function)			Secondary trunk road	Branch road (II includes the connecting paths within neighborhood blocks)	
		I	II	I	II	III		I	II
Road width (m)		25-35	25-40	40-50	40-45	40-45	20-35	14-20	-
		Width of arterial road ⩽70m (including frontage road or serviced road)							
Number of vehicle lanes		4-8	4-8	6-8	4-6	4-6	2-4	2	-

3.3.3 Characteristics in National Principles

(1) The lack of clear physical definition of block

The blocks referred in this research resemble the ancient Lifang system in history. Lifang system is rather an administrative system than a physical form system, even though the physical form of Lifang accorded with the administrative unit in Ming Dynasty. And the emphasizing on governance in Qing Dynasty made the administrative unit and physical form separated with each other, so the physical form of "block" was ignored.

During the modern urbanization, "residential district", "residential community" etc. were used in regulating the urban construction. They were limited mainly based on the consideration of population and area per capita, instead of the physical pattern itself. Simultaneously, urban road network also owned priority in urban planning, either its distribution or its density. Block is set back as an accessory of urban road network.

The definite attention has not been put on "block" until 2018 with hard index (Standard for urban comprehensive transport system planning GB/T 51328-2018). Before that "block" is discussed mainly in guidelines and suggestions. As a result, though there have been similar concepts as "block", the specific regulations on block's definition still have a short history in China, leaving high flexibility in block pattern diversification.

(2) Insufficiency in and between regulations causes uncertainty in block pattern

After referring to the principles in 3.3.2, some insufficiency and contradictions can be found in and between the relevant principles.

a) Insufficiency in "Code of Urban Residential District Planning & Design GB50180-93".

It can be found that the smallest "high-rise residential quarter" (residential community with all high-rise residential buildings) was regulated as at least 7 ha in the 1993 version, but it has reached 10 ha in the 2016 version. If the buildings adopt a combination of high-rise and multi-story, the size of residential communities will be larger. As the traffic inside is more inward and no external vehicles are allowed to pass through, it means that the distance between urban branch roads around the community must be at least 265m (1993 version) and 333 m (2016 version). The distance may reach 800m when the residential community is supposed to be 64.5ha. Hence, although the indicators in the code transformed from the 1993 version to 2016 version, the land use area did not decrease based on the Code, and it did not meet the requirements of "small block".

b) Insufficiency in "Code for transport planning on urban road GB 50220-95 (1995)"

According to the regulated indicators, the road network density of expressway and arterial roads can be calculated as 2.4-3.1 km/km². Therefore, the distance between arterial roads (block size) is 645-833m, which belong to a super block pattern. And it had not been revised for almost 13 years until 2018, even "small block, dense network" was encouraged in the recent decade. (Wang, Z. 2004)

c) Contradictions between different principles

"Code for transport planning on urban road GB 50220-95" regulated the total branch road network density as 3-4 km/km², which means the distance between branch roads need to be 500m-667m. But it may include large

areas of industrial areas with lower road network density, so the actual density in the central area of a city would be higher, reaching 6-8 km/km² (Bian, H., 2010), with the distance between increasing to 250-333m. Moreover, in the city center, the branch road network density tends to be 12-16 km/km², of which means the distance between branch roads need to be 125-167m. It is contradictory with the at least "10ha residential community without branch roads go through" which is regulated in the "Code of Urban Residential District Planning & Design GB50180-93(2016)". The lack of branch roads on Chinese urban roads is precisely the concrete result of this contradiction reflected in the real world.

Therefore, it was almost impossible to meet all the regulations in block design, and developers or urban designers have to choose some of them to follow. Undoubtedly, the outcome differentiated into more diverse and uncertain patterns, even they were controlled by the same series of principles. But it has been revised to some degree since the proposal of "Standard for Urban Residential Area Planning and Design GB50180-2018, (2018)" and "Standard for urban comprehensive transport system planning GB/T 51328-2018, (2018)", the contradictions between residential land use(≤300m) and road network density (8 km/km²) was modified (Table 3-8).

In order to encourage more diverse patterns that are more controllable, it is necessary to keep comprehensive consideration on controlling indicators in the relevant regulations on the basis of rethinking the reasonable scale of blocks to make them consistent with the established goals of urban planning.

3.4 Transition of Urban Planning Principles on Blocks in Beijing at Local Level

3.4.1 Local Urban Planning Principles on Blocks in Beijing

At the local level, Beijing continuously conducted its City Master Plan after modern time. Regulations and standards proposed by the local government adapted more to local conditions. They not only target at solving the functional problems on health and safety, but also take historic conservation, urban identity and streetscape etc. into consideration. Compared with the national principles, local principles adopt more direct impact on block form. And their transformation reflects the changes of focus on urban planning.

Table 3-9 Relevant principles from year 1153 to 1911

Year		Jin Zhongdu 1153-1267	Yuan Dadu1267-1369	Ming1369-1644			Qing1644-1911
Principle / Source		"Civil engineering in Kao Gong Ji"	"Civil engineering in Kao Gong Ji", "Zhou Yi"				Complete Map of Peking, Qianlong Period（乾隆京城全图）
Characteristics			• 6700m×7600m（EW×NS）	North city wall moved 2500m to the south (year 1369)	South city wall moved 500m to the south (year 1419)	Construction of the Outer Town:8000 m×3000m (year 1553)	• It inherited the central axis of Yuan Dadu and extended to the south to the Temple of Heaven; the northern section retreated southward to the Bell Tower and Drum Tower. The total length of the axis was about 7.8 km.
Guidelines/Characteristics	Street						• Beijing's inner town: the widest street leading to each gate (main road). The area divided by wide streets generated many east-west small streets. • Because of the juxtaposition of the southern (Outer Town) and northern (Inner Town) towns and the natural conditions, the Outer Town generated more inclined streets, with strong self-organization.
	Block			• "Fang" (similar to block) is an important basic management/ administrative unit and spatial unit. • "5 Cheng- 36 Fang- 100 Pai- 670 Pu- 1288 Hutong" 5-level management system. • 1 Hutong included 361 people.			• Management/administrative unit is detached from the street network. • Replace the 36 Fang (block) of Ming Dynasty with 8 gated communities, with Niulu(牛录) as the basic unit of community organization. 1 Niulu is 1.4 Hutong, including 505 people
Quantitative regulations	Street		• "Big street": 24steps (36.96m, mainly NS); "Small street""12 steps (18.48m); Hutong:6 steps (9.24m, mainly EW).				
	Block	62 Fang (440× 430m)	• Distance between big street and small street: 440 steps (672m); • Distance between Hutong: 50 steps (77m), 44 steps (67.2m) excluding streets' width				• Basic block model: 44 steps × 44 steps × 10 (67.76 × 677.6m); • Basic distance between E-W hutongs is 50 steps (77m), 23 places; some cases are over 100 steps, 150 steps, 200 steps, or 250 steps

Table 3-10 Relevant principles from year 1911 to 1949

Year		1911-1928	1941	1947
Principle /Source			**Beijing City Planning Outline (北京都市計画大綱)**	**Beiping Urban Planning Design Collection (北平都市計画設計資料集第一集)**
Characteristics		• No perfect urban management and construction institutions and systematic urban development guidelines; It is slowly moving forward in the "patchwork" modernization process.	• Beijing's first modern and comprehensive urban plan; • More focus on new town; • Leave influence on the following construction of East Suburban new town and West Suburban new town areas; Stopped in 1945	• Based on a review of history and current situation, Beijing's (Beiping) city planning was proposed. • Make balance between old town conservation and new town construction.
Guidelines/Characteristics	Street		• Inner Town: Streets connecting gates as main roads. • Outer Town: Radial roads from city gates as main roads; • Chang'an Street went through city center and extended out of the old town as main road; • 3 ring roads around the old town, and the nearest one to the wall as an avenue with green spaces on both sides.	• The roads connecting the city gates and the roads radiating from the gate to the surrounding suburbs are urban trunk roads. • Two urban ring roads are planned and constructed around the old city. • The area near the city wall is planned to be green belt and built into a small garden in the city. In order to facilitate traffic, appropriate openings should be opened on the wall. • The construction of buildings and structures is restricted on both sides of urban trunk roads, which is reserved for future highway construction. • Urban trunk roads should be planned and constructed between railway passenger stations, freight stations and urban areas (including old town and new towns in the eastern and western suburbs) to strengthen the connection between them. • The city wall on the south side of the inner city was demolished and built as a road.
	Block	• Construction of embassy area in Dongjiaomin Lane; • Planning and construction of Xiangchang New Area; • Reform of Zhengyang Gate	• The grid framework of East Suburban new town (862042.12 ㎡) and West Suburban new town(1800m-long roads) were almost constructed.	• Residential district planning adopts the model of "neighborhood unit"; • Unifying the height and form of buildings around conservation districts of historic sites
Quantitative regulations	Street		• Decide the arterial roads' location, W≥35m; • the extension of Chang 'a Street: 80m(W) and 60m (E); • Boulevard loops with green belts around the old city:140 m; • the highway to Tianjin is 50m; other general urban roads 15 -25m	
	Block			

Table 3-11 Relevant principles from year 1949 to 1982

Year		1953	1958
Principle /Source		**Master Plan Draft of Beijing Urban Reconstruction and Expansion (改建，拡建北京市計画草案)**	**Master Plan of Beijing City Construction （北京都市建設総体計画方案)**
Characteristics		• Although not officially adopted, it was implemented during the “First Five Year Plan”.	• Make living and working places as close as possible to save people ‘s time and urban traffic.
Guidelines/Characteristics	Street	• Add a loop / radial road on the grid plan; • Important high-rise buildings should be built along arterial roads: East and West Chang’an Street, Fuxing Gate, Jianguo Gate, Zhengyangmen Street, Tianqiao to Yongding Gate	• 4 ring roads in the urban area; • 3 ring roads in the outer area; • 18 radial roads outward, and do not enter the old town, intersecting at the 2nd Ring Road; • Keep the traditional grid plan of the old town;
	Block	• Super Block system from Soviet Union in residential districts	• Accelerate old town reconstruction, in 10 years, many hutong disappeared; • Introduce Soviet’s model Residential Quarter(居住小区) as a unit, with public service/ facilities such as primary and secondary schools and shops.
Quantitative regulations	Street	• the north-south, east-west axial street ⩾ 100m • The 1st ring road (inner ring) ⩾90m; • 4 radial arterial roads (start from the inner ring) ⩾ 80m; • Other loops and side roads: 60-90m	• The road width is same inside/outside the old town: • Chang‘an Street 100-110m; • arterial road 60-100m; • secondary trunk road 40-50m; branch road 30-40m. • After visiting Moscow, the arterial road +10m
	Block	• Super Block in residential districts: 9-15ha • Residential buildings:4-5F; • Buildings around the squares/along main roads:7-8F or higher;	• Soviet Residential Quarter 30-60ha，with population of 10,000-20,000

Table 3-12 Relevant principles from year 1982 to 2003

Year		1982	1985	1987	1989
Principle /Source		Beijing Master Plan (北京都市総体計画)	Urban building height control regulations （都市区の建物の高さ規制)	Beijing District Planning (分区計画)	Regulation on strict control of high-rise residential construction (厳格な高層住宅建設規制)
Characteristics		• Beijing is targeted to be "national political center and cultural center", instead of "economic center" and "modern industrial center".; • Land use shall be planned, developed and constructed by the Urban Planning Department of Beijing Municipality	• First height limitation	• Further regulations on height and FAR; • Densify road network	• Strict limitation on buildings' height
Guidelines/Characteristics	Street				
	Block	• Take "residential district" as the basic unit to organize residents' life; • As a famous historical and cultural city, not only cultural relics and historical sites, but also the surrounding environment should be protected		• Protect landscape corridors and historical blocks; • According to the land use classification, the building height of the old town and the urban central area is adjusted, and the floor area ratio is stipulated;	• High-rise residential buildings are not allowed to be built in the areas within the 2nd Ring Road (excluding the planning area of the 2nd Ring Road).
Quantitative regulations	Street			• Add side roads on both sides of the arterial roads, ⩾20m; • The old town's road area accounted for 9.5% of the total land area increased to 21%; Widen the 6-7m-Hutong with vehicles to 12-15m to relieve traffic.	
	Block		• Height limited depending on different height zones: • Old town：⩽45m; • Out of old town: ⩽ 60m； • Buildings are limited by one-floor、9m、18m、30m、45m、60m in different district from Forbidden City. Buildings around historical sites require to be lower.		• For the comprehensive development of residential buildings in the urban and suburban areas outside the 2nd Ring Road (including the planning area of the 2nd Ring Road), a small number of high-rise buildings can be built under special conditions: slab buildings ⩽12 floors, tower buildings ⩽16 floors, an in maximum 18 floors under special circumstances.

Table 3-13 Relevant principles from year 1982 to 2003

Year		1993	1999	1999	2002
Principle /Source		Beijing Master Plan (北京都市総体計画)	Regulatory plan of Beijing's central area (北京市中心地区控制性詳細計画)	Plans for the Protection of the Historical Cultural Relics of the Old City of Beijing and for the Areas Under Control (北京旧城歴史文化保護区保護と制限範囲計画)	Plans for Protection of the Famous Historical Cultural Metropolis of Beijing(北京歴史文化都市保護計画)
Characteristics		• Inherit grid plan	• Redevelopment of Beijing's Old Town	• Strict limitation in historic sites	• Protect the Old Town as a whole
Guidelines/Characteristics	Street	• Protection of the chessboard-like road network and the layout of streets, alleys, small lanes known as Hutong in the Old Town; • The urban road network includes four structural levels: expressway, trunk road, secondary trunk road and branch road.	• Densify road network; • The height control of public buildings on both sides of the main road, high point, urban landscape, landscape corridor, etc. are regulated.		• Protection of the chessboard-like road network and the layout of streets and small lanes known as Hutong in the Old Town
	Block	• 25 Pieces of Historical Cultural Relics to be planned in detail	• Land area, building height, building density, floor area ratio, green area ratio, and residential population density are regulated by different Administrative Regions		• Base on "Regulatory plan of Beijing's central area (1999)"
Quantitative regulations	Street	• Average density of urban road network is 2.44 km/km², and the road land use rate is 11.1%. • The density of road network within the 3rd ring road is 4.64 km/km², and the road land use rate is 21.18%. • The land use rate of planned roads in the old town reached 25.85%. • The trunk road width: 60m~80m; the secondary trunk road width: 40m~50m; the branch road width: 30m, the expressway width:≥80m, and the special trunk road is wider, such as 120m in east-west Chang'an Street.		• The red line requirements of the "Regulatory Plan of Beijing's Central Area" are not implemented within the scope of the key historical and cultural reserves. • 6% of Hutong for walking and motor vehicles, ≤3m; • 35% of Hutong for one-way vehicle, 3-5m; • 26% of Hutong for uncrossing vehicle, 5-7m; 17% of Hutong for two-way vehicle, 7-9m; 6% of Hutong for regional urban traffic, ≥9m.	
	Block	• The building height is controlled hierarchically. Old town：1F, 9m、12m、18m; Area within 2nd ring road: ≤30m, max45m;Out of old town: 60m. • Residential district generally planned with 10000households (30000 to 50000 people), composed of several communities.			

Table 3-14 Relevant principles from year 2004 to present

Year		2004	2006	2017	2020
Principle/Source		**Beijing Master Plan (北京都市総体計画 2004-2020)**	**Regulatory plan of Beijing's central area(北京市中心地区控制性詳細計画)**	**Beijing Master Plan (北京都市総体計画 2016-2035)**	**Detailed plan for the core area of the capital city of Beijing(2018-2035) 首都功能核心区控制性詳細計画(街区层面)(2018 年—2035 年)**
Characteristics		• Protect the Old Town as a whole and implement redevelopment sustainably; Reasonable control of construction intensity.	• To be further planned in detail based on the division of 33 code-districts and 330 blocks	• A city of globalization; • Control the scale of Beijing development. • Plans at all levels should be under the guidance of city master plan, with coordinated space allocation and scientific timing arrangement.	• Detailed plan of protection and renew is based on block as spatial unit, and subdistrict as administrative unit.
Guidelines/Characteristics	Street	• Urban road network maintains grid plan with ring roads and radial lines, (expressway, trunk road, secondary trunk road and branch road). • Maintain the chessboard pattern of the Old Town, the texture and spatial scale of Hutong; • Adjust the function and section of roads in the historical and cultural protection area; • Construction under the premise of strictly protecting the scale of Hutong in the Old Town.		• Densify road network in built-up areas; • Maintain the chessboard pattern of the Old Town; • Improve the urban expressway and arterial road system; • Promote the construction of road network around key functional areas, major transportation infrastructure and rail stations; • Greatly improve the implementation rate of secondary trunk road and branch road planning.	• Strengthen the chessboard pattern of the Old Town's road network
	Block		• The central area is divided into 33 code-districts by urban expressway, main road and river as the boundary. • Further divided into 330 blocks(200-300ha) for detailed planning.	• Development of streets and districts of historical and cultural value; • Improve the areas along 2nd-ring road, Central Axis, and Chang'an Street; • Limitations on building height, construction intensity.	• 183 blocks are divided based on the 33 subdistricts in the Core Area. Renovation aims at small-scale blocks, being conducted in 3 levels of" block-plot-building".
Quantitative regulations	Street	• Road density (city center): 4.46km/km²; • Road area ratio: 16.4%; • Road width(excluding Old Town): expressway 60～80m，trunk road 40～80m，secondary trunk roa30～45m，branch road 20～30m • Road density in new town: 5~7km/km²; Road area ratio:＞20%.	• Road width(excluding Old Town): expressway 60～80m，trunk road 40～80m，secondary trunk roa30～45m，branch road 20～30m • The total length of the planned roads in the central area is 4965 km. • Total length of trunk road network is 2612 km, accounting for 52.6%; • Total length of branch roads (including 201 km of Hutongs more than 5 m in the old city) is 2353 km, accounting for about 47.4%. • Density of road network is 4.58 km/km². Road area ratio is 18.1%.	• Road density in newly built areas will reach 8 km/km² by 2020; • Road density in concentrated construction areas will reach 8km/km² by 2035. • Widening the roads in the Old Town is generally prohibited	
	Block		• Building height limitation: Northwest part of central area ≤ 45m; South and north of the central area ≤ 60m, reflecting the rhythm of the ups and downs of the central axis; The eastern part of the central area ≤80m, and CBD is the city landmark. • FAR of residential area ≤ 2.5, and max 2.8 under special circumstances (excluding supporting facilities with large scale); FAR of commercial and financial area ≤ 4.5 (except for special areas such as CBD); FAR of industrial storage area ≥ 0.8.		• 3 Height zones: Original Zone, Multi-story Zone with basic height of 18m, Middle/high-story Zone with basic height of 36m. Newly built/reconstructed buildings under 45m.

3.4.2 Characteristics of Principles on Blocks in each Urban Development Stage in Beijing

According to the above arrangement, the characteristics of principles in each urban development stage and the overall tendency can be summarized (Table 3-15, Table 3-16). Discontinuity and significant changes of principles' preference in different urban development stages can be revealed; Block form was influenced by modern urban planning concepts, Soviet planning concept, and international style sequentially; Block size and road width are transforming into smaller scale.

Representative blocks with patterns finished in different periods are shown in Fig. 3-13 and Fig. 3-14. As the areas constructed in urban development stage 2 have transformed a lot, so they are not shown in the following figures.

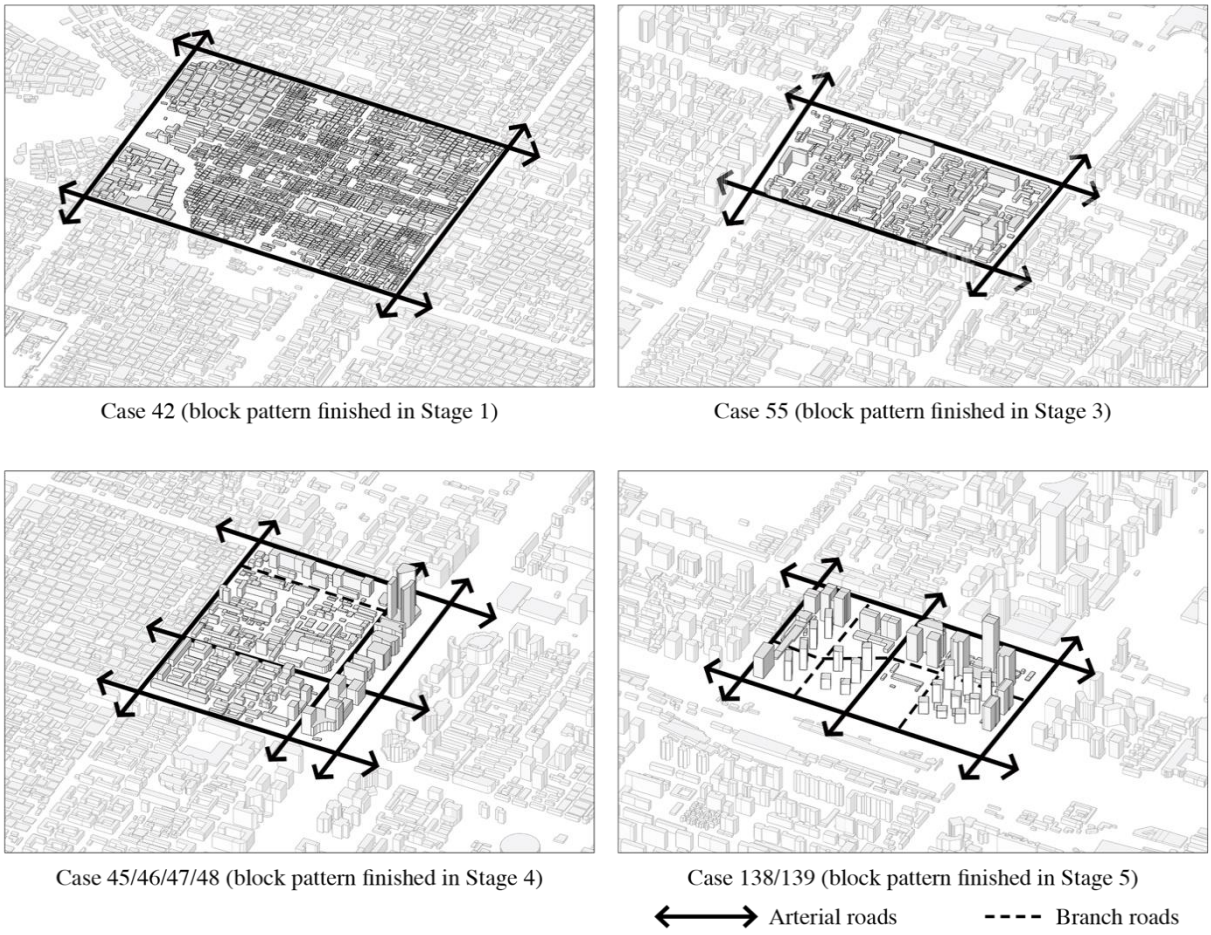


Fig. 3-13 Representative block morphology constructed in urban development Stage1, 3, 4, 5
(By author, based on the data of Gaode Map, https://ditu.amap.com)

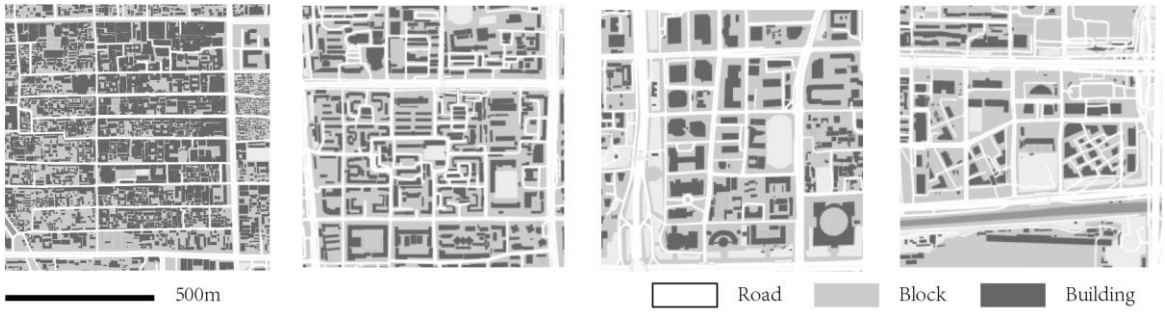


Fig. 3-14 Representative block plans in urban development Stage1, 3, 4, 5 (from left to right)

(By author, based on the data of Baidu Map, https://map.baidu.com)

Stage1 The imperial city period (1153~1911)

One significant policy of feudal government that fundamentally influenced traditional urban blocks in large Chinese cities is Lifang system. It was a system of social ordering employed by the government, and one LiFang was physically identical to an urban block (Chen, F., & Romice, O., 2009). A city was divided into a number of LiFang of rectangular or square blocks, that were easier for governance. Beijing was first constructed (from 1153) in the state of Jin, with gated Lifang from Tang Dynasty and open Lifang from Song Dynasty coexisting. When Beijing was reconstructed as Yuan Dadu of Yuan Dynasty, a dual system of "Lifang and Hutong Unit" appeared. Administration system matches street network, so Lifang took the duties of both administration and shaping urban form. After the re-division of 36 Lifang into 8 communities in Qing Dynasty, administration system separated from street network (Fig.3-15). The role of Lifang in shaping urban form was weakened, and Hutong Units became more diverse. Its impact on the morphology of traditional urban blocks and their subdivision remained, and Beijing retains many traces of this.

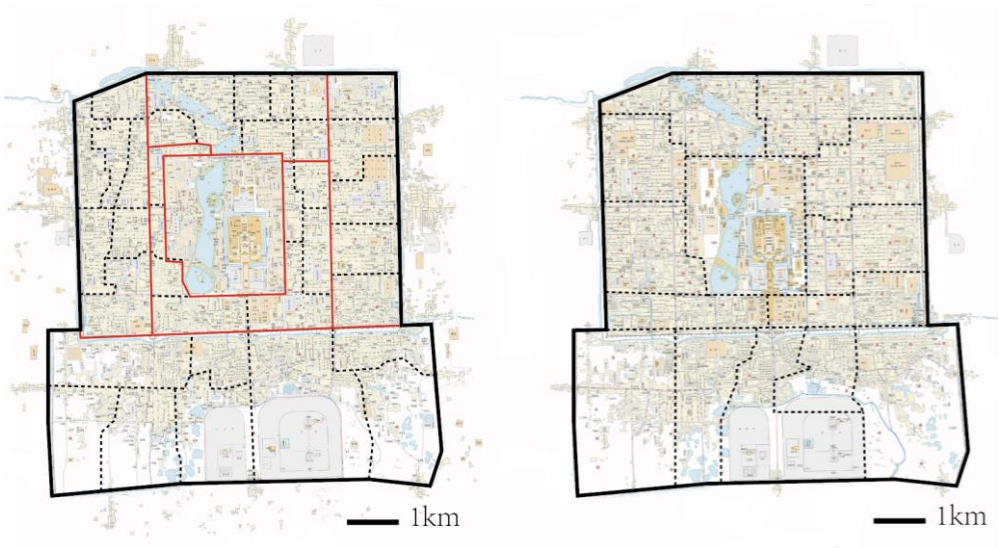


Fig. 3-15 Administrative division in Ming Dynasty and Qing Dynasty

(By author, base map from "Detailed plan for the core area of the capital city of Beijing 2018-2035")

The current relationship between block boundary and administrative boundary is shown in Fig.3-16, the boundaries of administrative subdistricts mostly correspond to the location of arterial road network (not exactly the same). But the block boundaries (in city plan) are not. The discordance of planning unit and actual physical block may cause problems in urban design and place-making.

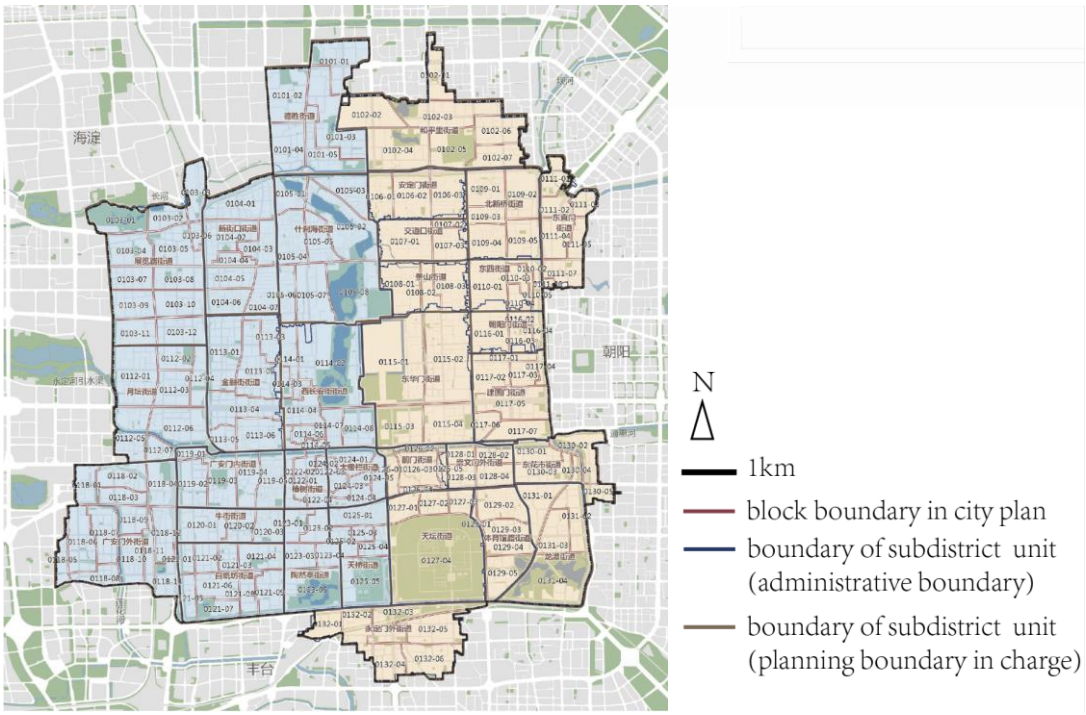


Fig. 3-16 Relationship between block boundary and administrative boundary
(Base figure from "Detailed plan for the core area of the capital city of Beijing 2018-2035")

Stage 2 The initial modernization period (1911-1949)

At this stage, although numbers of suggestions and discussions about Beijing's urban planning were proposed, the built-up area of Beijing is still within the Old Town, with Xiangchang New Area and Dongjiaomin Lane Area reconstructed. They were constructed exploring the modern urban planning concepts. New districts in the West and East Suburb were planned by Japan following modern urban planning concepts and were not finished construction, but they left influence on the following city plans after 1949 (Koshizawa, A., 1985).

Stage 3 Socialist planned period (1949-1982)

The political ideology was the determining force on a social and spatial organization in Beijing after 1949. The society was intended to be ordered through the organization of urban space. The following two forms can be regarded as prototypes of superblock formation in Beijing.

First, the widespread industrialization of the 1950s-70s took on a specific urban form of Work-Unit Compound, of which the physical layout is usually defined as dàyuàn ("big courtyard"). They were not only the units of production, but also of urban form and social welfare.

Second, the close contact with the Soviet Union led to the introduction of Soviet design concepts of "Residential quarter" and "Neighborhood block", as well as the industrialized housing techniques and standardized housing forms. Both the two patterns of the urban form led to the sense of inwardness, self-sufficiency and locality, and the former adopts more closedness and monopolization.

Stage 4 Socialist marketing period with rapid urban development (1982-2003)

The political ideology and economic strategies shifted in China after adopting Reform and Opening-up Policies in 1978. Marketing forces led to the unprecedented speed in urbanization and the most dramatic change on urban form. The developed area of Beijing increased from 346 km² in 1980 to 654.5 km² in 2003 (Beijing Municipal Bureau of Statistics, 1980 & 2003). Moreover, the new urban form emerged rapidly, such as CBDs (Central Business District), development zones, large-scale housing, landmarks, urban conservation and regeneration. High-profit land use in city center and gated communities in super blocks became representative.

Moreover, it is also in this period that the urban planning principles began to get in touch with more aspects and more detailed level, such as the suggestions on densifying road network, preservation of historical districts and strict height limitation. It is an examination resulted from the rapid urban construction process.

Stage 5 Internationalization period with urban development and redevelopment (2004-present)

The targets set for 2010 in the "Beijing City Master Plan 1993" were almost achieved in 2003. From 2004, Beijing has still been targeting at an international city and historical city. The cultural identities and livability have gained more attention in urban planning. As there are few lands for new construction in city center, regeneration projects have played more roles.

In particular, the previous principles related to blocks were mainly targeting at residential issues and traffic issues, so "block" has not been officially proposed as an urban spatial unit. It seemed to be a similar term of residential community, or just a residual space of road network. The definition of "block" was finally proposed in 2018, with quantitative regulations depending on land use functions.

Table 3-15 Transition of Urban Planning Principles on Block and Street in Beijing (By author)

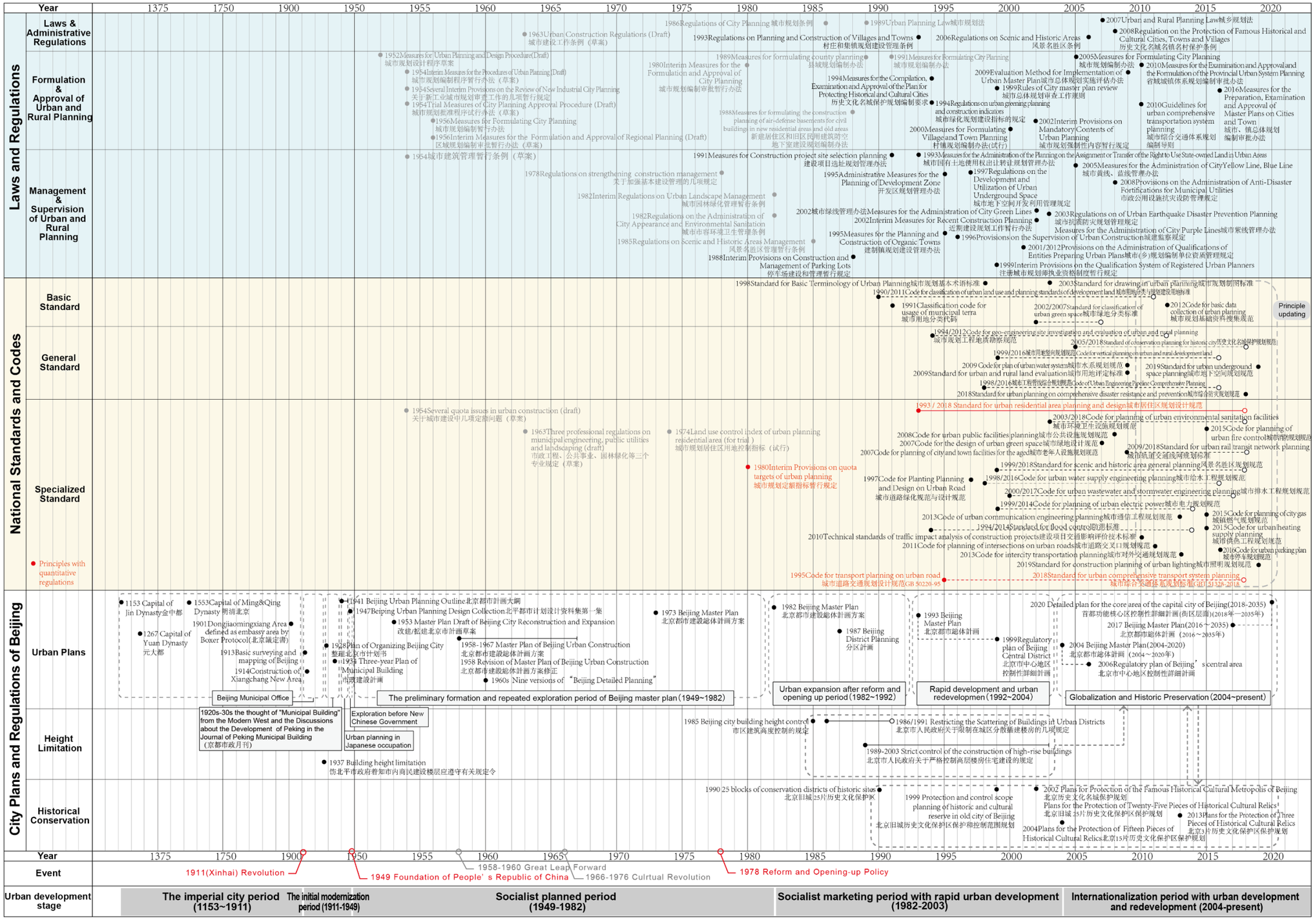
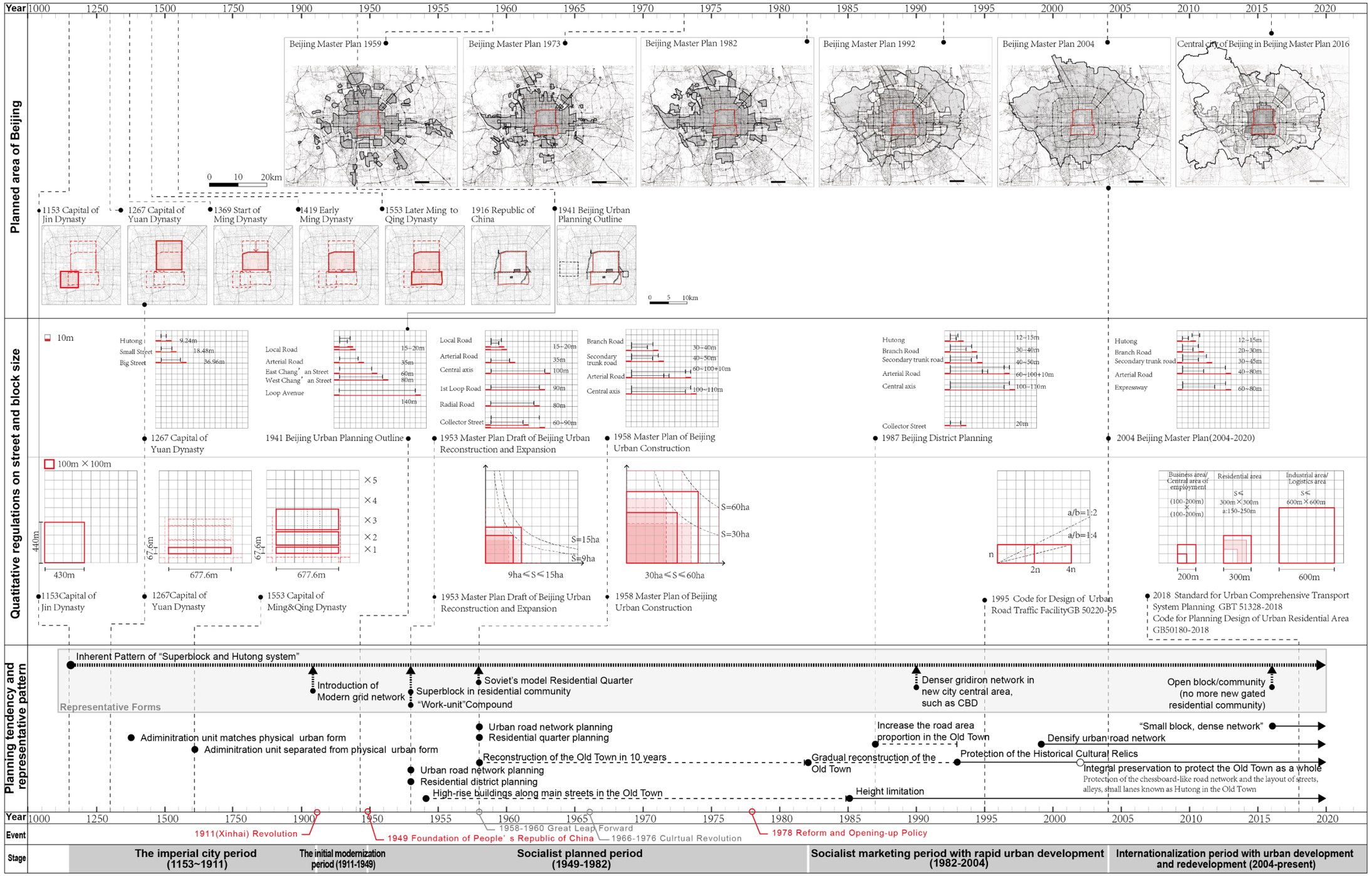


Table 3-16 Quantitative Tendency of Urban Planning Principles on Block and Street in Beijing (By author)



3.5 Conclusions

This chapter took the grid blocks in Beijing as the representative inherent pattern in China for case study. It investigated the formation process of grid blocks in Beijing, their correspondence with urban development stages, and the transition of urban planning principles about block design, which is regarded as a significant factor in Chinese urban morphology.

The conclusions drawn from this chapter are as follows:

(1) Construction of grid blocks covering long time span

Based on the five stages of urban development in Beijing and the four time points in block formation process, the formation of gird blocks in Beijing was clarified. Over 1/3 of the cases within the 3rd ring road of Beijing were initially constructed in ancient times but few patterns were inherited, endowing Beijing with an image of "massive uprooting and demolition". Most of the blocks were initially constructed in Socialist planned period (1949-1982), but the relative rough urban sprawl resulted in most of the blocks being unfinished. The largest number of blocks were shaped during the rapid urbanization and redevelopment in 1982-2003, and the tendency continues in a weaker degree in recent years.

(2) Uncertain order in block formation process

According to the six typologies of the block formation process, grid blocks in Beijing have not been built in a certain order or entirely within a certain period. Their formation lasts a long time. Consequently, their design may be necessary to comply with the principles of different phases, which lack consistency and integrity. Moreover, the unclear order of boundary defining and inner space subdivision weakens the connection between the two elements.

(3) Insufficiency in urban planning principles at national level

Urban planning principles at national, especially the technical standards typically control urban planning from a quantitative view, but with the main goal of resolving practical health and safety concerns instead of physical form and spatial perception. Hence, there have been similar words resembling "block" in the regulation but were not a clear physical definition of "block" for a long time. Until now, there have been only 5 standards that mention the quantitative metrics for block morphology, even with some discordance with each other. All the aforementioned has made the control of block form rather rough in the rapid urbanization.

(4) Discontinuity in urban planning principles at local level

Urban planning principles at local level in Beijing have changed largely according to different urban development stages. The rapid change in China's regime and social structure, as well as the influence from foreign countries over the last hundred years have directly resulted in various urban planning principles. Principles were hardly to be inherited, and some are contradictory to the previous versions.

In conclusion, this chapter provides the construction background and regulatory reference for the analysis of diversification in Chapter 4. Both the formation process and principles' tendency were complicated in Beijing, thereby, their roles and significance in causing urban form diversification need further clarification in the next Chapter.

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Chapter 4 Diversification of Inherent Grid Plan in Chinese Cities

——Transformation Process and Current Morphology of Grid Blocks in Beijing, China

4.1 Introduction

4.1.1 Background and Objectives

The grid plan is the most convenient and universal urban planning approach to date, both geographically and chronologically (Kostof, S., 1991). It can be seen in numbers of top-down planned cities worldwide. But it was criticized for leading to boring city image and indifferent society by urban planners like Camillo Sitte and Lewis Mumford (George, R. et al., 1965; Kostof, S., 1991). However, Kostof also argued that "any grid holds the potential to become a beautiful city over time depending on how it is fleshed out" and it is largely because of "what was allowed to happen or was not encouraged to happen after the initial lines were drawn that impelled grids to serve up a routinized, alienating urban setting" (Kostof, S., 1991; Groth, P., 1981). Hence, the differentiation of grid blocks with similar background and their dynamics in creating morphological diversities require clarification.

This chapter continues to take Beijing as case study, aiming to clarify the diversification of the inherent grid pattern in Chinese cities, especially the grid blocks. Based on the conclusions in Chapter 3, the objective of this chapter was to investigate the mechanism of the morphological transformation process in Beijing, and clarify how the grid blocks, as the similar geometric prototype, developed under principles in different periods and shaped diverse typologies of the urban form. To this end, the current block typologies were carried out, and their transformation process was decomposed into two layers in order to clarify the factors and dynamics. The proposed approach and findings of this chapter contributes to understanding morphological diversification in cities with grid blocks. Additionally, typological database of grid blocks in Beijing is built up. Suggestions are made with regard to block patterns and typological process, in order to achieve appropriate design which is harmonious with the urban context and enhances local identities.

Last but not least, diversification is not exclusive to the inherent grid plan. Macrocosmically, the diversification process of grid blocks in Beijing can be treated as a procedure that the inherent Chinese grid plan localized into Beijing's urban context. Microcosmically, it can also be decomposed into many procedures that similar grid blocks localized into different parts of Beijing. "Diversification" and "Localization" process are not separated from each other. But based on the definitions in Chapter 1.3, when taking the cultural origin or the origin of urban planning concept as prerequisite, this chapter focused more on how the archetypal grid blocks were diversely transformed, with the localization process in a more micro scope as an approach of creating diversification.

4.1.2 Previous Research

In the previous studies about the transformation process of urban morphology in Beijing, especially in the block scale, they were usually focusing on specific areas (Fujikawa, M., 2002). By studying the development process of different periods of urban construction in the "Chang'an Street - Qian'sanmen" area, the characteristics of the "collage" construction and the evolution of urban form in this area were summarized (Liu, J., 2013). The

"urban text" representing the abstracted urban texture of Shichahai, Dongzhimen, and Dàshílànr areas in Beijing's old town were clarified (Tang, M., 2000). Some focused on the historical districts from the view of historic preservation (Deng, Y., 1999; Arai, R. et al., 2008; Kawai, M., 2015). Blocks were regarded as research target instead of an element reflecting the urban morphological transformation. Hence, this chapter take grid blocks as a clue and basic unit. The diversification process of the whole city is revealed by clarifying the mechanism of block form diversification.

4.1.3 Research Methodology and Framework

Based on the composition of urban morphology, the transformation of blocks is representing the long-term change in time dimension. Simultaneously, the block itself can be decomposed further into detailed elements, such as block boundary, plot, buildings, open space etc. As a result, in order to identify the factors and dynamics for block diversification, this chapter was conducted based on the two decomposed layers (Fig.4-1). First is the primary block-boundary layer, which is decided by the structural urban road network with high unchangeability. Second is the inner space of each block, including the subdivision, buildings etc. The diversification of each layer, and the mutual influence were investigated, and connected with their construction time, formation process, principles etc. in order to clarify the main factors.

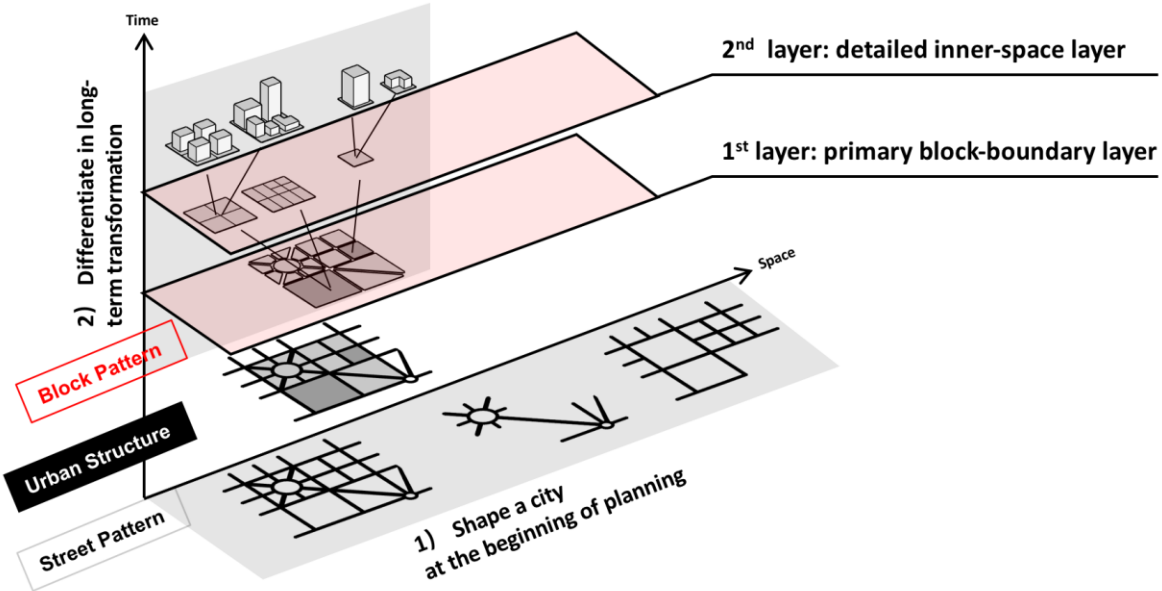


Fig. 4-1 Composition of block morphology (By author)

The 194 case blocks were introduced and collected in Chapter 3.

Chapter 4.2 clarifies the current morphology of grid blocks in Beijing in terms of geometric features by means of cluster analysis, in order to establish the foundation for the following analysis on the transformation process.

Chapter 4.3 focuses on the diversification in primary block-boundary layer of the blocks. It clarifies their distribution in spatial dimension and evolution in time dimension. The probable multiple dynamics are concluded in terms of location, principles' transition and time differences in urban construction.

Chapter 4.4 focuses on the diversification in inner-space layer of each block. It clarifies the diverse subdivision patterns and building density inside blocks, as well as their relationship with features in block-boundary layer, construction time, location, formation process and relevant principles. The probable dynamics of inner space diversification are concluded.

Chapter 4.5 summarizes the conclusions and discussion on grid blocks' transformation and diversification, and proposes suggestions on future renovations.

4.2 Current Conditions of Block Morphology in Beijing

This section develops from the existing morphological research methods, trying to reveal the morphological characteristics of the cases in Beijing through the morphological quantitative indicators describing blocks with buildings and streets inside.

4.2.1 Quantitative indicators for describing block morphology

Pont, M. B. and Haupt, P. suggested that a multivariable density concept consisting of the three fundamental indicators: intensity (FAR or FSI), coverage/compactness (GSI) and network density (N), can offer a method that is specific enough to allow for the definition of urban types (Pont, M. B.et al., 2009). However, in order to describe the shape and height of block in a more directly way, the block size(S), block shape regularity(R) and average floor(F) are included. In addition, when considering the road network and subdivision, the area of plot (S_p), the Standard Deviation of S_p (SD_p), the regularity of plot (R_p) and the average width of roads(W), are also necessary in reflecting the inner fabric of the block. But because of the limitation of data of the lower-level streets such as Hutong and Jiefang road, only branch roads, which are in similar width, inside the blocks are calculated in this section. So, the average width(W) was not included as one of the indicators. Cluster analysis will be conducted based on the selected indicators.

The definition and calculation of the indicators are as follows.

1) Block size(S)

The base land area of block.

2) Building Intensity (FAR or FSI)

FAR reflects the building intensity independently of the programmatic composition and is calculated as:

$FAR=S_F/S$

S_F: Gross floor area within the block;

S: the base land area, as block size.

3) Coverage/Compactness (GSI)

GSI, or coverage, demonstrates the relationship between built and non-built space and is calculated as:

GSI=B/S

B= footprint of all buildings within the block(m^2)

S = the base land area, as block size (m^2)

4) Network density (N)

The density of the network, N, refers to the concentration of networks in an area, in this section the block. The density of a network is defined as network length per square kilometer of base land area (km/km^2), and is calculated as the sum of the whole internal network and half of the length of the network used to demarcate the base land area.

$N=(\Sigma li+(\Sigma le)/2)/S$

l_i = length of interior network (km), as the total length of branch roads inside the block;

l_e = length of edge network (km), as the perimeter of block;

S = area of block (km^2), as block size.

5) Average floor of buildings in the block(F)

The average number of storeys, F, can be arrived at by ascertaining the intensity and coverage or, FAR and GSI, for the block. If more floor area is developed in a block, without changing the footprint, F will increase. If the building height remain constant, then FAR and GSI have to increase.

$F= S_F/B=FAR/GSI$

6) Block shape regularity(R)

The regularity of block shape can be expressed by the ratio of block area(S) to the square of block perimeter(P). In the case of the same perimeter, the larger the area, the more regular the shape is and the closer it is to the square shape.

$R= S/P^2$

S = the base land area, as block size (m^2);

P= the perimeter of block.

7) Plot shape regularity(R)

Similarly, the regularity of plot shape can be expressed by the ratio of plot area (S_p) to the square of plot perimeter (Pp). In the case of the same perimeter, the larger the area, the more regular the shape is and the closer it is to the square shape.

$R_p= S_p/P_p^2$

S_p = the base land area, as plot size (m^2);

P_p= the perimeter of plot.

8) Standard Deviation of Sp (SDp)

Standard Deviation of S_p reflects the amount of variation between plot sizes. A low standard deviation indicates that the values tend to be close to the average area of plots, while a high standard deviation indicates that the values are spread out over a wider range.

Among all the eight indicators, Correlation analysis is conducted to exclude the indicators that have high correlation with another, so as to decrease the unnecessary factors for cluster analysis (Table 4-1). As a result, average floor(F) was not included for its high correlation with FAR. So, Block size(S), Building Intensity (FAR), Coverage (GSI), Network density (N), Block shape regularity(R), Plot shape regularity (Rp), Standard Deviation of plot size S_p (SDp) are selected as final indicators (Table 4-2).

Data was collected from: Beijing Master Plan 2016-2035; Detailed plan for the core area of the capital city of Beijing (2018-2035); Baidu Map, https://map.baidu.com; Gaode Map, https://ditu.amap.com)

Table 4-1 Correlation analysis

		S	N	R	FAR	GSI	F	R_p	SD_p
S	Pearson Correlation	1	-.357**	.335**	-.290**	.178*	-.323**	-0.038	.603**
	Sig.(2-tailed)		0.000	0.000	0.000	0.013	0.000	0.596	0.000
N	Pearson Correlation	-.357**	1	-.179*	.491**	-.310**	.530**	-.182*	-0.096
	Sig.(2-tailed)	0.000		0.012	0.000	0.000	0.000	0.011	0.181
R	Pearson Correlation	.335**	-.179*	1	-0.055	0.029	-0.066	.399**	.185**
	Sig.(2-tailed)	0.000	0.012		0.448	0.685	0.358	0.000	0.01
FAR	Pearson Correlation	-.290**	.491**	-0.055	1	-.200**	.879**	0.059	-0.089
	Sig.(2-tailed)	0.000	0.000	0.448		0.005	0.000	0.414	0.215
GSI	Pearson Correlation	.178*	-.310**	0.029	-.200**	1	-.543**	-0.062	0.07
	Sig.(2-tailed)	0.013	0.000	0.685	0.005		0.000	0.39	0.332
F	Pearson Correlation	-.323**	.530**	-0.066	.879**	-.543**	1	0.06	-0.135
	Sig.(2-tailed)	0.000	0.000	0.358	0.000	0.000		0.407	0.06
R_p	Pearson Correlation	-0.038	-.182*	.399**	0.059	-0.062	0.06	1	-.179*
	Sig.(2-tailed)	0.596	0.011	0.000	0.414	0.39	0.407		0.012
SD_p	Pearson Correlation	.603**	-0.096	.185**	-0.089	0.07	-0.135	-.179*	1
	Sig.(2-tailed)	0.000	0.181	0.01	0.215	0.332	0.06	0.012	
** Correlation is significant at the 0.01 level (2-tailed)									
* Correlation is significant at the 0.05 level (2-tailed)									

Table 4-2 Seven indicators describing the block morphology in Beijing

Block-boundary layer	Block size(S)	
	Block shape regularity(R)	R= S/P^2; S = the base land area, as block size (m^2); P= the perimeter of block.
Inner-space layer	Building Intensity (FAR)	FAR=S_F/S; SF: Gross floor area within the block; S: the base land area, as block size.
	Building Compactness /Coverage (GSI)	GSI=B/S; B= footprint of all buildings within the block(m^2); S = the base land area, as block size (m^2)
	Network density (N)	N=(Σli+(Σle)/2)/S l_i = length of interior branch road network (km); le = length of perimeter of block(km); S = area of block (km^2), as block size.
	Plot shape regularity (Rp)	$R_p= S_p/P_p^2$; Sp = the base land area, as plot size (m^2); Pp= the perimeter of plot.
	Variation among plot sizes (SDp)	Standard Deviation of SDp

4.2.2 Block morphological characteristics based on cluster analysis

By means of cluster analysis (Ward methods) (Fig.4-2), the 194 cases were classified into 5 clusters (Table 4-3, Table 4-4), based on the above seven quantitative indicators in Table 4-2 (Fig.4-3).

Table 4-3 Five morphological clusters of grid blocks in Beijing (By author)

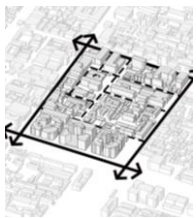
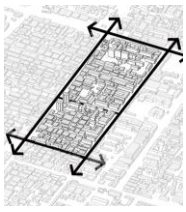
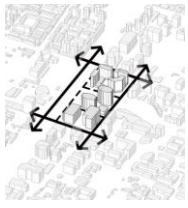
	Cluster A	**Cluster B**	**Cluster C**	**Cluster D**	**Cluster E**
Size(S)	**Big**	—	**Mid**	Small	Small
Shape Regularity (R)	Square-shape	Square-shape	Square-shape	**Rectangular-shape**	—
Building Intensity (FAR)	Low	Low	**Mid**	Low	**High**
Building Compactness (GSI)	High	High	**Mid**	High	**Low**
Road Density (N)	Low	Low	Mid	Mid	**High**
Plot Regularity (Rp)	—	Regular square	—	Irregular/ Rectangular	—
Subdivision (SDp)	**Highly uneven**	**Even**	Relative uneven	—	**Even**
Number of cases	14 cases	69 cases	72 cases	26 cases	13 cases
Examples					

Fig. 4-2 Cluster analysis of morphological characteristics of case blocks (By author)

Table 4-4 Characteristics of each morphological cluster (By author)

Characteristics	Example	Case ID	Total number
Cluster A	 Case 1	1, 11, 15, 63, 78, 98, 122, 142, 145, 174, 175, 181, 187, 188	14
Large blocks with uneven subdivision and a sense of mixing			
Cluster B	 Case 42	2,3,6,7,8,10,12,13,19,21,22,23,24,25,27,28,29,30,31,32,35,42,43,44,46,52,53,54,55,56,57,58,62,64,69,70,76,77,79,83,84,96,100,105,106,107,109,121,125,131,134,135,143,148,151,152,153,155,156,158,161,165,166,178,179,182,184,191,193	69
Almost no/a little even subdivision with inwardness			
Cluster C	 Case 116	4,5,9,14,26,33,34,36,37,40,45,49,50,51,59,60,61,71,74,80,81,82,87,90,91,95,97,99,101,108,111,112,113,115,116,117,118,119,120,123,124,126,127,128,129,130,132,133,136,137,140,146,147,149,150,154,157,159,160,162,163,164,170,172,176,183,185,186,189,190,192,194	72
Middle building density with higher but uneven inner accessibility			
Cluster D	 Case 65	16,17,18,20,38,39,41,65,66,67,68,89,92,93,94,102,114,141,144,167,168,169,171,173,177,180	26
Rectangular blocks along liner-shape elements			
Cluster E	 Case 86	47,48,72,73,75,85,86,88,103,104,110,138,139	13
High-rise buildings and large open space, with high road density			
			0 500 1000 m

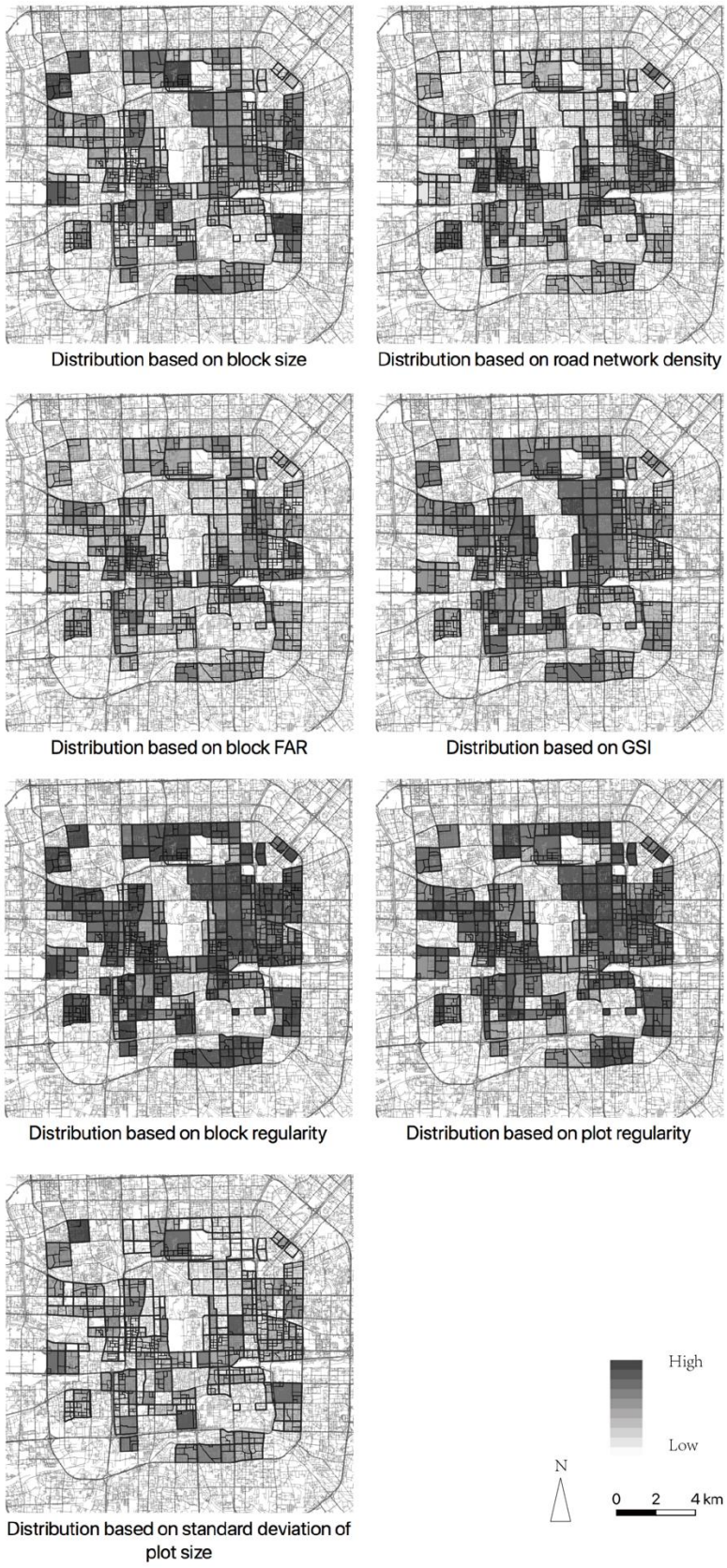


Fig. 4-3 Distribution of blocks based on the above 7 indicators (By author)

Cluster A

Blocks with higher coverage, lower intensity, low road network density, highly uneven subdivision, square-shape, and big size. This type of blocks is typically made up of many parts that may vary greatly from one another, either in morphology or in function. For example, the block that consists of a campus, a work-unit complex and a residential community. But there are not always definite boundaries, or just small spaces between the parts. The parts of the different characteristics therefore stick to each other, giving the whole block a sense of mixing.

Cluster B

Blocks with higher coverage, lower intensity, low network density, only few homogeneous subdivisions, and square shape. This type of block pattern includes the ancient model and the one widely seen in residential districts of the late 20th century. Less subdivision inside the blocks contributes to a low accessibility of inner space, which gives more inwardness to the blocks. It also resulted in less variations in spatial perception. It has therefore created a feeling of "unwelcoming" to the public, but it provides a general service and a sense of security and belonging to the residents of the block, showing a sort of collectivism.

Cluster C

Blocks with middle coverage, middle intensity, middle network density, relative uneven subdivision, square-shape, and middle size. This type of block pattern can be regarded as a result of subsequent subdivision. With the boundary of the block sustained, the inner space was diversely subdivided. It is a representative form widely used in commercial areas. Higher inner space accessibility is being sought in search of higher profit. Compared to blocks in Cluster B, these cases have enhanced visibility for the general public in the area. Nevertheless, due to the irregularity of the initial construction, the internal accessibility is to some degree, unbalanced.

Cluster D

Blocks with highest coverage, lowest intensity, middle network density, even subdivision, rectangular shape, and middle size. This type is rather distinctive in Beijing, limited by the location along liner-shape elements in Beijing city, such as the imperial city walls and ring roads. Thus, they are more likely to be controlled by height limitation, with comparatively unusual rectangular shape.

Cluster E

Blocks with lowest coverage, highest intensity, high network density, even subdivision, small size. This type of blocks has been affected intensely by globalization and international style, aiming to optimize vehicle traffic capacity and increase the accessibility of land at a higher market value. It is favored in commercial centers, such as CBD areas. It plays the role of the city center, providing service to the entire city. However, compared to the four typologies mentioned above, this combination of high-rise buildings and open space, is somewhat "foreign" which shows the opposite characteristic of the inherent grid block.

4.2.3 Distribution of different morphological clusters

At the first glance of the distribution of different morphological clusters, it seems to be unordered within the 3rd Ring Road of Beijing in large scale. But when focus on a smaller scale, some hidden orders appeared, helping us to read the city. (Fig.4-4)

Taking the interface between the Inner Town and the Outer Town as a boundary line, the south part based on the original Outer Town shows almost no regularity. Because, when the Outer Town was constructed in Ming Dynasty, streets were curved and slanted, and some intersect with each other, making the pattern more complex and freer than the Inner Town. On the contrary, in the north part of the boundary line, continuity can be clarified in different districts.

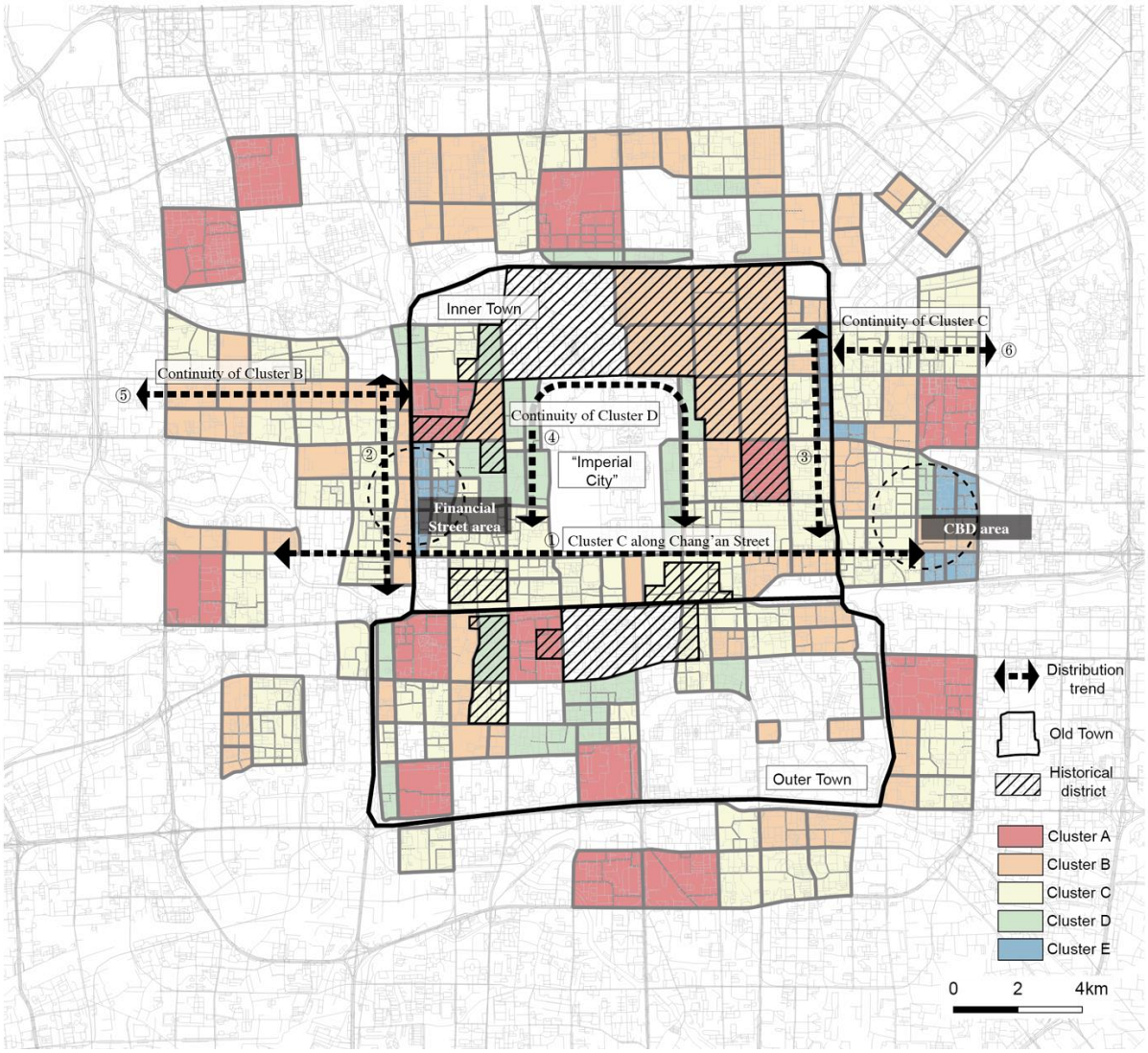


Fig. 4-4 Distribution of blocks in each morphological cluster (By author)

First, it shows some continuity in orthogonal liner-shape distribution. The ancient city walls of the Old Town and Imperial City (only partly preserved), and the Chang'an Street which act as the west-east city axis of Beijing, take up the role as the framework arranging the liner-shape distribution. Cluster C shows continuity along Chang'an Street(①), height limitation leads to relatively higher intensity rather than the highest in Cluster E, and because the "façade" areas along Chang'an Street were overemphasized during 1950s-1960s' reconstruction, with large-scale independent buildings, subdivisions of "façade" areas and their backland became imbalanced. Along the west and east edges of the Inner Town (②③, especially the west part near Financial Street), Cluster B, C, E, located in layered structure, which adds potentials to create continuous urban interface along north-south arterial roads, and variability in west-east direction. Moreover, continuity of Cluster D along Imperial City Wall(④), and that of Cluster B and C(⑤⑥), also offer chances for shaping local identity with their unique block morphology.

Second, though Cluster A and Cluster E take up only less than 1/6 of the 194 cases, they are representing the two converse extremes in Beijing's block morphology. Cluster A represents the huge blocks with only few branch roads that divide the block in an imbalanced way, while Cluster E represents the small blocks with dense road network, and sparse but high-rise buildings. Cluster E concentrates in redeveloped areas after urban development Stage 4, especially the Financial Street District and CBD District, reflecting that high development intensity and homogeneous network were preferred in New District Redevelopment. It is a digesting process from the western pattern to local development. However, the rather random distribution of Cluster A, resemble tumors stuck in the traffic network, because the accessibility differentiates in different directions. Although they may give birth to the local community with local centers which is the status between the public and the private in Chinese culture, measures need to be proposed to make the streetscape, walkability as well as the inner vitality more friendly for all the citizens. They require a balance between the updating functional needs and the traditional social cultures.

Finally, the cases of Cluster B, much of which were included in the historical districts, are distinctive in ancient Chinese culture. Unlike Cluster A, they adopt almost no branch road subdivision or few subdivisions in homogenous way. In order to preserve the historical block pattern, measure can be considered in a more bottom-up way compared with Cluster A, increasing permeability and accessibility through micro approaches.

4.3 Diversification in the Primary Block-boundary Layer

Urban structural elements are the foundation of shaping urban form, since it cannot be changed easily once being constructed. They are relatively stable in the long-term urbanization process, and are more likely to persist the distinctive pattern that may reflect the identities of the previous time.

Among all the geometric features of blocks, block size and block shape regularity depend on arterial road system, which can be considered as the stable structural elements. Therefore, the transformation tendency of block size and block shape regularity is convincing to clarify the preference of different periods or different locations. Both the two indicators were calculated based on the time when block boundaries were defined.

4.3.1 Distribution and Evolution of Block Size(S)

The size of grid blocks in Beijing differs incredibly from 5.65ha to 172.45ha, but cases of 20-40ha take the highest proportion (Fig.4-5). The several cases of 140-180ha are distinctive, requiring more consideration. Although there is a continuity in planning history originating from ancient Chinese urban planning concept, the block sizes in Beijing are not unified at similar scale. When the blocks in super large size distribute randomly, the smaller-size ones are more likely to concentrate in limited areas along the ring roads and main streets. (Fig.4-6)

The average block size revealed a changing tendency that, apart from the cases defined during 1911-1949 which were of smaller average size, the average size of blocks in Urban Development Stage 1, Stage 3, Stage 4 and Stage 5 declined sequentially. It is in line with the mainstream of urban planning principles' preference (Chapter 3), tending to apply "smaller block" and "denser network" in recent years. This concept originated from the homogeneous western grid network, which is considered to be efficient in accommodating the vehicle traffic, as well as improving the walkability for human beings. The average block size in Beijing is 31.49ha in Stage 5, decreasing from 56.49ha in Stage 1, while the average block size in Portland, US, is 4.9ha (Atlas of Urban Expansion, http://atlasofurbanexpansion.org/cities/view/ Portland_OR). But it can be regarded as a compromise of the traditional grid pattern, that is aiming to integrate with the modern urban planning tendency. Hence, the hybrid pattern which is the transferring status from the big scale of the traditional grid pattern to the dense modern grid pattern appeared and became distinctive in the diversification process in Chinese urbanization.

In spite of the fact that block size is in line with the mainstream of urban planning preference, it has a large amount of variation (Fig.4-7). In other words, cases differ greatly even they were constructed in the same period, following the same principles. Excluding the limitation of data accuracy, the insufficiency of planning principles and other hidden possible reasons need clarification.

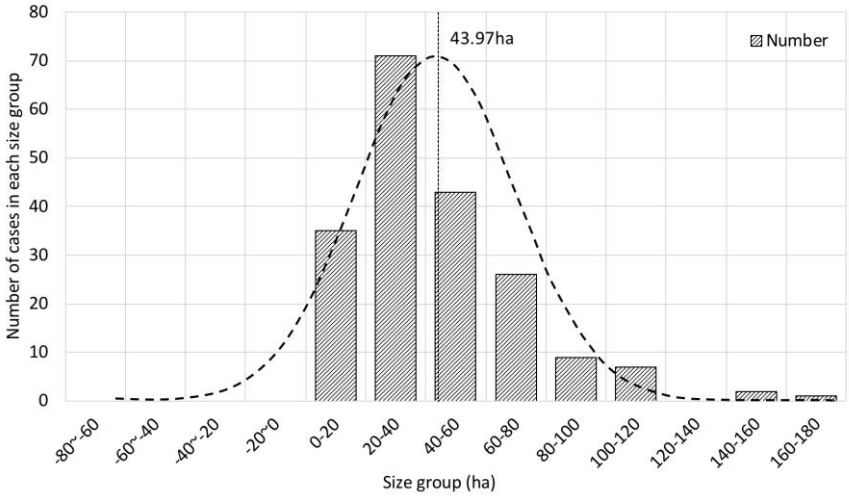


Fig. 4-5 Normal distribution diagram of block size (By author)

Fig. 4-6 Distribution of blocks based on size and shape regularity (By author)

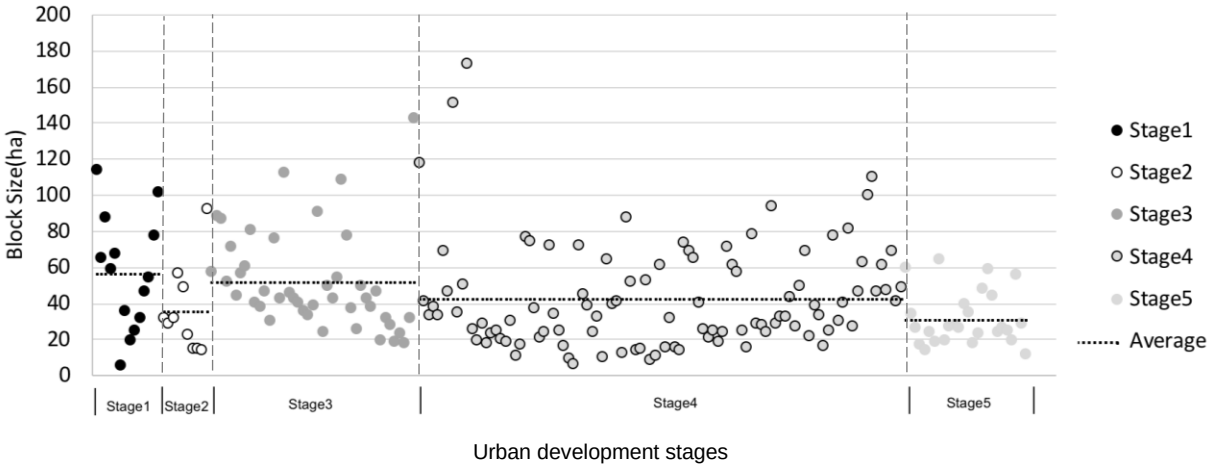


Fig. 4-7 Block size based on the time when block boundaries were defined (By author)

4.3.2 Distribution and Evolution of Block Shape Regularity(R)

Different from the rigid image of grid plan, the blocks in Beijing is not strictly in square shape. When the main structure remains in orthogonal system, diagonals and curves can also be found in shaping blocks. It differs from the ancient Lifang block in Tang Chang'an. Moreover, many blocks are in rectangular shape with longer size in north-south direction, especially along the former imperial city walls and old city walls, which is now the ring roads of Beijing (Fig.4-6).

There is not any obvious tendency in the evolution process, as the regularity differed a lot in every period (Fig.4-8). Hence, it is the location of blocks instead of the construction period that influence the block shape regularity more.

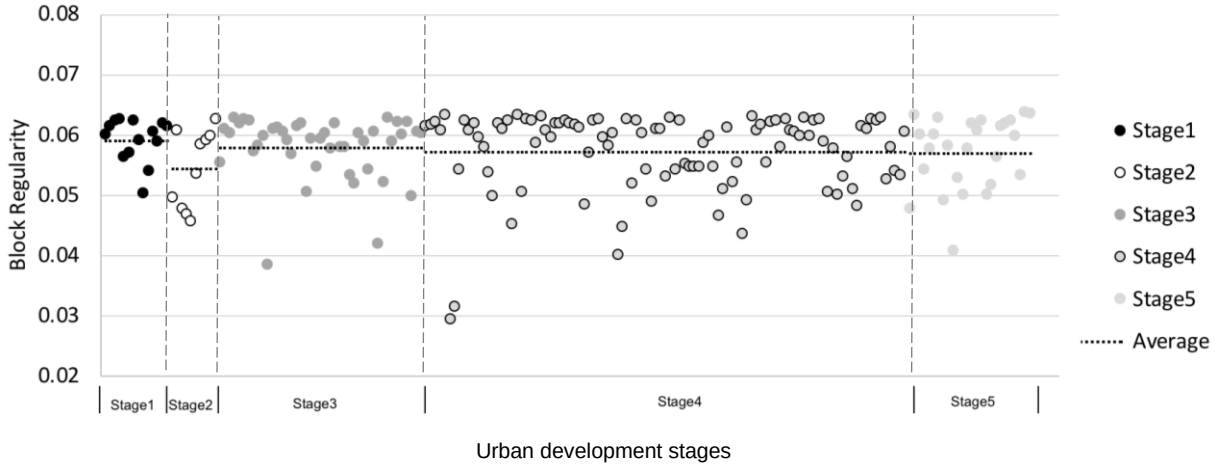


Fig. 4-8 Block shape regularity based on the time when block boundaries were defined (By author)

4.3.3 Characteristics and Dynamics of Diversification in Primary Block-boundary Layer

(1) Block Size transforms mainly following urban development and urban planning principles' tendency, but differentiates because of their insufficiency

Rapid change of social system and influence of foreign planning tendency in the past over a hundred years directly resulted in the different urban planning preference in each urban development stages. It led to the declining of block size. For example, the homogenous and dense gridiron planned by Japan in the 1940s, the superblock model imitating from the Soviet Union in the 1960s, and the smaller block as a result of international style. They are singly implemented or combined with existed local patterns, which become two ways of grid block diversification in Beijing.

The lack of clear physical definition of block, and some contradictions in principles of different fields lead to less specific regulations on the block pattern, which causes the unexpected differentiation among blocks constructed in similar period.

(2) Block Shape Regularity relates to the location, especially the linear urban structures

Compared with the close connection between blocks size and urban planning principles, block shape regularity relates more to the location. The rectangular blocks with lower regularity concentrate more on the areas along linear shape urban structures, such as the previous city walls of Imperial City and Old Town (now is the 2nd ring road).

(3) Co-existence of "Time Differences" in Urban Construction

Urban spaces created in similar period of time followed similar planning principles, techniques, material and aesthetics, so they are more likely to be developed into similar form. The diversification of grid blocks in Beijing is a result of spatial co-existence of "time differences" in urban construction.

Beijing persists continuity in urban planning and urban construction, without thorough replacement either by intentional planning or by war or disaster etc. Although, there has been some intensive demolishment in the mid-20th century, aiming to reconstruct the Old Town completely, principles of historical preservation were proposed in time in 1993(Chapter 3.4). Since then, the Old Town has been preserved better on purpose. As a result, representative patterns of different stages have been existing in Beijing. Diverse urban space can be precepted at the same time in Beijing.

4.4 Diversification in the Detailed Inner-space Layer

4.4.1 Road Network Density

Road network density is related to both arterial road system and branch roads, and its transformation is calculated based on the time when block patterns were all finished

Similar with the transformation of blocks size, there is a wide range of variation in road network density (Fig.4-9). But on the contrary to the declining tendency in block size, the road network density increased sequentially, and leaped up substantially in urban development Stage 5. It is also a result of encouraging the "smaller block" and "denser network". However, there is still a big gap between the target density regulated in the recently-proposed principle: Standard for urban comprehensive transport system planning GB/T 51328-2018 (2018). The road network density differs a lot in Beijing, especially the ones built in Stage 1 in the Old Town and the newly built ones in recent decades. The later ones adopt concentrated distribution in several regions (Fig.4-10).

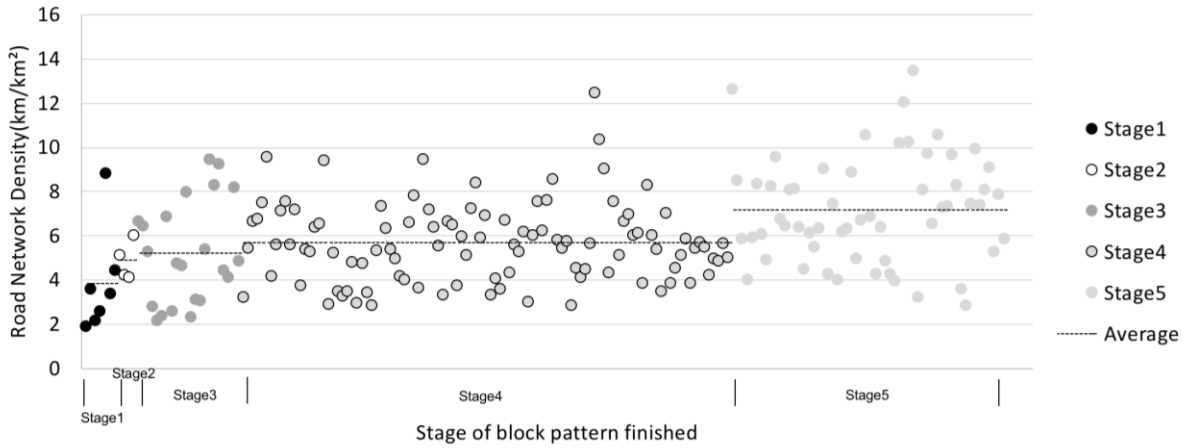


Fig. 4-9 Road network tendency based on the time when block patterns were finished (By author)

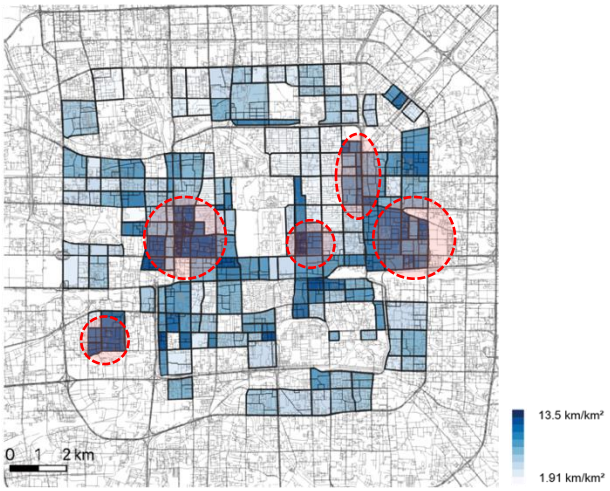


Fig. 4-10 Distribution of blocks based on road network density (Blocks with higher value marked in red) (By author)

4.4.2 Building Density

(1) Distribution

The blocks with high FAR have a relative corresponding relationship with the ones of smaller size and denser road network density, concentrating on the Financial Street area, CBD area and Wangfujing business area. They take up a relatively small proportion but create a strong image for Beijing, with high-rise landmarks. As for the compactness/coverage (GSI), there is a increasing trend from the outside to the inside of the Old Town. Hence, within the 3rd Ring Road of Beijing, the open space increases from the center to the outer, with intense construction concentrate in limited areas. (Fig.4-11)

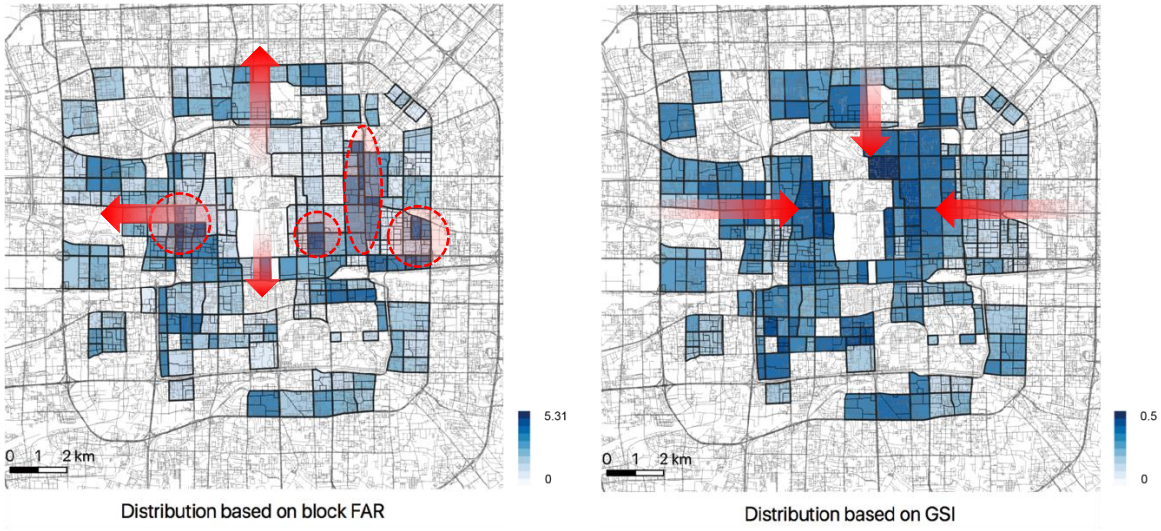


Fig. 4-11 Distribution of blocks based on building intensity and coverage
(Higher value marked in red) (By author)

(2) Building Density changes among blocks defined in different periods

Using Spacemate to prescribe densities and related spatial qualities has been tested (Pont, M. B.et al., 2009). Hence, the Intensity (FAR), Coverage/Compactness (GSI), were extracted to calculate the derived indicators Building Height(F) and Spaciousness (OSR), so as to describe the block morphology from the view of density. The result was combined with the time that each block was defined, so that the density transformation tendency within grid blocks was clearly clarified (Fig.4-12). The definition and calculation of FAR, GSI, F and OSR are explained as follows (Pont, M. B.et al., 2009):

a) <u>Building Intensity (FAR or FSI)</u>

FAR (Floor Area Ratio, or FSI as Floor Space Index) reflects the building intensity independently of the programmatic composition and is calculated as:

$FAR=S_F/S$

S_F: Gross floor area within the block;

S: the base land area, as block size.

b) Coverage/Compactness (GSI)

GSI (Ground Space Index), or coverage, demonstrates the relationship between built and non-built space and is calculated as:

GSI=B/S

B= footprint of all buildings within the block(m^2)

S = the base land area, as block size (m^2)

c) Average floor of buildings in the block(F)

The average number of storeys (or layers), F, can be arrived at by ascertaining the intensity and coverage or, FAR and GSI, for the block. If more floor area is developed in a block, without changing the footprint, F will increase. If the building height remain constant, then FAR and GSI have to increase.

$F= S_F/B=FAR/GSI$

d) Spaciousness (OSR)

The variable OSR (Open Space Ratio), or spaciousness, is a measure of the amount of non-built space at ground level per square meter of gross floor area. This figure provides an indication of the pressure on non-built space. If more floor area is developed in an area (with the same footprint), the OSR decreases and the number of people who will use the non-built space increases.

OSR=(1–GSI)/FAR

Although there are some special cases in different urban development stages that may blur the identities of each stage, the main tendency can also be identified. From the ancient time to present, the intensity (FAR) leaped up dramatically, especially some cases in Stage 4 and Stage 5. And the Compactness, or building coverage (GSI) gradually decreased. It correspondingly resulted in high-rise buildings with average storey of over 15 floors, far beyond the others that were of about 3-10 floors. Therefore, people can only share about half of the non-built spaces compared with the amount in previous. Take the cases with GSI about 0.2 as examples. With similar coverage (GSI), cases of Stage 4 are about 1.5 times of FAR compared with the ones in Stage 3, and unpredictably cases of Stage 5 are about 5 times high. That is to say, now, 5 times of people have to spend their time in the same range of open space as in Stage 3. Comparing the so-called modern pattern with higher FAR and lower GSI, and the previous pattern with higher GSI and lower FAR, there seems to offer more non-built spaces for landscape and better environment. However, for every individuals, they may actually lose more privilege in enjoying the open space.

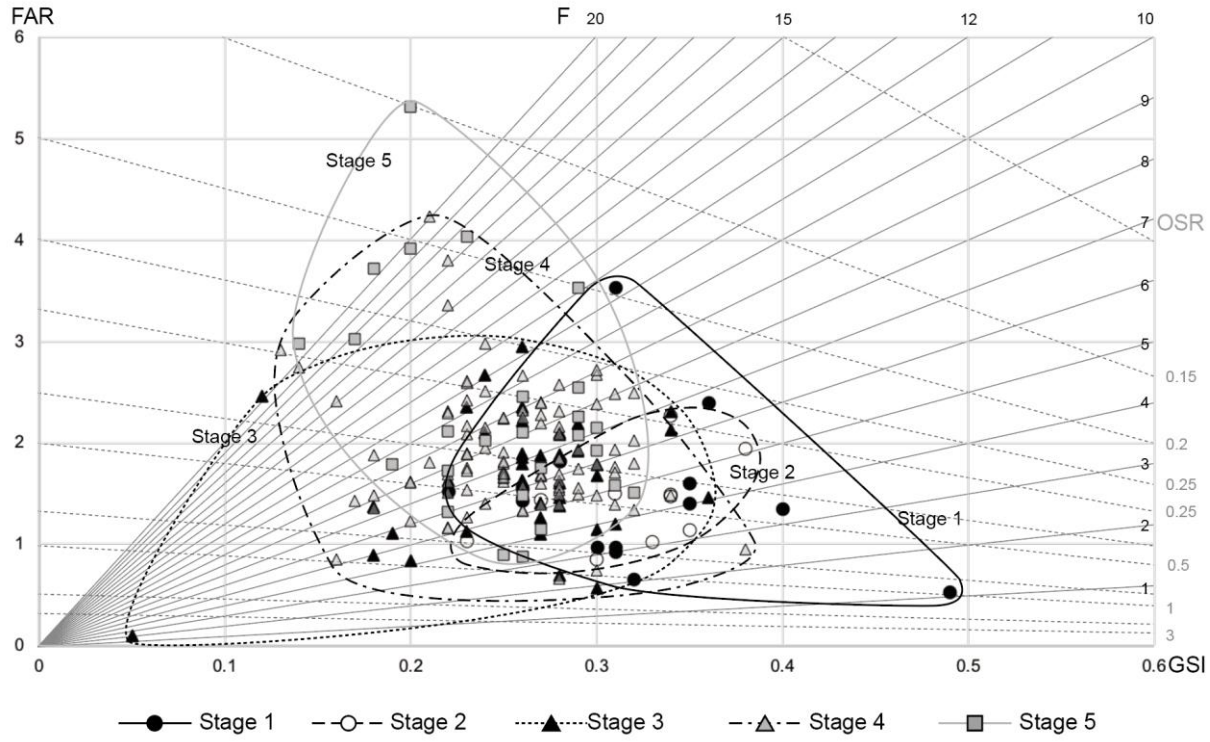


Fig. 4-12 Building density of blocks defined in each urban development stage (By author)

4.4.3 Subdivision inside Grid Blocks

(1) The current condition of branch road construction

Following the urban road hierarchy, branch road is the last grade of urban road network, mainly with local service function. They are planned and regulated in city plans and relevant principles. However, when comparing the current condition with city plans, features of branch road construction in blocks can be summarized.

The amount of accessible branch roads is less in current condition than planned. First, although Branch Road and Jiexiang Road are planned respectively in city plans, many existed roads cannot be clearly distinguished from their width or section (Fig.4-13 left). Hence, functions like retailing may be limited by road width and road furniture. Second, some qualified branch roads are actually located in gated communities or compounds. They are calculated in road network density but are unable for public to access. (Fig.4-13 right)

Dead-end branch road weakens the accessibility of super blocks. Some roads that are supposed to connect two side can be found only partly reconstructed with qualified width, or are stuck in the middle, resulting in residual spaces.

Similar with the block system, the subdivision inside grid blocks is arranged roughly and unorderly in gridiron. As a result, the block pattern and inner space are more complicated than the common grid plan.

Fig. 4-13 Brach road in city plan but with width resemble Hutong (left, Dafangjia Hutong)
Brach road in residential community (right, Hepingjiayuan Community)
(Photos by author)

(2) Types of subdivision patterns

According to the layout of branch road subdivision in grid blocks (Table 4-5), 7 types were abstracted with corresponding cases decreasing from Type1 to Type7. Only seven of 194 cases are orderly arranged in common gridiron (Type 7), with smaller size and higher road network density.

1) **Pattern Type 1 No-subdivision Type:** (Fig.4-15)

It is the most commonly implemented block pattern in Beijing, regardless of block size. It needs to be pointed out that, though there is not any subdivision by urban branch roads, there can be other roads of lower classes, such as Jiexiang road connecting buildings, and Hutong lanes.

2) **Pattern Type 2 Edge-corner Type:** (Fig.4-16)

They distribute mostly along axial/liner urban elements, such as significant roads, rivers and city walls (including historic sites). On one hand, new development of commercial and administrative buildings took part in the edge-corner space for higher accessibility and visibility. On the other hand, liner greenbelt or city park were constructed as buffer zones for keeping out traffic influence.

3) **Pattern Type 3 Mid-uneven Type:** (Fig.4-17)

They were mainly developed in Socialist planned period and Socialist marketing period, with Work-unit Compound or Residential Community of large parcels of land use. The larger parcels of Work-unit Compound or Residential Community remains, while the other part was divided into different scale for suitable development.

4) **Pattern Type 4 Equal Type:** (Fig.4-18)

It can be regarded as an alternative form of homogenous grid network implemented in the small rectangular blocks, whose length and width differ much. The longer side is usually equally divided, increasing the connection between the longer sides.

5) **Pattern Type 5 Unordered Gridiron Type:** (Fig.4-19)

Cases are divided into a more unordered gridiron but some of them are relatively in a homogeneous network. Their patterns were all finished in Stage 4 or Stage 5. Although subdivision was implemented, but the unordered

branch roads are not directly connected with each other. T-shape intersections are usually implemented, making the block pattern illegible. The illegibility is also a big contrast with the outer arterial road system.

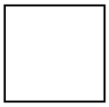
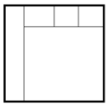
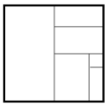
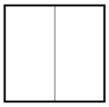
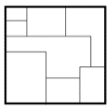
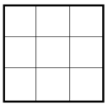
6) **Pattern Type 6 Irregular Type:** (Fig.4-20)

Although the boundaries are mainly in orthogonal system, but the inner subdivisions are in irregular patterns.

7) **Pattern Type 7 Equal Type:** (Fig.4-21)

It resembles the western modern grid network most. But it shows its compromise to Beijing's local context. Hence, it can be regarded as an unstrict grid network. Blocks seem to be divided in an equal way, but several of the branch roads are not accessible thoroughly, leading to a grid network that seems to be "unfinished".

Table 4-5 Subdivision pattern types of grid blocks in Beijing (By author)

	Type1	Type2	Type3	Type4	Type5	Type6	Type7
	No-subdivision	**Edge-corner**	**Mid-uneven**	**Equal**	**Unordered gridiron**	**Irregular**	**Gridiron**
Diagram							
Characteristics	No-subdivision by branch roads inside	Subdivided along block edge or block corner	Subdivided unevenly in the two halves. Mostly rectangular shape.	Subdivided into 2 or 3 parts in similar size	Arranged in gridiron, less orderly. Shapes are various but mostly in orthogonal.	Irregularly subdivided and not in orthogonal system	Orderly arranged. Almost rectangular shape.
Total Number	**60**	**42**	**34**	**24**	**16**	**11**	**7**
Big size	10	8	13	3	10	4	0
Mid-big	6	7	7	0	2	5	0
Mid-small	16	11	7	6	3	1	1
Small size	28	16	7	15	1	1	6

(3) Distribution of different subdivision pattern types

The distribution of grid blocks of different subdivision pattern types is shown in Fig.4-14.

Type 1 and Type 2 take up the main part of the Old Town in Beijing, especially inside the inner town. Type 1(No-subdivision Type) accords with most of the historical districts, proving its common implementation as the traditional and distinctive pattern from the antiquity. While, Type 2 shows its advantages along main streets aiming to get higher accessibility for the plots along streets, or continuous streetscapes.

In the distribution of morphological clusters (Fig.4-4 in Chapter 4.2.3), Cluster 5 (small blocks with dense road network, sparse but high-rise buildings) concentrates in redeveloped areas after Stage 4, especially the Financial

Street area and CBD area. It reflects that high development intensity and homogeneous network were preferred in New District Redevelopment. However, they are applying several subdivision patterns (Type 2, 5, 7), instead of the only one pattern, to realize this. This may avoid the monotone in streetscape to a certain degree.

The distribution out of the Old Town seems to be more random. Some previous Work-unit Compound and residential community from Soviet Union in the west persist the no-subdivision type. The residential districts developed by single estate developer may adopts more random subdivision (Type6 in the south), while the residential districts developed by several estate developers adopt more even subdivision. Moreover, type 7 that resemble the western gridiron network most are implemented limitedly, only in a few commercial area and newly constructed residential communities.

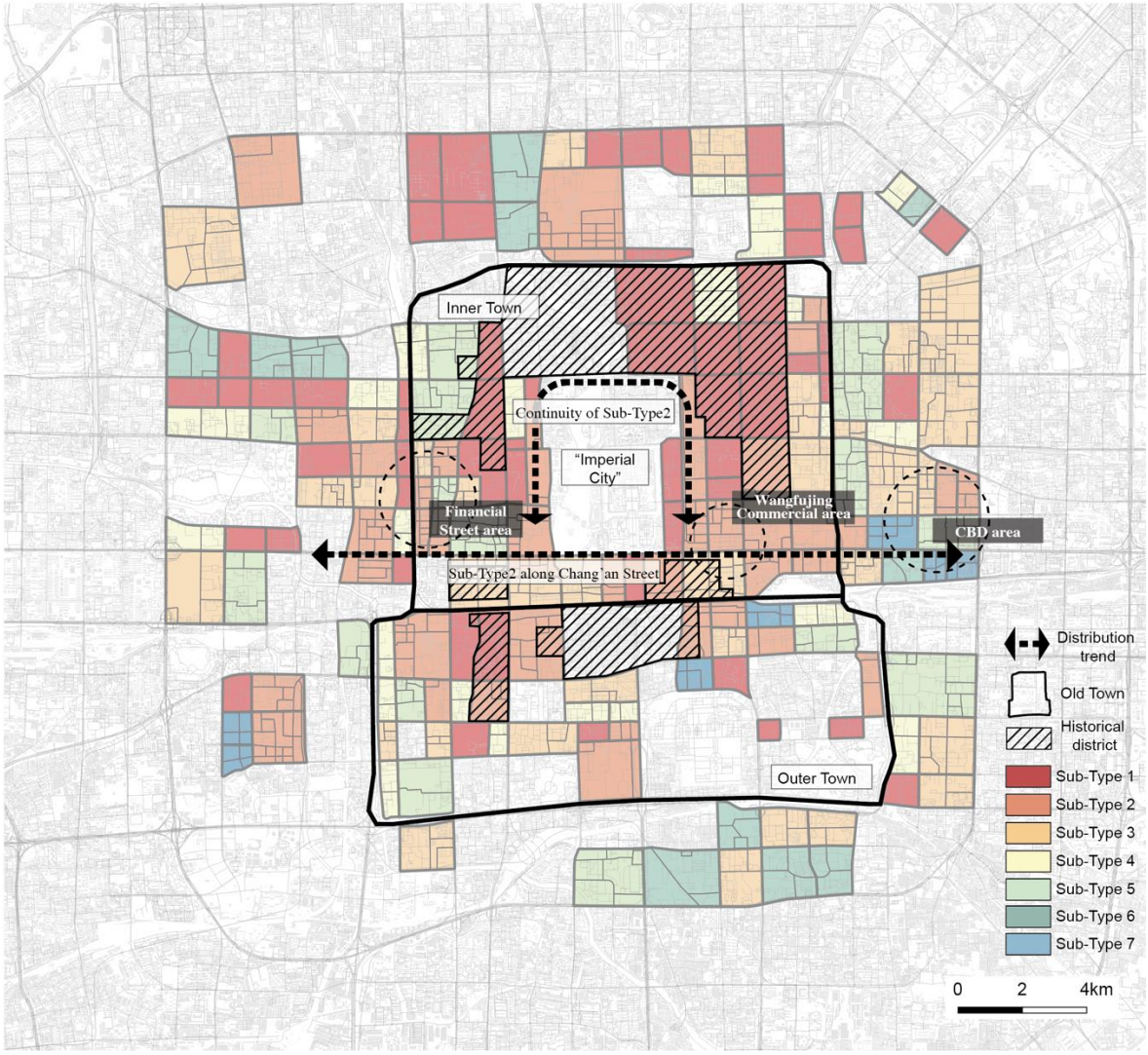


Fig. 4-14 Distribution of blocks in each subdivision pattern type (By author)

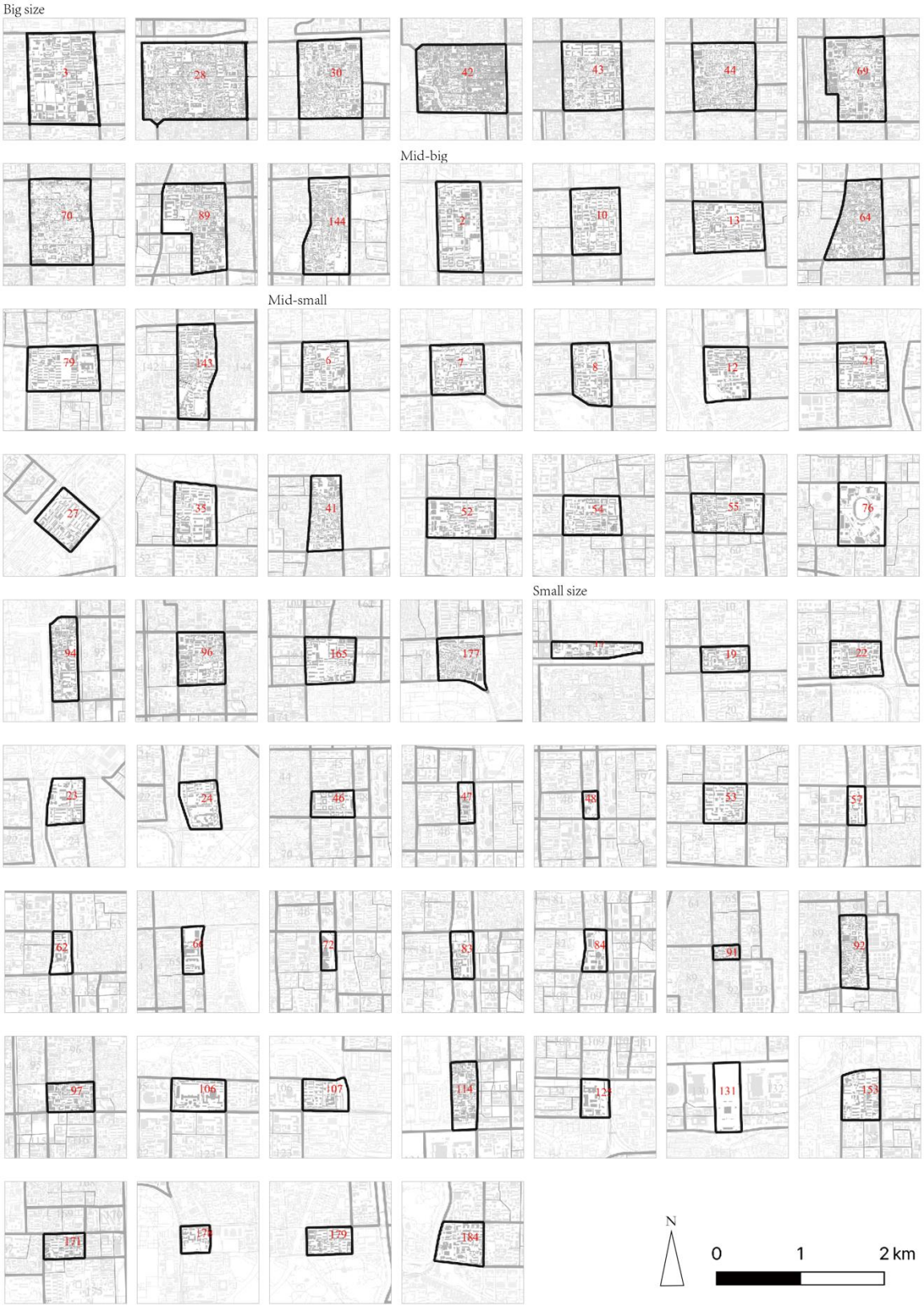


Fig. 4-15 Cases of subdivision pattern type 1(By author)

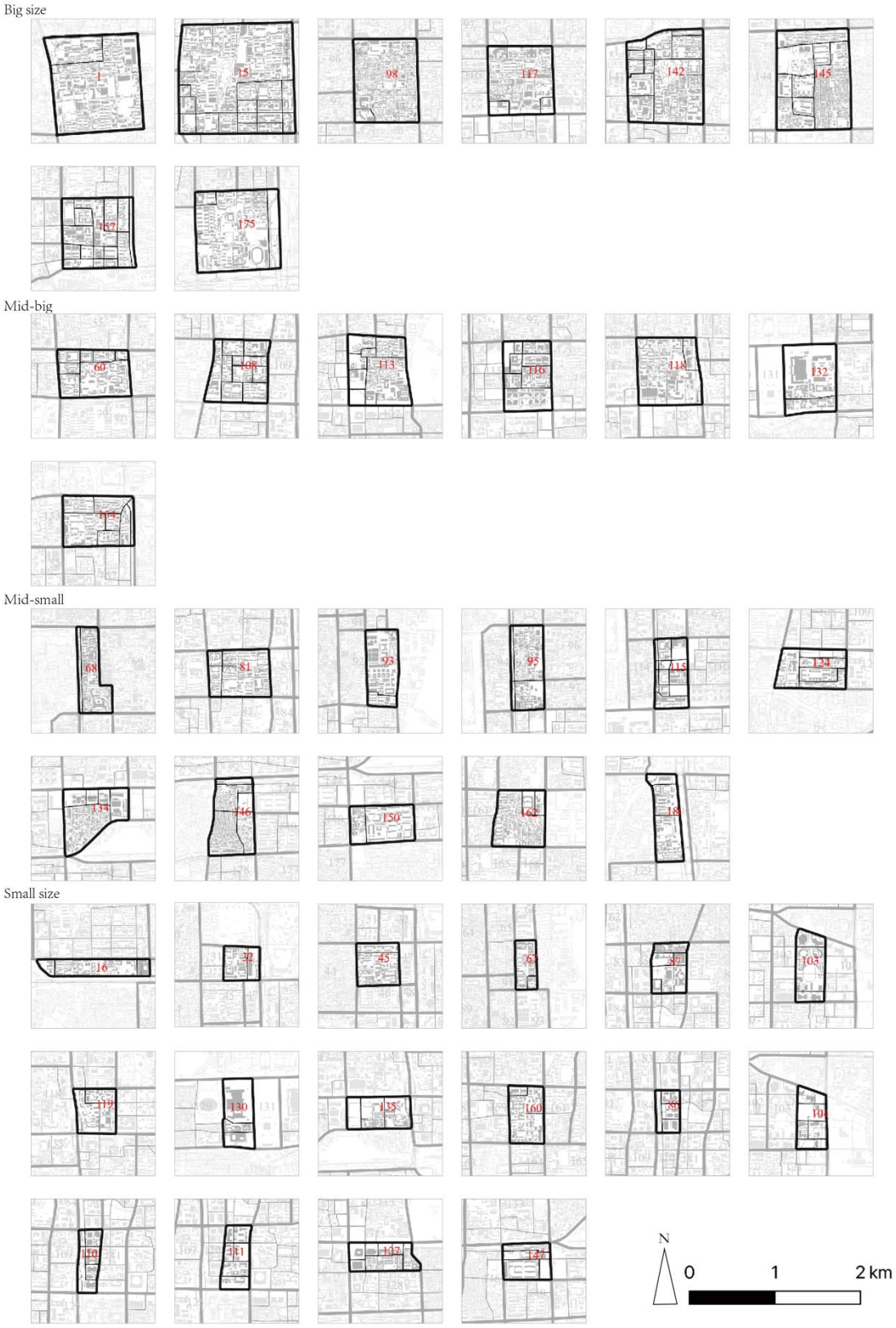


Fig. 4-16 Cases of subdivision pattern type 2(By author)

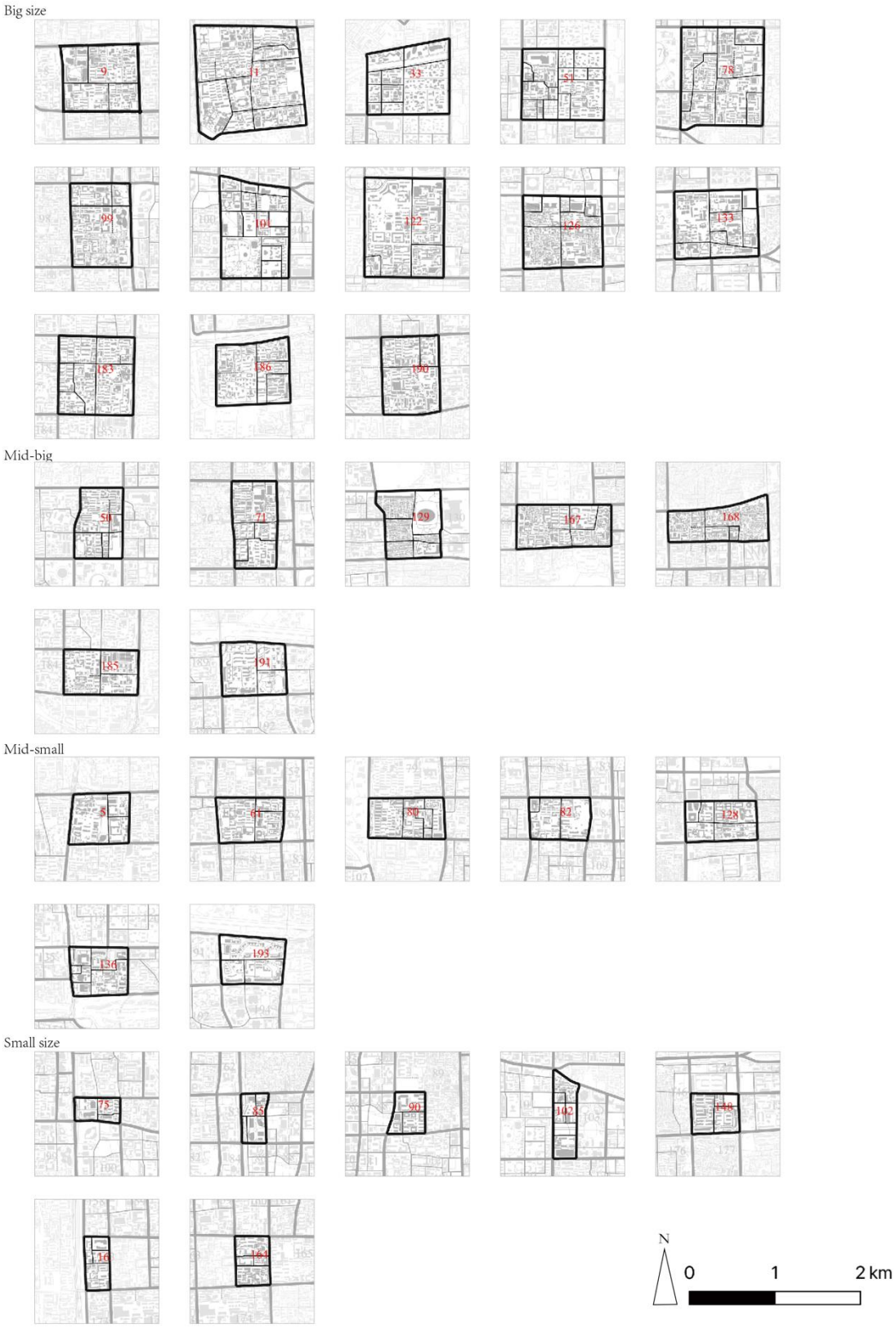


Fig. 4-17 Cases of subdivision pattern type 3(By author)

Fig. 4-18 Cases of subdivision pattern type 4(By author)

Fig. 4-19 Cases of subdivision pattern type 5(By author)

Fig. 4-20 Cases of subdivision pattern type 6(By author)

Fig. 4-21 Cases of subdivision pattern type 7(By author)

4.4.4 Connections of Subdivision Pattern Types with Block-boundary Layer and Time Dimension

(1) Connections between subdivision pattern types with different block sizes

As block sizes in Beijing differs greatly, this section examined the relationship between subdivision pattern types with block size, in order to find if there is any preference of subdivision patterns for different sizes. Proportion of different block sizes in each subdivision pattern are showed in Fig.4-22. Blocks of bigger size prefer Type 3, Type 5, and Type 6, which adopt higher random in subdivision pattern. Blocks of smaller size prefer Type 1, Type 4 and Type 7 which are in a more homogeneous pattern, especially Type 7.

It needs to be point out that small blocks that prefer no inner subdivision by Branch Roads do not equal to completely no subdivision. Comparing with the walkable block size in Portland, US, that is approximately 60m×60m (0.36ha), the smallest block in Beijing can be regarded as super "huge". Hence, without enough Branch Roads, streets of lower grade take up the duty of connection inner space of the blocks. As a result, the small lanes make a huge contrast with the arterial road systems outside, leading to lower accessibility or the lower desire for accessing, in the inner space.

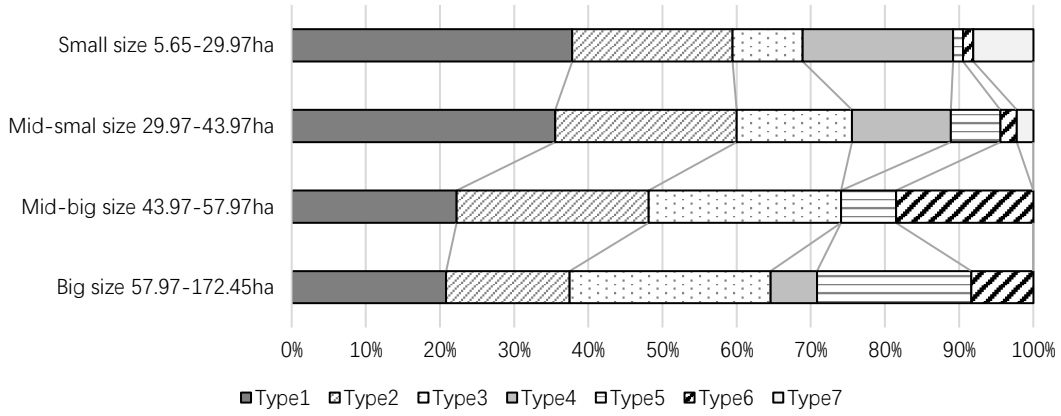


Fig. 4-22 Proportion of subdivision pattern types in different block sizes (By author)

For the cases that are re-subdivided after their block boundaries were defined earlier, Pattern Type 2, Type 3, and Type 5 are more commonly used. Among them, bigger-size blocks take up a higher proportion. (Fig.4-23)

Twenty-one of 48 blocks which were re-subdivided after the block boundaries were defined, were in Big Size. It correlates with the common sense that larger blocks are more like to be divided. But instead of re-subdividing the super blocks in homogeneous way, all the three patterns convey a sense of unbalance and contrast. Not only the plot size differs a lot within the big-size block, but the distribution of access into the inner spaces is unbalanced. As a result, blocks with re-subdivision, especially the ones in pattern Type 2, Type 3, and Type 5, did not provide enough accessibility for all the inner space. It may cause diverse spatial perception inside the blocks. However, the obvious spatial contrast shaped by the plot sizes and the street connection also can be regarded as a potential

in creating unique spatial perception in the blocks, when the modern gridiron is criticized as causing boring streetscape.

In summary, compared with the small-size blocks, grid blocks of bigger size in Beijing are more likely to adopt the subdivision patterns that is more unbalanced or uneven. In addition, spatial contrast is strengthened by the gap between internal space and external space of big-size blocks. The aforementioned may lead to urban spaces with higher diversification.

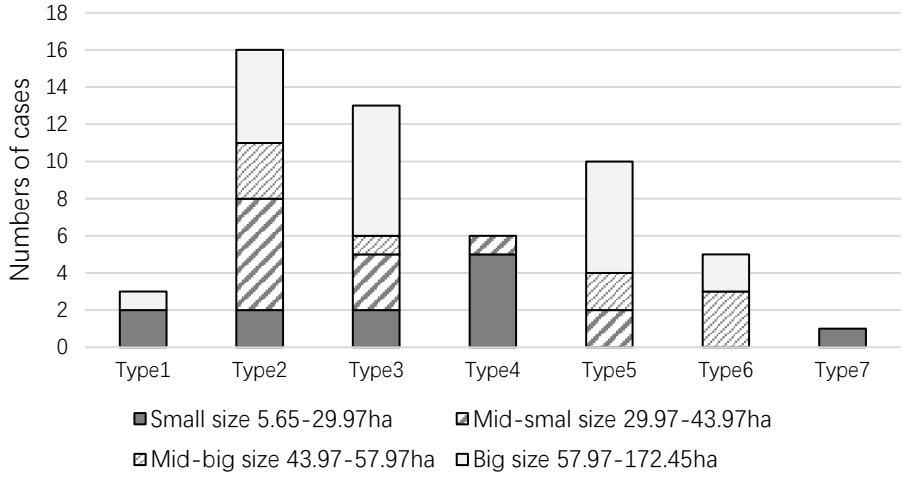


Fig. 4-23 Numbers of cases that were re-subdivided after boundaries were defined, in each pattern (By author)

(2) Changes in subdivision pattern types by the time of block boundary being defined

Changes in subdivision pattern types by the time of block boundary being defined are shown in Fig.4-24.

Form urban development Stage 1 to the current Stage 5, new types of subdivision patterns have appeared, on purpose or spontaneously. Type 5, Type 6, and Type 7 were newly applied after Stage 3. The proportion of each type has become more evenly distributed from the previous to the present.

In addition, there is a noticeable increase of modern gridiron (Type 7) in Stage 5, but they are all in small size (Table 4-3). It is an absorption of the western gridiron network which was rarely used in traditional Chinese cities. Hence, they are more likely to be implemented in the newly developed area or as a measure for redevelopment.

What's more, blocks without branch-road subdivision existed in every period, and it is an inheritance of the ancient dual system of "Big street" and "Hutong" in traditional Chinese blocks. But the sizes of them differs significantly from previous to current (Fig.4-25). This reveals that although with similar inner patterns, the overall block patterns were diversified into other forms. In addition, there were many big-size and mid-big-size blocks that adopted no subdivision during the Ancient time (Stage 1) and Socialist planned time (Stage 3), but this changed surprisingly in Stage 4, that 30 out of 33 cases without subdivision were in small size and mid-small size. Although there are a number of big-size cases in Stage 5, but as they are mainly the re-defined ones in the Old

Town (Fig.3-6 in Chapter 3.2.3), they actually partly represent the preference of the ancient time. Therefore, it means that superblocks without subdivision are more common in Ancient time and Socialist planned time, and are decreasing in recent decades. The preference of superblocks without branch road subdivision was abandoned in Socialist marketing period to some degree.

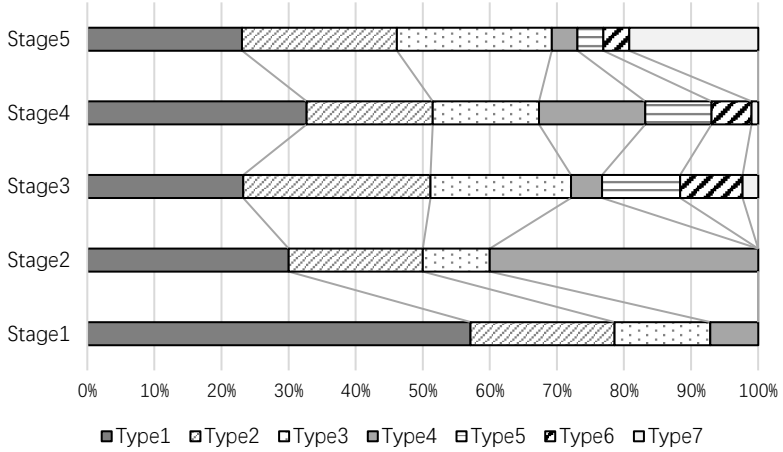


Fig. 4-24 Proportion of different subdivision types in each period
(the urban development stage that block boundary is defined) (By author)

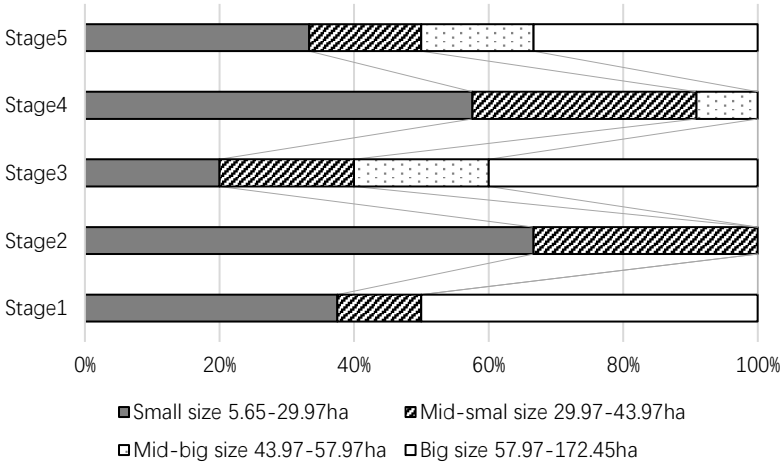


Fig. 4-25 Numbers of cases in subdivision pattern Type 1 in each urban development stage (By author)

(3) Changes in subdivision pattern types based on the block formation process

Blocks can be divided into two categories based on whether they have been re-subdivided or not. Among the typologies of block formation process, Type A1 and Type C1 show that the blocks were not re-subdivided again in their transformation. In other words, they maintain the initial subdivision patterns till now. While, the others have been re-subdivided in the subsequent development.

When the blocks without re-subdivision concentrate on type 1, the blocks with re-subdivision adopt every types more evenly, particularly, pattern Type 2, Type 3, and Type 5. Hence, it can be concluded that, the subsequent re-subdivision truly stimulates the diversification process of block pattern. (Fig.4-26)

Fig.4-27 shows the proportion of each subdivision pattern type in Process Type A1 and C1, in order to clarify the preference of subdivision pattern in each urban development stage. It is clear that subdivision pattern Type 1 is the most common original pattern, that it takes up the highest proportion in all the 5 stages. It is far higher than the proportion of all the other types. It reveals that top-down subdivision of blocks in Beijing are more likely to be ignored at first, but it may be implemented in the subsequent development. Hence, both advantages and disadvantages appeared. On one hand, the inner pattern can keep the chance to be planned according to the updating requirements and advanced urban planning concepts. On the other hand, as an independent process, it may not have strong connection with the existed boundaries. Moreover, if the buildings inside were finished before, it requires higher costs in the re-subdivision process.

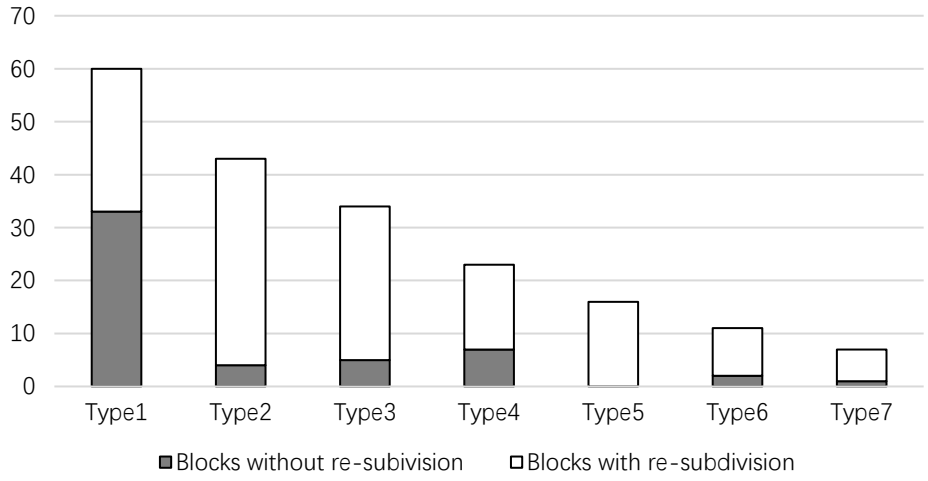


Fig. 4-26 Diversity of subdivision pattern types adopted in blocks without or with re-subdivision (By author)

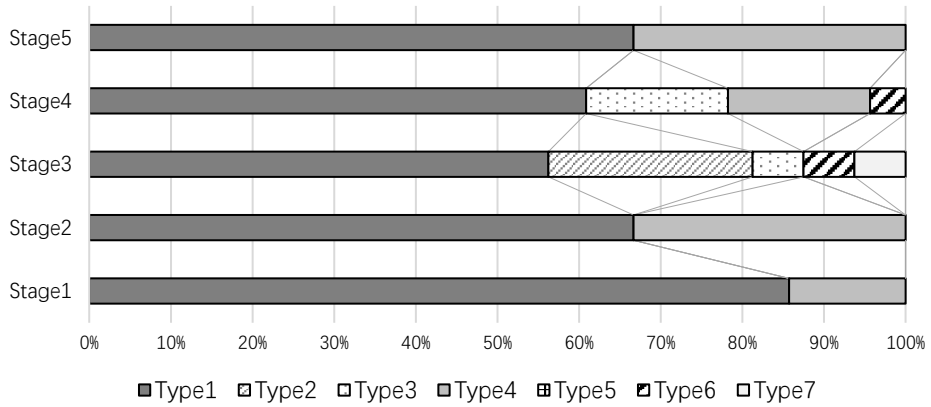


Fig. 4-27 Proportions of each pattern type as the original pattern (the cases in process Type A1 and C1, that have not been re-subdivided afterwards) of each stage (By author)

4.4.5 Dynamics of Diversification of Inner-space Layer

(1) Land use in large size, not only in superblock but also in large plot, results in possibilities in diversification

The large-size blocks have been inherited in different forms in Beijing from ancient till now. In pre-1949, Lifang system, which was constructed as administrative unit can be considered as the prototype of the current superblock. In the immediately post-1949 Chinese urban development, urban form was heavily influenced by soviet-inspired wide streets, huge blocks, monumental buildings, work-unit estates (danwei) (Bray, D., 2005), and residential microdistricts (Dong, G. Q., 2006). After the 1979's opening-up, a strong wave of danwei building occurred again during the 1980s, as gated worker quarters in response to changes in the tax laws, and most of them were enclosed by walls and guarded entry gates. It was a way of retaining a greater amount of surplus, which would otherwise be returned to higher authorities (Webster, C. et al., 2017). In recent decades, the modern gated residential community is an extended genre of the work-unit compound (danwei) during the centrally planned era.

As a result, all the above forms with land use in large size, got land boundaries determined but the inner space planned independently. The inner pattern of Lifang system was constructed by citizens, while the state-owned work-units and residential communities are designed by enterprises and estate developers. Local plans were determined individually, so even the communities were opened up, the existed patterns may leave impact on the urban pattern. Hence, even after the re-subdivision process, diversified patterns are more probably to occur in large-size blocks.

Based on the research of Webster and Zhao (Webster, C. et al., 2017; Zhao, Y. J., 2011), public service supplement and the local-tax funding system can be regarded as the institutional genes of continuous construction of large-size communities. In China, public services are provided by two levels of organizations: local government, and enterprises or developers. Local governments provide basic public services including main roads, water supply, and airports etc. They build better infrastructure, in order to attract more investment and obtain more tax through land auction, instead of directly getting tax from residents. Hence, the missing daily public services are provided by enterprises or developers. Moreover, aiming to increase the competitiveness of commercial housing, developers often provide more personalized but exclusive services, such as swimming pools, greening, clubs, and even schools etc. The larger the scale and the higher the quantity of personalized public services are, the larger the community is required. This explains why Chinese urban blocks are much larger than similar foreign cities. The boundaries of the services provided by the two-level organizations determine the size of the block. The more public services the government undertakes, the smaller the block will be. Conversely, the fewer public services the community undertakes, the larger the gated community will be for exclusive purposes. China's absence of a local property tax base, and local government's reliance on land leasing for income, make the phenomenon continue to exist.

(2) Irregular pattern leaves complexity in spatial arrangement and future redevelopment

Frist, significant public buildings were distributed along arterial road system, creating a façade of the block in Socialist planned period, leaving the backland as integral work-unit or residential area. With the technique's development and the absence of land marketing, buildings were not limited by the previous scale, even without considering land price. This gave larger land and more uncertainty for each building.

Second, similar phenomenon appeared along the edge and at the corner of work-unit compounds. The plot of one compound cannot reflect its inner land use and subdivisions. Both functions and land use patterns were mixed or even intertwined, but public buildings were more likely to sit along main roads for sake of higher accessibility. After marketing economy flourished, land development was affected by the law of markets. On one hand, some highly accessible parcels along main roads were detached form the former compound, becoming individual plots. They may be in charge with previous enterprises or given to other enterprises through replacement, transferring, or sale. On the other hand, the backlands with lower accessibility remain undeveloped, maintaining the previous functions. Large blocks tended to be disintegrated from the boundaries in irregular plot patterns.

Third, pushed by marketing economy and the increasingly improved urban detailed planning regulations, further subdivision of the original large block or plot became necessary for more intensive development in future. However, as the shapes and functions of land use inside compounds were ambiguous, the detailed plan was based on the disordered existing conditions, as a subsequently confirm of the built environment (Liang, J. et al., 2007). Therefore, the shapes of subdivided plots differed a lot form each other, which left hidden troubles to future redevelopment.

(3) Unstrict implementation of principles leads to variations generated in different periods

During the implementation of similar principles, the outcome may be not as expected. It is noticeable inside the Old Town. Fig.4-28 shows that urban development Stage 5 continues the redevelopment tendency, even inside the Old Town. It means that demolishing or renewing is happening in recent years, although the historic preservation policies after 2000 required to preserve the Old Town as a whole, completely, such as Plans for Protection of the Famous Historical Cultural Metropolis of Beijing (2002), and Beijing Master Plan (2004-2020). According to comparison between Google satellite maps of 2005 and 2016, the area of all changed patches accounts for 11.8% of the total area of the Old Town, among which the renewal patches account for 9.3% (accounting for 79%) and the removed patches account for 2.5% (accounting for 21%) (Sun, S. et al., 2018). Nearly 1/3 of the changed patches are located in the conservation district of historic sites, accounting for 7.9% of the total area of the conservation district; among them, 6.4% are renewal patches and 1.5% are removed patches. Outside the conservation district, 13.5% of the total area changed, of which 10.6% were replaced ones and 2.9% were removed ones (Sun, S. et al., 2018) (Fig.4-28). From the perspective of planning management and control, although the basic principle of "overall protection" has been clearly defined, there has not been a comprehensive and

hierarchical urban form control and guidance for Beijing's old city renewal in the past years. In particular, compared with the situation that a clear protection system, increasing social attention and professional research, have been established in the conservation district, the protection and renewal outside the conservation district still has not received enough attention and intervention. In Beijing Master Plan (2016-2035), the “overall protection” of the Old Town was emphasized again, adding more strict regulation of preserving the original block pattern, such as prohibiting demolishing any Hutong lanes inside the Old Town. Consequently, the unstrict implementation of preservation principles caused a chance that the current modern construction was directly imposed on the ancient patterns of superblocks with Hutong system. It created some huge contrast in urban form both visually and spatially.

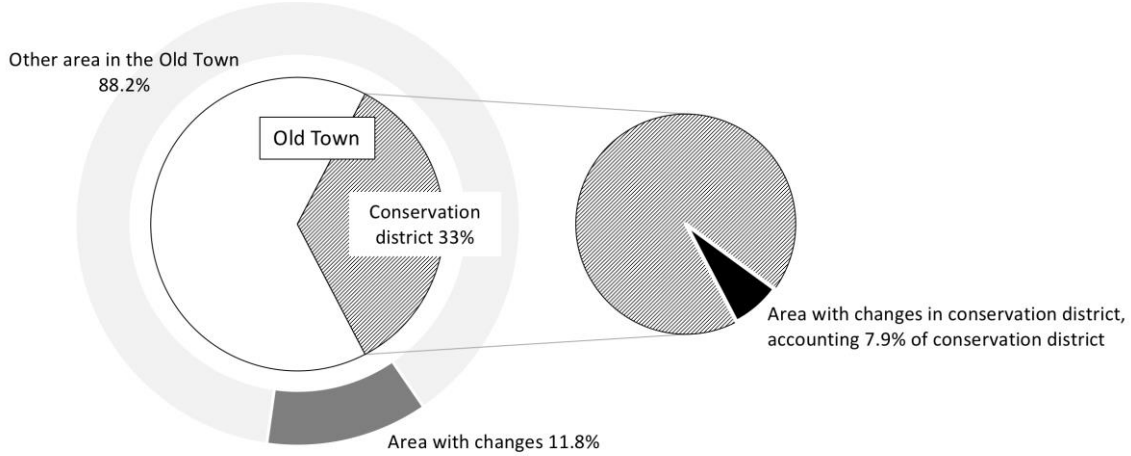


Fig. 4-28 Area with pattern changing in the Old Town of Beijing

(By author, data from Sun, S. et al., 2018)

4.5 Conclusions

4.5.1 Summary and Conclusions

This chapter took the grid blocks in Beijing as the representative inherent pattern in China for case study. It investigated the current conditions and transformation process of grid blocks in Beijing, and clarified how and why the grid block, as the inherent archetypal pattern, diversified in the primary block-boundary layer and detailed inner-space layer, in both time and spatial dimension.

The conclusions drawn from this chapter are as follows:

(1) Current conditions of grid block morphology in Beijing

Current morphology of grid blocks was investigated from the view of geometric features. Five morphological clusters were classified based on 7 indicators: Block size(S), Building Intensity (FAR), Coverage (GSI), Network density (N), Block shape regularity(R), Plot shape regularity (Rp), Standard Deviation of plot size Sp (SDp). Grid blocks with high variety co-exist in limited liner-shape distribution, showing an incredible sense of contrast.

(2) Diversification in block-boundary layer

The diversification process of grid blocks in the primary block-boundary layer, was investigated form the view of block size and shape regularity. Block boundary layer in Beijing shows large difference from the regular grid network in western cities. It adopts large size and lower regularity, which inherited the network from traditional Chinese grid. They differ a lot from each other, as a result of discontinuous planning principles and locations, reflecting the urban spatial contrast. The correlation between block size and urban planning principles' transition was clarified, while, block shape regularity corresponded more to its location in Beijing. Moreover, when the large size resulted in more diversification in the inner-space layer, smaller size correlated with higher density in inner-space layer especially in commercial areas.

(3) Diversification in inner-space layer

The diversification process of grid blocks in the detailed inner-space layer, was investigated from the view of road network density, building density and subdivision pattern. Their differentiation in the same period of time, and their evolution in long-term transformation were investigated. The building density correlated with road density in an increasing tendency, following planning principles' transition, but has a rather reversed tendency with building compactness. Subdivision pattern strengthened the spatial contrast of block boundary layer, and the re-subdivision process stimulated the diversification inside blocks, because that the existing irregular inner pattern would increase complexity in spatial arrangement.

(4) Multiple dynamics lead to the diversification

The diversification of grid blocks in Beijing resulted from not only the disordered formation process and insufficiency of planning principles in Chapter 3, but also strengthened by the interaction between boundary and inner space. It was clarified from the view of time and spatial dimension:

From the view of time dimension, first, less continuity and unstrict implementation of principles led to variations generated in different periods. Second, no exact order of block formation and the large time span they covered during the formation process provide higher changeability of morphology. Finally, the irregular inner pattern of blocks, which can be considered as an inheritance from the inherent grid pattern, leaves complexity in spatial arrangement and future redevelopment.

From the view of spatial dimension, the co-existence of "time differences" in urban construction; the land use in large size from the ancient times; and the lack of clear physical definition of "block" and contradictions in and between regulations, contribute to the diversification process in spatial dimension.

(5) In conclusion, the diversification in transformation process of urban morphology refers to the time difference of urban construction and the subsequent changes appeared after construction, in time dimension. And it also represents the simultaneous spatial distribution of "time difference" in urban construction, and the unexpected differentiation in similar construction periods. The "diversification" can be considered as being composed of a series of localization process in micro scope, according to the positions and functions of the urban pattern. It can also be regarded as a result of localization process.

4.5.2 Issues and Suggestions on Grid Block Construction and Renovation

By clarifying the diverse transformation process of grid blocks in Beijing, this chapter identified limitations and potentials with regard to grid block construction and renovation, from the perspective of satisfying the updated requirements of cities and creating unique city images.

(1) Small blocks and dense grid network implemented as a newly born, advanced but questionable pattern

Small blocks and dense grid network were an outcome of introducing the modern urban planning concepts from western countries. It became more encouraged since "small block, dense network" concept was released in 2016. However, the grid network implemented was not as strict as in typical western cities, disorthogonal pattern, curve roads, and unconnected branch roads appeared, making the pattern specialized in Beijing's urban context. And it can be considered as a transition form from planned economy to marketing economy.

Although this pattern is a kind of diversified genre of grid block, it is the big contrast with the previous block pattern in Beijing makes it global but heterogeneous to some degree. It does improve traffic efficiency or urban diversity as Jacob suggested (Jacobs, J., 1961), but largely at the expense of Beijing's original urban spatial structure. Hence, the implementation of small blocks and dense grid network need to be considered more about its influence on Beijing's urban identity.

(2) A sense of spatial contrast in urban form

A sense of contrast in urban fabric can be found thorough the diversification process. The contrast between super blocks and small blocks, the wide arterial roads and narrow small lanes, the off-scale urban public space and spontaneous local space, and the uneven subdivision inside super blocks, make the sense of contrast in Beijing

distinctive and unique. Instead of attempting to demolish the inherent hierarchical structure blindly, to propose optimization require more attention. How to make balance between the increasing “Small blocks and dense grid network” and the existing “contrast” require future discussion.

(3) Connections between social unit and physical form unit

As the community and neighborhood play important roles in citizens’ daily life in China, the sense of contrast may be taken advantage of when considering the citizens’ participation and local belongings. Thus, the grass-roots administrative units in Chinese civilization are possible to become a media connecting human and the physical form. With regards to the current separation between social units and physical form units to a certain extent, their integration may allocate the duties and responsibilities in a clearer way. Hence the urban form may be strengthened by the invisible dynamics of social perceptions.

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Chapter 5 Localization of Imported Ring-radial Space in Chinese Cities

——Morphological and Functional Transformation of Ring-radial Spaces and Rotaries in Dalian and Changchun, China

5.1 Introduction

5.1.1 Background and Objectives

As the “skeleton” of urban infrastructure, street patterns define the identity of a city, and are highly unchangeable. As a typical street pattern of Classicism, the ring-radial spaces and rotaries (RS&Rs) have been frequently implemented in European cities. This pattern offers centrality and possibilities in every direction, compared with the monotonous crossroads in the prevalent grid plan. However, after the influence of Modernism in urban planning, the grid plan has been highly preferred to achieve a better land utilization rate and business value in Capitalism (Mumford, L., 1961). The blooming traffic also causes congestion and safety problems in RS&Rs (Gates, T.J, et al., 2000). Hence, in the current urban context, the role and significance of RS&Rs’ are questionable.

Ancient Chinese cities that have been constructed by urban planning, such as Beijing and Xi’an, are more likely to adopt a grid plan. However, under the influence of Baroque Style, Howard’s Garden City Theory, and North America’s City Beautiful Movement (Liang, J., et al., 2006) in the 1800s and 1900s, RS&Rs appeared in several Chinese cities, and particularly in those that were initially planned by colonial administrations. Street patterns with RS&R-shaped urban characteristics exist until today. The RS&Rs were constructed during urban development. Simultaneously, their morphology and functions transformed, and in turn influenced the urban development process. Hence, clarifying the transformation process and exploiting the RS&Rs can be useful for creating attractive public spaces and forming unique city images.

The objective of this chapter was to investigate the transformation process and current conditions of RS&Rs in representative cities, and clarify how the RS&R, as a foreign pattern localized in Chinese cities, and how did the similar geometric prototype, diversely developed in different cities adapting to local conditions, and shaped these cities in different ways.

To this end, comparative analysis was carried out between Dalian (Chinese: 大连; Japanese: 大連) and Changchun (Chinese: 长春; Japanese: 長春). The two representative cities were selected according to the following criteria: 1) Similar abstract street pattern. Both cities are characterized by the circle+radial+axis pattern with circular city squares, but their concrete urban forms are different. 2) Similar construction time. Dalian was first planned as a modern city in 1899, and the first modern plan was initiated in 1898 in Changchun. 3) Similar colonial background. The two cities were initially constructed by Russia and Japan, successively. In addition, RS&Rs are also implemented in other cities with colonial background, such as Ha’erbin and Shenyang, but the two cities only have RS&Rs in limited areas such as railway stations, and RS&Rs are not continuously implemented in the two cities. Hence, they are not as representative as Dalian and Changchun. The proposed approach and findings of this chapter provide a new viewpoint for further understanding the morphological

transformation and urbanization process of cities with RS&Rs. Additionally, suggestions are made with regard to RS&R renovation to satisfy the updated requirements for cities and create unique city images.

Moreover, the localization process of RS&Rs in Chinese cities can be treated as an approach of Baroque ring-radial space's diversification worldwide. It makes up the diversification of RS&Rs in the world's range, to some degree. Based on the definitions in Chapter 1.3, "Localization" and "Diversification" process can transform into each other in different resolutions. But when taking the cultural origin or the origin of urban planning concept as prerequisite and focusing on Chinese cities independently, this chapter focused more on how the foreign RS&Rs were transformed to adapt to different local conditions.

5.1.2 Definition of Ring-radial Space and Rotary

The research target was limited within the urban built-up areas. The RS&R considered in this research represent: 1) the road junctions where traffic streams circulate a central island (Fig.5-1, left); 2) focal public urban spaces existing at the intersection points of the street network with roads radiating from the center, but without necessarily adopting central islands (Fig. 5-1, right).

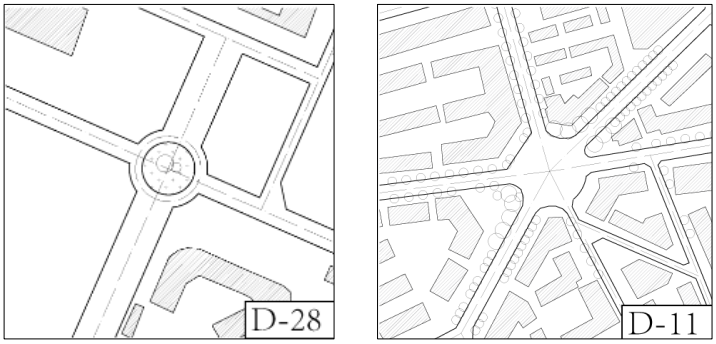


Fig. 5-1 Examples of RS&Rs considered in this chapter (By author)

5.1.3 Previous Research

Previous studies have mostly emphasized the urban planning history of Dalian and Changchun, respectively. The urbanization process of Dalian (Liu, C., 1999), and particularly the transformation and characteristics of urban construction before 1955(Jiang, Y., 2013; Xiao, Z., 1988a, 1988b; Koshizawa, A., 1984; Yano, T., 1931; Hess, C., 2006; Perrins, R. J., 1998), has been clarified. Similarly, the urbanization process (Cui, Y., 2011) of Changchun, and particularly the urban planning features in the Manchukuo period (Koshizawa, A., 1988; Guo, Q., 2004), has also been clarified. Moreover, because Dalian and Changchun are typical cities with colonial backgrounds, they have been compared with other colonial cities such as Shenyang and Haerbin with regard to their historic urban form (Liu, Q., 2008; Sun, H. et al., 2002) and urban construction process (Koshizawa, A., 1978) in modern times. However, although RS&Rs are important parts of street pattern, which shapes a city's skeleton, not enough attention has been put to RS&Rs when discussing the whole urban planning history of Dalian and Changchun. Previous studies have also emphasized the representative urban spaces related to the RS&Rs in the two cities. The

city square (city plaza) has been investigated, including some historical RS&Rs such as Zhongshan Square in Dalian and South Square in Changchun. However, these studies mostly regarded city square (city plaza), not specifically RS&Rs, as a single or a type of public space. They contributed to the classification of the geometric shapes, and provided design suggestions based on spatial features (Zhou, Y., 2009; Hou, C., 2013; Feng, W., 2007; Li, Y., 2007), human behaviors, and historic preservation (Zhang, J., 2016; Chen, Yu., 2011). But the relationship between RS&Rs are lacking in discussion. Moreover, some RS&Rs have also been focused on from the perspective of traffic. Studies focusing on traffic roundabouts have more frequently attempted to improve the capability and organization of transportation (Han, P., 2011).

Studies that considered RS&Rs as specific components of urban infrastructure, and particularly those that were not from the traffic view, are lacking. Moreover, the previous comparative studies conducted for Dalian and Changchun during the urban planning process did not focus on the characteristics of the RS&Rs in the two cities. Therefore, in this chapter, the RS&Rs were not only considered as social function containers, but also as nodal points of the street network. The reason for the diverse development of the RS&Rs, the localizing way in which they developed as similar elements in the two cities, and their current conditions, require further investigation.

5.1.4 Research Target and Methodology

(1) Outline of Target Cities

Dalian is a major seaport city located in Liaoning Province, China. Its urban construction started in 1899, and it is the province's second-largest city with sub-provincial administrative status. Dalian is the southernmost city of the Liaodong Peninsula (Fig.5-2), and is mostly a hilly area with a coastline of 1906 km. The urban built-up area is 404 km^2 (2018). (Dalian Municipal Bureau of Statistics, 2018)

Changchun is the capital and largest city of Jilin Province, situated at the heart of Songliao Plains in Northeast China (Fig.5-2). Its first administrative agency (Changchun Ting, Chinese: 长春厅, Japanese: 長春庁) was established in 1800 (Koshizawa, A., 1988). The urban built-up area of Changchun is 541.37 km^2 (2018). (Ministry of Housing and Urban-Rural Development of P.R. China, 2018)

(2) Case Collection

The cases (Fig.5-3) were collected based on the definition given in Chapter 5.1.2, excluding those implemented in areas such as residential communities and campuses, which are not accessible by the public. The cases were limited within the core area of Dalian (Fig. 5-4) and 4^{th} Loop Road of Changchun (Fig. 5-5).

In total, there were thirty cases in Dalian (Table 5-1), amongst which, one (Zhangzhe Square) was deconstructed and transformed into a rectangle city plaza (presently Renmin Square) around 1949. In Changchun, there were twenty-nine cases (Table 5-2), of which eight cases have been deconstructed and transformed into common crossroads.

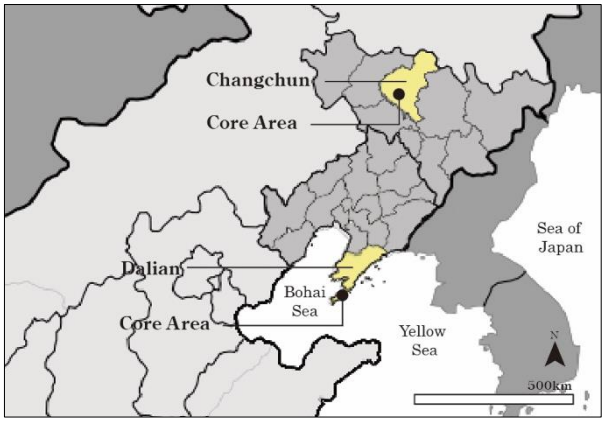


Fig. 5-2 Location of Dalian and Changchun (By author)

Fig. 5-3 Shuma Square (D-23) in Dalian (By author)

Table 5-1 RS&R cases in Dalian (S.: Square)

ID.	Name	Construction Time	Deconstruction Time
D-1	Xingzheng S.	1903	—
D-2	Youhao S.	1903	—
D-3	Gangwan S.	1903	—
D-4	ZhongShan S.	1903	—
D-5	Shengli Bridge S.(N)	1903	—
D-6	Shengli Bridge S.(S)	1903	—
D-7	Minzhu S.	1903	—
D-8	Erqi S.	1909	2006*
D-9	Sanba S.	1909	2006*
D-10	Zhangzhe S.	1914	1949
D-11	Huayuan S.	1920	—
D-12	Wuyi S.	1920	2003*
D-13	Wusi S.	1920	—
D-14	Jiefang S.	1920	—
D-15	Northwest of Renmin S.	1980	—
D-16	Haida S.	1987	—
D-17	Youyi S.	1995	—
D-18	Yufeng S.	1995	—
D-19	Huanan S.	1995	—
D-20	Yaojia S.	1995	—
D-21	Fumin S.	1995	—
D-22	Xueyuan S.	1999	—
D-23	Shuma S.	2000	—
D-24	Bayi S.	2002	—
D-25	Xiaopingdao Central S.	2009	—
D-26	Xiaopingdao Kanhai S.	2010	—
D-27	Donggang S.	2012	—
D-28	Matou S.	2013	—
D-29	Quanshui S.	2015	—
D-30	Hongqi S.	2015	—

* Cases with only central islands deconstructed or reconstructed.

Table 5-2 RS&R cases in Changchun (S.: Square)

ID.	Name	Construction Time	Deconstruction Time
C-1	Changchun Station S.	1908	—
C-2	West S.	1908	—
C-3	South S.	1908	—
C-4	East S.	1908	—
C-5	Dongda S.	1918	—
C-6	Guangfu S.	1918	Before1945
C-7	Renmin S.	1933	—
C-8	Xinmin S.	1937	—
C-9	Xi 'an S.	1937	—
C-10	Sanjiao S.	1937	—
C-11	Gongnong S.	1937	2000*
C-12	Xinfa S.	1937	1980s-1990s
C-13	Jianshe S.	1937	
C-14	Tongzhi S.	1937	
C-15	Jiefang S.	1937	
C-16	Quan'an S.	1937	
C-17	Ziyou S.	1937	1993
C-18	Nanhu S.	1942	—
C-19	Jingyang S.	1942	—
C-20	Zhengyang S.	1942	—
C-21	South Station S.	1942	—
C-22	Weixing S.	1993	—
C-23	Qianjin S.	1998	2013
C-24	Saide S.	1998	—
C-25	Shiji S.	2002	—
C-26	Shengtai S.	2007	—
C-27	Qiche S.	2007	—
C-28	Dazhou S.	2007	—
C-29	Longxiang S.	2010	—

* Cases with only central islands deconstructed or reconstructed.

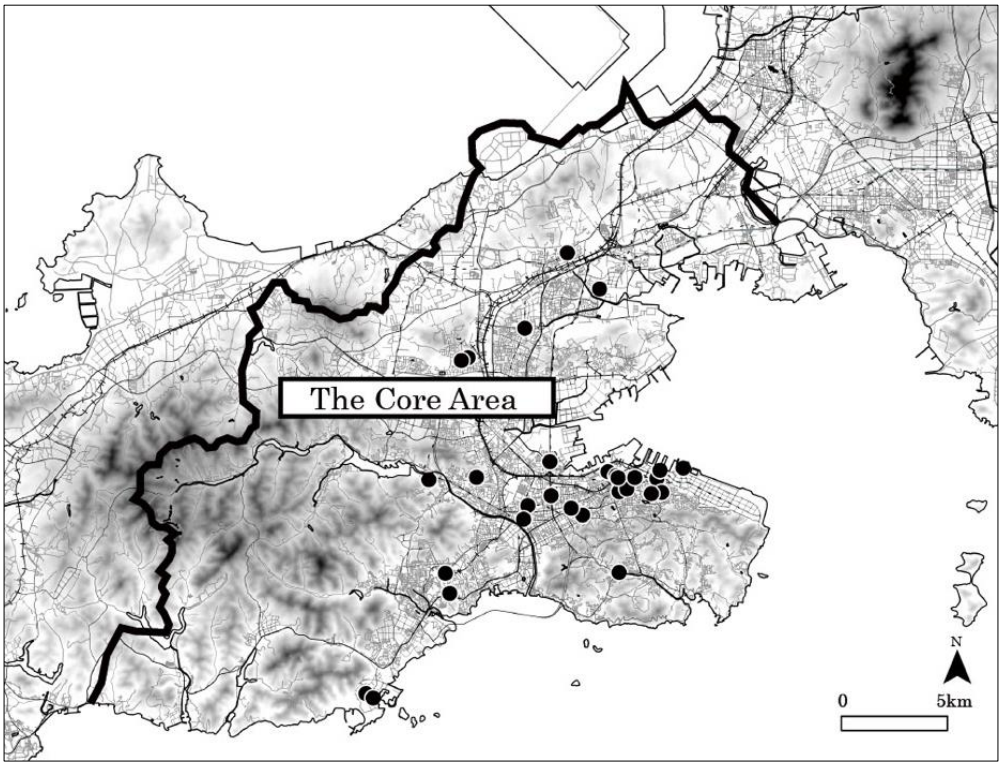


Fig. 5-4 Core area of Dalian and case locations (By author)

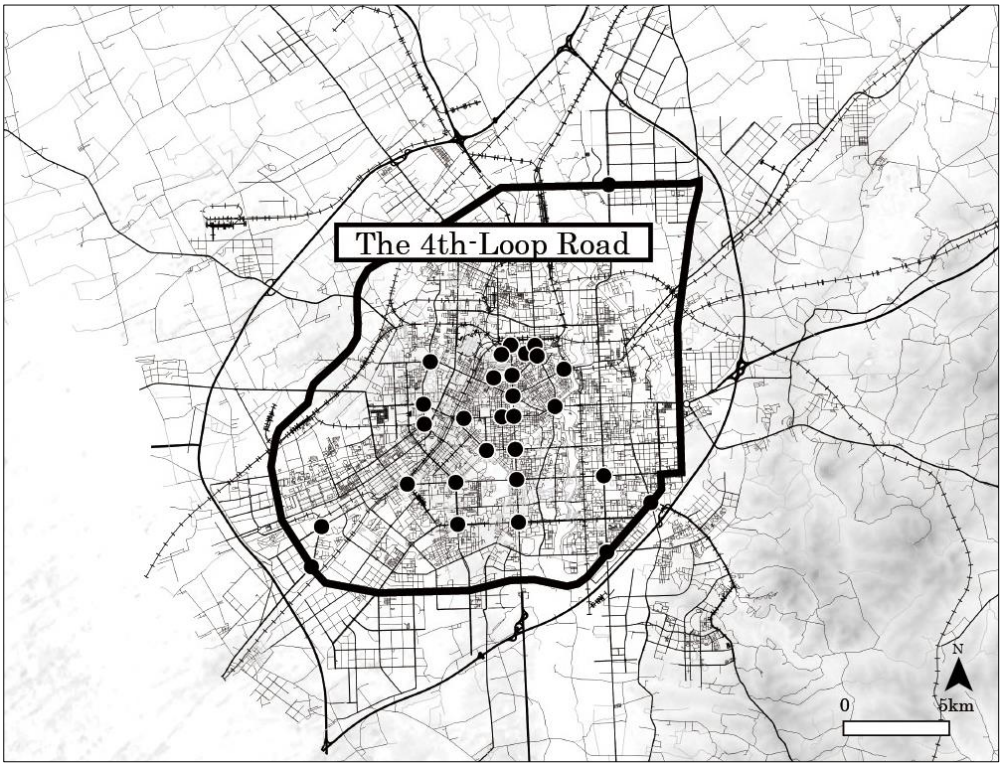


Fig. 5-5 Fourth Loop Road of Changchun and case locations (By author)

(3) Research Methodology and Framework

Chapter 5.2 shows the initial background for the implementation of the RS&Rs. The urban planning timelines, street pattern characteristics, natural conditions, and social conditions of the two cities are compared to explain why the RS&Rs were initially selected for urban planning. Then, the dynamics of their first localization are clarified.

Chapter 5.3 overlays the urban planning history, planning principles, and RS&R construction process in Dalian and Changchun by carrying out literature review and mapping. Thus, the connective relationship between the RS&R construction process and the urban development process is clarified from the viewpoint of both time and space.

Chapter 5.4 describes the RS&Rs in terms of spatial morphology, functions and surrounding building fabric to clarify their current conditions, transformation process, and multiple dynamics. Their long-term localization in respective urban context is clarified. Field surveys were conducted in Dalian and Changchun in September 2018, and the geometric forms and functional elements of each case were recorded.

Chapter 5.5 summarizes the conclusions and discussion on RS&Rs' transformation and localization, and proposes suggestions on future renovations.

5.2 Origin of Ring-radial Spaces and Rotaries' Implementation

5.2.1 Beginning of Modern Urban Planning

Modern urban planning was first introduced into Dalian and Changchun in 1899 and 1898, respectively. However, owing to the different city positioning at different times, modern urban planning was strictly implemented when Dalian began to be constructed as an international free trade port (Jiang, Y., 2013). However, at the same time, modernization in Changchun went through a process, from spontaneity to discipline, in three stages, following the rising city positioning: a standard station of the Chinese Eastern Railway (CER), the central transport hub of South Manchuria Railway (SMR), and the capital of Manchukuo (Table 5-3).

As part of the Guandong Leased Territories (Kantoshu), Dalian came under the territorial control of the Russian Empire from 1898[*1)] until the country's defeat in the Russo-Japanese War in 1905. In 1899, its first urban plan was made by Sakharov[*2)], who implemented the American Grid in the master plan, similar to Manhattan in the United States. The plan considered the street network as an urban infrastructure priority. For the first time, modern urban planning was introduced into Dalian. However, it was soon overturned by Russian urban planner Kazimierz Skolimowski (Казимир Сколимовский, 1862-1923) in 1900. With nodal city squares as priorities and the radial street network being implemented as connecting elements, Dalian was expected to become a European-style city, such as Paris (Liu, C., 1999).

Changchun was established and named by the Qing Dynasty in 1800, with an irregular urban pattern resulting from the small peasant economy (Liu, Y., 2006). Urban modernization started in 1898 when CER established Changchun's first railway station and constructed the Kuanchengzi area (Chinese Eastern Railway Affiliated Areas, CERAA, now in North Changchun). Considered as a standard station, Changchun CERAA was constructed according to a grid plan within a rectangle-shaped area to achieve higher land-use efficiency. In 1907, Changchun began to be constructed as a hub of SMR, and Japan initiated the Manchuria Railway Affiliated Areas (SMRAA) centered at Changchun Railway Station. Circular squares with radial streets were overlaid on the grid pattern, aiming to relieve traffic and plan large-scale public facilities to beautify the townscape (Cui, Y., 2011). In 1932, Changchun was renamed to Hsinking (新京) as the capital of Manchukuo. The Metropolitan Plan of Great Hsinking (大新京都市計画) was proposed, and provided the foundation for the current urban pattern in Changchun.

Table 5-3 Beginning of modern urban planning in Dalian and Changchun

		Dalian		Changchun		
Planning time		1899	1900	1898	1907	1932
Characteristics of urban planning		Grid plan (not implemented), street network as priority	Baroque Style, circular squares as priority and radial street network as connecting elements	Grid plan	Baroque Style, grid plan with radial roads from the central square	Baroque + Chinese, A geometric combination of radial, circular, hexagon and grid pattern
Natural condition		Hilly peninsula city, Huanghai Sea in the east, Bohai Sea in the west, seaside low hilly land in south, mid-low mountain area in north		Flatland in the Northeast China Plain with three small hills and a river as natural landscape element		
Social conditions	**Administration**	Russian Empire		CER by Russian Empire	SMR by Japan	Guandong Army by Japan
	City positioning	1898 International free-trade port city, based in the current city center of Dalian		Railway Affiliated Area, based in Kuanchengzi	South Manchuria Railway Affiliated Areas (SMRAA), based on Changchun Station	1932 "Hsinking," capital of Manchukuo
	Related urban planning theories & practices		18th-century baroque city plan 1853 Haussmann's renovation of Paris		18th-century baroque city plan 1791 L'Enfant's Plan of Washington D.C	1898 Howard's Garden City Theory 1913 Canberra urban plan Functional city theory Neighborhood unit theory Chinese traditional north-south axis and grid plan

5.2.2 Geometric Manners of Ring-radial Spaces and Rotaries

The geometric manners are pronounced in both cities, and can be recognized both as a combination of RS&Rs and street axes, following the Baroque City Plan, which originates from western cities and has successfully shaped famous cities such as Paris and Washington D. C. Moreover, this city plan demonstrates the ascendancy of centralized coercion and stringent control (Koshizawa, A., 1988). Both Dalian and Changchun were built with the preconceived objective of being planned into an ideal city. Therefore, the Baroque City Plan was suitable. The localization of Baroque City Plan in China was started up.

The geometric manners in the two cities are different in terms of the scale of the RS&Rs (Fig.5-6) and the relationships between the RS&Rs (Fig.5-7). Before 1945, the average size of cases in Changchun was almost double than that in Dalian. In Dalian, the original RS&Rs were randomly distributed. Irregular axial networks connect the RS&Rs, which produces a sense of romance. In contrast, the RS&Rs in Changchun are more orderly, following orthogonal or oblique grid patterns, which produces a sense of solemnity and hierarchy.

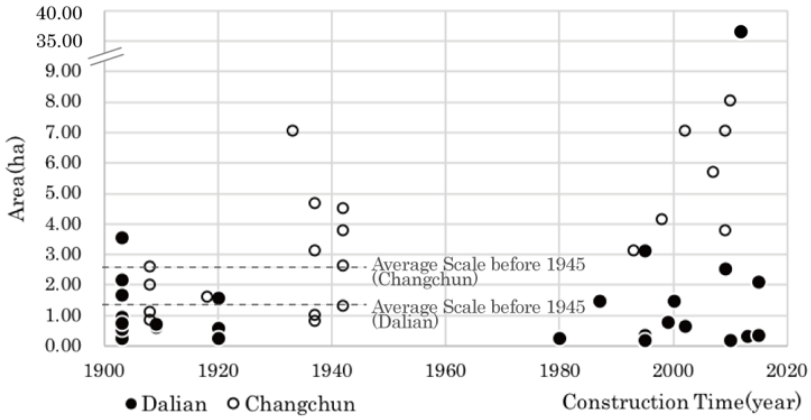


Fig. 5-6 Size of RS&Rs in Dalian and Changchun (By author)

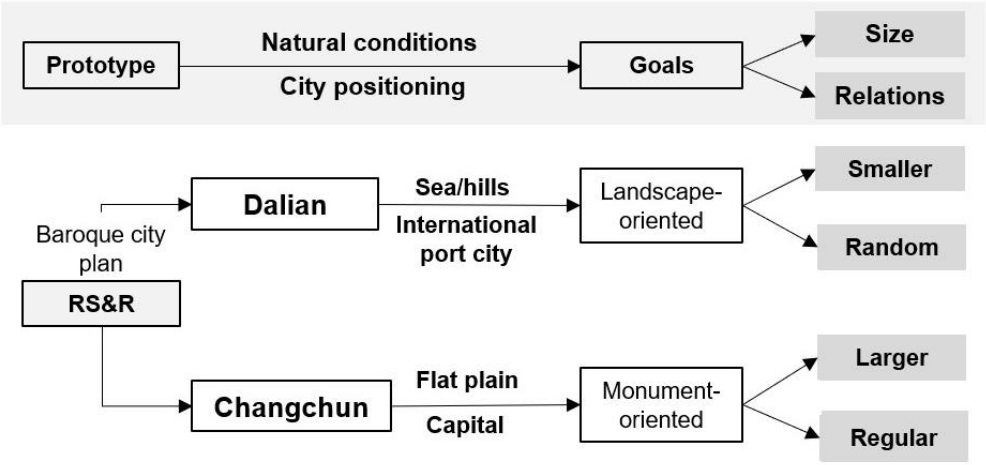


Fig. 5-7 Relationships between RS&Rs and their dynamics (By author)

5.2.3 Dynamics of Initial Differentiation in RS&Rs' Localization Process

(1) Different planning goals resulting from various natural conditions and city positioning

The adaptation of natural terrain is the main reason for changing the first plan of Dalian from the American Grid to the Baroque axial system. Compared with Paris' strong sense of artificial plan, the RS&Rs were localized following the natural condition primarily.

First, as a city located on a hilly peninsula, the scenery of hills and sea makes Dalian distinctive. The Baroque axial system offers visual corridors directing to remote hills and the sea, which makes the RS&Rs and surrounding streets landscape-oriented (Fig.5-8).

Additionally, while the American Grid ignores the exhaust caused by climbing abrupt slopes, which can be up to 11.5° (Liu, C., 1999), and includes high land leveling costs, the Baroque axial system follows natural hills and valleys to realize functional zoning.

Finally, considering the bulging areas as circular city squares and connecting them with each other by streets reduces the destruction of the existing terrain. The scale of the RS&Rs and the distance between them are controlled for high efficiency with regard to traffic and human activity. Hence, important transportation junctions are quickly achieved within 1.5 km by walking (Liu, C., 1999).

In contrast, for the flat plain in Changchun, the objective of RS&R implementation is more subjective and monument-oriented (Fig.5-9). The cases in SMRAA emphasize the significance of the central station and activate the monotonous grid townscape. The cases planned in the Metropolitan Plan of Great Hsinking took up a powerful representative character, demonstrating the new government's absolutism. At that time, twenty-three percent of the total urban area was reserved for avenues and circuses (SMR, 1939). For instance, Datong Square (presently Renmin Square; diameter of 300 m) was the center of the Japanese administration, and an open space for public assembly.

(2) Application of various urban planning theories

To exploit the natural conditions, the intention of the original RS&Rs in Dalian was pure and straightforward, and imitated famous urban plans such as Paris' renovation, by creating a unique and charming townscape. As a brand new and ideal capital city in the 1930s, Changchun offered a test ground for various modern urban planning theories.

Thus, the RS&Rs performed multiple symbolic functions (Fig.4-9):

a) Being a symbol of the Garden City. Approximately all RS&Rs had parks or gardens in the center, with extensive tree planting, which is a part of the green system and public spaces.

b) Being centers of functional zones (Cui, Y., 2011). They provided dominant space for surroundings as the city's sub-centers, which made the functional zones more explicit.

c) Being nodal points along the traditional Chinese North-South axis.

Hence, the imported Baroque style in Changchun was localized with more traditional Chinese culture especially the concepts in ancient capital planning.

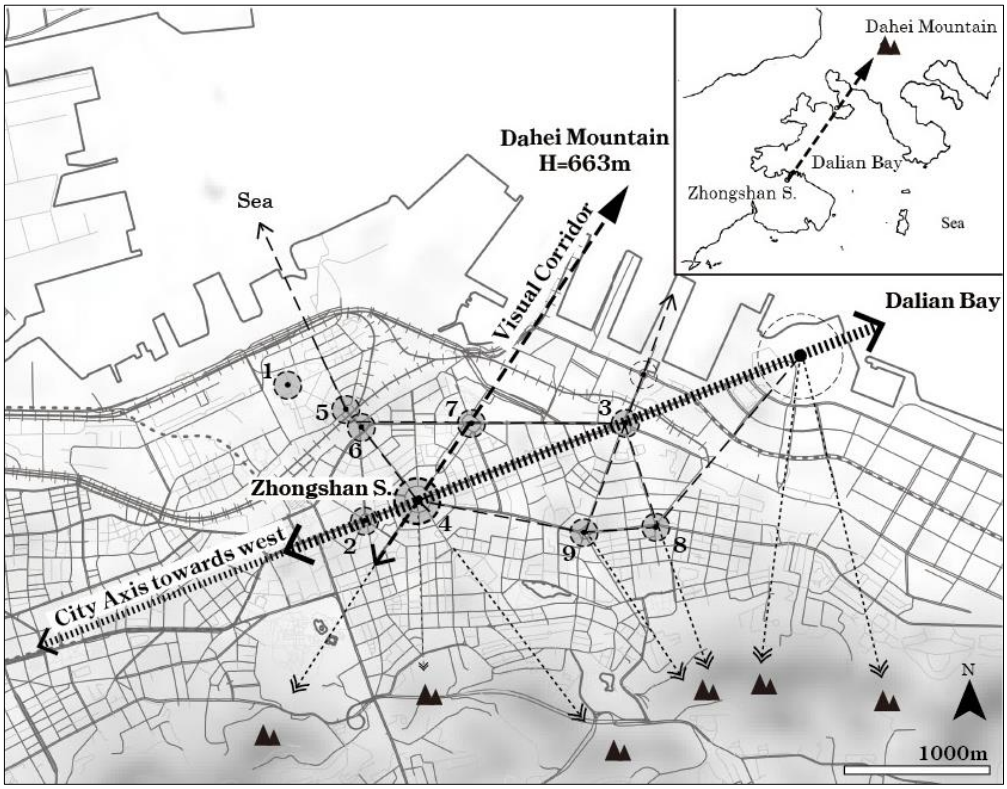


Fig. 5-8 Diagram of landscape-oriented RS&Rs in Dalian (By author)

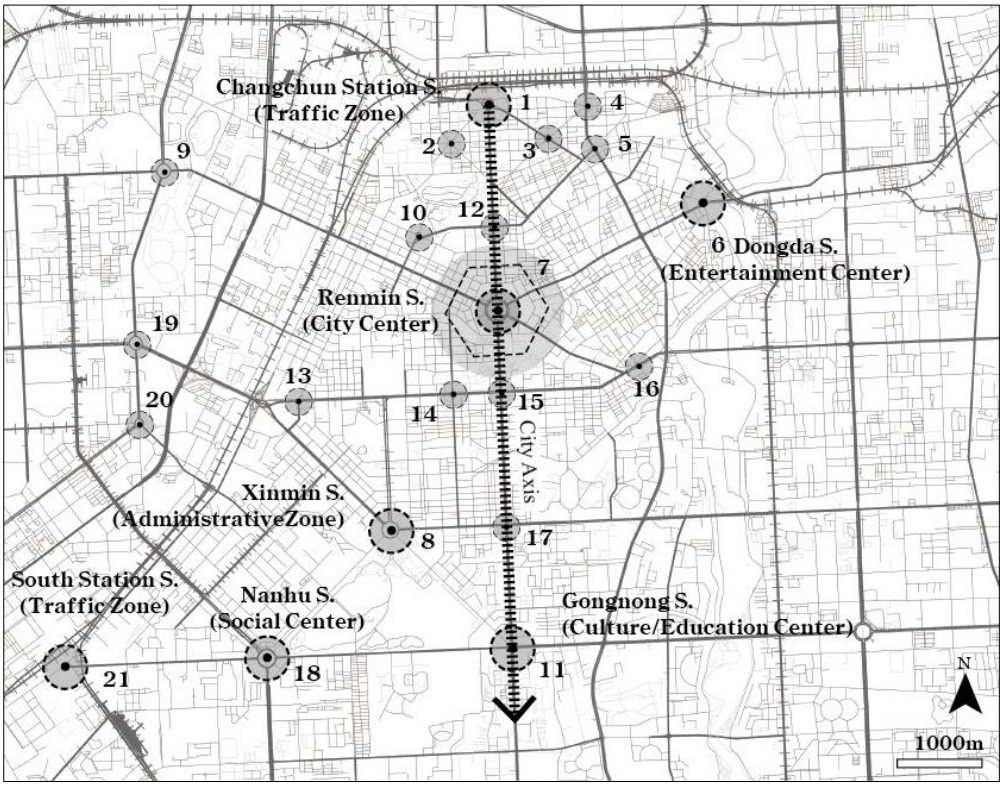


Fig. 5-9 Diagram of RS&Rs with symbolic perspective in Changchun (By author)

5.3 Urban Development Process and Construction of Ring-radial Spaces and Rotaries

The quantitative increase, both in Dalian and Changchun, did not only appear before 1950, but also in recent decades (Fig.5-10). This reveals that the RS&Rs are not an outcome of a specific period, such as colonial times, but rather an inherited planning icon. In this section, their relationship to the urban planning and urban sprawl processes is clarified from the perspective of time and space.

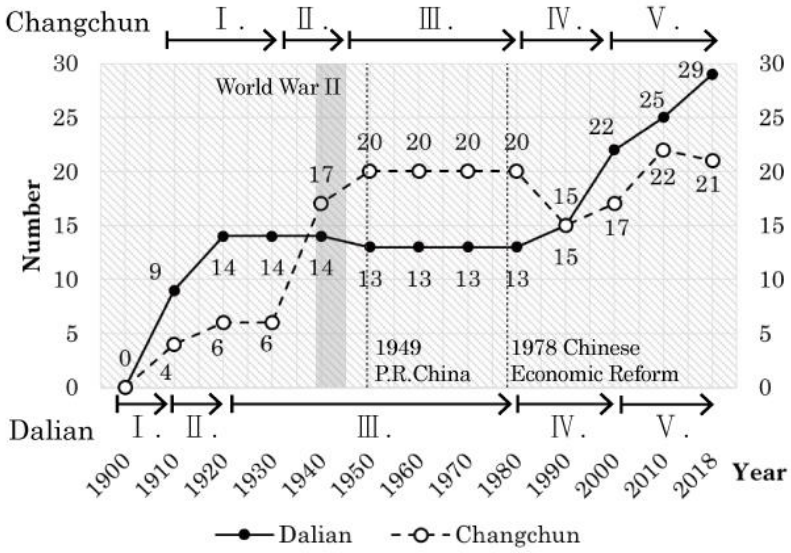


Fig. 5-10 Quantity changes (By author)

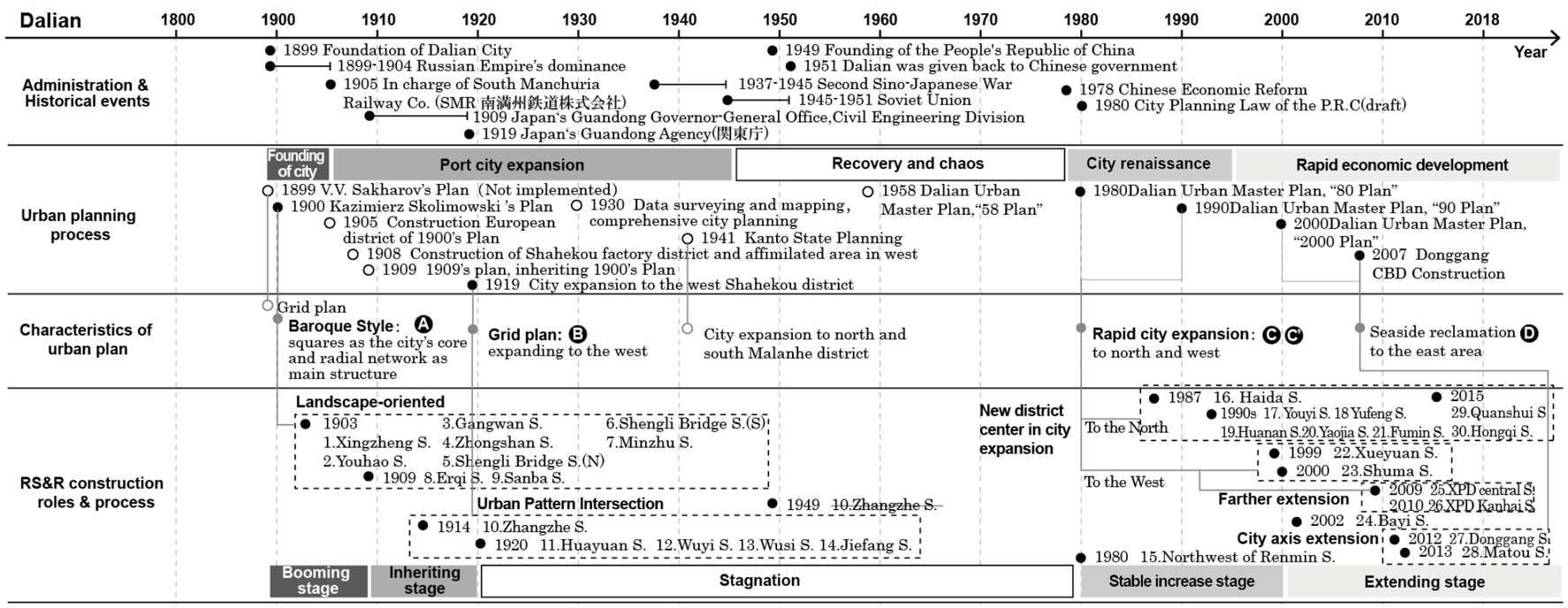
5.3.1 Ring-radial Spaces and Rotaries with Urban Planning and Urban Development Stages

Based on the quantities and changing rates of the RS&Rs, five stages were identified for each city (Fig. 10). Dalian: I. Booming stage (1899-1908); II. Inheriting stage (1909-1920); III. Stagnation (1921-1979); IV. Stable increase stage (1980-2000); V. Extending stage (2001-present). The five stages of Changchun are as follows: I. Preliminary stage (1908-1931); II. Booming stage (1932-1945); III. Stagnation (1946-1979); IV. Decreasing stage (1980-1997); V. Stable increase stage (1998-present).

According to the urban planning process, five stages are identified for Dalian: I. Founding of city (1899-1905); II. Port city expansion (1905-1945); III. Recovery and chaos (1945-1978); IV. City renaissance (1978-1995); V. Rapid economic development (1995-present). Five stages were also identified for Changchun: I. Partial construction (1800-1932); II. Capital construction (1932-1949); III. Recovery and chaos (1949-1978); IV. Spatial expansion (1978-1996); V. Structural transformation (1996-present) (Fig.5-11).

It is not coincidental that the RS&R construction corresponds to the urban planning process. The construction typically followed the guidance of new planning principles, which indicates the significance of RS&Rs as a

continuous inherited planning icon. The highest growth rate existed when the Baroque plan was the primary planning concept, while the second highest growth rate appeared in the 1990s in Dalian and in the 2000s in Changchun, during the rapid urban sprawl. However, the sharp decrease in Changchun appears to be contradictory to the city's spatial expansion and the national trend of large-scale square constructions in the 1980s (Hou, C., 2013), and also demonstrates the rapid urban development from an alternative viewpoint. With the increase of the intersection traffic volume from 329.69 k veh/d (1980) to 953.03 k veh/d (2000) (Yang, Q. et al., 2010) in Changchun, from 1979, seven cases in total were deconstructed and transformed into common crossroads to relieve the booming traffic. Although their traffic-calming function was once questioned, the many cases that built up in recent decades, and particularly those along the arterial roads and expressways, indicate their efficiency at present.



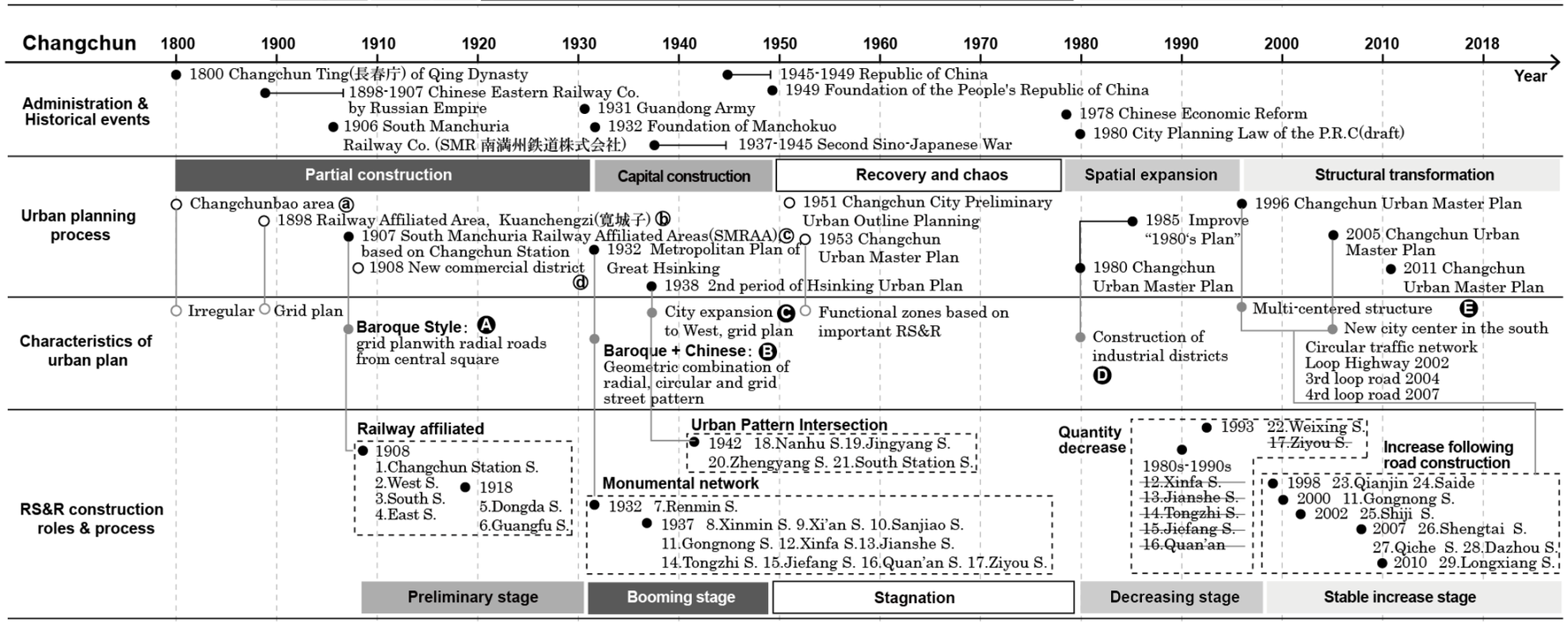


Fig. 5-11 Urban development process and construction of RS&Rs in Dalian (upper) and Changchun (lower) (By author)

5.3.2 Distribution of Ring-radial Spaces and Rotaries

The construction of the RS&Rs accompanied the urban sprawl tendency, but the RS&Rs distribution varied according to the urban form. Fig.5-12 and Fig.5-13 shows the distribution of RS&Rs constructed at different times, along with the urban sprawl process. The following observations can be made:

1) The RS&R locations mostly coincide with the urban sprawl areas in each stage;
2) In Dalian, the RS&Rs are unevenly distributed in groups, and the RS&R groups are situated in an approximately linear manner. However, in Changchun, almost no prominent groups can be identified and the RS&Rs are distributed in a layered circular diagram, centering at Renmin Square.

The RS&R groups in Dalian originate from collage urban patterns, which can be recognized based on the relationship between the RS&Rs and street networks. Nine landscape-oriented cases (constructed before 1909) in Area A are highlights of the Baroque urban pattern, which holds priority over the radial street network. However, the five cases in Area B (four of which were constructed during 1909-1949) are set back as subordinate to the street grid. In other words, the street network holds priority. The cases constructed during 1980-2000 are dispersedly located but oriented toward three general directions limited by natural hills. The lack of geometric manners weakens the connection between them. Finally, the most recent cases can be considered as a continuation of the previous stage, and two cases (D-27 and D-28) have re-inherited the original Baroque manner, and thereby extend the street axis from Area A as a new ending point. For Changchun, the RS&Rs are dispersedly and more evenly located along arterial roads or expressways; therefore, the loop road system leads to their layered circular distribution. The five cases around Changchun Station (Area A) act as a starting point, and the locations of newly built cases indicate the tendency of city expansion toward the southwest direction.

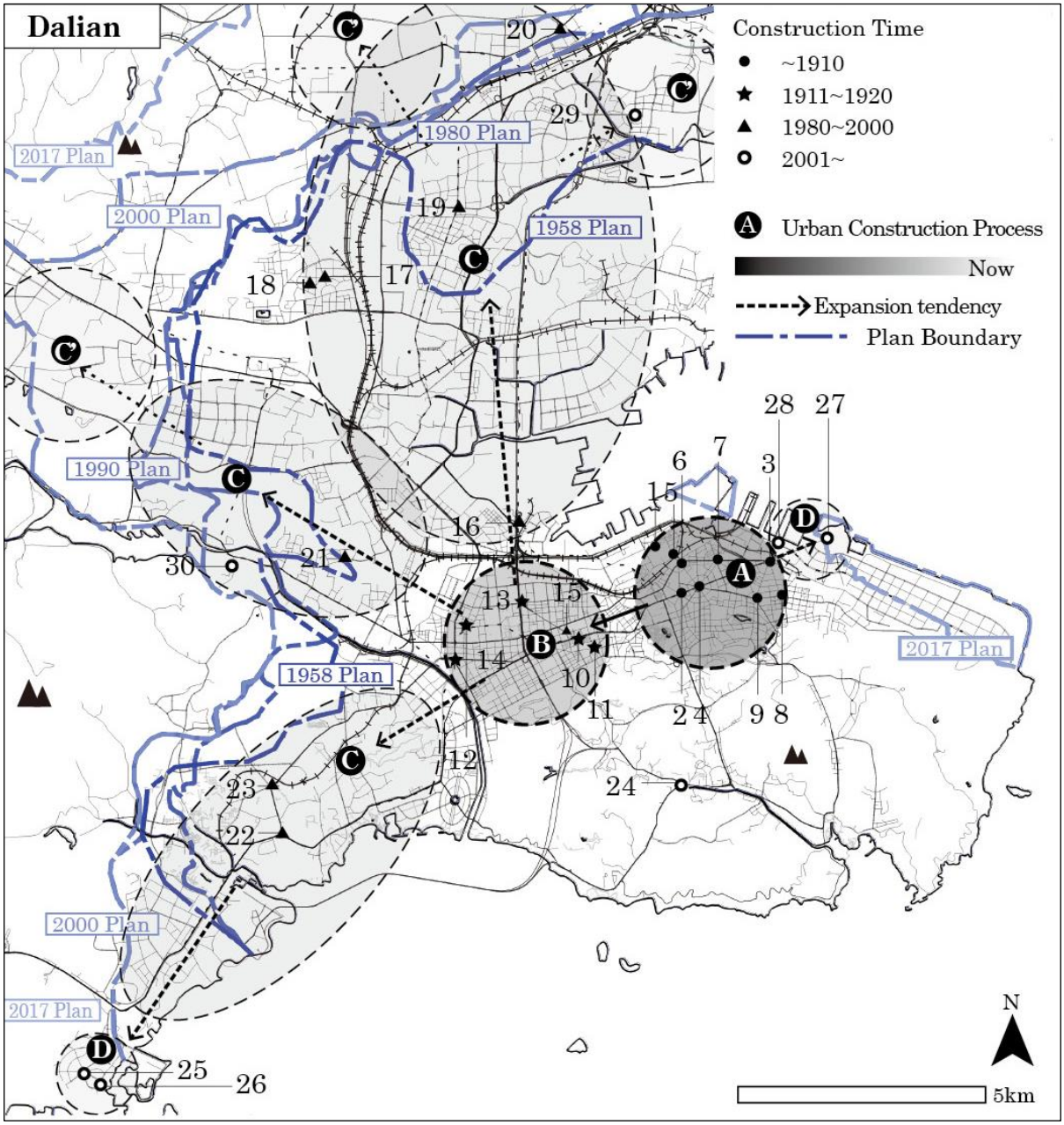


Fig. 5-12 Distribution of RS&Rs in Dalian (By author)

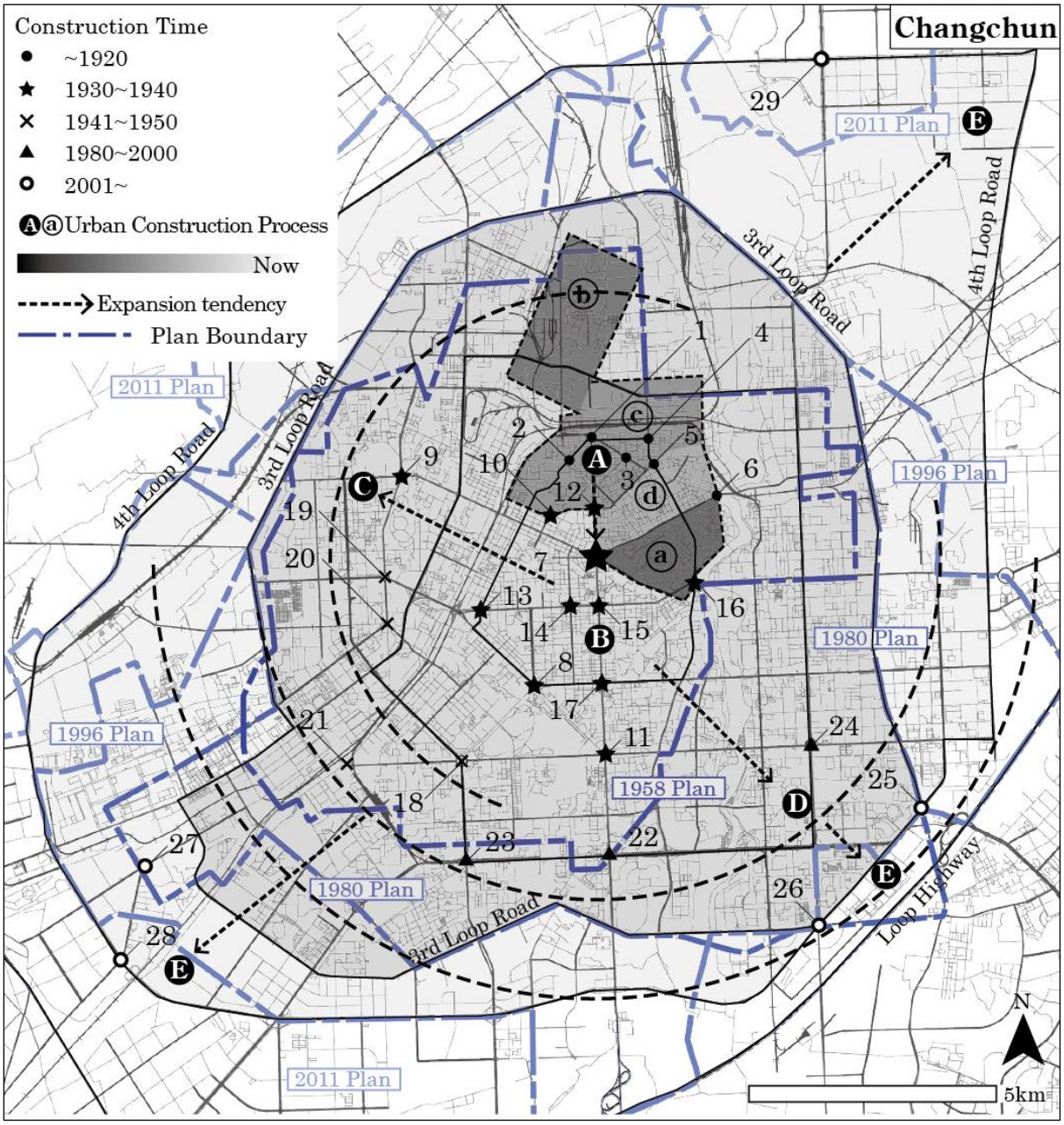


Fig. 5-13 Distribution of RS&Rs in Changchun (By author)

5.4 Morphological and Functional Characteristics of Ring-radial Spaces and Rotaries

5.4.1 Classification and Transformation of RS&R Morphology

Based on whether the streets around each case have a similar pattern or not, 59 cases (Fig.5-14, Fig.5-15) were divided into two groups. Further, the cases were classified into six types (Table 5-4): Type 1, Centralized Type; Type 2, Centralized with axis Type; Type 3, Grid Type; Type 4, Grid with diagonals Type; Type 5 Pattern intersection Type; Type 6, Starting point Type. Notably, Types 1, 2, and 6 offer more possibilities for the surrounding street directions. In contrast, Types 3, 4, and 5 are typically fixed by street networks.

(1) Similarities in morphological preference

From the total number of each type, two cities hold similar morphological preferences (Fig.5-16). The high ratio of Types 3 and 5 reveals their flexibility in the street network arrangement. The twenty Type 5 cases represent the extensive application of the RS&Rs to the connection of different street patterns, because the circular shape is isotropic in all directions. This is also the reason for the likely implementation of Type 5 throughout the entire urbanization process, and not only at the time of the city's founding, but also during the rapid urban sprawl after the 1978 Chinese Economic Reform. Moreover, the 14 Type 3 cases demonstrate the potential for vitalizing the townscape by emphasizing the grid pattern's focal point, even though the street networks have fixed locations. This is similar to Type 4, but these cases are more closely related to the conventional planning methods used during Japanese colonial times. Moreover, the centrality of the RS&Rs results in the large-scale Centralized type (Type 1) as the city center in physical space, which dominates the street networks.

(2) Morphological transformation differences and their dynamics

Morphological diversity existed in various periods (Fig.5-17, Fig.5-18), but the preference transformed differently from Types 2 and 6 to Types 3 and 5 in Dalian, and from Types 3 and 5 to Types 3 and 2 in Changchun.

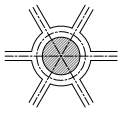
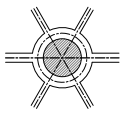
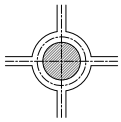
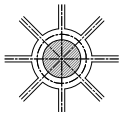
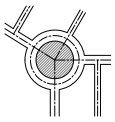
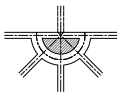
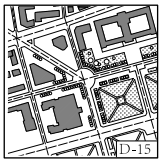
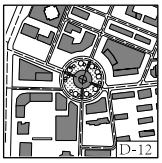
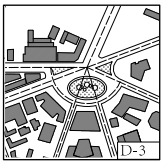
First, the high ratio of Types 3 and 5 appeared after 1980 in Dalian, but before 1950 in Changchun, when the focus was on street networks and the street networks determined the location of the RS&Rs.

Secondly, Type 2 appeared in different periods of the two cities and resulted from diverse elements. In Dalian, the Type 2 cases were mostly shaped by additional ground tram lines implemented as early as 1909. However, in Changchun, where ground tram lines do not exist, Type 2 reveals that new elements, such as an overpass or highway, promoted the strengthening of specific arteries.

Thirdly, in Dalian, Type 6 originated from natural boundaries such as coastlines and valleys, which indicates the emphasis on natural conditions. In Changchun, the continuity of Type 3 reveals that the North-South axis and the grid plan were overlaid on the Beaux-Arts plan (Guo, Q., 2004), which indicates the compelling identity of the street pattern in Changchun. Hence, in Dalian, the priority of the RS&Rs was gradually weakened and gave place

to street networks. However, in Changchun, the RS&Rs have continuously coexisted with the arterial street network, as strengthened junction.

Table 5-4 Classification of RS&R morphology (By author)

		Similar patterns				Different patterns	
Type		1.Centralized	2.Centralized with axis	3.Grid	4.Grid with diagonals	5.Patterns Intersection	6.Starting point
Diagram							
Examples							
Features		Centrality	One direction being emphasized	Strengthen the junction space of crossroads	Vitalize grid network	Connect different patterns smoothly	Close to area's boundary/station / harbor etc.
Dalian	Completed CI	Zhongshan S. (Diameter=213m) / Siaopingdao Central S.	Youhao S.	Youyi/ Yufeng/ Fumin/ Matou/ Xiaopingdao Kanhai/ Hongqi S.	Xingzheng S.	Wusi/ Huanan/ Haida / Shuma / Yaojia/ Xueyuan/ Bayi /Quanshui S.	Gangwan/ Donggang S.
	Separated CI		Minzhu /Sanba /Erqi S.				
	No CI				Jiefang/ Wuyi/ Northwest of Renmin/ Zhangzhe* S.	Huayuan S.	Shengli Bridge S. (N)/ Shengli Bridge S. (S)
	Number	2	4	6	5	9	4
Changchun	Completed CI	Renmin S. (D Diameter=300m)/ Shiji S.	Saide/ Dazhou/ Shengtai S.	Xinfa*/ Tongzhi*/ Jiefang*/ Quan'an*/ Ziyou*/ Weixing/ Qianjin*/ Longxiang S.	South/ West/ Gongnong S.	Xinmin/ Guangfu/ Sanjiao/ Jianshe*/Nanhu / Xi'an/ Jingyang/ Zhengyang/ Dongda/ Qiche S.	Changchun Station S.
	Separated CI						South Station S.
	No CI					East S.	
	Number	2	3	8	3	11	2
Total Number		4	7	14	8	20	6

(D-: Cases of Dalian; S.: Square; CI: Central island; * was deconstructed)

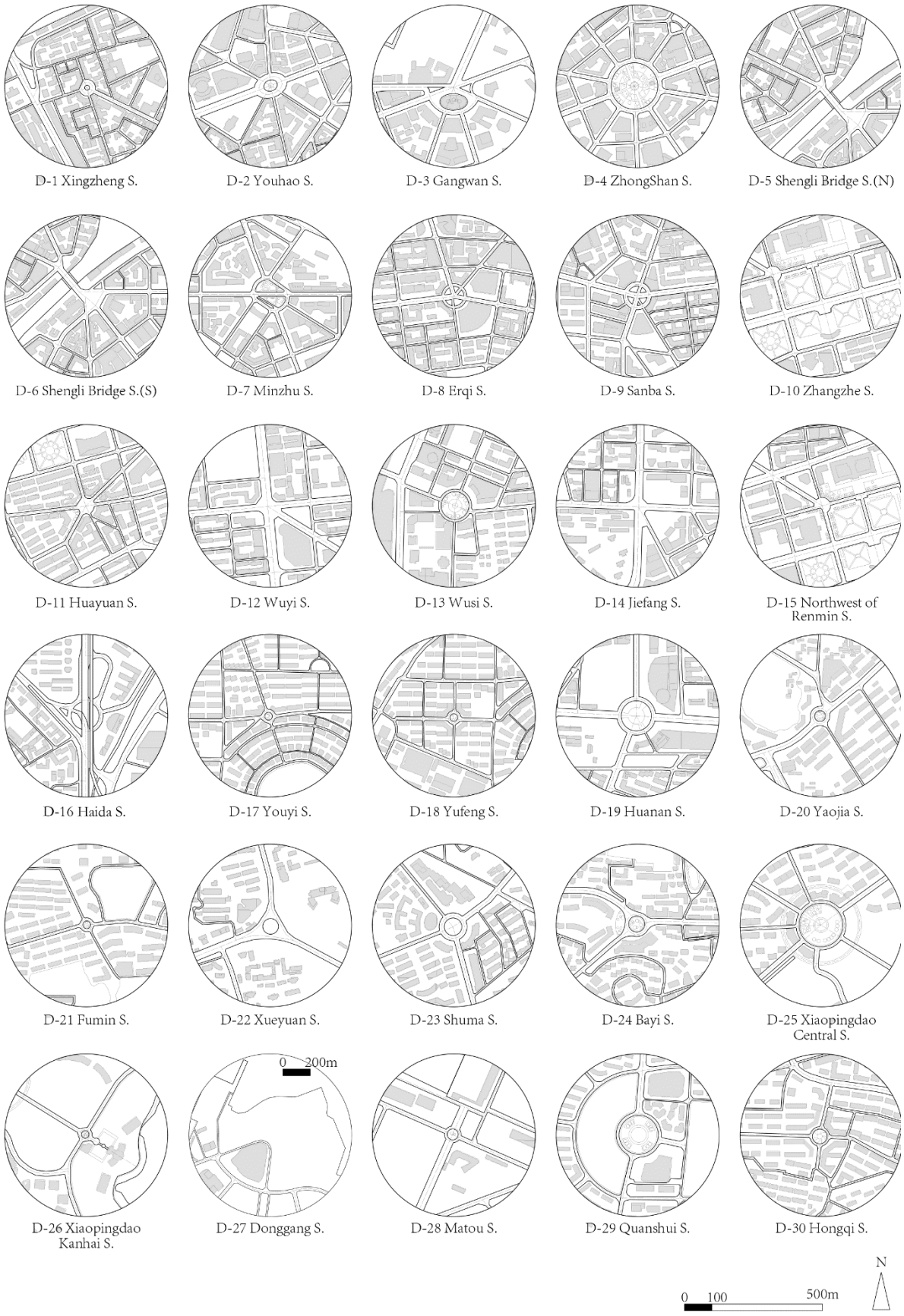


Fig. 5-14 RS&R Cases in Dalian (S.: Square) (By author)

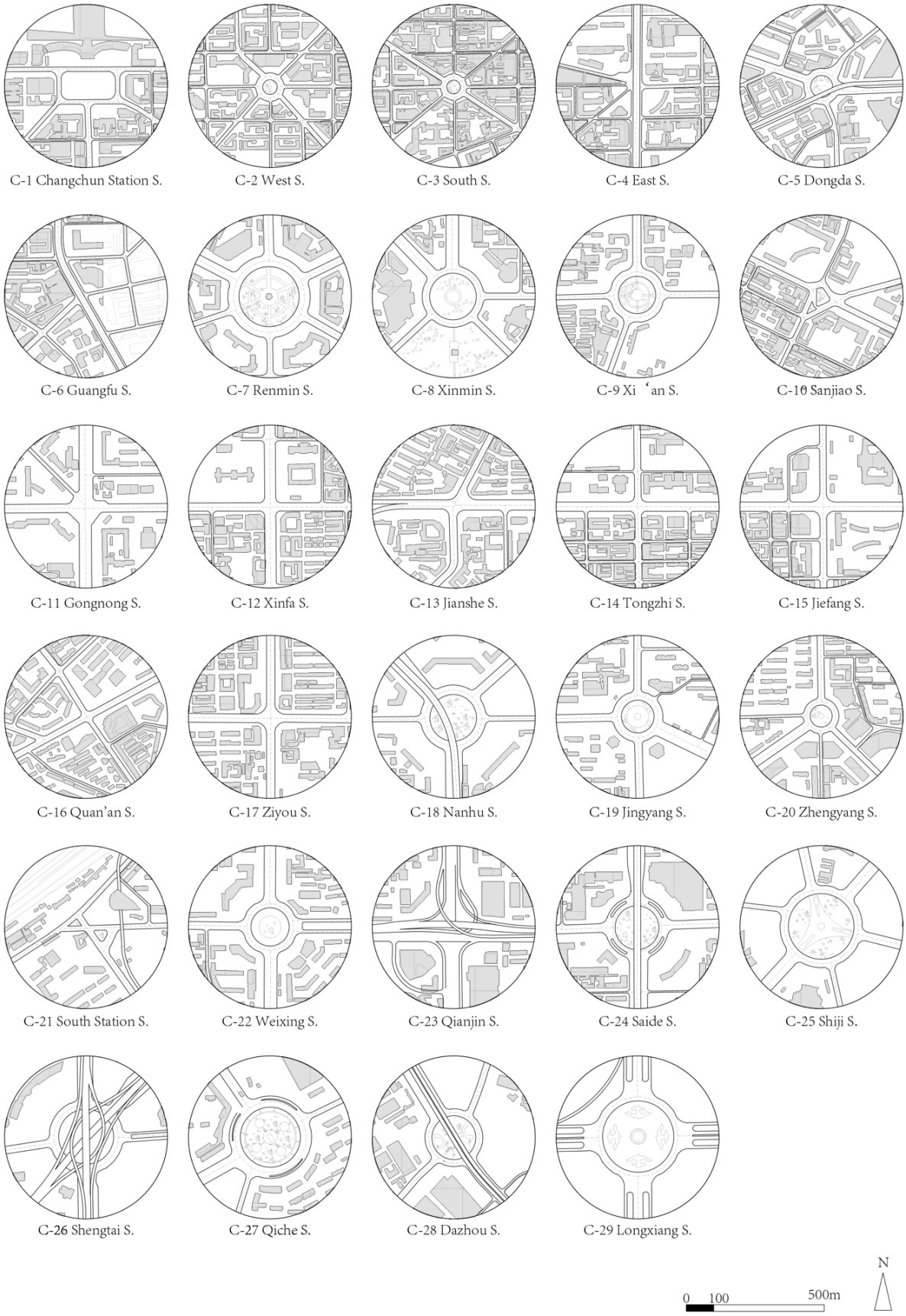


Fig. 5-15 RS&R Cases in Changchun (S.: Square) (By author)

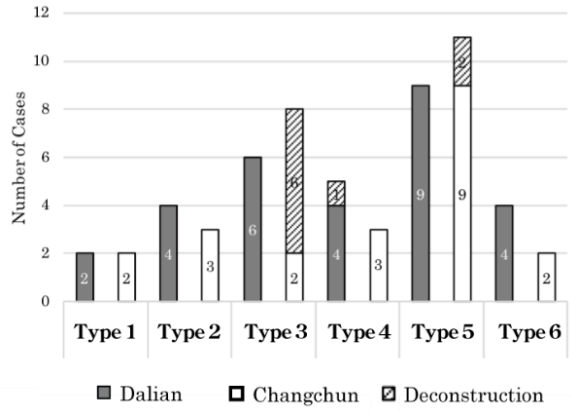


Fig. 5-16 Number of cases belonging to six types (By author)

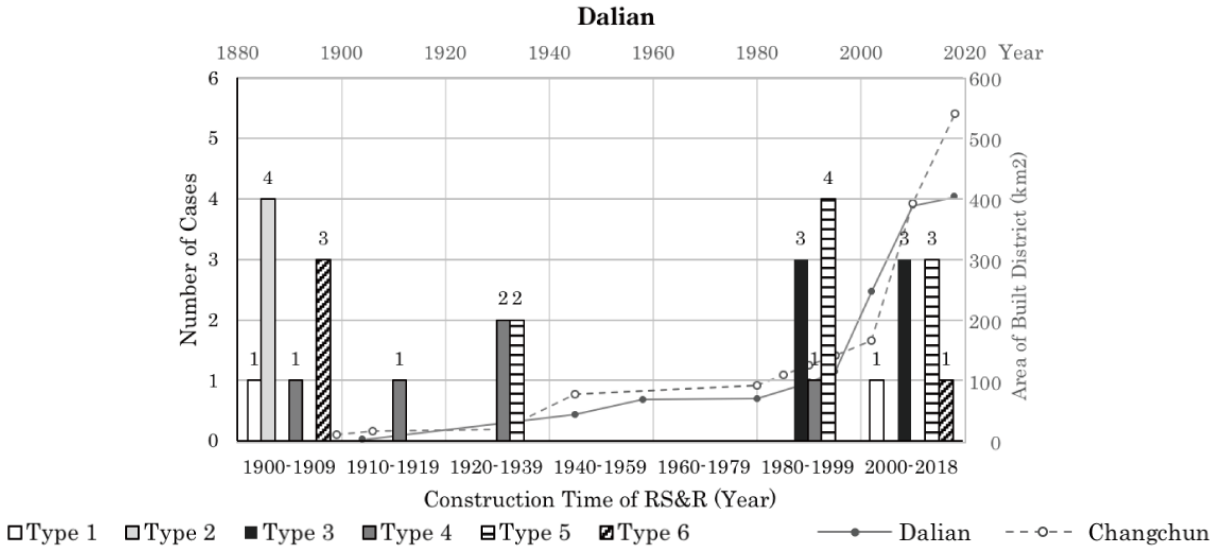


Fig. 5-17 Number of cases belonging to six types by construction time in Dalian (By author)

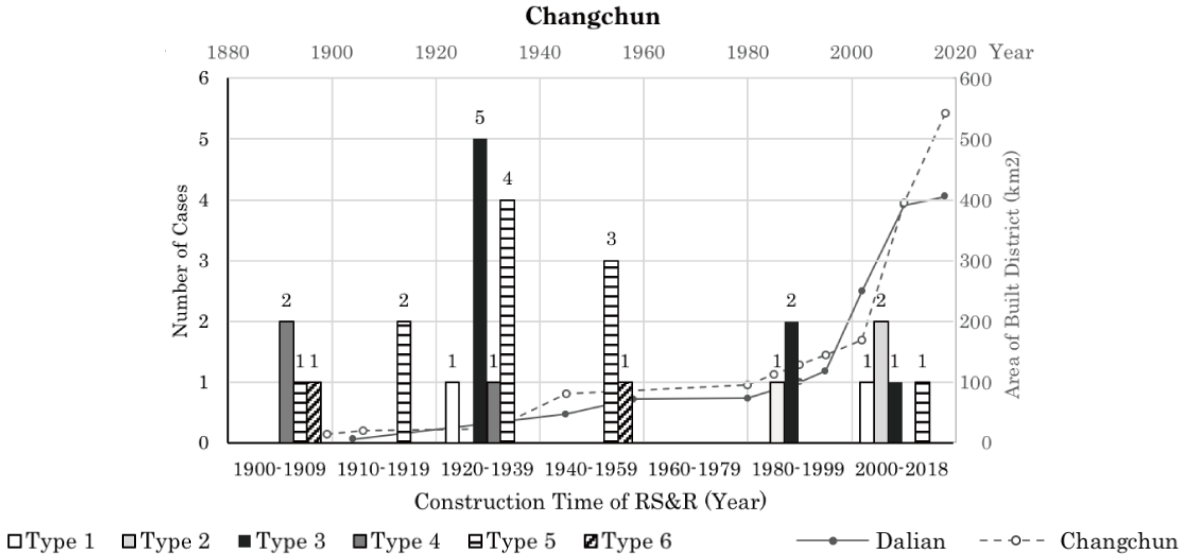


Fig. 5-18 Number of cases belonging to six types by construction time in Changchun (By author)

5.4.2 Classification and Transformation of RS&R Functions

By carrying out field surveys in Dalian and Changchun, 13 types of basic elements were recorded for each case (Table 5-5, Table 5-6) as indicators for functional classification. Moreover, whether there are visual connections between the RS&Rs, and whether they have been included in Historical and Cultural Blocks or have Heritage Buildings around, were also recorded as complementary elements. Based on the usage of basic elements, three main categories were identified: Traffic, Activity, and Landscape. According to the existence of elements, the cases were first classified into two groups by cluster analysis: activity-oriented or traffic-oriented. Then, they were further classified into four clusters (cluster analysis, excluding those that have been deconstructed or transformed into common crossroads): Cluster A, Activity Cluster; Cluster B, Railway Cluster; Cluster C, Vehicle Cluster; Cluster D, Multidimensional Vehicle Cluster (Table 5-7).

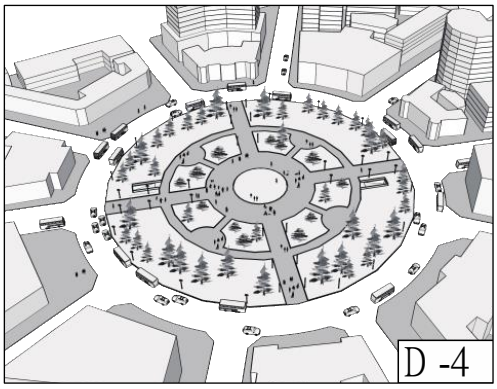
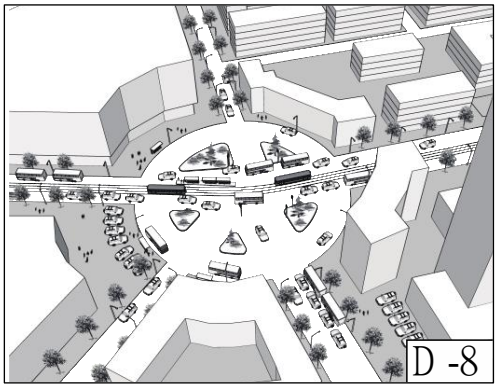
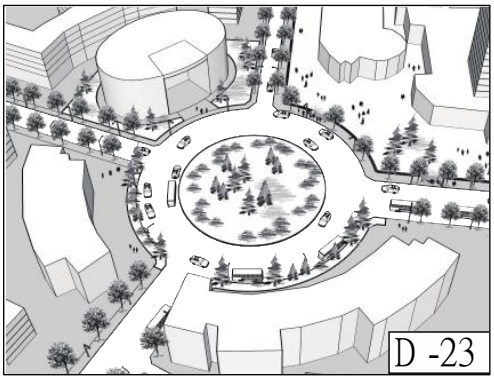
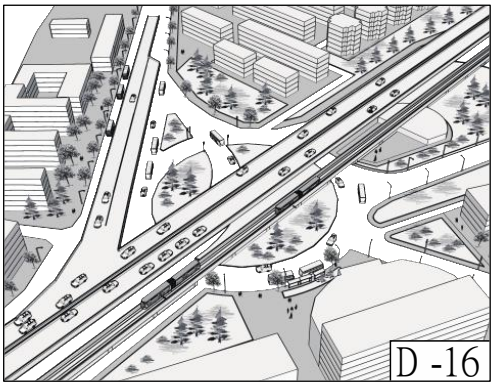
Table 5-5 Record of functional elements in Dalian

Dalian (Case ID: D-)	Functions & Elements															
	Traffic					Activity (in central island)				Landscape				Visual corridors	Historical preservation	
	Railway		Vehicle		Non-vehicle	Accessibility		Accessible space(paving)	Facility (chair/street light)	Natural		Artificial			Historical building	Historical block
	Ground-railway	Underground-railway	Overpass	Non-railway	Non-vehicle road	Crossing	Underpass			Tree	Grassland	Sculpture	Others			
1					○	○		○					○	○	○	○
2		○		○	○						○	○		○		
3		○		○	○						○			○	○	
4		○		○	○	○	○	○	○	○	○			○	○	○
5				○	○									○	○	○
6	○			○	○						○			○	○	
7	○			○	○	○		○	○	○	○			○		
8	○			○	○						○			○		
9	○			○	○						○			○		
10																
11				○	○									○	○	
12				○	○	○		○	○	○	○					
13	○		○	○	○											
14	○	○	○	○	○											
15				○	○											
16			○	○	○						○					
17				○	○	○		○	○		○	○				
18				○	○			○	○		○	○				
19		○		○	○	○		○		○	○					
20				○	○						○	○				
21				○	○						○	○				
22		○		○	○							○				
23				○	○						○					
24				○	○					○	○					
25				○	○	○		○	○	○	○	○		○		
26				○	○						○	○		○		
27				○	○	○		○	○				○	○		
28				○	○						○			○		
29				○	○			○	○	○	○		○			
30				○	○					○	○					

Table 5-6 Record of functional elements in Changchun

Dalian (Case ID: D-)	Functions & Elements															
	Traffic					Activity (in central island)				Landscape				Visual corridors	Historical preservation	
	Railway		Vehicle		Non-vehicle	Accessibility		Accessible space(paving)	Facility (chair/street light)	Natural		Artificial			Historical building	Historical block
	Ground-railway	Underground-railway	Overpass	Non-railway	Non-vehicle road	Crossing	Underpass			Tree	Grassland	Sculpture	Others			
1		○		○	○		○	○			○			○	○	○
2				○	○			○	○		○		○	○	○	○
3				○	○	○				○	○					
4			○	○	○			○							○	○
5			○	○	○						○					
6			○	○	○											
7		○		○	○					○	○	○				
8				○	○	○		○		○	○				○	○
9				○	○			○	○	○	○				○	○
10				○	○	○		○		○	○		○			○
11				○	○			○								
12				○	○										○	○
13				○	○										○	
14				○	○											
15		○		○	○										○	
16			○	○	○											
17		○		○	○											
18			○	○	○					○	○				○	
19				○	○					○	○	○				
20				○	○			○	○	○	○					
21				○	○						○					
22		○		○	○					○	○					
23		○	○	○	○											○
24			○	○	○						○					
25				○	○					○	○	○				
26			○	○	○						○					
27				○	○						○	○				
28			○	○	○					○	○		○			
29				○	○					○	○	○				

Table 5-7 Classification of RS&R functions (By author)

Clusters		Examples	Characteristics	Dalian	Changchun
Activity-oriented	**Cluster A. Activity**		Offering public space for citizens' activities	D- 1, 4, 7, 12, 17, 18, 19, 24, 26, 27	C- 1, 3, 8, 10, 19
Traffic-oriented	**Cluster B. Railway**		Space with vehicle and railway traffic, it may be passed through by railway elements, which can act as an axis strengthening a specific direction	D- 2, 3, 6, 8, 9, 21	C- 7, 22
	Cluster C. Vehicle		Space mainly for arranging vehicle traffic	D- 5, 11, 15, 20, 22, 23, 25, 28, 29	C- 2, 9, 11, 20, 21, 25, 27, 29
	Cluster D. Multi-dimensional Vehicle		Space with double layered aboveground traffic, being overlayered by elements, such as overpass, strengthening a specific direction	D- 13, 14, 16	C- 4, 5, 18, 24, 26, 28

(1) Functional transformation and inheritance

The high percentage of traffic-oriented cases indicates the primary function of the RS&Rs, that is, traffic organization, while the activity-oriented cases indicate the potential of RS&Rs as public spaces (Fig.5-19).

The transformation differs widely after 1980. Dalian established more cases in Clusters A and C, respectively, mostly at a scale similar to that of previous cases. However, Changchun adopted more cases in Clusters C and D without activity space inside, which almost doubled the size of previous cases (Fig. 5-20). In other words, the close connections created by the visual corridors between the RS&Rs in Dalian in the early 1900s were ignored. The previous activity function in Changchun gave way to vehicle traffic, which led the RS&Rs being used as traffic space instead of public space.

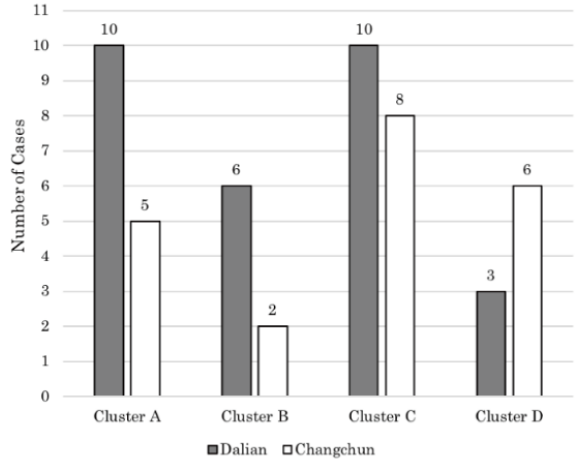


Fig. 5-19 Number of cases in four functional clusters (By author)

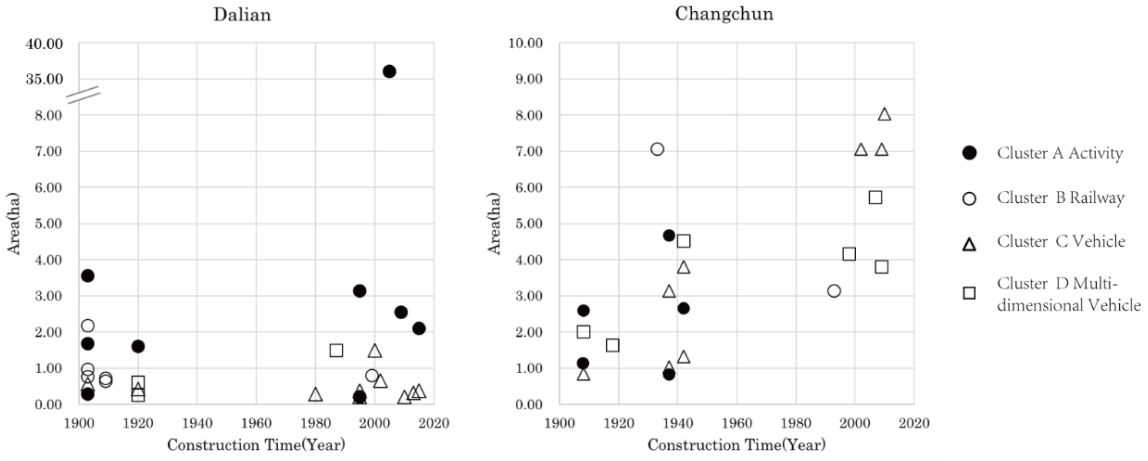


Fig. 5-20 Construction time and size of cases in four function clusters (By author)

For Dalian, recent cases have mostly been implemented in newly constructed areas with residential districts, which are separated by natural hills. Therefore, owing to the lack of connectivity amongst them, the RS&Rs form the district center as public space that makes activities more attractive. Almost no inheritance of visual corridors was maintained after 1910 and up to the establishment of Donggang Central Business District (CBD) on reclaimed

seaside area in the 2000s, when Donggang Square in Donggang CBD inherited visual corridors again as in the cases before 1910. Donggang Square extends the previous city axis along Youhao Square-Zhongshan Square-Gangwan Square, as a strong ending, which is considered as the revival of the original purpose of RS&R implementation (Fig.5-21).

For Changchun, the recent cases have been attached along arterial roads or expressways (Fig.5-22). Therefore, the massive traffic has resulted in large-scale and large distance between them. Instead of creating public space at the center, recent cases have been implemented with overpasses to achieve higher efficiency. Even some central RS&R islands, which allowed activities, were closed down owing to safety and management considerations. To some degree, this is a waste of space and the lack of inheritance results in the weaker unity of characteristics for recent cases.

According to the analysis on current significance of RS&Rs, there is a tendency of strengthening social functions worldwide. However, it has not been specifically emphasized in Dalian and Changchun, which reveals a different divergence in their localization process.

(2) Historic preservation as a new responsibility

In total, sixteen cases have been included in Historical and Cultural Blocks[*3)] or have Heritage Buildings around. The RS&Rs do not only adopt physical functions, but have also began to take cultural significance. The combination of physical space and emotional significance transforms the RS&Rs of a city into cultural symbols. Moreover, integral plans for their preservation and renovation can efficiently improve the spatial and spiritual perception. Despite the fact that Weixing Square in Changchun was built in 1993, it has also been included within the range of the Renmin Street Historical and Cultural Block, along with Changchun Station Square, Renmin Square, and Gongnong Square (proposed in 2010), which demonstrates the creation of continuity between the past and the present.

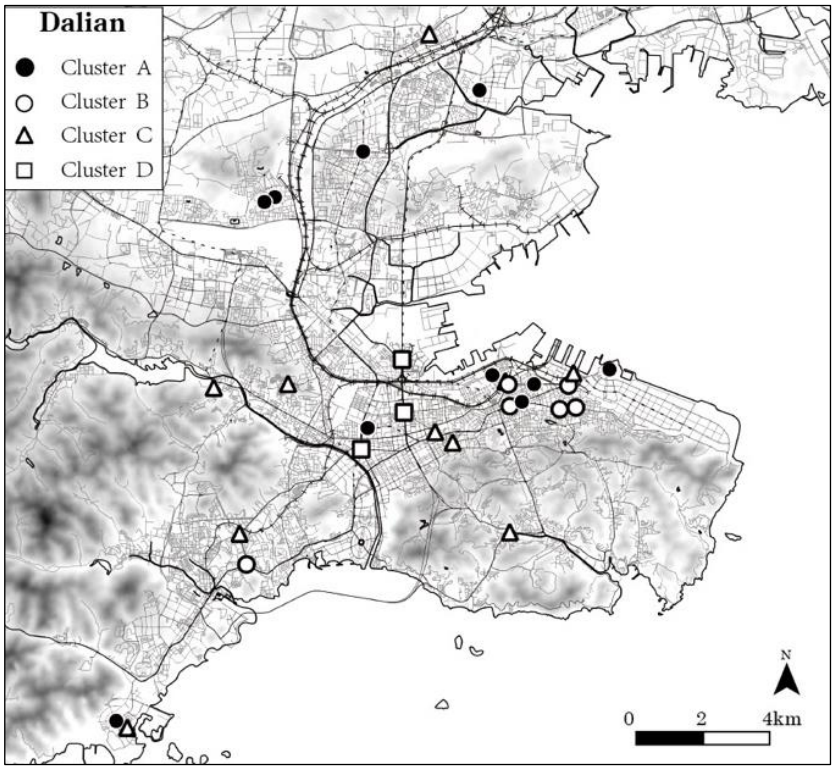


Fig. 5-21 Distribution of RS&Rs by functional clusters in Dalian (By author)

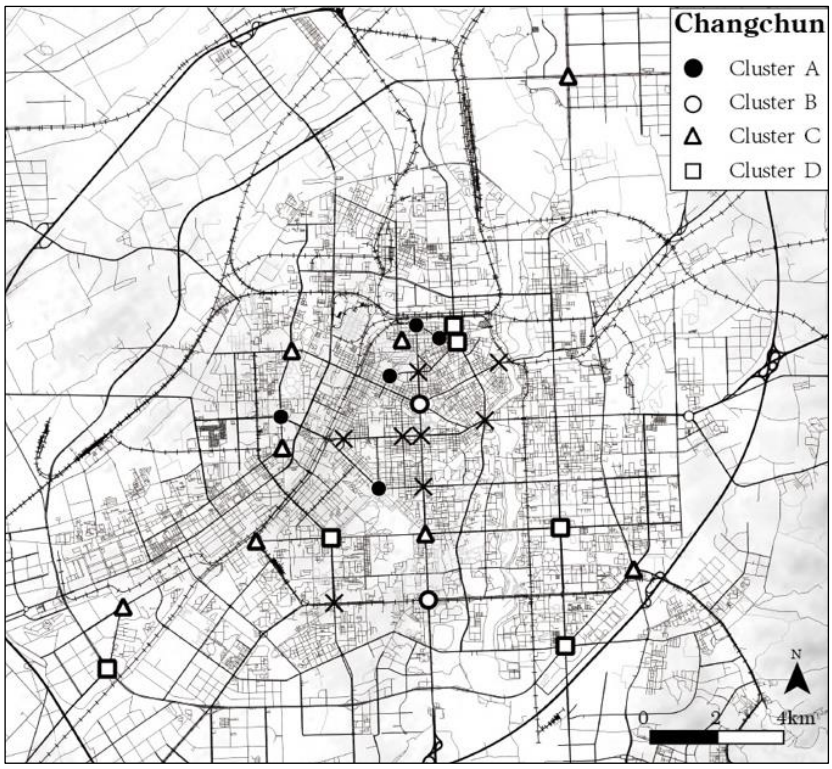


Fig. 5-22 Distribution of RS&Rs by functional clusters in Changchun (By author)

5.4.3 Relationship between RS&Rs and Surrounding Building Fabric

When considering the figure-ground relationship of surrounding fabric of RS&Rs, there is a similar tendency. When the original cases were more closely enclosed by the street walls created by surrounding buildings (Fig.5-23), the recently built cases are lack of this consideration (Fig.5-24).

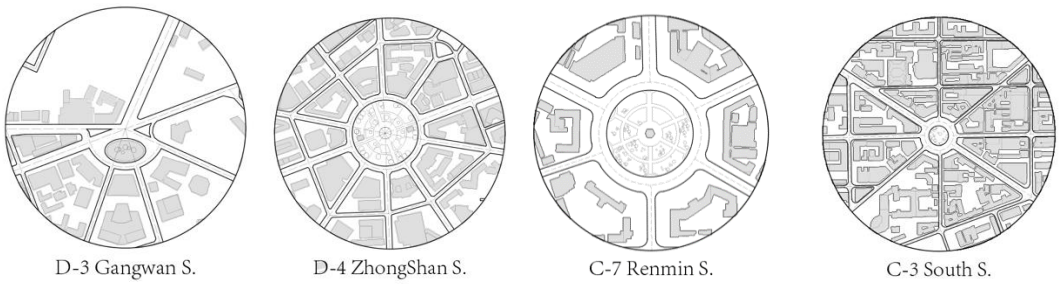


Fig. 5-23 Representative RS&Rs constructed before 1950(By author)

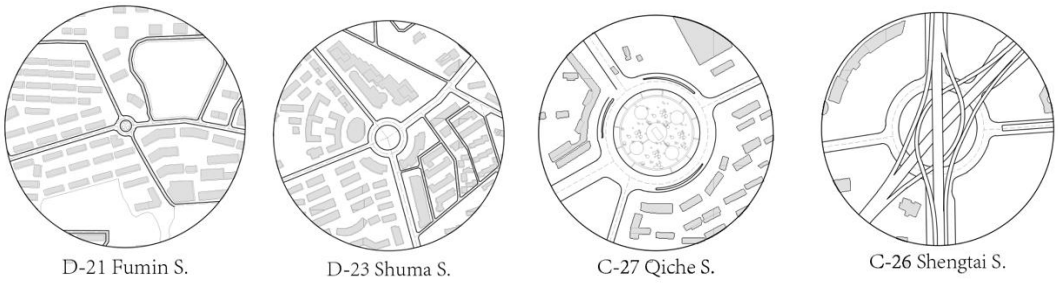


Fig. 5-24 Representative RS&Rs constructed after 1995(By author)

For the building's orientation, when the former ones were built up facing the center of RS&Rs, the newly built ones are arranging the buildings in a more random way. It is largely related to buildings' functions, whether they are residential buildings or public buildings. Take representative RS&R cases in Dalian for instance. In the cases constructed before 1950(Fig.5-25: D-1, D-3, D-4, D-13), surrounding buildings are mainly public buildings, with less strict orientation regulation from the view of energy saving (Design Standards for Energy Efficiency of Public Buildings, GB50189-2015). Therefore, public buildings orientate towards the center, strengthening the spatial centralization. On the contrary, as RS&Rs have been more likely to be implemented in residential districts, the surrounding buildings are usually residential buildings, or the supporting facilities partly with public functions but also planned by the estate developers. Therefore, residential buildings are mainly simply distributed in the common north-south direction in China, to achieve enough sunlight (Design Code for Residential Buildings, GB50096-2011), without much correspondence to the unique circular street pattern (Fig.5-25: D-21, D-29, D-30). Some supporting facilities correspond to the center more or less, but in a simple and rough way, such as the diagonal

volumes facing the rotary's center (Fig.5-25 D-30). Hence, the centralized urban space is weakened instead of taking advantages of.

Moreover, there have been less coverage rate, larger building volume with higher building height and larger setback in the surrounding land of RS&Rs in recent cases. It is the result of pursuing higher building density in urban development in recent decades. First, aiming to achieve higher profits, higher building intensity is pursued (higher FAR) by implementing higher-story buildings with lower coverage rate. So, there is not enough building volume for creating circulating street walls. This weakens the horizontal continuity of buildings' interface around, but increases the vertical tendency. Second, the large building volume with high floors create a sense of pressure to the central space. Third, when architectures are always chasing to become landmarks, they usually focus on its individual shape and style, without much connection with surrounding environment. This underlines their independence. Large set back and open space are applied to emphasize distinction and imposing appearance. But, the large distance of set back from ring roads to the building's elevation makes it difficult to percept a sense of enclosure for the space with high sense of geometric aesthetics. (Fig.5-25)

When the continuity in street walls and the enclosure by building's interface are representative and persisted in the European cities like Paris, France. It can be seen as a loss in their localization into Dalian and Changchun, but also as a recreation in adapting to local context. Their advantages and disadvantages require further clarification considering both functions and streetscape.

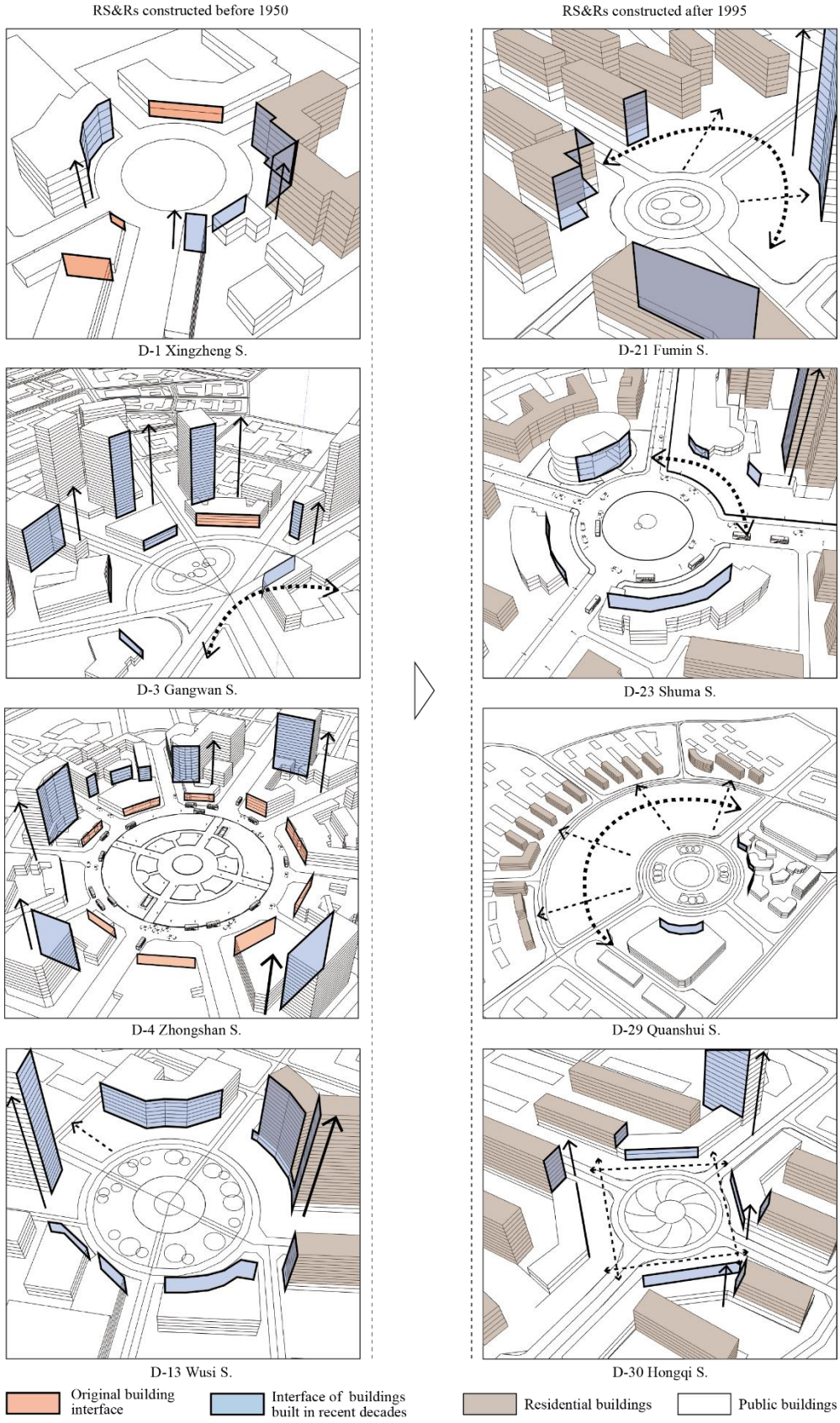


Fig. 5-25 Interface of surrounding buildings in case RS&Rs constructed before 1950 and after 1995(By author)

5.5 Conclusions

5.5.1 Summary and Conclusions

This chapter investigated and compared the transformation process and current conditions of RS&Rs in Dalian and Changchun, and clarified how the RS&Rs were imported and localized accompanying urban development. It identified how the similar geometric prototype, diversely developed adapting to local conditions in different cities and shaped these cities in different ways.

The conclusions drawn from this chapter are as follows:

(1) Initial localization of RS&RS in Chinese cities

In the two case cities, the RS&Rs were initially considered as an approach for achieving ideal urban planning. The natural conditions, city positioning, and application of multiple modern urban planning theories are the main dynamics for initial localization, not only within the RS&Rs themselves, but also with regards to their relationships. In Dalian, the RS&Rs are landscape-oriented and randomly distributed, which creates a sense of romance. Contrarily, the RS&Rs in Changchun are monument-oriented, endowed with multiple symbolisms, and located in a more regular manner, which produces a sense of solemnity and hierarchy.

(2) Continuity of RS&Rs in urban development and urban sprawl

The RS&R construction can be considered as a clue for understanding the urban planning process from the perspective of both time and space. From the perspective of time, the RS&R constructions correspond to the urban planning process and are typically carried out according to new planning principles. These constructions are not an outcome of a specific period, such as colonial times, but rather a continuous inherited planning icon. From the perspective of space, the location of RS&Rs mostly coincides with the urban sprawl areas in each urban development stage, strengthens urban infrastructures, and reflects the features of different areas. In Dalian, the RS&Rs are unevenly distributed in groups situated in a linear manner. However, in Changchun, almost no prominent groups appear and the RS&Rs are distributed in a layered circular diagram centering at Renmin Square.

(3) Lack of inheritance in form, functions and building fabric

Based on maps and field surveys, six morphological types, and four functional RS&R clusters were identified. Both cities have implemented a higher ratio of the Grid Type and Pattern intersection Type, owing to the flexibility of the RS&Rs in activating the townscape and connecting the street networks with different directions. However, in both cities, the transformation of RS&Rs lacks unity and identity inheritance, which manifests as the lack of connective relationships between the RS&Rs in Dalian, and as the disappearance of activities in Changchun. In Dalian, the RS&Rs have gone through the process of RS&R leading, street network leading, and separated distribution, and thus the connections between the RS&Rs have been weakened. Simultaneously, the RS&Rs in Changchun closely interact with street networks, and thus focus on the traffic function at the expense of the activity function. Moreover, both cities transformed with a loss of original building fabric around RS&Rs, as a result of

buildings' function and density change. It can be considered as a kind of localization and recreation adapting to local requirements, but it can also be considered as a loss of conceptual inheritance of imported pattern.

(4) In conclusion, the localization in transformation process of urban morphology first refers to a continuity in urban construction from the view of time dimension, and also a continuity in urban sprawl from the view of spatial dimension. Second, it refers to the integration at the initial phase of its implementation, as well as its transformation in both form and functions so as to adapt to cities' updating requirements. The localization of RS&Rs in Dalian and Changchun is a component of RS&Rs' diversification in the world, and it is realized by diverse transformation with respective preference in local adaptation.

5.5.2 Issues and Suggestions on RS&R Construction and Renovation

By clarifying the localized transformation process of RS&Rs, this chapter identified issues with regard to RS&R construction and renovation to satisfy the updated requirements for cities and create unique city images.

(1) Exploiting distinctive characteristics

In Dalian, the Centralized with axis Type with the Railway Cluster is characterized by traditional ground tram lines. The ground trams pass through the RS&R, and some tram stops are located on central islands. This does not only create a unique townscape, but also enables interaction between humans, landscapes, and central space. Moreover, the Starting point Type results from natural terrain, which outlines the charm of the peninsula environment. In Changchun, traffic has become a double-edged sword for placemaking in RS&Rs. For the Centralized with axis Type with the Multidimensional Vehicle Cluster, the linear overpasses weaken the centrality of the RS&Rs, while the vast volumes conflict with the circular open space and negatively affect spatial perception and landscape creation in the central islands. However, they also shape linear space with top interfaces. Therefore, leveraging the residual space between overpasses and the ground requires more attention in renovation works.

(2) Emphasizing the inheritance of RS&Rs in a critical way

Firstly, for historical cases, historic preservation requires continuous attention. The integral renovation does not only contribute toward improving the built environment, but also contributes toward emotional placemaking. The RS&Rs become iconic spaces and have cultural and historical significance as city symbols. Secondly, the descent of the original identities mentioned in Chapter 5.5.1(3) requires being examined the necessity. And it needs more consideration in future planning. Specifically, this is related to the lack of connective relationships between the RS&Rs in Dalian, and the disappearance of activities in Changchun, as well as the building fabric loss in both cities. Thus, it is not single spaces, but rather the inheritance and unity among spaces that shape a city's identity.
This chapter demonstrates the potential of imported RS&Rs as a new viewpoint for understanding the development of cities with RS&Rs, and their potential as unique public spaces for the shaping of urban identity. Moreover, the clarification of RS&R characteristics lays the foundation for further in-detail investigation into the influence of RS&Rs on architectural patterns and land use.

Notes

*1) In 1899, Dalian was given the name Dalny (Russian: Дальний), which means “distant” or “remote.”

*2) V.V. Sakharov (Владимир Васильевич Сахаров, 1860-1904), a Russian engineer who had previously been tasked with developing the plan of Vladivostok.

*3) Refer to “Comprehensive Urban Plan of Dalian City (2009-2010)” and “The Decision of the People's Government of Liaoning Province [2015] No. 44 Document.” In 2010, The People’s Government of Jilin Province agreed to approve Renmin Street, Xinmin Street, Manchu Palace, South Square, First Automotive Works (FAW), and Kuanchengzi Station of the Middle East Railway as six Historical and Cultural Blocks.

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Chapter 6 Mechanism of Urban Morphological Transformation in view of Diversification and Localization in Chinese Cities

6.1 Framework of Reading the Evolution of Urban Morphology in China

6.1.1 Dual Processes in the Transformation of Urban Morphology

The transformation process of urban morphology in Chinese cities, especially in this research, refers to double processes:

First process is to focus on a single space of a specific urban element, and review the dynamic mechanism linked to the action of time on it. For the grid block, it refers to its formation process including its initial construction, boundary defining, inner space subdivision and final pattern completion. For the ring-radial spaces and rotaries, it refers to the changes appeared after its construction, such as reconstruction of central islands. It is a relatively direct process of urban form transformation.

However, transformation process also includes a process of tendency's change in larger scale that requires additional analysis and summary. So, the second process concentrates more on a wider range like a district or a whole city, referring to the changes of the categories, numbers, forms etc. of specific urban elements. A single case of the elements does not necessarily transform, but the overview of the whole area reveals the internal tendency, which is a vital part in the transformation of urban morphology. For the grid block, it refers to the proportion changing of morphological types and subdivision patterns in different phases. For the ring-radial spaces and rotaries, it refers to the preference changing of morphological types and functional clusters accompanying urban construction.

Therefore, both the dual aspects require investigation in understanding the urban form transformation process.

6.1.2 Complexity of Chinese Urban Form

China is an ancient urban civilization, but with an incredible modern urbanization process, following historical continuities. On the one hand, a number of historic cities in China, have survived in the thousands of years of history with smallholding economy, that few unparalleled changes took on stage in urban system. So, cities developed in a mild and constant way. On the other hand, China's hyper-urbanization almost compressed what would have taken the world two more centuries to achieve in the past one century. Sudden changes appeared in economy, administration and so forth. As a result of particular periods' planning principles, aesthetic and building techniques, urban form in China also went through the dramatic process, with patterns originating from various phases co-existing.

Culture exchange is inevitable in urban development history, with either culture importing or culture exporting. It is always depended on the positioning of a civilization. Chinese civilization experienced great ups and downs in the long-term history, which led to chances for the culture exchange. Similarly, as a concrete expression of culture, urban patterns became a media in the exchange process. Urban planning concepts like Fengshui, principles like

Kao Gong Ji and so on, were exported to other countries, guiding cities' form, such as Heiankyo in Japan; Seorabeol of Silla in Korean Peninsula, when Tang Dynasty flourished and affected neighbor countries. Conversely, China also went through some tough times in modern time, that resulted in a period with passive cultural import. It can also be revealed from the urban form. Totally new patterns were implemented in some cities in China, even without any integration with the traditional space. However, apart from the passive cultural import, an active cultural absorption took on stage in China as well. It may stem from the increasing communication and rapid globalization background in recent decades. As a result, the culture export, passive import and active absorption appeared in Chinese cities sequentially, resulting in urban patterns which may originate from various cultural sources.

The long-term continuity and mild evolution in ancient China are capable of inheriting the traditional urban pattern, although there may be a transformation to some extent. It is considered as the inherent pattern of Chinese culture. While, during the intense urbanization process in the past hundred or more years, foreign-style patterns were introduced into China, as the imported patterns. They may be directly implemented into Chinese urban context or improved following the local conditions. Anyway, after the subsequent transformation, imported patterns can be seen as being internalized into a category of Chinese urban form.

In short, the above analysis reveals the complexity in Chinese urban form. It relates to contrasting urban development process, and the multi-sources of the urban patterns. Therefore, in order to seek appropriate methods to read the urban form in China and understand its transformation process, clarifying the sources of archetypal patterns is essential. It builds up the foundation for further investigating the following evolution.

6.1.3 Limitation of the Existing Methodologies in Reading Urban Morphological Transformation in Chinese Cities

(1) Overall exploration of urban form in macroscope in lack of detailed physical space previously

The research on urban morphology in China started from about 1980s, beginning with the issues in macroscope and city-scale. For instance, the spatial form of cities, the spatial organization of human activities and land use, the description of urban landscapes, and typological classification systems. Urban researchers with a geographical perspective prefer to understand urban form from the point of view of internal/external structural patterns, to address morphological problems from the point of view of spatial distribution and linkage, mechanisms of evolutionary processes. Moreover, existing studies have concentrated on the study of "dynamics of development" of urban form. However, the specific analysis on detailed physical space drew attention much later, especially in the microscope.

(2) "Block scale" as a limitation in area instead of a research target or typical urban structural element

Previous research on urban morphology in Chinese cities in the so-called block scale primarily referred to restricted study in small areas within the scale of several blocks. In other words, "Block," as the specific urban structural element, is not always considered to be a medium or a physical clue in the analyzing process.

(3) Complicated urban morphology being analyzed through abstraction, equally

In recent years, the methodologies proposed to analyze urban morphology in western countries have been gradually introduced and applied in reading Chinese cities, focusing more on the concrete physical space. They include the morphology methods, typology methods, typo-morphology method, and techniques such as Space Syntax etc. Cities are decomposed into elements at different resolutions, and the relationship between the different elements has been investigated in order to read the city comprehensively. In this way, the complicated urban issues were simplified into abstract models to a certain degree.

However, these methods treat cities and urban elements equally without particular consideration on their background or the transformation of a single element. For instance, how the city became diverse and complicated from the original cultural source has not attracted enough discussion. Moreover, the limitations and incompatibility of applying Western theories in China also need consideration, in particular the necessity to understand the cultural context.

(4) Flattening the time dimension in analyzing urban morphological transformation

Compared with the static studies on urban morphology, the dynamic process under the action of time is drawing increasing attention. Concepts like typological processes etc. were introduced to describe the typology changes in time dimension. But it has to be pointed out, the transformation process is more than a linear process which sequentially combines the different representative typologies of each epoch. In the opposite, there is a "thickness" in the dimension of time. The other typologies, which may not have as much weight as the representative ones, are also a substantial part of urban morphological transformation.

6.1.4 New Perspectives and Frameworks in Understanding the Transformation Process of Urban Morphology in Chinese Cities

(1) Take urban structural elements in street/block scale, as the concrete clue in reading urban morphological transformation process

This research focuses on the street/block scale, which can be regarded as a media connecting the macro and micro scope. Its potential for both analyzing architectural and human level, and being as a unit in understanding the whole city, were explained in Chapter 1.1(4). It is decomposed into block pattern and street pattern for concrete

analysis (Fig.6-1). What's more, the block pattern can be further divided into two layers, the block-boundary layer and the inner-space layer. The decomposition makes the analysis clearer and helps to make the transformation process more legible. As a result, the "grid block" and the "ring-radial spaces and rotaries" were selected as two typical urban structural elements in street/block scale. By investigating the transformation of the above two elements, the characteristics in the morphological transformation of the whole city can be reflected.

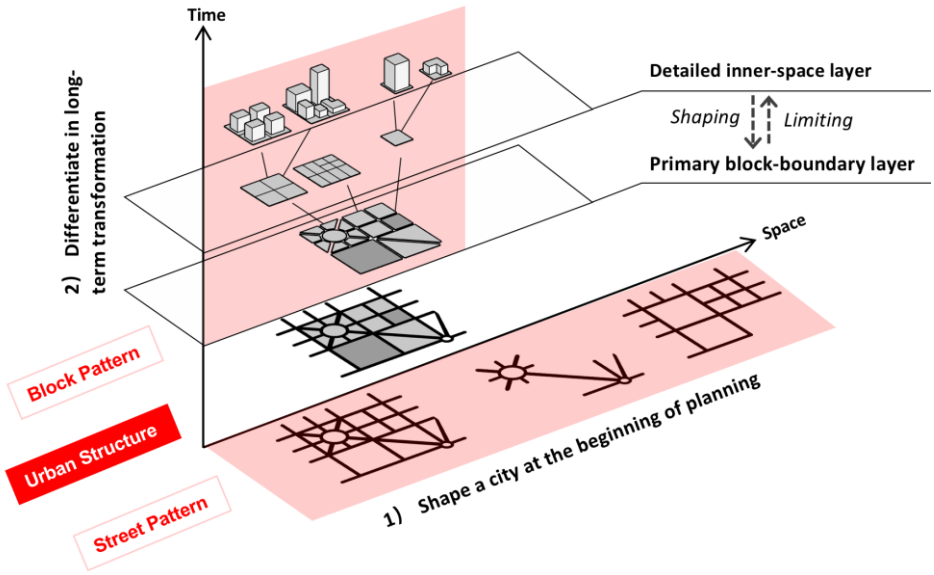

Fig. 6-1 Composition of urban physical form in street/block scale (By author)

After clarifying how the street/block-scale elements influence the macro and micro scope in the urban form transformation, a converse influential relationship has been identified (Fig.6-2). Street/block pattern not only puts influences on city scale and building scale, but is also being influenced by them.

On the one hand, from the city scale, limitations on street/block depend on their positioning in the whole city. Street/block morphology is limited by urban planning guidelines and should not get out of the macro strategies. The top-down planning is guiding the street/block morphology transforming in a rational and efficient way. On the other hand, from the building/lot scale, although the building/lot is limited by street/block pattern, especially in 2D-dimension, they are shaping 3D-dimensional street/block morphology conversely. This was reflected in the building density discussed in Chapter 4.4. Building density was an indispensable indicator in categorizing block morphology. But limited by the data accuracy, the influence of inner space on the boundary layer was discussed depending on the average data and main tendency. The influence was more precisely revealed in the analysis on surrounding building fabric in Chapter 5.4. Different arrangements in building height, density, interface and open space etc. lead to various street/block morphology. The analysis set up foundations for the micro-scope investigation, so as to clarify how the different combinations of inner buildings and open space comprehensively differentiate street/block morphology.

As a result, urban structural elements in street/block scale can be treated as the concrete clue in reading urban morphological transformation, but this research suggests that they cannot be separated as an independent link in shaping urban morphology, because urban morphology transformation is not a linear chain but rather a comprehensive and interactive process.

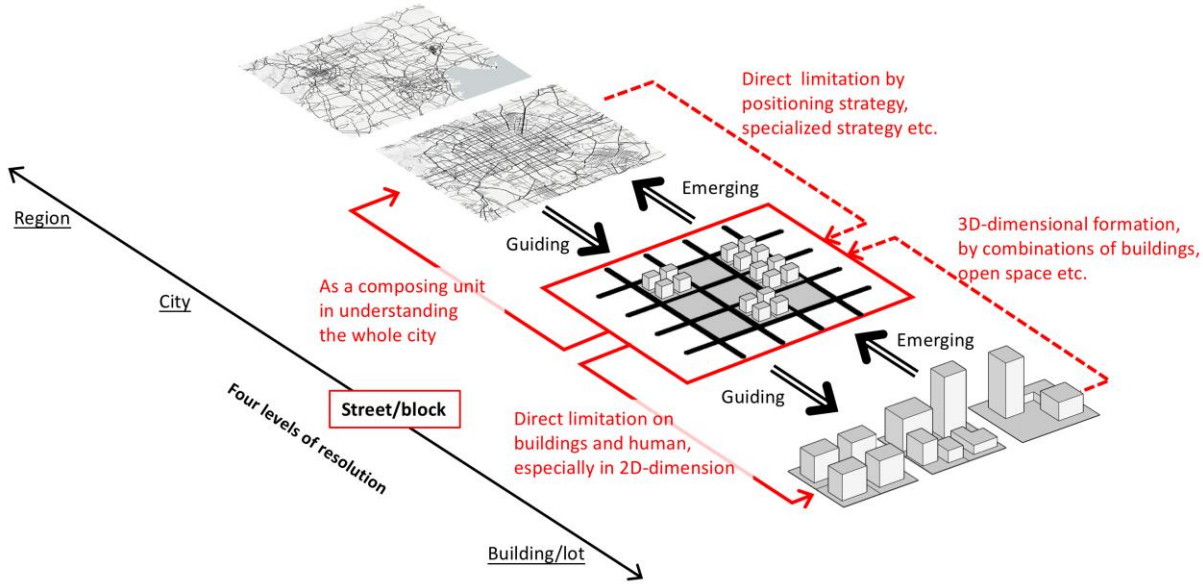

Fig. 6-2 Influential relationship between resolutions in analyzing urban physical form (By author)

(2) Take time dimension and spatial dimension as perspectives

First, in spatial dimension, this research clarifies the static condition of urban form, which includes the decomposition and description of urban elements

Second, the research focuses on the length of time axis in order to understand the evolution as the result of a dynamic and continuous process of urban production.

Finally, the research suggests paying attention to the "thickness" of time. It refers to the morphological differentiation happened in similar period of time. It can also be regarded as reading the "sections" of the continuous process.

(3) Take cultural source and its archetypal pattern as prerequisite

The concrete and complicated urban form can be traced back to the original archetypal pattern, which is always an expression of a typical culture. Hence, clarifying the cultural source and understanding the internal meanings behind the pattern, are the precondition for reading the subsequent transformation. Otherwise, it would be difficult to distinguish whether a pattern is inherited from traditions or newly created by other factors. Moreover, it may also contribute to preserving urban identity in future urban design.

As a result, in order to understand the urban form in China, the research first categorized the urban patterns into the inherent pattern and imported pattern, basing on whether it is created from the traditional Chinese culture or imported from the foreign culture. Then the urban form transformation process is further defined as the "diversification" of inherent pattern, and the "localization" of imported pattern.

The complexity of urban form in Chinese cities may cause difficulties in reading their transformation process. Multiple dynamics and diverse patterns co-exist, and intertwine with each other. Hence, a reading flow is proposed with four main steps: (1) tracing the origin, (2) investigating the transformation process from time and spatial dimension, (3) clarifying the factors causing transformation, (4) proposing suggestions and future issues.

6.2 Redefinition and Mechanism of "Diversification" and "Localization" in Transformation Process of Urban Morphology

6.2.1 Definition of "Diversification"

"Diversification" can be understood simply as a process from "one" to "many", but it is actually not a strict process of physical form changes, but a process that from the unified and abstract cultural archetype, transformed into diverse concrete patterns. It can be decomposed and explained from the view of time dimension and spatial dimension as follows. (Fig.6-3)

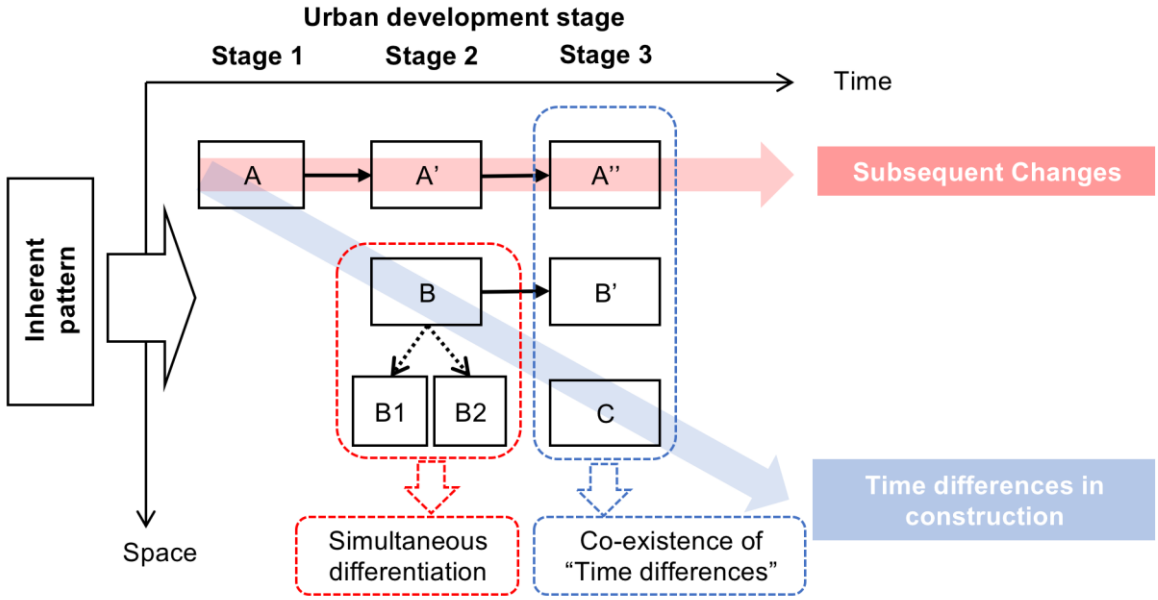

Fig. 6-3 Diagram of meanings in "Diversification" (A, A', B1 etc. refer to urban pattern) (By author)

(1) Time dimension:

Firstly, it represents the time difference of urban construction. Urban development can be divided into different phases, and very little has changed during this time, from the regulating principles, technology of construction to the materials used in construction. So, it stands to the reason that areas built during the same period of time would look more alike, because they are basically similar in both technology and aesthetics. In Beijing, the grid blocks share the same origin from the ancient planning theory of "Kao Gong Ji", but it is highly recognizable of the variants constructed in different urban development phases, such as the super blocks with less subdivisions from the social planned economy, and the relatively small ones from the recent redevelopment.

Secondly, it represents the subsequent changes appeared after construction. For the patterns that were constructed at the same period, they were supposed to resemble each other at the beginning. But it cannot create a permanent and continuing limitation. Hence, re-subdivision and re-development contribute to another potential in "Diversification" relating to time dimension.

(2) Spatial dimension:

Firstly, it represents the spatial co-existence of "time difference" in urban construction. As mentioned above, "time difference" stimulates diverse urban pattern, and the unprecedented urbanization process in Chinese cities led to rapid changes and replacement. Hence, patterns representing different phases may co-exist closely to each other, resulting in a various streetscape and spatial perception in one city.

Secondly, it refers to simultaneous differentiation. It reveals the phenomenon that, even constructed in the same time, following similar principles, technology and aesthetics, diverse patterns also appeared. It seems to be unreasonable to some degree, but it truly happened and is inevitable to be more investigated, especially in Chinese cities that they were usually considered to be strictly following the tops-down plans.

6.2.2 Definition of "Localization"

"Localization" can be understood as a process that the foreign archetypal pattern integrates into local urban context in China, rooted and transformed correspondingly, after being imported. It can also be decomposed and explained from the view of time dimension and spatial dimension, but as compared to the "diversification" process, it is the spatial dimension rather than time dimension that primarily triggered the process of "localization". (Fig.6-4)

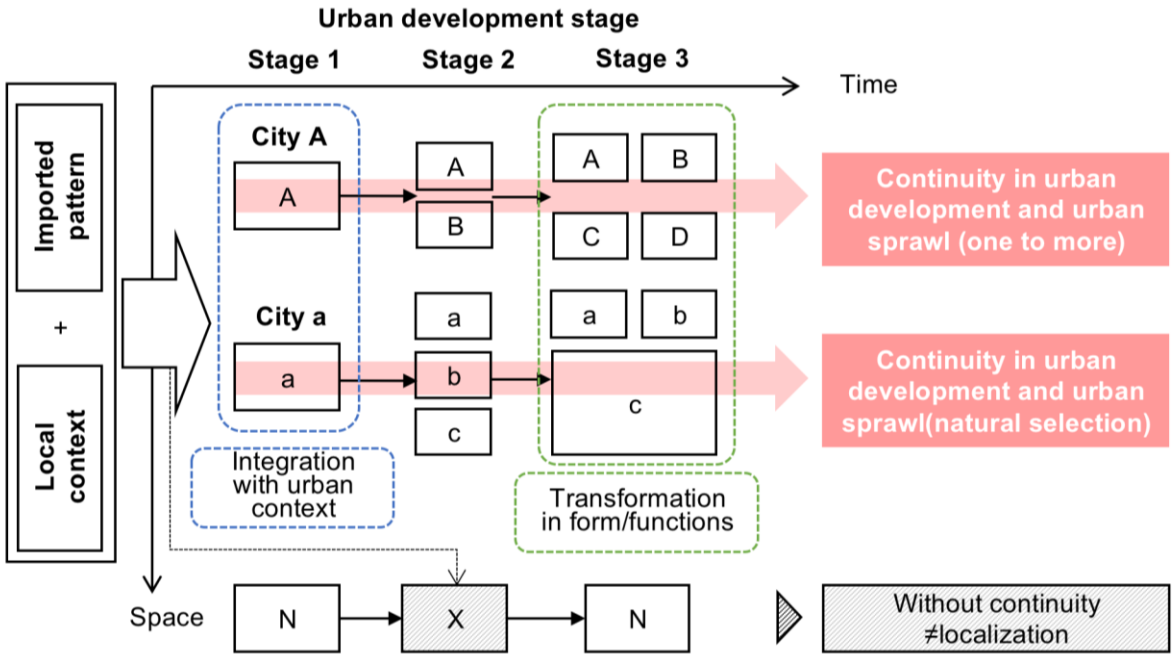

Fig. 6-4 Diagram of meanings in "Localization" (A, a, N etc. refer to urban pattern) (By author)

(1) Spatial dimension:

Firstly, it refers to the initial phase when the foreign pattern was introduced into Chinese cities. It can be a process of simply "copy" and "paste" without adjustment to local urban fabric, such as the dense gridiron network in some of the concessions. But for the Ring-radial Spaces and Rotaries, there is an integration of foreign archetypal pattern with traditional Chinese ideas or local conditions. The process of making foreign patterns root in Chinses urban context is a part of "localization". Moreover, when focusing on different cities, the foreign pattern was integrated in a more targeted way, according to the different conditions of each city, like Dalian and Changchun. As a result, instead of being a foreign matter, the imported pattern developed in harmony in the cities with colonial background.

Secondly, it refers to the continuity in construction following the urban sprawl. The imported pattern does not only belong to limited area, but is internalized into urban structures accompanying urban sprawl directions.

(2) Time dimension:

Firstly, it represents the following long-term transformation process in form and functions from the initial implementation to current conditions. In other words, it refers to the process that how the similar imported pattern transformed diversely in each city, adapting to their requirements. Hence, the time dimension of localization can be considered as a differentiation process labeled by urban identities in different cities.

Secondly, it also represents the implementation continuity during urban development. For the ring-radial spaces and rotaries' implementation in both Dalian and Changchun, although there was a period of stagnant in construction, they were applied again as an inheritance. Hence, the former imported pattern is no longer a result of specific period but has been internalized as an identical pattern of urban form.

6.2.3 The Mechanism of "Diversification" in the Transformation Process of Inherent Pattern

(1) "Time differences" decided by the transition of social background in different phases

Chinese civilization persists the centralized government for a long history, so it is in Beijing. As a result, the top-down plan is decisive in guiding urban form transformation. And, the principles give the direct impact on the grid block transformation. Based on the analysis in Chapter 3, principles' changes in different urban development stages due to multiple factors. They can be further defined as internal factors and external factors.

Internal factors involve many aspects, among which the regime alternating, social system, and economy system can be representative. Regime alternating reveals a new start up urban form, as proposals of different regime differ from each other. Social system is affecting the urban form in a milder way, either strengthening or weakening, because they do not regulate the urban form like block size directly, but act as a gene inside its transformation. For example, when the administration unit, such as community, accord with the physical urban form like block, the physical space is more likely to be endowed with identities, by means of events, landscape etc., which are created

by the corresponding administration. Conversely, the separation between the physical form and administration unit weakens the physical pattern to some degree, leading to splits in continuous spaces following respective guidelines. As for the economy system, although it does not regulate physical patterns directly, it is quickly responded by the changes in land allocation regarding to profit. For instance, as the state-owned land began to be traded for its usage rights by personal companies purchasing higher profits self-dependently, equality and higher accessibility are required resulting in a relative smaller block size and homogeneous subdivisions. As a result, the internal factors are decisive in enacting principles.

Principles are also influenced by external factors, such as the cross-cultural communication and global trends in urban planning concepts. Unlike the passive implementation in colonial period, the external factors, currently, are integrated subjectively as an assist of responding to internal factors.

Finally, the co-existence of blocks constructed in different periods shows the diversification. As a city of unified and continuous plan, Beijing adopts an overlayered structure, that both urban plans and urban constructions are overlaid on the previous one, partly maintained and partly demolished. Hence, blocks constructed in each period co-exist at the same time in Beijing. It is a synchronic record of the diachronic diversification in previous history. (Fig.6-5)

(2) Less consistency in block construction caused by the uncertain order of block formation

The uncertain order of block formation can be concluded as another factor leading to diversification in time dimension. Although most of the grid blocks in Beijing were planned and constructed with boundaries and subdivisions together at the same periods, or having re-subdivision after boundaries being decided, there are still a number of cases with reverse process. That is having block boundaries defined later than the inner subdivisions. The uncertain order reveals that block boundaries and inner subdivision may be decided based on various back ground and consideration, so the connection between can be weakened and new pattern may be generated. The continuity of streetscape and block pattern may also be affected.

(3) Unexpected differentiation resulted from insufficiency of principles in each period

The diversification of grid block in the spatial dimension reveals a contradictory phenomenon from the stereotype of some of the Chinese cities. It is that they were constructed under unified and strict city plans and principles, and were also built up in similar period with similar technologies and aesthetic, so that urban spaces are supposed to be monotonous. So are the grid blocks.

However, it does show a wide range of morphological diversity in grid blocks in Beijing, even among the ones that were constructed in similar time. One important reason is related to the definition of “block”. In other word, it refers to the relationship between the physical form and social form. “Block” represents a range of area surrounded by urban streets, so that it is a description of physical space. However, instead of focusing on the

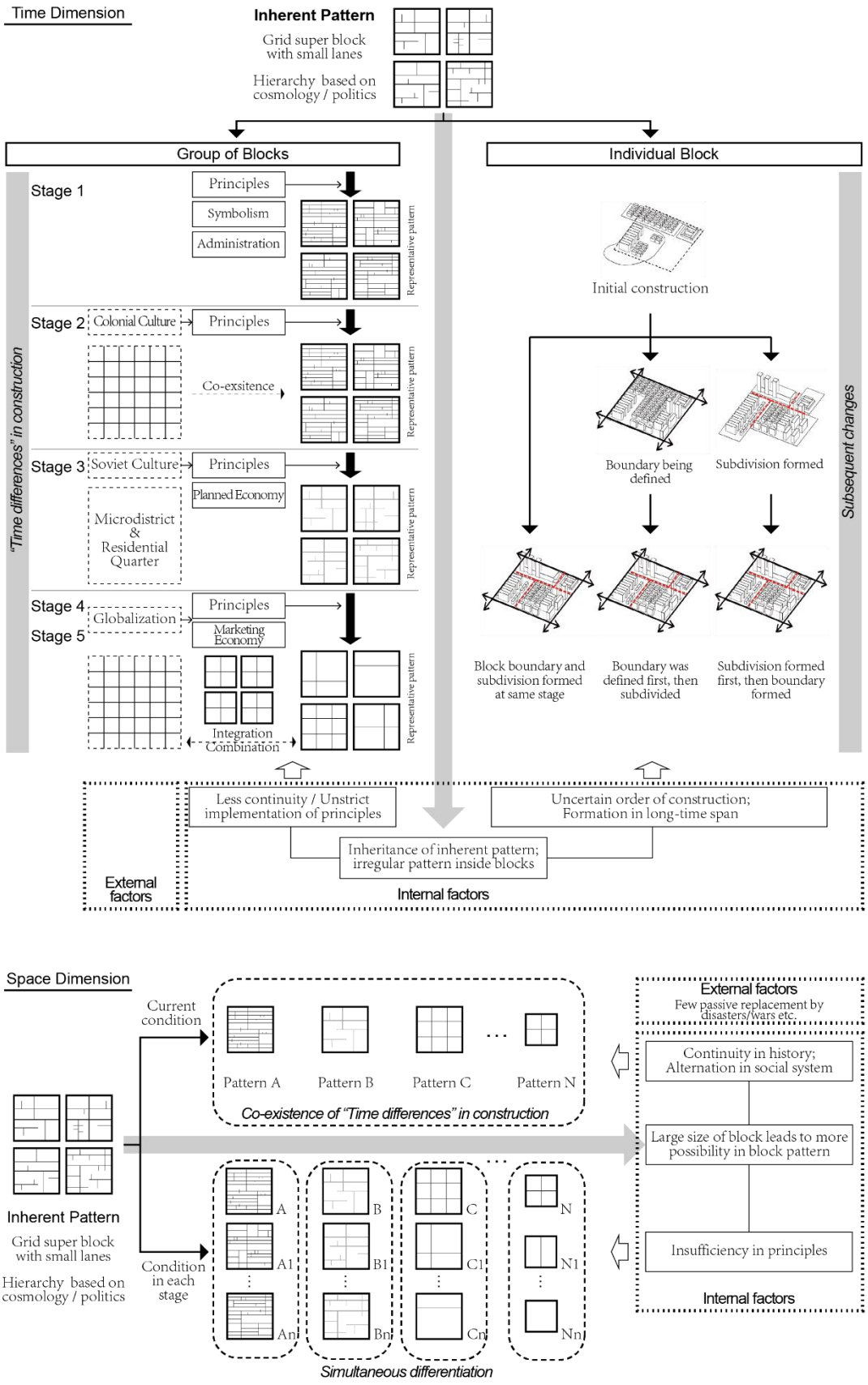

Fig. 6-5 The Mechanism of "Diversification" in the transformation process of Inherent Pattern (By author)

physical space as the basic unit arranging a city, Chinese cities prefer some other words that have social meanings but may be accordance with the physical ones. For instance, Lifang system, residential community, work-unit compound, and subdistrict etc. Hence, the regulations from the view of social system may resulted in various physical forms. And it is until 2018 that “block” was extracted as a specific word with quantitative regulations in the relevant principles.

Insufficiency of principles also leads to some diverse patterns, especially the ones diversified unexpectedly. As the principles in Chinese cities are mainly targeting at solving the functional problems on health and safety, such as fire prevention, earthquake, lighting, ventilation, transportation and sanitation. They are more likely to focus on their specific fields. Connections and correlations are possibly neglected. As a result, the contradiction in and between principles makes it unable to meet all the requirement simultaneously, so that some of the indicators became insufficient.

(4) Large size and irregular inner space lead to higher freedom in subsequent redevelopment of blocks

The rapid urbanization in Beijing resulted in some quick sprawl and rough construction of grid blocks, so redevelopment, such as re-subdivision or mergence, are required to accommodate the updating needs. Hence, it offers an opportunity for the previous blocks diversified into more patterns. Locations, functions and initial patterns play important roles in causing the diversification.

The locations reveal where the diversification may appear more intensely. Subsequent block re-subdivision in Beijing prefers to concentrate on the parts along main streets or at the corner for higher accessibility in order to earn more profits.

The functions or the land use reflect why the diversification appear.

The initial patterns then provides higher irregularity in diversification. Take the disintegration of Work-unit Compound as an example. As the inner space was self-dependently planned by the company or organization, there are not any regularity or common standards in the arrangement. Consequently, many re-subdivisions had to base on the built environment, causing uncertainty in the renewed patterns.

(5) The characteristics inherited in the “Diversification” of Grid Block

a) The internalization of hierarchical system

The inherent grid pattern was created based on a strict hierarchical structure from antiquity, as a symbol of cosmic and imperial power. Although the current urban form is no longer an expression of the cosmology, the traditional hierarchical system is inherited but expressed in an internal way. The obvious hierarchy in urban street system led to large differences in road width in Beijing. Therefore, arterial road systems that surround blocks

create public spaces of large scale, while the branch roads and the ones with lower grades inside the block generate spaces in human scale. The distinctive spatial contradiction is identical and potential in Chinese cities.

b) A sense of irregularity in the ordered system

Due to the accuracy and depth of urban plans in antiquity, the inner space of blocks is spontaneously generated compared with the gridiron network outside. Although the urban plans tend to become more accurate in regulating urban form, the spontaneity is still representative, not only in Beijing but also in other cities in China. Developers of residential communities, and the former work-unit compound own decision-making power in limited range of areas, creating the spaces with local styles.

Moreover, the irregularity can also originate from the preference of symbolism and privilege from ancient times. As the discussion in Chapter 2, the diversification of inherent grid pattern in China resembles a game between hierarchy and homogeneity. Even in the process of introducing the western homogeneous network in recent decades, the strict homogeneity has hardly achieved. Curved roads and diagram-like structures are applied for symbolism. Therefore, the sense of irregularity becomes a continuity in the long-term diversification process.

c) Social attributes in physical system

Physical form in Chinese cities can hardly be understood when being completely separated from social system. Simply form the view of urban design, the huge block size, the spatial contradiction in and out of the blocks, and the irregular inner spaces may cause series of problems, such as walkability, accessibility. But it is also these elements that offer potentials in strengthening the social concept of “neighborhood” and “community” in China. It can be considered as the buffer zones between public and private, and also a mental bond connecting residents with identification. How to balance the place-making with local identification inside the large blocks and the creation of public-friendly streetscape need to be further considered.

6.2.4 The Mechanism of "Localization" in the Transformation Process of Imported Pattern

(1) Similar urban planning expectation caused the import of foreign pattern, while natural conditions and city positioning initiated the localization

Ring-radial Spaces and Rotaries are the representative elements in Baroque city plan, symbolizing the power of governance, connecting significant urban spaces in a compulsory way. Their introduction into Chinese colonial cities reveals the similar expectation of colonial governments, but natural topography and cultural background led to different concrete expressions. They can be considered as the internal factors causing localization. (Fig.6-6)

The implementation of ring-radial spaces and rotaries in Dalian is a combination of Baroque prototype with local topography. The pattern in Paris, where Dalian learnt its urban form from, was constructed completely from an artificial aspect, strengthening the political symbolism. However, the pattern in Dalian was actually based on natural terrain that the ring-radial spaces and rotaries were mostly located in the higher site of the hilly terrain. Rather than the subjective decision of ring-radial spaces and rotaries in Paris, the ones in Dalian are a corporation between human and the nature. Therefore, the oppressive feeling created by the strict artificial space was weakened by the focus on natural landscape in Dalian.

Simultaneously, the implementation of ring-radial spaces and rotaries in Changchun is a combination of Baroque ideas with traditional Chinese culture. The traditional north-south urban axis, and grid plan in ancient Chinese capital cities was integrated with the ring-radial spaces and rotaries, adding a sense of hierarchy. Both natural topography and traditional culture motivated the localization process of the foreign ring-radial spaces and rotaries.

(2) Continuity in time and space of urban construction is the prerequisite of localization

Advantages and distinctions motivate the continuity of Ring-radial Spaces and Rotaries as an identical urban pattern.

Unlike the common concessions aiming to purchase higher efficiency and profits, both Dalian and Changchun were planned by the colonial governments with a long-term scope, targeting at creating an ideal city. The implementation of ring-radial spaces and rotaries was suggested after consideration of a set of conditions. Therefore, they do adopt advantages and advance in urban planning at that time, and were worth to be inherited in the subsequent construction.

Moreover, as a totally different pattern with the inherent grid plan in China, ring-radial spaces and rotaries endowed both cities with distinguishable urban spaces. The inheritance of ring-radial spaces and rotaries is a way of strengthening the urban identity to some extent. The imported pattern has transformed into a continuously inherited planning icon.

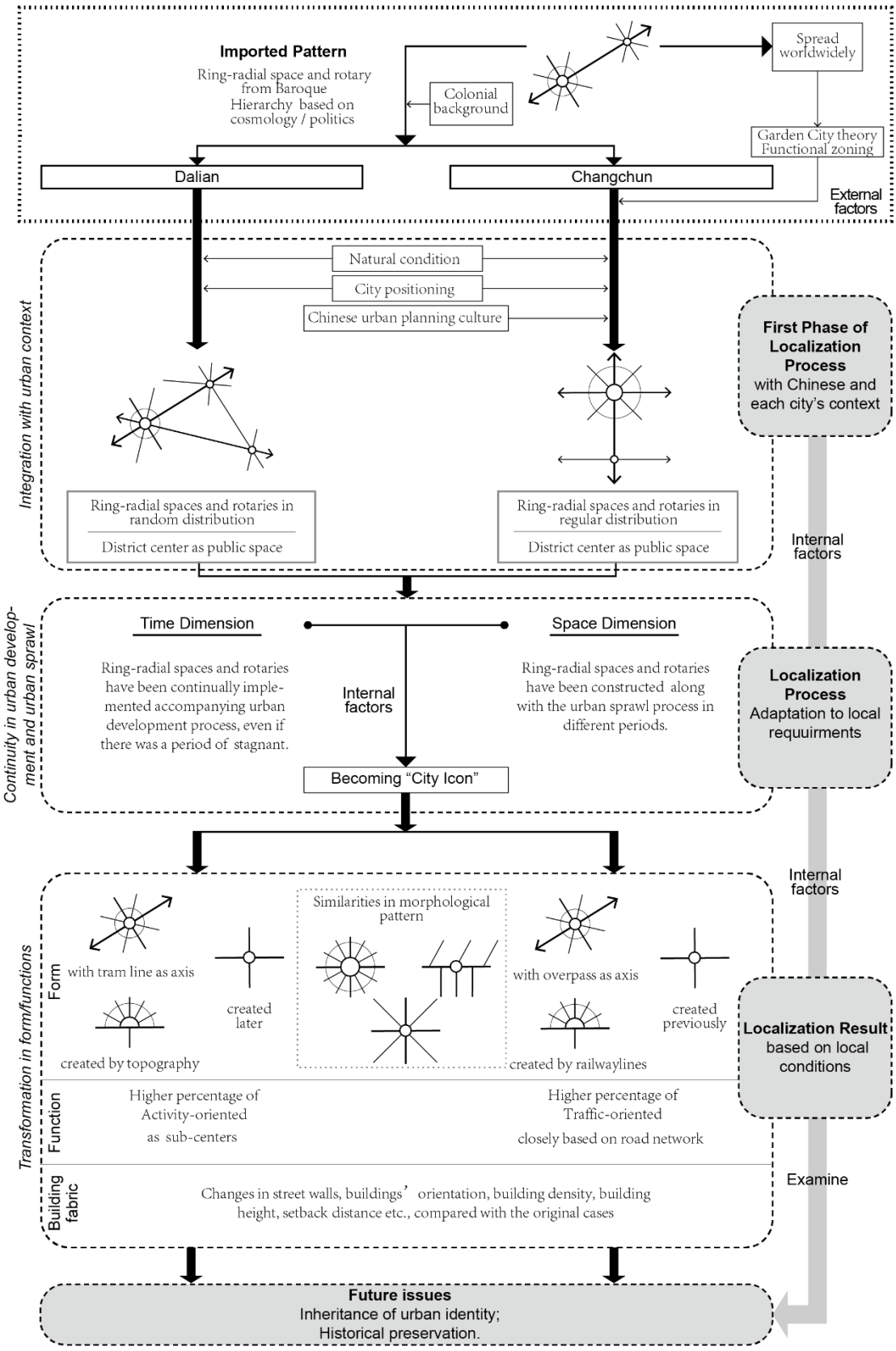

Fig. 6-6 The Mechanism of "Localization" in the transformation process of Imported Pattern (By author)

(3) Different urban planning strategies and urban sprawl tendency lead to respective differentiation in morphology and function

Limited by the hilly and peninsula topography, urban areas in Dalian sprawled towards different directions, splitted by hilly terrains. There is hardly close connection between the ring-radial spaces and rotaries, making them act as a small center of surrounding areas offering public space. Also, based on its geometric feature of isotropic, they were more preferred in connecting various urban fabrics in Dalian.

For Changchun, the latterly constructed cases were usually located by structural road network, showing the emphasis on vehicle traffic. Correspondingly, cases in Changchun tend to become intersections with landmark serving for the vehicle scale, instead of offering public spaces in human scale.

(4) Loss of initial planning concepts in the adaptation to local requirements

Imported pattern was implemented in Chinese cities as a measure for achieving ideal cities via western concepts. Even it was integrated with local conditions and domestic culture in China at the first phase of introduction, the characteristics of Baroque city plan, such as the axial connection between ring-radial spaces, were conceptually obtained in Dalian and Changchun. When considering each city respectively, their initial implementation of ring-radial spaces and rotaries has been endowed with distinctive features. For instance, the visual corridors created for viewing natural landscape in Dalian, and the central islands designed as public spaces in Changchun. However, a lack of original planning concepts can be seen in both cities following the long-term transformation of adjusting to local requirements. It manifests as the lack of connective relationships between the RS&Rs in Dalian in recently built ones, and as the disappearance of activities in Changchun. In Dalian, the RS&Rs and the street network have gone through the process of RS&R leading, street network leading, and separated distribution. Therefore, the connections between the RS&Rs have been weakened. Simultaneously, the RS&Rs in Changchun closely interact with street networks and many of them are in incredibly wide width, thus, they focus on the traffic function at the expense of the activity function.

As a result, there is more in visual or physical continuity rather than conceptual inheritance during the localization process. The loss of original planning concepts motivated the recent attention on historic preservation. Integral plans for the historical cases have been proposed in both cities. However, it is not enough for only preserving the existing ones. It needs more consideration on inheriting identity in the new ones to be constructed.

6.2.5 Comparison between "Diversification" and "Localization" Process of Urban Morphological transformation in Chinese Cities

(1) Simple and abstract archetypal pattern as the starting point

The complexity of urban form in Chinese cities may cause difficulties in reading their transformation process. Multiple patterns co-exist, and intertwine with each other. Hence, tracing back the original source and its geometric features is the first step to clarify the whole process.

Inherent pattern from traditional culture and imported pattern from foreign cultures, are firstly categorized. They are the beginning of understand the "Diversification" and "Localization" process, respectively. Both of them can be abstracted as a simple and archetypal pattern. The inherent pattern is represented by grid plan, while the imported pattern is represented by ring-radial spaces. They share the common significance of acting as the concrete expressions of specific cosmology. The inherent grid plan shows the symbolism with strict hierarchy, while, the imported ring-radial space suggest it with a series of focuses. They were created with strong and clear purposes, and constructed in a relative short time. To clarify the transformation process is to figure out how the archetypal patterns adapt to the changing urban context.

(2) Continuous transformation in both time and spatial dimension

Starting from the abstract archetypal pattern, the transformation appeared in different dimensions: a static process in spatial dimension that focusing on the decomposition and classification of urban patterns, and a dynamic process related to the action of time on the urban patterns. Both the processes of "Diversification" and "Localization" include the two dimensions, but their significance differs in the two processes.

For the diversification of inherent pattern, time dimension plays a more decisive role. First, the top-down plans and principles endowed the grid pattern in different periods with different preference. Second, the built-up ones may respond again to the subsequent tendency with changes in morphology. Then, in the spatial dimension, variants of the inherent pattern in each period were compressed in the same space, at the same time. The diversification in spatial dimension can be seen as a record of the diversification process in time dimension. Hence, by means of reading the morphology in spatial dimension, the diversification process in time dimension can be inferred conversely.

For localization of imported pattern, spatial dimension triggered the whole process, that abandoned unnecessary characteristics of foreign pattern and endowed it with local requirements. Then the further adaptation to local identities in following periods continued, completing the localization in time dimension.

(3) Influence of internal forces and external forces at different time and with different proportion

Both the "diversification" and the "localization" can be regarded as the process that patterns originating from specific theories and sources evolve to accommodate local urban context and updating requirements of each periods. But, both the two processes cannot happen self-dependently only base on internal factors or external factors. They are the different solutions for the interaction and conflict between 1) updating social requirements, and 2) different cultures.

When targeting at a single specific city, the diversification of inherent pattern and the localization of imported pattern require appropriate conditions to trigger the process respectively.

For the inherent pattern, inheritance is the prerequisite for diversification. Constructions without inheriting any previous characteristics can only be called a process of replacement. As a result, it requires continuity in urban construction. In other words, strong impact from foreign culture may result in demolishment of inherent pattern, preventing the diversification with the totally new urban pattern. However, appropriate social and culture alternation may stimulate the diversification, promoting the inherent pattern transform to adapting to new tendency.

On the contrary, strong impact from foreign culture is the source of imported pattern. It needs to be point out that not all the implementation of imported pattern can be defined as a complete localization process of the specific pattern. Take the concessions in some Chinese cities for instance, the implementation of western gridiron network, can be regarded as an "insertion" of foreign pattern, rather than a localization. Because there is little transformation that was planned aiming to respond surrounding urban context. The phenomenon is rather obvious in the cities with traditional built-up areas, like Tianjin, Shenyang etc. In addition, the construction of the imported pattern has not been applied in the later periods. It is more like an antithesis between the imported one and the existing one, without integrating local identities. Therefore, the above pattern is just a diverse type from foreign culture in urban form transformation, without complete localization. Conversely, in the cities without large area of built-up areas, like Dalian and Changchun, the imported pattern took up the role of creating the main body of urban form. There was not much conflict between the new and the old. Instead, a close bond was established between the imported pattern (ring-radial spaces and rotaries) and the city's construction, which provide the opportunity for the pattern rooted in the local context. What's more, the imported pattern has been continually constructed, accompanying urban development, proving that it has been localized as a common element in urban form.

(4) A process from "one" to "more" in diversification but an uncertain tendency in localization

The difference is that, "diversification" represents the process from "one" to "many", either timely or spatially. While, "localization" place particular emphasis on the efforts that have been made to let foreign patterns root in Chinese culture, and the further revelation that how the similar imported archetypal pattern transformed diversely in different cities. Rather than the process from "one" to "many" in "diversification", "localization" is more likely to be defined as a process of adaptation.

For the inherent pattern, “diversification” represents the process from “one” to “many”, either timely or spatially. Requirements of different periods directly lead to its transformation on purpose, while within each period unexpected transformation may also occur spontaneously. Both of the procedures are leading to new variants of the original inherent pattern. The process from “one” to “more” is therefore inevitable.

But there is not such absolute tendency in the localization of imported pattern. Apart from the similar “one” to “more” tendency, there is a possibility in “simplification”. As there is not any cultural foundation of foreign pattern in Chinese cities, it is some of its advantages that make it selected in urban planning. Only the strong point or specific features that are adaptive to the local conditions are possibly selected and maintained in construction. Variants of unnecessities are probably abandoned or transformed into the practical ones. It resembles the natural selection to some degree. Morphology and functions may tend to be simplified into several typologies, which adapt the city perfectly, but do not necessarily matches the initial form and function when first being implemented.

(5) Connections and transformation between “Diversification” Process and “Localization” Process

The two processes are not independent or totally separated from each other. According to the different ranges or resolutions and different evolving phases, there is possibilities for them to transform into each other.

The diversification of inherent grid pattern in Beijing has been understood in a meso-scope. However, when being put in the macro-scope in the whole Chinese civilization, it is one procedure where the traditional Chinese grid plan is localized to Beijing’s identical location and urban development. Similarly, when scaling to the micro-scope, into the inner parts of Beijing, the diversification process is composed of a series of localization procedures, basing on specific positions and construction time in Beijing.

Correspondingly, the localization process of imported RS&Rs in Dalian and Changchun, can be considered as a part of RS&Rs’ diversification worldwide in macro-scope, influenced by Chinese background. In micro-scope, it is also through a diverse transformation with respective preference in each city that their localization process can be finally achieved.

Both the processes actually happened in Chinese urban form transformation, but which of them takes the leading role depends on how the city is read. This research defined and redefined the two processes based on the cultural origin which is the basic distinction in Chinese urban forms. Hence, it benefits revealing the basic characteristic of transformation, so as to distinguish the dynamics and reveal a clearer causation logic in the transformation of urban morphology.

6.3 Application in Urban Planning and Design of Chinese Cities

6.3.1 Constancy of Conceptual Inheritance in the Inherent Pattern, but Variability in the Imported Pattern

Form the diversification process of inherent pattern, it conveys a constancy of conceptual inheritance. Even if there has been various compromise of the traditional grid pattern in adapting to industrialization, economy system, urban planning concepts and globalization, there is not any complete replacement with foreign patterns. The configuration of dualism, hierarchy and irregularity can be identified constantly (Fig.6-7). This is questioning the currents in some cities in China that encourages the imitation of western urban patterns without fully considering the cultural background and spatial identities. It may go against with the cultural preference and custom of local citizens.

Fig.6-7 The small-scale inner space of blocks constructed before 1911(upper left), in 1950s (upper right), after 1990s (lower left) and the large-scale arterial road (lower right) in Beijing
(Photos by author)

On the other side, the imported urban pattern shows higher variability in its localization in Chinese cities. In spite of the continuity in urban construction in both time and spatial dimension, differentiation in both form and functions, as well as the planning objectives appeared (Fig.6-8, Fig.6-9, Fig.6-10). Regulations on historic preservation have been proposed for preventing the complete loss of original identities of the unique urban form. But the loss continually happened among the newly built ones. How to balance the previous city identity with the adaptive differentiation, or creating a more localized pattern, are essential in future urban design.

Fig. 6-8 Round view of RS&R constructed in 1900s (Zhongshan Square, Dalian) (By author)

Fig. 6-9 Circular road (left) and inner public space (right) of RS&Rs constructed in 1920s (Wusi Square, Dalian) (Photos by author)

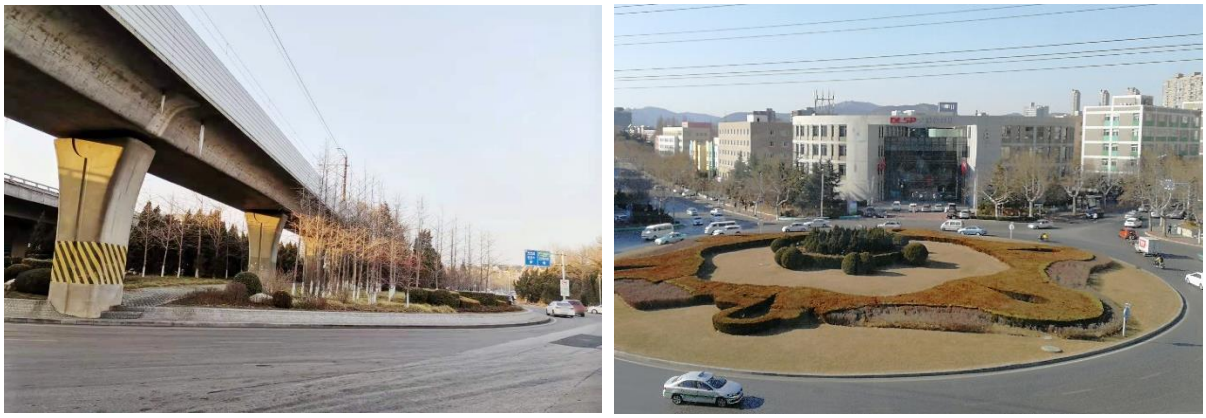

Fig. 6-10 RS&Rs constructed in 1980s (left, Haida Square) and 2000s (right. Shuma Square) in Dalian (Photos by author)

In short, the constancy of conceptual inheritance in the inherent pattern, and variability of the imported pattern have been revealed from reading the transformation process of urban morphology in Chinese representative cities. It set up the foundation of optimizing the urban form in both concrete place-making and social policy-making.

6.3.2 Issues and Strategies for Traditional Cities with Inherent Grid Plan

Based on Chapter 2, the traditional grid plan has been persisted in the long history of Chinese cities as the most representative inherent pattern. They are commonly applied in ancient capital cities like Beijing, Xi'an and Kaifeng. And they are also applied within the old town of some other cities, such as Shenyang and Tianjin (the old town of Tianjin has been reconstructed thoroughly). Hence, the clarification in the case of Beijing can be referred by the other cities with similar conditions.

(1) Main Typologies of large-scale grid blocks

The hierarchy of ancient Chinese urban planning concepts resulted in the dualism of grid blocks: the large-scale block boundary and the tiny scale inner space. From the ancient to present, because of the highly unchangeable feature of urban structure, the large-scale boundary has changed in limited degree, especially compared with the dense gridiron network in western cities, such as Barcelona, and Manhattan, New York. But the inner space has diversified in a higher degree. (Fig.6-11)

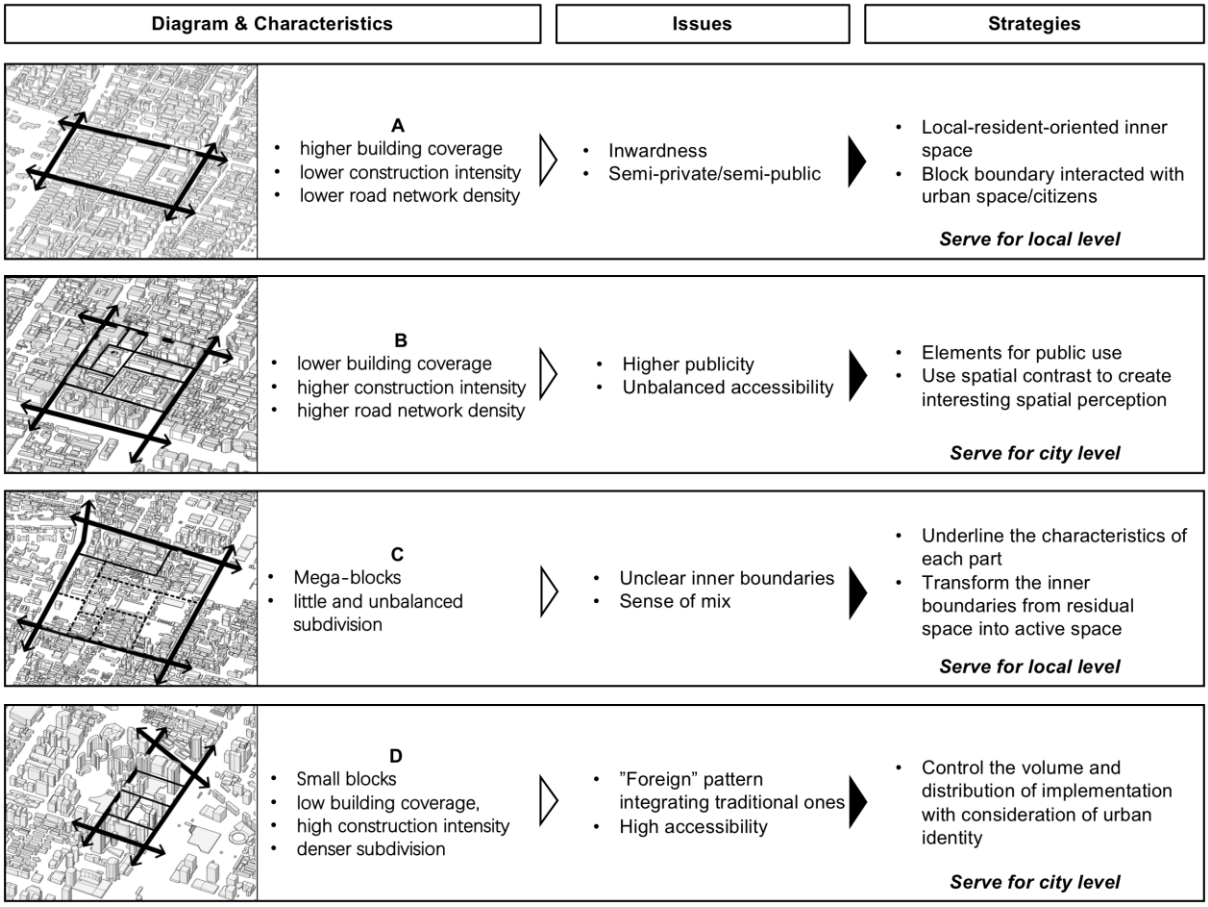

Fig. 6-11 Diagram of issues and strategies for traditional cities with inherent grid plan (By author)

Among the variants of the ancient grid blocks, two typologies take up the most proportion:

A. Blocks with higher building coverage, lower construction intensity and lower road network density

This kind of block pattern resemble the most to the ancient model. It is also the representative type commonly applied in residential districts especially in the late 20th century. Because of the less subdivision inside the blocks, the accessibility of inner space is relatively low, which endowed the blocks with more inwardness. Also, the less subdivision leads to less differences in spatial perception. Hence it created some sense of "unwelcoming" for the public citizens, but offers general service and a sense of safety and belongings for the residents in the block. The inner space of blocks is relatively private for the local residents compared with the public street space outside, showing a sort of collectivism. It can be potential in community building with concept of place-making.

Strategies:

The connections between local residents and block space can be one of the main points in future design. Instead of opening the existing inward blocks completely to the public urban space, creating local public space which orients mainly to the local residents can be another measure to be considered. It may contribute to promoting the community vitality, which is an important part of urban vitality. Residents' participation may be also included aiming to create what the residents really need.

Simultaneously, the interaction between block boundaries and public citizens using the public streets require improvement, avoiding the sense of "unwelcomed" and "boredness". It can be a new expression of "dualism" inside and outside of the large-scale blocks.

B. The middle-size blocks with middle building coverage, higher construction intensity and higher road network density

This kind of block pattern can be considered as the variant of ancient model by subsequent subdivision. With the block boundary sustained, the inner space was diversely subdivided. It is the representative type commonly applied in commercial areas. Higher accessibility of the inner space is pursued for chasing higher profits. Compared with the blocks in A, these cases adopt higher publicity for the general citizens in the city. However, influenced by the irregularity in the initial construction, the accessibility inside is unbalanced for some extent.

Strategies:

The higher publicity requires more design for public use, such as building façade, street furniture, traffic flow and pedestrian paths. The unbalanced accessibility inside may limit the use of space, but it can also be regarded as a potential in creating uniqueness. Spatial contrast among spaces of various scale is essential in creating interesting spatial perception.

Compared with the above common typologies, there are two other types that represent the two extreme morphology.

C. Mega-blocks with little and unbalanced subdivision

This kind of blocks are usually composed of several parts that may differ a lot form each other either in morphology or in functions. For example, the blocks composed of campus, work-unit compound and residential community together. But there is not always clear boundaries or only narrow space between the parts. Therefore, the parts of different characteristics adhere with each other, endowing the whole block with a sense of mix.

Strategies:

The boundaries of different parts inside the mega-block can be more considered. When the inner plans of each parts are always carefully considered by their stakeholders, the boundary space is usually left over, as residual space. Problems such as sanitation, safety, landscape and walkability may consequently appear. As a result, taking use of the boundary space between contributes to underline the characteristics of each part and improve the environment integrally.

D. Small blocks with low building coverage, high construction intensity and denser subdivision

This kind of blocks represent the strong currents in the globalization. It is introduced to meet the need for optimizing vehicle traffic capability and raise the accessibility of land for higher business value. Hence, it is preferred in the commercial centers, such as CBD areas. It plays the role of city center, offering service for the whole city. However, compared with the above three typologies, this type is rather “foreign”, which shows an opposite characteristic from the inherent grid blocks.

Strategies:

The implementation of this type needs to be regulated based on complicated condition of different locations instead of aimless promotion. Although its integration with the traditional grid pattern can be recognized to a certain extent, the volume and distribution of this type still need to be controlled with the consideration of urban identity. Within the spaces in the current blocks, elements that may reflect urban identity need to be integrally designed.

Finally, the urban design strategies need to be proposed in a hierarchical way, instead of treating all the blocks equally. Urban planning principles need to touch upon the detail level of space, and guarantee their implementation. At the same time, balancing the state-led principles and self-depend decision of developers and grass-roots administration can be efficient in planning.

(2) Urban Planning Principles and Management

Urban planning principles is the main factor that people can directly manipulate urban construction, so the regulatory control has a deep influence in the evolution of urban form. Facing the complicated diversification of inherent grid block, principles require refinement. The refinement includes two aspects. The first is the accuracy, controlling the detailed conditions of every element of blocks, and underlining the connection between different fields of urban plan. The second is the specialization, which means proposing specialized strategies for specific typology of blocks, depending on their positioning and current condition.

In addition, as the social attributes have always been sustained behind the urban physical form, they are potential to be combined with continual management of block space. The connections between block form and social attributes, such as administrative units, citizens' participation and community building with place-making, need to be considered. Hence, the quality and directions of spatial transformation can be possibly guaranteed in a sustainable way.

6.3.3 Issues and Strategies for Cross-culture Cities with Imported Pattern

Similar with the experience in Beijing, the localization process of RS&Rs in Dalian and Changchun is also worth learning from. In the first phase of localization, the implementation of imported pattern mainly based on foreign cultures with local conditions and Chinese culture as assistance. It started up from the view of foreigners when considering planning strategies. As a result, the initial implementation provides a perspective of what the planners of foreign culture take as the urban identical elements. It is worth referring in the following urban planning.

However, the following issues gradually appeared in the long-term transformation process, that may influence the future planning strategies. (Fig.6-12)

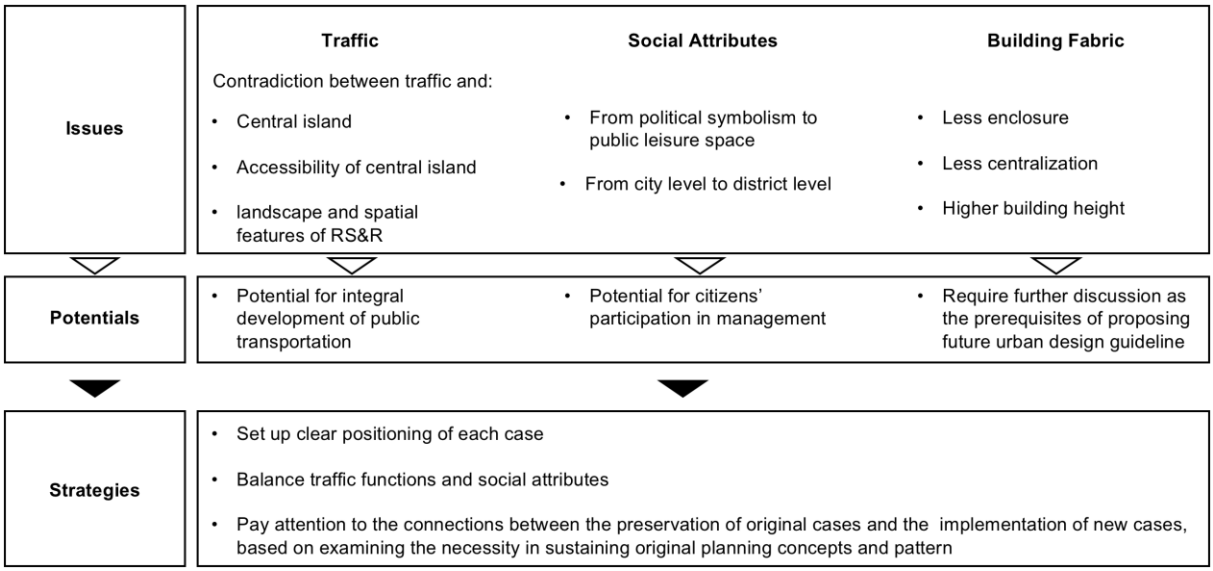

Fig. 6-12 Diagram of issues and strategies for cross-cultural cities with imported pattern (By author)

(1) Traffic functions

First, the contradiction between traffic and central island. The rapid increase of traffic caused deconstruction of central islands in RS&Rs. The temporary method for calming traffic is simple and crude, but it led to the most demolishment of the distinct urban space.

Second, the contradiction between traffic and accessibility of central island. Heavy traffic circulating in the RS&Rs causes more danger of getting into the central islands, weakening people's willing in using the public space inside, even the underground passage has been applied in a few cases. Some cases were even closed up considering the safety and less utilization of the central space.

Third, the contradiction between traffic, and landscape and spatial features of RS&R. Elements serving for traffic functions have been inevitably implemented, such as railway lines, overpasses or even the traffic signals. They weakened the centralization in RS&Rs which is its uniqueness in geometric features. Hence, how to balance the centralization and axial elements need to be considered. Moreover, taking advantages of the axial elements may add another feature to the RS&Rs, which possibly results in special spatial perception.

Finally, the potential for integral development of public transportation. It has become a redevelopment measure for the RS&Rs in other countries, and it has not been applied widely in China. It can be a discussed depending on comprehensive evaluation for necessity.

(2) Social Attributes

First, from political symbolism to public leisure space. The imported pattern is connected with either politics, governance or religion etc., originally, resembling the Baroque cities in Europe. The religious consideration did not implement at the initial phase. And the symbolism has been weakened when the central space is gradually endowed with functions for daily leisure activities, such as exercising, dancing, and walking. Compared with the function that being a public stage for voicing in some countries, RS&Rs in Chinese cities have afforded more day-to-day use. They became a container for activities in Chinese custom.

Second, from city level to district level. Compared with the original cases dominating the urban structure, some newly built ones take up more duties for serving surrounding districts. They are relatively independent, acting as district centers. Therefore, they became potential in improving community quality. The current RS&Rs are included in urban management, but citizens' participation can be discussed in future, referring to Seattle's Neighborhood Traffic Control Program (Chapter 2.4.4).

(3) Building Fabric

There has been an identical change of building fabric around RS&Rs. Both enclosure and centralization have been weakened by the dense and direction change in surrounding buildings. But the building height increased a lot in the cases without historical preservation. It may fit some needs adapting to local conditions, such as the preference of north-south orientation in China, but the reasons for the common changing tendency require further discussion as the prerequisites of proposing future urban design guidelines.

(4) Strategies

First, set up clear positioning of each RS&R. According to the location in the urban structure, its role in the city needs to be clearly set up. Whether it is the city center, an intersection of urban axis or simply a public space serving limited district, is the precondition for proposing future developing strategies. Different positioning led to different functions, landscape and management. The unification of the whole system of RS&Rs in the city can be guaranteed.

Second, the balance between traffic functions and social attributes need to consider the citizens' preference and convenience. It is also a balance between vehicle traffic and pedestrian. Hence, the only consideration from top-down functionalism is not enough. Its potential in acting as public space should include the possibility of citizens' utilization.

Third, examine the necessity in sustaining original planning concepts and pattern from different aspects, based on which, connections need to be paid attention to between the preservation of original cases and the implementation of new cases. Otherwise, fragmentation will probably appear among the RS&Rs all over the city, weakening the uniqueness of the distinctive urban pattern.

6.3.4 Optimizing the Connection Between Statutory Planning and Practical Implementation

Apart from providing issues and proposals for cities with inherent patterns or imported patterns, the approach and conclusions of this research also contribute to optimizing the connection between statutory planning and practical implementation.

According to the National Spatial Planning System proposed in 2019 (Notice of the Ministry of Natural Resources on the Comprehensive Development of Spatial Planning, proposed by Ministry of Natural Resources in China, 2019. No.87), Statutory Planning in National Spatial Planning System includes (Fig.6-13, upper): 1) Spatial Planning System of different resolutions, such as national scale, province scale, city scale; 2) Specialized Plan, and 3) Detailed Plan. Among these, Detailed Plan is the final step of Statutory Planning System, which is compulsory in regulating urban plans. Then, the non-compulsory plans such as urban design, and other designs that directly guide practical implementation that are commonly proposed by architectural and urban design institutes, are sequentially created following the regulations in Detailed Plans. The contents of Detailed Plans can be referred to the Detailed Development Control Plan and Detailed Construction Plan in the urban planning system 2007.

Detailed Plans bridge the planning strategies from master plans, urban management and implementation in practice (Geng, H., 2008), but there is a gap between the compulsory detailed plan and the following non-compulsory plans, because of different considerations.

As compulsory regulation, Detailed Plan has higher effectiveness, but it was made “Indices-oriented”, based on basic functional requirements, lacking considering the relationship with social/human aspects of urban habitation; However, the sequential urban design considers more about the issues, such as urban identity, spatial quality etc., but its non-compulsory regulation weakens its effectiveness (Chen, F. et al., 2013). So, there appears a contrast and gap: their different consideration may cause insufficient guidance and differentiations in urban space.

This research examined the block/street pattern in a quantitative and visualized way, from the view of urban form inheriting and transforming. As the morphological analysis relates to the indices in Detailed Plan, this research described and understand the morphological transformation with relevant indices. Hence, it provides possibilities for the Detailed Plans to make indicators more based on social/human consideration, instead of just satisfying basic functions. It combines the urban design issues with the final step of statutory plans (Detailed Plan), to better guide the following design and implementation rationally. Hence, it helps to connect the planning bureau and design institutes, to produce culturally sustainable urban forms (Fig.6-13, lower).

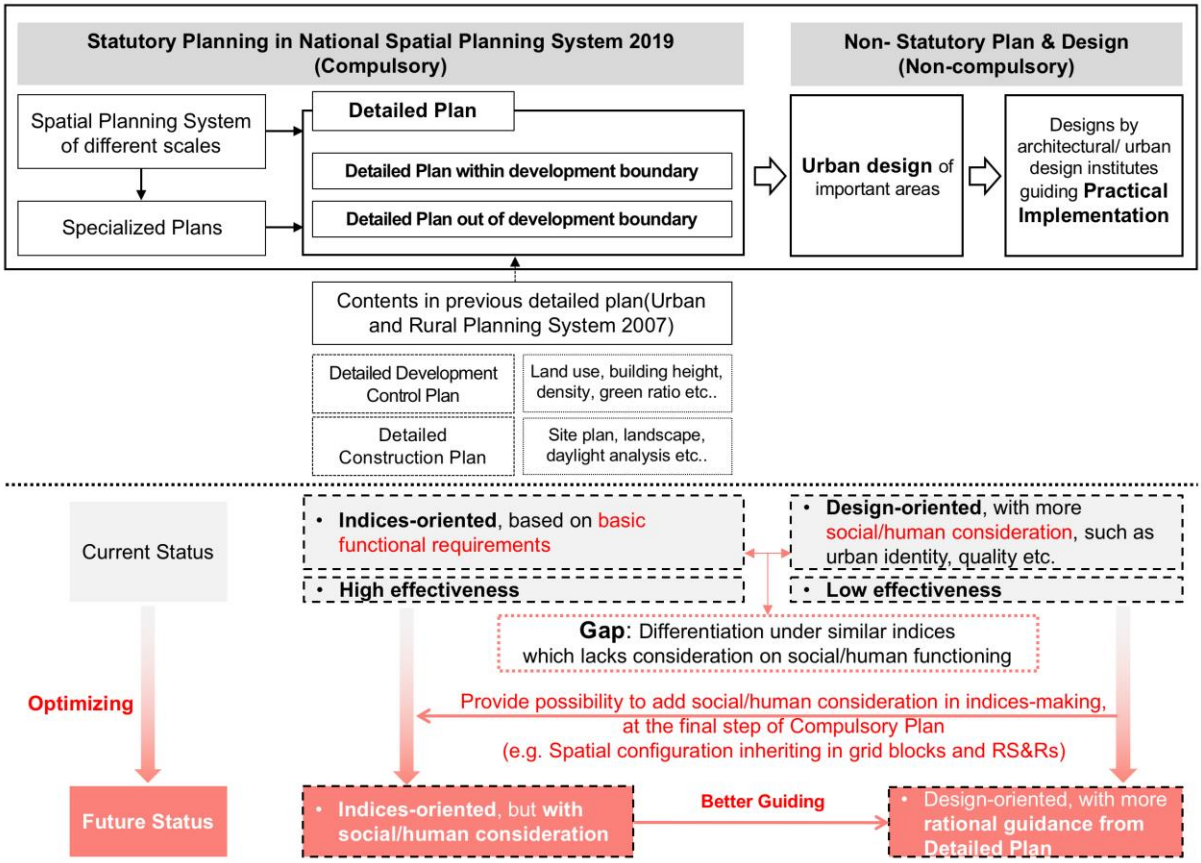

Fig. 6-13 Optimization of the connection between statutory planning and practical implementation in Chinese urban planning system (By author)

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Chapter 7 Conclusions

7.1 Summaries and Conclusions of Each Chapter

This research aims to propose new perspectives and frameworks for understanding the complicated transformation process of urban morphology in major cities of China. First, urban forms were abstracted and classified into inherent pattern and imported pattern based on cultural background and planning concept. Second, the transformation of inherent pattern was mainly defined as a "diversification" process, and its procedure and dynamics were clarified, by case study of Beijing. Third, the transformation of imported pattern was mainly defined as a "localization" process, and its evolution of rooting in Chinese urban context was examined and clarified by comparative study of Dalian and Changchun. However, the two processes are not independent or totally separated from each other. According to the different ranges or resolutions and different evolving phases, there is possibilities for them to transform into each other. Finally, the mechanism of the above two representative transformation process was clarified and compared, in order to bring up proposals and issues for future urban design.

The contents and conclusions of each chapter are summarized as follows.

Chapter 1 Introduction

Chapter 1 introduced the research background, research objectives, definitions, research framework and previous research. Based on the background about urban morphology transformation in China, Chinese urban form adopted complexity and uniqueness, driven by historical continuity with an unprecedented modern urbanization process. Both the internal and external forces from culture exchange contribute to the transformation. It required suitable methods for reading the process. By reviewing the previous research on urban morphology transformation in China, a lack of studies taking urban structural elements in street-block scale as a physical clue in understanding the transformation, was identified. Moreover, studies focusing on the procedure from the "archetypal" to the "concrete" form was not enough, especially considering the different cultural origins.

The position of this research was clarified as an in-between approach between urban form history research and urban planning theory research. That is, after the new pattern was introduced in the history, how it naturally adapts to the new urban requirements and problems. This process is qualified positively in the process of enriching urban morphology in this research, balancing the view of Modernism and Post-modernism theories about urban planning and urban design.

Therefore, it is important to have a concrete perspective on the scale of the street and block by the time-and-space-dimensional reading of representative cities, to make the urban morphological transformation more legible, which contributes to solving the monotone in city images in the flow of industrialization and globalization, and inheriting local traditions to develop and maintain as a fundamental part of city identity.

Chapter 2 Inherent Pattern and Imported Pattern from Different Cultures in Chinese Urban Form

Chapter 2 began with the multiple sources of Chinese urban forms, sorting out the representative patterns, and clarifies their inheriting relationship, time sequence, and current issues, from the view of culture inheritance and importation. The investigation was not limited in Chinese urban context, but also in the range of the world, so as to give a whole view of the position of specific patterns, before further clarifying the "diversification" and "localization" process in urban morphological transformation. Conclusions can be summarized into the following 4 parts:

(1) Cultural exchange appeared in different epochs in China. Advances and prosperity in ancient China (such as the Tang Dynasty) have contributed to the export of culture to neighboring countries, while, in modern times (late 19th century and early 20th century), China has passed through colonial and tumultuous periods of passively importing foreign culture. And at present, rapid urbanization and globalization are making Chinese cities aggressively absorb advanced foreign ideas and incorporate them into the domestic context. Therefore, in order to understand the transformation process of urban morphology in Chinese cities, original cultural source cannot be neglected.

(2) The comprehensive culture exchange in history was reflected in the urban form. Different urban patterns convey various ideologies. Top-down cities in China can be classified according to the initial cultural source concealed in the urban plan. The first group includes those that were planned on the basis of traditional Chinese cosmology, represented by a dualistic grid plan, such as Xi'an and Beijing. The second group contains those that were on the basis of western symbolism, represented by the Baroque ring-radial spaces, such as Dalian and Changchun.

(3) The grid plan of dualism or hierarchy, is the physical expression of traditional Chinese cosmology and hierarchical feudal society. It has been inherited through the thousands of years of ancient times and the unprecedented urbanization in the past century, as the inherent pattern existing in Chinese urban form. Its inheritance resembles a "game" between "hierarchy" and "homogeneity." Homogeneity was underscored when marketing flourished with less prohibition, or as a further indicator of hierarchy and political control in colonial background. It was weakened when the management system required. Currently the homogeneous grid pattern has been merged with the conventional hierarchical one, as a unique Chinese result in globalization. The inherent grid plan has a high potential for constant transformation in adaptation to a changing society, which is also proven by the homogeneous divergence that emerged in Japan after export.

(4) The Baroque ring-radial spaces, as a totally "exotic" from foreign culture, is a result of passive urbanization in colonial background, without any foundation in Chinese civilization. So, to clarify its transformation in the worldwide context is the prerequisite of understanding its import into China. As the measure of symbolism in the 17th century, it was optimized to suit individual urban context following functionalism and modernism emerged at the end of the 19th century. More social functions were given to it, such as creating public stages, a fitting place for integral development, which may weigh heavier than its insufficiency in traffic calming

and land use. So were the ones implemented in China. As a result, Baroque ring-radial spaces was imported into China when its symbolism was endowed with more concrete functions, adding a tendency of Pragmatism in the cases in China. Worldwide, Baroque ring-radial spaces are irreplaceable and updating constantly, setting up a reference for understanding how the “exotic” pattern adapted to the Chinese conditions, so its localization in China require clarifications.

Chapter 3 Formation of Blocks and Transition of Urban Planning Principles about Block Form

——Formation Process and Principle Reference of Grid Blocks in Beijing, China

Chapter 3 focused on the inherent pattern of grid blocks, investigating their creation mechanism and the related principles that directly influence block form, both at national and local level, with a case study in Beijing, China. Their possible effect on the subsequent transformation has been explained. The proposed methods and findings of this chapter build up the foundation for further analysis of the mechanism and dynamics of morphological diversification in Beijing in Chapter 4.

(1) Construction of grid blocks in Beijing covers a long-time span. The formation of gird blocks in Beijing was clarified by combining their time of initial construction, boundary defining, subdivision, and final pattern finished, with the five urban development stages in Beijing. Over 1/3 of the grid blocks within the 3rd Ring Road in Beijing were initially built in ancient times, but few patterns were inherited, which may be a significant factor giving Beijing an impression of "massive uprooting and demolition." Most of the blocks were initially constructed in Socialist planned period (1949-1982), but the relative rough urban sprawl resulted in much of the blocks being incomplete. The largest number of blocks were created during rapid urbanization and reconstruction in 1982-2003, and the trend has continued but declined in recent years.

(2) Uncertain order in block formation process increases possibility in form diversification. Six typologies of the block formation process were classified based on the order whether the boundary or the subdivision was first created. Grid blocks in Beijing were not constructed in a certain order or completely within a certain period of time. Their formation lasts a long time. As a consequence, elements of one block may comply with the principles of various phases, lacking of continuity and integrity. Also, the ambiguous order of the boundary defining and the inner space subdivision weakens the relation between the two elements.

(3) Urban planning principles at national level adopted insufficiency. Quantitative standards prefer guiding urban planning with the main aim of addressing realistic health and safety issues rather than physical shape and spatial perception. Although there were similar terms resembling "block" in the regulations, for a long time the physical meaning of "block" was not clear. Consequently, few principles contribute to quantitative control of block form. Until now, there have been only 5 standards that mention the quantitative metrics for block morphology and some indicators may be contradictory with each other. It has made the control of block form rather rough in the rapid urbanization.

(4) Urban planning principles at local level own discontinuity. They have changed substantially according to the various stages of urban development in Beijing. The change in regime and social structure, as well as the influence of foreign countries over the last hundred years, has directly contributed to a number of urban planning concepts. Principles were hardly to be inherited, and some of them contradict previous versions.

Chapter 4 Diversification of Inherent Grid Plan in Chinese Cities

——Transformation Process and Current Morphology of Grid Blocks in Beijing, China

Chapter 4 continued the analysis on grid blocks in Beijing, targeting at revealing their current conditions and transformation, and clarified how and why the grid block, as the inherent archetypal pattern, diversified in two layers: the primary block-boundary layer, and the detailed inner-space layer. Factors and dynamics were identified from the view of time dimension and spatial dimension.

(1) Grid blocks with high variety co-exist in limited liner-shape distribution in Beijing, showing an incredible sense of contrast. Current morphology of grid blocks was investigated from the view of geometric features. Five morphological clusters were classified based on 7 indicators: Block size(S), Building Intensity (FAR), Coverage (GSI), Network density (N), Block shape regularity(R), Plot shape regularity (Rp), Standard Deviation of plot size Sp (SDp).

(2) The diversification process in the block-boundary layer related to block size and shape regularity. Block boundary layer in Beijing shows large difference from the regular grid network in western cities. It adopts large size and lower regularity, which inherited the network from traditional Chinese grid. Block size related to urban planning principles' transition, while, block shape regularity corresponds more to its location in Beijing. Both indicators adopt large variation, reflecting the spatial contrast. Moreover, when the large size resulted in more diversification in the inner-space layer, smaller size correlated with higher density in inner-space layer especially in commercial areas.

(3) The diversification process in the inner-space layer, related to road network density, building density and subdivision pattern. The building intensity connected with road density following planning principles' transition, but has a rather reversed tendency with building compactness. Subdivision pattern strengthened the spatial contrast in block boundary layer, and the re-subdivision process stimulated the diversification inside blocks, because that the existing irregular inner pattern would increase complexity in spatial arrangement.

(4) Multiple factors and dynamics resulted in the diversification. In time dimension, the abovementioned attributes to three dynamics. First, less continuity and unstrict implementation of principles lead to variations generated in different periods. Second, no exact order of block formation and the large time span they covered during the formation process provide higher changeability of morphology. Finally, the irregular inner pattern of blocks, which can be considered as an inheritance from the inherent grid pattern, leaves complexity in spatial arrangement and future redevelopment. In spatial dimension, the co-existence of "time differences" in urban

construction; the lack of clear physical definition of block and contradictions in and between regulations; and the land use in large size from the ancient times, contribute to the diversification process.

Chapter 5 Localization of Imported Ring-radial Space in Chinese Cities

——Morphological and Functional Transformation of Ring-radial Spaces and Rotaries in Dalian and Changchun, China

Chapter 5 investigated the transformation process and current conditions of Ring-radial spaces and rotaries (RS&Rs) as representative imported pattern. It clarified how the RS&Rs localized with Chinese urban context and diversely developed in different cities, by comparative analysis between Dalian and Changchun, China. It provides a new viewpoint for further understanding the development of cities with RS&Rs, and lays the foundation for future research on RS&R renovation to create unique urban images. The conclusions drawn from this chapter are as follows:

(1) By investigating the urban planning timelines, street pattern characteristics, natural conditions, and social conditions, the initial reasons for implementing RS&Rs for urban planning is clarified. Although both considered cities are influenced by the Baroque City Plan, different natural conditions, city positioning, and the application of multiple modern urban planning theories have led to the original RS&Rs being landscape-oriented in Dalian, and monument-oriented in Changchun. Hence, the investigated cases in Dalian are randomly distributed, which produces a sense of romance, whereas the investigated cases in Changchun are more orderly arranged, according to the North-South orthogonal grid pattern, which produces sense of solemnity.

(2) The construction of RS&Rs can be considered as a clue for understanding the urban planning process from the perspective of both time and space. The RS&Rs correspond to the urban planning process and have typically been adopted by following new planning principles. Moreover, these constructions are not an outcome of a specific period, such as colonial times, but rather a continuous inherited planning icon. The location of RS&Rs mostly coincides with the urban sprawl areas in each stage, strengthens urban infrastructure, and reflects the features of different areas.

(3) Based on physical morphology, the RS&Rs were classified into six types: Centralized Type, Centralized with axis Type, Gird Type, Grid with diagonals Type, Pattern intersection Type, and Starting point Type. Based on the functional elements, four clusters were identified: Activity Cluster, Railway Cluster, Vehicle Cluster, and Multidimensional vehicle Cluster. Both cities have implemented the Grid Type and Patterns intersection Type at a higher ratio, owing to the flexibility of RS&Rs in activating the townscape and connecting street networks with different directions. However, in both cities, the transformation of RS&Rs lacks unity and identity inheritance, which manifests as the lack of connective relationships between the RS&Rs in Dalian, and as the disappearance of activities in Changchun. Moreover, both cities transformed with a loss of original building fabric around RS&Rs. It can be considered as a kind of localization with local requirements, but it can also be considered as a loss of

conceptual inheritance of imported pattern. Therefore, exploiting distinctive characteristics, emphasizing the inheritance of RS&Rs critically must be considered in future work.

Chapter 6 Mechanism of Urban Morphological Transformation in view of Diversification and Localization in Chinese Cities

Based on the analysis in Chapter 2, Chapter 3, Chapter 4 and Chapter 5, Chapter 6 redefined the "Diversification" and "Localization" in Chinese urban morphological transformation, as new perspective and framework for understanding the transformation process of Chinese cities. The mechanism of both processes was clarified. Then the generating conditions, characteristics and dynamics were clarified and compared. Hence, the significance and roles of the inherent pattern and imported pattern were examined and identified in Chinese urban morphological transformation, in order to guide the future urban planning and design. The conclusions are as follows:

(1) The transformation process of urban morphology in Chinese cities refers to double processes: the dynamic evolution of a single space of a specific urban element, and the collective tendency in the wider range like a district or a whole city. Urban structural elements in street/block scale can be treated as the concrete clue in reading urban morphological transformation process. Hence, a reading flow is proposed with four main steps: 1) Tracing back to the archetypal pattern and its cultural source, 2) investigating the transformation process from both time and spatial dimension, 3) clarifying the factors causing transformation, 4) proposing limitation and future issues.

(2) Diversification in transformation process of urban morphology refers to: the time differences of urban construction and the subsequent changes appeared after construction, in time dimension; and the simultaneous spatial distribution of "time difference" in urban construction, and the unexpected differentiation in similar construction periods, in spatial dimension.

(3) Localization in transformation process of urban morphology refers to a continuity in urban construction from the view of time dimension, and also a continuity in urban sprawl from the view of spatial dimension. It also includes the initial phase when the foreign pattern was introduced into Chinese urban context or specific Chinese cities, in spatial dimension; and the differentiation in form and functions in adapting local identities cities' updating requirements, in time dimension.

(4) Both the two process can be abstracted as a continuous evolution starting from simple and abstract archetypal pattern in time and spatial dimension They were triggered by internal and external forces but at different time with different proportions. For the diversification of inherent pattern, principles and social background alternation stimulated the procedure from "one" to "more", but the conceptual idea and configuration have been constantly inherited. For the localization of imported pattern, continuity in time and spatial sprawl is necessary, but there may be an uncertain tendency preferring specific types with vital changes in form and functions. The two processes are not independent or totally separated from each other. According to the different ranges or resolutions and different evolving phases, there is possibilities for them to transform into each other.

(5) The inherent block pattern and the imported street pattern in this research were treated as a concrete clue for understanding the transformation process of Chinese cities. The issues and conclusions can be referred by the other cities with similar patterns and background. For cities with traditional grid blocks, strategies need to be proposed hierarchically according to the positioning of block typologies, balancing the inherent spatial configuration and the newly emerging patterns. For cities originating from foreign urban forms, changes in physical form, functions and planning objective require critical examination, avoiding the complete separation between the previous and the new, but also prevent dogmatic inheritance. The patterns were examined in a quantitative and visualized way, from the view of urban form inheriting and transforming. It also helps to endow the “Indices-oriented” detailed plans with more social and cultural consideration, optimizing the connection between statutory planning and practical implementation in China.

7.2 Proposals Basing on Reading the Transformation Process of Urban Morphology in Major Chinese Cities

7.2.1 A Reading Approach from Diversification and Localization is Proposed in Understanding Chinese Urban Form Transformation

This research provides an in-between approach between understanding the intended planning and the natural evolution of a city. That is, after the new pattern was introduced in the history, how it naturally adapts to the new urban requirements and problems. Although a city can be planned intentionally with the pure forms, it will naturally emerge into diverse human settlements. This process is qualified positively in the process of enriching urban morphology in this research. It can also be understood from balancing the view of Modernism and Post-modernism theories about urban planning and urban design.

The reading approach first take urban structural elements in street/block scale, as the concrete clue in clarifying urban morphological transformation process. Second, it takes time dimension and spatial dimension as perspectives. Third, it takes cultural source and its archetypal pattern as prerequisite.

As a result, the Diversification of inherent pattern and Localization of imported pattern are identified as the two main process in Chinese urban form transformation. But the two processes are not independent and may coexist with each other. They may transform into each other, even in the same city, according to the different ranges or resolutions and different evolving phases.

7.2.2 Corresponding Proposals are Suggested to Cities with Similar Urban Patterns

(1) Constancy of Conceptual Inheritance in the Inherent Pattern, but Variability in the Imported Pattern

Urban form is not only a visual thing, it contains social and cultural meaning and citizens' psychological attachment as well. Apart from the primary concerns for the visual continuity, the research encouraged a wider concern with place-making and its contribution to urban identity. According to the analysis in Beijing, Dalian and Changchun, the inherent grid pattern shows stronger inheritance in conceptual features.

In China, the ancient grid block with dualism was compromised to the western homogeneous gridiron to a certain extent, resulting in diverse variations, but a conceptual inheritance is sustained. First, the hierarchical tradition has been maintained in the big contrast between the human-scale spontaneous space inside the blocks and the regular off-scale urban space outside the blocks. Second, the big contrast encouraged a semi-private and semi-public space, which can be considered as a local scale. It leads to the unique Chinese social system, emphasizing the neighborhood and community with local identity, which directly connect with residents' psychological attachment.

Conversely, during the inheritance of ring-radial spaces and rotaries in cities with colonial background, the imported pattern has localized following cities' development, but different from the conceptual inheritance in the inherent grid pattern, it only seems to be a visual continuity, with vital changes in forms, functions, surrounding building fabrics, as well as their interactive connections.

(2) Optimization of inherent pattern considering current requirements

There is the fact that conceptual inheritance in the inherent grid pattern is highly unchangeable, even though there are strong currents of encouraging smaller blocks and denser road network when considering traffic and walkability. Hence, balancing the inherent spatial configuration and the newly emerging patterns needs consideration. The optimization of current pattern rather than replacement by totally western gridiron network can be another method to solve the problems. The following factors need further consideration.

First, planning strategies and design guidance need to be based on the specific condition or typology of different blocks. From the hierarchy of public functions to private functions, it is inefficient to set up equal strategies for every block. The current conditions of each block can become its potential when targeting at suitable positioning in the city.

Second, urban planning principles require to be examined in an integral view. Current principles that mostly targeting at their own respective fields caused separation and contradiction between each other. Moreover, the continuity, clarity and accuracy need to be maintained in principle implementation, in order to avoid excessive fragmented development.

Third, the super block with spontaneous inner space has high potential in creating local identical space. Instead of imitating the western dense network, taking advantages of the spaces with contrast is more beneficial. Because it adopts natural advantages in avoiding monotone in urban spaces.

Finally, take use of the social system in creating physical form and spaces. Inherent grid blocks with dualism lead to the high value of community and neighborhood for local citizens. Hence, the combination of physical form and social administrative unit can be an efficient way in attracting residents' participation and endowed the physical space with more place-making consideration.

(3) Necessity for re-examining the guidance of future implementation of imported pattern

With the fact that visual continuity is more possibly inherited in the imported ring-radial spaces and rotaries, with a loss of original concepts and functions to a certain degree, it is the time to examine the future tendency for implementation. The following issues need further consideration, in order to avoid the complete separation between the previous and the new, as well as the dogmatic inheritance.

First, the necessity in sustaining original planning concepts and pattern require examination in different aspects. From the view of city identity, continuity and strengthening their implementation are beneficial in creating city image. However, it also need consideration from other aspects which may transcend the necessity of the

aforementioned, such as traffic and public space distribution. Hence, the degree of inheritance and the degree of transformation need to be balanced integrally.

Second, the localization process of imported pattern is a sustainable procedure. Although the import of foreign pattern is a result of specific historic periods, it has already become an identical urban planning element. Uniformity needs to be concerned all along with the localization process, to prevent the loss of city image consistency. However, current principles only pay attention to historic preservation of the original cases, lacking of the regulations guiding new implementation. Consequently, a lack of orientation in the recent construction became a common issue.

7.2.3 Effectiveness of Statutory Planning in Guiding Practical Implementation is Possibly Improved

Apart from the improvement in morphological reading and the benefits in solving specific issues in urban form which were mentioned above, this research also offers some important insights into the current urban planning system in China. As there is more functional consideration in the statutory plans, such as Detailed Plan, but more socio-cultural consideration in the non-statutory plans, such as Urban Design, gaps between the two procedures can be always found. Indices in Detailed Plans are not sufficient in controlling the subsequent designs in view of inheriting a city's cultural identity. Therefore, this research contributes to bringing the issues in current Urban Design and practical implementation, into the indices-leading Detailed Plans. The socio-cultural issues were described and visualized, which may modify the indices-making in Detailed Plans. As a result, it will be more effective in guiding the following non-compulsory plan & design, as well as the practical implementation.

7.3 Future Issues

This research provided new perspectives in reading transformation process of urban morphology in Chinese major cities, and clarified the mechanism of inherent pattern's diversification and imported patterns' localization. However, limited by the lack of detailed public map data in more microscope in Chinese cities, the research is conducted limited in the street/block pattern, with less consideration on the mutual influence with building patterns, which is also connected closely with urban morphology. In addition, based on the co-existence of government-led urban planning and the estate developers' autonomy in large scale land use, the balance and problems of different holders of management require further clarification. Therefore, the following issues should be addressed in future research.

(1) Influence between block pattern transformation and building patterns

According to the principles arranged in Chapter 3, urban planning principles in China regulate the microscope layout mainly in targeting at solving the functional problems on health and safety, such as fire prevention, earthquake, lighting, ventilation, transportation and sanitation. The figure-ground relationship in Chinese cities is distinctive. The relationship between buildings and block patterns are not as clear and close as western countries, where the block pattern limits the building construction tightly in height and street wall. Different combination of buildings and open space result in various block morphology, which directly affect human activities and perception. What's more, as a result of unprecedented urbanization, a rapid alternation of buildings appeared in Chinese cities. Hence, it is necessary and valuable in clarifying the influence between block pattern transformation and building patterns, in order to propose suitable guidelines for detailed construction.

(2) The roles, duties and responsibilities of state-led plans and the developers with autonomy

This research was mainly focused on the analysis on physical form of urban morphology. The analysis did get in touch with the urban planning principles to a certain extent, but there was a limitation in clarifying the influence of management system on creating urban form. Under the city plans by government, the roles of developers and grass-roots administrative units need to be identified and modified in a more accurate way. It is also an internal factor that may impact urban morphological process. It may also contribute to avoiding unexpected and negative patterns appear in creating pleasant urban space.

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