

Towards Diversified Street Life: The Social-spatial Research of Central Inner City's Mixed District, Nanjing c.1900s-2018

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Abstract

This paper explores the transition of street pattern in the mixed district of central inner-city, Nanjing, with a focus on the transitional mechanism and the local streets that provide high potentials for natural pedestrian movement, triggering diversified activities in urban dwellers' quotidian life. Based on a series of historical maps, the streets formed and developed in different periods have been analysed to reveal the mechanism. Space Syntax theory and method are then employed to examine the changing configuration of street network in the case study area over five historical periods. The analysis emphasizes the higher potential of local streets, compared with the main street, in advocating pedestrian movement, which is widely connected with citizens' domestic and commercial activities. The paper extends understandings of how street pattern, as one of the most important urban form elements, has interacted with citizens' socio-economic life over time.

Keyword: street network, pedestrian movement, space syntax, mixed district

Introduction

This paper investigates the transition of street network and its related pedestrian movement pattern in the mixed district of central inner-city, Nanjing since 1900s. As one of the most important historical cities located in the middle and lower Yangtze River with almost 2500-year history, the development of Nanjing city is based on the transitional street pattern, which combines mountains, waters, forests and urban artefacts together, interacting with the changing political, social and economic environment over time. The case study area is located in the central district of inner-city and the northern part of the southern old city (the oldest settlement in Nanjing called Lao-Cheng-Nan), of which the street pattern is highly organized. Most of urban dwellers living there are much prefer to pedestrian movement during the everyday life, especially when participating commercial activities (Figure 1). Compared with the newly-built districts, where the street networks have been gradually turned into sparse, this district has remained its role as one of the most vibrant and dynamic commercial areas inside the old city since early 20th century, with a stable street pattern in transition. This study examines the street pattern of the district that has been influence by the transitional mechanism and identifies the streets which have high potential in advocating pedestrian movement economy and social-spatial correlation in this mixed district over time.

Methodology

This investigation employs a mixed approach to study the transition of the district's street pattern in inner-city, Nanjing. Firstly, through analysis of urban morphology, two historical maps before 1900s, are used for the study of the earliest period, which have been compared with the latest (2018), combined with local chronicles, historical images, construction documents, to identify the streets formed from various periods with different changing forms. Through the quantitative analysis of the number and length of each type of streets, the transitional mechanism of street pattern can be revealed. As for the pedestrian movement, five historical aerial/ satellite maps, dating from between 1929 and 2018, are used for a local-scale space syntax analysis, to map the changing value of each street with both accessibility and permeability and explore the characteristics of streets with high value within the city's evolving street network.

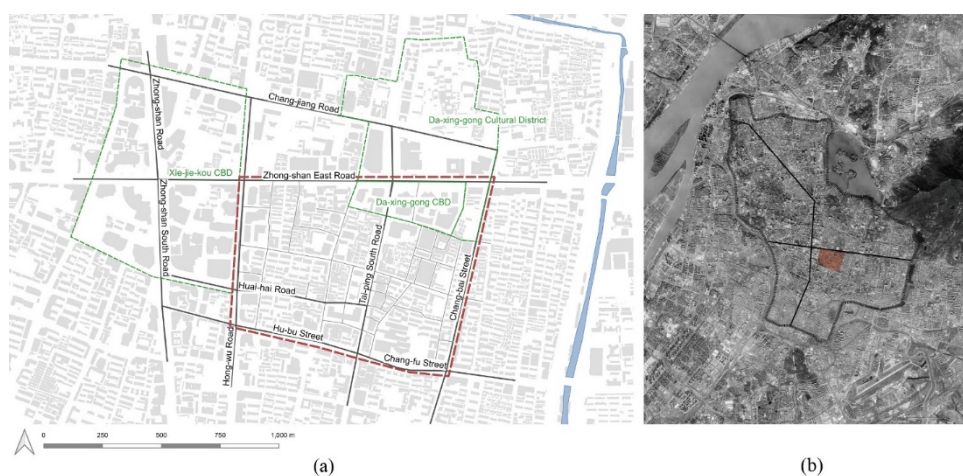


Figure 1. The location of case study area: (a) the main streets and districts inside and surround the district (b) the case study area located in the centre of inner-city

Transitional Street Network

With the evolution of street pattern in city-scale, the local street network of the Northern Tai-ping South Road District has been accordingly developed since 20th century, which forms a unique and interactive relationship with the overall system. The street map of the earliest time of 20th century has been drawn at first, following the principles of “cartographic redrawing” (Pinho and Oliveira, 2009), which can be compared with the latest one in 2018, so that the transitional process can be revealed initially. The earliest historical street map of Nanjing City that has been discovered is *the Complete Map of the Historical Sites in Jingling (the historical name of Nanjing) Provincial City*, which can be traced back to the 18th century in the mid Qing Dynasty. Without precise proportion, this map presents the city structure in an abstract way, with the name of each street, alley and bridge labelled in detail, and important public buildings shown in axonometric view, providing rich information for the research of early street pattern (Figure 2-a).

Based on the local chronicles that the street pattern of the inner city has remained stable from the mid till the end of Qing Dynasty, the historical information of Figure 2-a can be overlapped in the *Map of Jingling (Nanjing) Provincial City newly surveyed by Lu-Shi School (1903)*, which is the first city map of Nanjing

measured by modern survey and mapping technology with precise proportion (Figure 2–b). Through this overlapping, the basic street pattern of the district in early 1900s has been redrawn, which is the beginning of this comparative study. Then, re-overlap this map with the street map of 2018, through which the evolution of this district's street system over one hundred years can be initially presented (Figure 3-a). It is revealed that the street pattern and the historical names of each street in this district has been basically established before the early 20th century, which remains a high degree of stability and continuity during the one century transition, forming a strong contrast with the fiercely-changed built form.

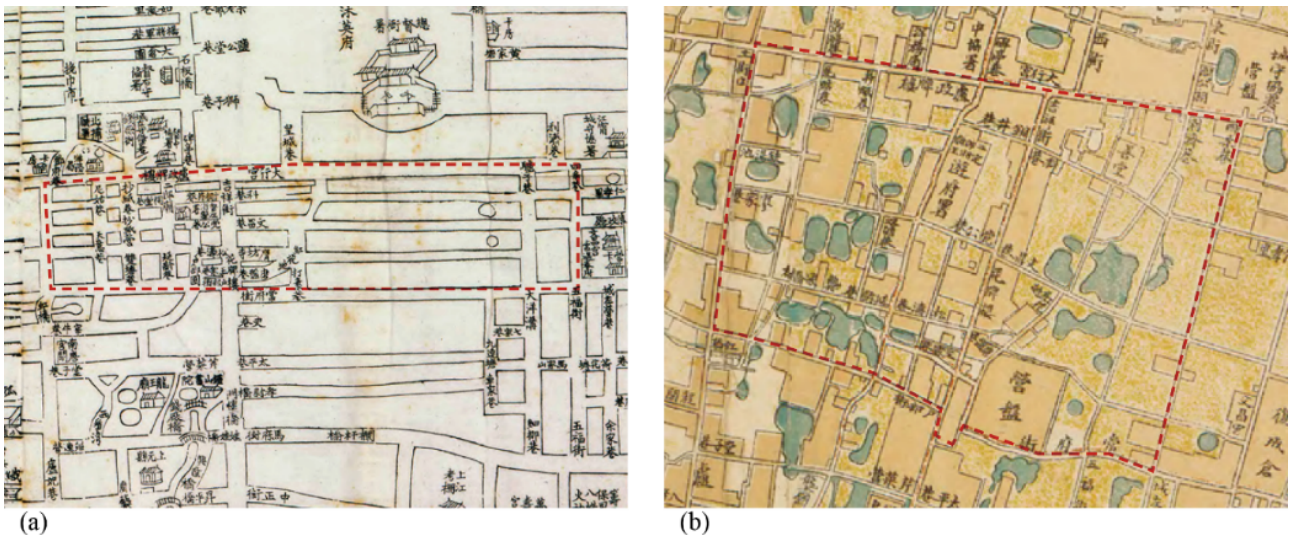


Figure 2. The historical street maps of Nanjing in the mid and late Qing Dynasty: (a) the Complete Map of the Historical Sites in Jingling (the historical name of Nanjing) Provincial City (1684-1722); (b) the Map of Jingling (Nanjing) Provincial City newly surveyed by Lu-Shi School (1903).



Figure 3. (a) The overlapped Street Map of 1903 and 2018; (b) The transitional types of streets, according to the forming/vanishing periods.

According to the forming and vanishing periods, these streets can be mainly divided into three types. The first one is the historical streets that have been already formed before 1900s and remain their alignments till

now; the second one is the newly-established streets during the 20th century and the last one is the historical streets that have formed before but gradually vanished during the urbanization process. In the light of the specific changes of both locations and historical names, the first type of streets can be subdivided into four categories, which have been labelled in the map with different degrees of black and blue: 1) Streets which remain their historical names in the original locations; 2) Streets with names changed in the original locations; 3) Streets which remain their historical names but change their original locations; 4) Streets that are formed through merging or splitting the original ones.

As for the streets constructed after 1990s, they have been classified based on the forming periods. Following the time passed from early to late, the red colour changes from deep to light. In addition, the streets gradually vanished have been presented in dotted line. These streets with varied forming periods and changing types have been spatially labelled in the Street Map of 2018, which reveals the diachronic transition in a synchronic way (Figure 3-b).

From Figure 3-b, the streets formed after 1900s are mainly located inside the original blocks, apart from Zhong-shan East Road and Chang-bai Street which have crossed several blocks following the top-down urban planning. During 1927-37, which is called "Nanjing Decade", the overall street system has been planned according to *the City Plan of Nanjing* and a series of main streets have been constructed in this period, of which Zhong-shan Road was established in 1928, to transport the coffin of Dr Sun Yat-sen (the Provisional First President of Republic of China), who has been buried in the Mausoleum of Dr Sun Yat-sen in 1929, located in Zi-jin Mountain, which is on the east side of the old city (Figure 4).

As for Chang-Bai Street, it has been a part of the inner-city railway line during 1907-58, which was welcomed by citizens as a convenient transportation tool for both people and goods (Figure 5). However, with the development of public transportation and the increasing trend of population since the establishment of People's Republic of China (1949), the previous railway line has seriously influenced the safety of people's everyday life through noise and air pollution. Therefore, it has been decided to move out of inner-city in 1958, where many buildings were added along the previous line by bottom-up constructions at first, which later has been changed into Chang-bai Street officially in 1982.

Apart from the two main streets, the local street network formed in the Bai-Cai-Yuan Block has undergone the transition of street pattern in different periods of 20th century. During 1927-37, with the West Bai-Cai-Yuan Residential Area constructed by private real estates and individuals from bottom-up, the two streets in north-south direction have been initially formed. Later, as the result of large-scale reformation projects in inner-city (1985-1994), a series of residential communities have been planned from top-down, of which East Bai-Cai-Yuan Area was finished in 1990. It forms a unique micro-scale street network inside the eastern side of the block, with the previous function of market and housing combined through both vertical and horizontal spatial arrangement, which remains as one of the most vibrant places in the old city of Nanjing (Figure 6).

With the number and length of streets formed in different periods calculated, it can be seen from the chart (Figure 7) that the streets formed before 1900s constitute the largest number of streets with longest length in total, compared with which, although the number of streets constructed after 1900s accounted for 39%, which is not far from the ones built before 1900s (47%), their total length is 31% less than latter. It is worth noting that the streets formed before 1900s are mostly main streets with longer length which constitute the stable structure of this area, while the streets formed later are used to be local streets inside the district with shorter length (apart from Zhong-shan East Road and Chang-bai Road), forming micro-scale street networks.

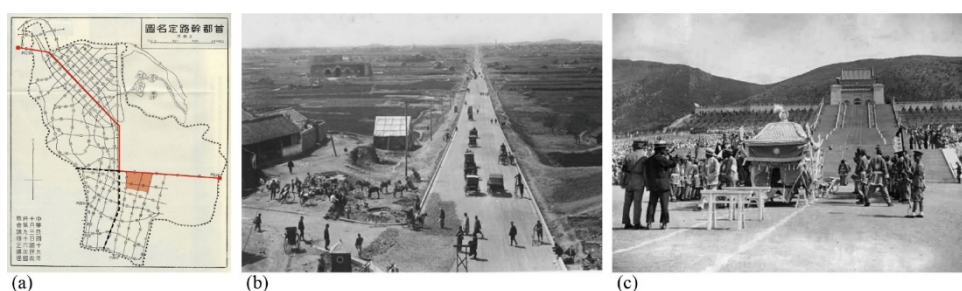


Figure 4. Zhong-shan Road built in Nanjing Decade (1927-37): (a) the Main Streets' Named Map in the City Plan of Nanjing, the red line is Zhong-shan Road; (b) the construction site of Zhong-shan Road in 1928; (c) the Grand Funeral of Sun Yat-sen in 1929.

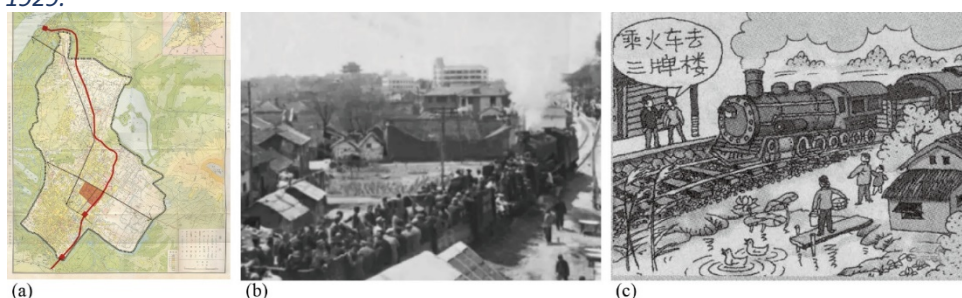


Figure 5. Chang-bai Street which used to be a railway line in 1907-58: (a) the Street Map of 1946s, the red line is the railway; (b) the train fully loaded with passengers in inner-city area; (c) a comic drawn by a local citizen, based on his childhood memory in 1950s.

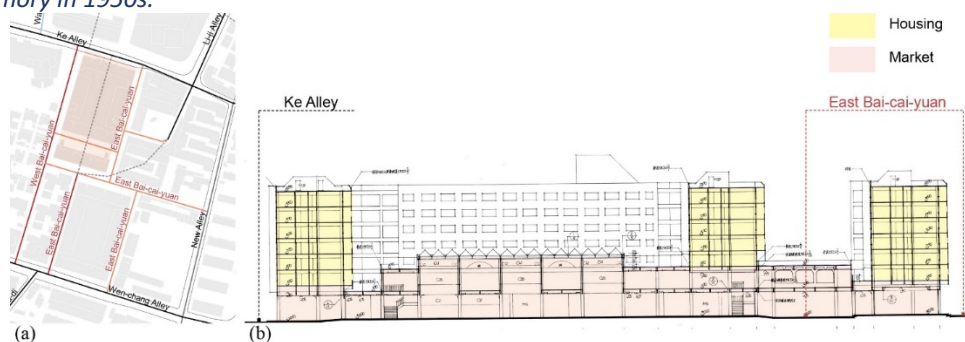


Figure 6. East Bai-cai-yuan Streets, mainly built during the reformation project of inner-city (1985-94): (a) the local street network inside East Bai-cai-yuan residential area; (b) a housing complex inside the area, combing streets, markets and housing in one system as whole.

As for the forming mechanism, most of the streets formed before 1900s remain their historical names in the original locations or merge/split streets along the previous alignments, mainly because since early 20th century, the significance of both historical streets and their names in inner-city of Nanjing have been strengthened in each up-down urban planning and policy. For streets formed after 1900s, it is the top-down planning and the bottom-up construction together, influenced by the fiercely-changed political, social,

economic etc. urban environment during the over 100-year period, that precipitate the shifting pattern of these streets, most of which were initially built in Nanjing Decades (1927-37) and Inner-city Reformation Period (1985-94). It could be argued that the stable configuration of historical streets with local stories and memories remained through historical names, and the newly-developed streets influenced by both directions from 1900s till now, together constitute the unique transition of the street pattern with high value of diversity in this district.

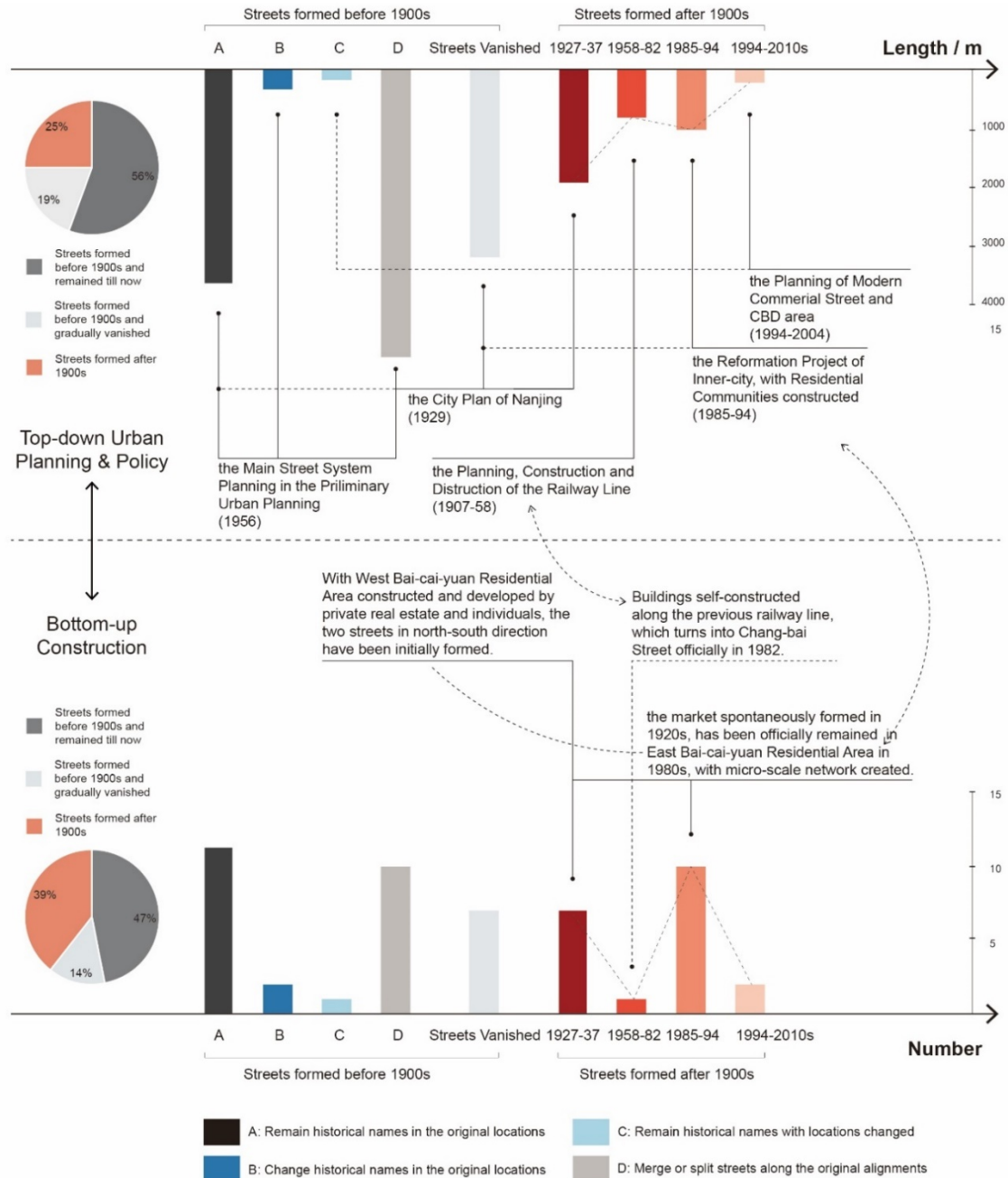


Figure 7. The transitional mechanism of streets pattern based on the number and length of each types of streets.

Transitional Pedestrian Movement Pattern

Based on the analysis of transitional mechanism of street network in this district, this section examines the specific evolution of the pedestrian movement pattern over five periods, taken space syntax theory and

method as the main approach. In order to avoid the edge effect (Dhanani and Vaughan, 2013), a comfort zone should be set outside of the research area, with the boundary naturally set by Qin-huai River and Wu-tai Mountain inside the inner city of Nanjing (Figure 8).

For this analysis, the segment maps of street network were drawn on ArcGIS mainly based on the historical maps of the city from 1929, 1946, 1975, 2004 and 2018, of which the satellite and aerial maps are the most precise ones with complete information recorded. The syntactical angular measure of the *combined integration and choice* has been used here to present both the *accessibility* and *permeability* of the street layout for the radius 400 meters, which is a comfortable walking distance for local pedestrian movement (Thai, Stevens and Rogers, 2020).



Figure 8. The research area and the boundaries of studied street segment map.

From Figure 9, streets inside the case study area have gradually gained larger proportion of warm colour from 1929 to 2018, which means the street system inside the district has shown an increasing spatial correlation within the overall street network. From the map of 1929 (Figure 9-a), the street along which self-constructed commercial houses were built has shown the strongest relation, together with Ke Alley, Li-ji Alley and the Railway line, when the train has worked as one of the important transportations in the inner-city. Later in 1946 (Figure 9-b), with the railway line gradually dismissed after the second world war, the cultivated land in surroundings has been further divided, forming a local narrow street network with high accessibility.

During 1950s, the Tai-ping North Road has been wholly opened, which connect Tai-ping South Road in the south directly, forming a much stronger spatial relation than before. Meanwhile, with the railway line officially abandoned in 1956 and the local street network gradually encrypted, the area with high value of both accessibility and permeability has been moved into the central area of the district, seen from the map of 1975. Besides Tai-ping South Road, which worked as one of the most important commercial streets in Nanjing City, Yan-ling Street, East Bai-Cai-Yuan, Ke Alley, You-fu West Street, Wen-chang Alley, Hong-hua-Di and Yang-gong-jing have shown higher correlation within the street network in 1975, most of which have remained till 2018 (apart from Yang-gong-jing, which has shown lower value in the map of 2004 and 2018). As the result of the reformation project of inner city since 1985, the newly-built residential communities

developed by different *Danwei* and local real estate companies together have merged the previous small plots along streets and changed the overall street network into sparse, only with some local network encrypted, such as the East Bai-cai-yuan area. It is worth noting that Wu-lao-cun Street, as the eastern boundary of Bai-Cai-Yuan area, has been changed into warm colour since the residential area finished in 1991, seen from Figure 9 - d, e.

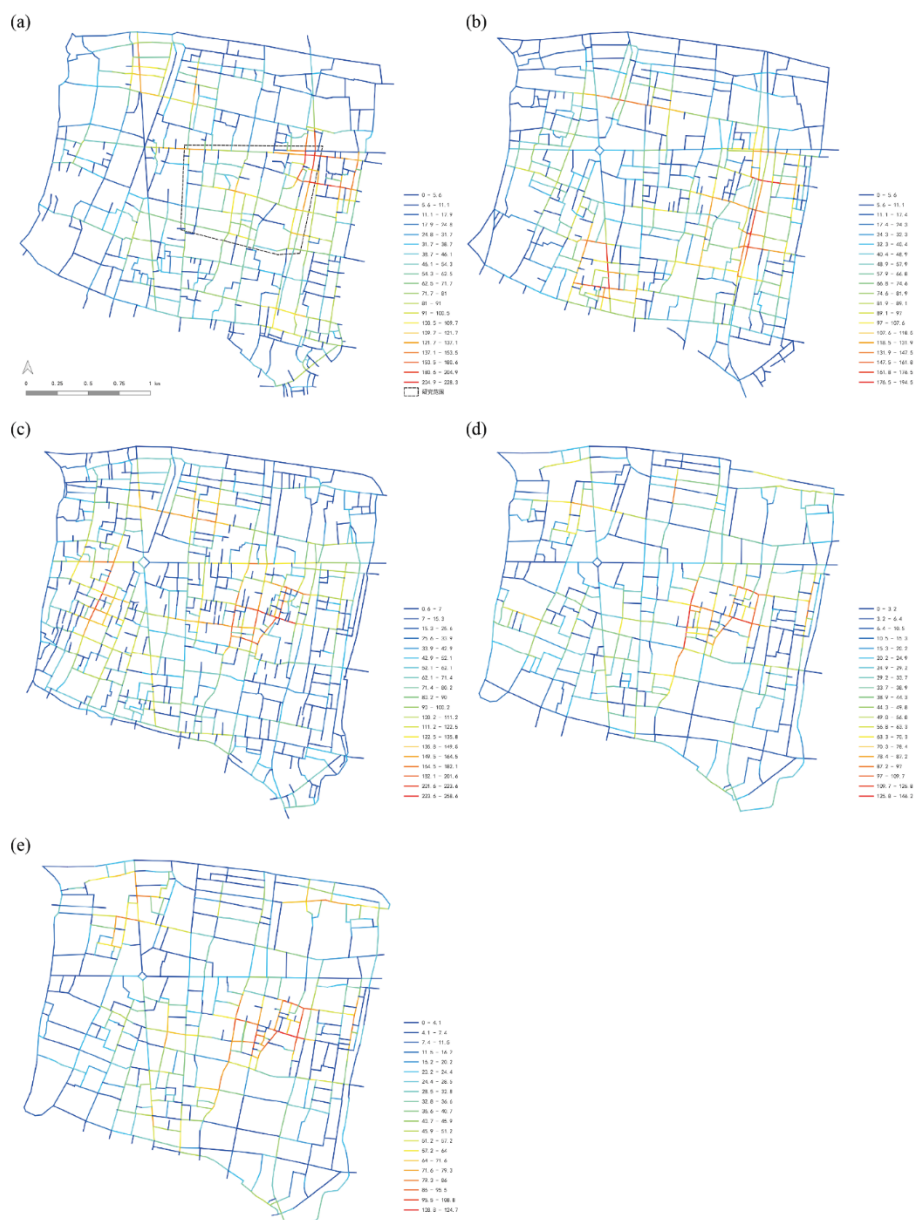


Figure 9. The transitional street network, showing segment angular analysis for the measure of combined integration and choice, for radius 400m: (a) 1929; (b) 1946; (c) 1975; (d) 2004; (e) 2018.

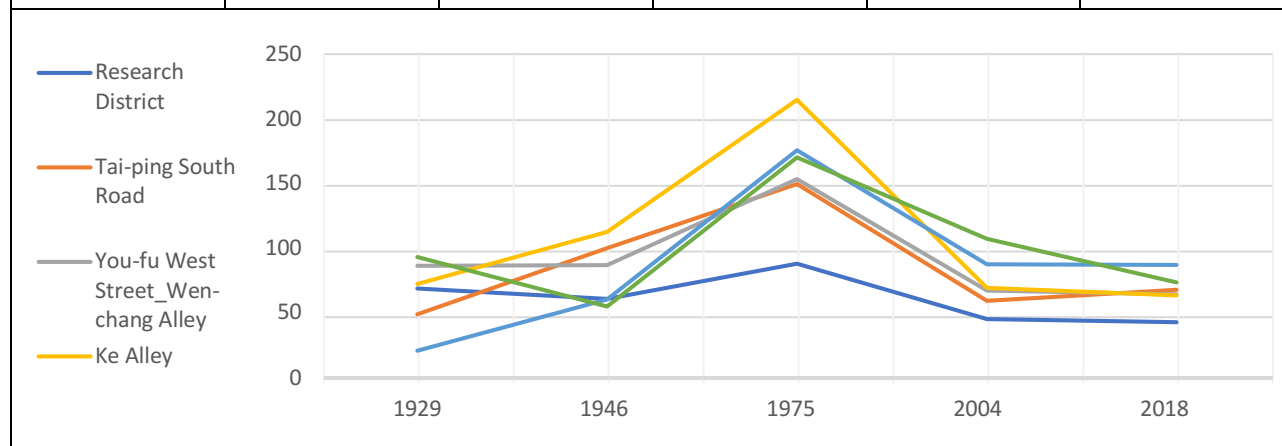
To compare the changing spatial correlation of each street precisely, the total length of each street segment has been weighted to measure the value of each street, among which the streets with mostly-remained high value have been chosen to identify the historical significance of these streets for the case study area in pedestrian movement (Table 1). It can be noticed that in 1929 and 1946, there are three streets of which the values are higher than the case study area, while Hong-hua-di and Yan-ling Alley are closely reaching it in

1946. Later in 1975, 2004, 2018, all the five streets' values have been higher than the study area and the streets in 1975 are in the strongest spatial correlation with others which then gradually weaken till 2018. Among the streets with highest value in each period, Yan-ling Alley has been the highest one in 1929 and 2004; Ke Alley has the strongest configuration with others in 1946 and 1975; and Hong-hua-di is the highest one in 2018.

As for Tai-ping South Road, one of the crucial commercial streets in this area since 1900s, it is worth noting that its value has been higher than the area since 1946, while remains lower than other four streets mostly across time. According to the land use maps, these four streets with higher value were usually aligned with diversified land uses including housing, commerce, public space, production etc. over various periods, while Tai-ping South Road remains as the street with single land use distributed, mainly based on commerce. Therefore, it can be estimated that the streets with higher value in pedestrian movement have much more potential in advocating citizens' dynamic activities, widely connected with their domestic and commercial life. Tai-ping South Road, which has been planned from top-down as the main street in city-scale, has been mainly worked for horses and vehicles in various periods, forming less spatial correlation in walking distance, compared with the walkable local streets. It could be argued that it is these local streets that constitute the high quality of pedestrian movement pattern and precipitate the diversity of socio-economic activities in this district from 1900s to 2010s.

Table 1. Table showing the combined measure of the case study area and streets with high value in pedestrian movement (weighted in street length)

CH_IN_R400	1929	1946	1975	2004	2018
Case Study Area	69.34	61.39	88.23	46.34	43.78
Tai-ping South Road	50.75	100.94	149.72	61.17	69.24
You-fu West Street _ Wen-chang Alley	87.48	88.27	153.54	68.96	66.00
Ke Alley	74.75	114.30	214.72	71.90	66.14
Hong-hua-di	23.48	62.32	175.77	89.30	88.48
Yan-ling Alley	94.79	57.00	170.28	108.53	75.23



Conclusions

This paper has analysed the evolution of street network and accordingly pedestrian movement pattern in the mixed district of central inner-city, Nanjing since 1900s. Employing historical maps, it reveals that based on the stable continuity of historical street network and names, it is the top-down planning and bottom-up construction together that contribute to the transition of the diversified street pattern over time. Taken Space Syntax theory and method as approach, it presented the changing overall configuration of the district, which has influenced the distribution of pedestrian movement. Apart from the main streets, which are used to be the main “pools” of economic opportunity (Hiller *et al.*, 1993), it highlights the significance of normal streets, widely connected with diversified land uses, especially housing, in the walking movement, which has high potential in advocating movement economy and social-spatial quotidian correlation inside the inner-city area. The paper has limitations, due to the accuracy of historical maps and the deviation of the cartographic redrawn, but it provides new possibilities to understand urban transformations through street pattern transition. And it emphasizes the importance of the streets that are not main streets in city-scale and often overlooked by public, however, strongly related with residents’ domestic and commercial activities in pedestrian movement, which provides new perspective for the next term of Chinese urban transformation.

Acknowledgements

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