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Spatial Assessment of Supply-Side Structural Reform in Super-Large Communities—A Case Study of Tiantongyuan, Beijing

Yijie Ju

University of Nottingham, NG7 2RD, Nottingham, UK

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Abstract: This paper takes 'Beijing Tiantongyuan', a super-large community, as the research object, focusing on two government-led policies for the renovation of human settlements under the supply-side structural reform. It examines the effectiveness of the optimization of the community's spatial layout through spatial mapping analysis and interview methods, with emphasis on evaluating the effects of such dimensions as spatial structure adjustment, supply of public service facilities, and optimization of the transportation system, as well as the residents' perception of environmental improve and demand matching degree. The results show that the reform has made certain progress in reducing the mismatch of spatial resources and improving the accessibility. However, deeper issues such as the separation of workplaces and residences, and weak linkage remain to be addressed. At the same time, challenges persist due to fundamental contradictions in community development and complex interrelated constraint mechanisms.

1. Introduction

As a systemic national strategy to promote high-quality economic and social development, the supply-side structural reform launched in 2015 has influenced urban spatial production and the transformation of public service supply. The core of reform in the field of human settlements lies in optimizing resource allocation, improving efficiency, and meeting residents' demands for quality living. However, as China's urbanization rate continues to rise and the population keeps gathering in megacities and super-large cities[1], structural contradictions in the urban human settlements system have become increasingly prominent: temporal and spatial mismatch between infrastructure and population growth, imbalance between traffic carrying capacity and travel demand, intensified heterogeneity in public space allocation, and disharmony between environmental capacity and population density. These issues not only restrict residents' sense of happiness but also have become key bottlenecks for sustainable urban development.

Due to large-scale development amid rapid urbanization, Beijing Tiantongyuan Community has defects in the planning of infrastructure and public services, and these contradictions have become more obvious with development. Thus, it serves as an ideal case for studying the evolution law of human settlements in super-large communities. This study combines spatial analysis and interview methods to explore the coupled relationship of human settlement elements and the interaction among

governance subjects. It aims to provide practical references for adjusting spatial strategies in the supply-side reform of human settlements in super-large communities and offer insights for solving spatial governance problems in similar communities.

2. Theoretical Basis and Evaluation Framework

2.1. Clarification of Concepts

2.1.1. Supply-Side Structural Reform

Supply-side structural reform refers to a reform model that, in the process of economic development, addresses medium- and long-term economic issues, achieves long-term high-quality economic growth, and activates the vitality of markets and urban spaces by optimizing the supply structure through means such as promoting innovation, advancing industrial upgrading, and improving efficiency.

As China's urbanization drive enters the middle and late stages, although demand-side management in the past has significantly driven economic growth, its inherent nature of 'prioritizing total volume expansion over structural optimization' and 'prioritizing short-term growth over long-term sustainability' has brought about side effects such as 'rapid growth in quantity but low quality' of economic growth and weak risk resistance. Against this background, the supply-side structural reform was proposed in 2015, and the focus of urban development has shifted from demand-side reform to supply-side structural reform.

In the field of urban planning and development, supply-side structural reform is reflected in the shift of spatial development from 'incremental expansion' to 'inventory potential tapping'. Strict control over new land use has forced the renovation of old areas and the redevelopment of inefficient land, forming a policy system of 'controlling increments, optimizing inventories, and improving quality'. Specifically, it is carried out from five aspects: optimizing spatial structure, making up for the shortcomings of public services, improving the efficiency of infrastructure, strengthening ecological protection, and promoting regional coordination.

Tiantongyuan has ushered in reform opportunities under the background of supply-side reform. In 2018, the Beijing Municipal Government issued a community renewal action plan, involving measures in education, health care for the elderly and other fields; from 2021 to 2025, it issued an in-depth promotion plan, putting forward the content of deepening regional improvement.

2.1.2. Human Settlements

Regarding Human settlements science, as a comprehensive discipline closely related to human survival and development, it not only occupies an important position in the field of academic research but also influences people's daily life practices. It takes human settlement environments as its research object and integrates theories and methods from multiple disciplines such as architecture, urban planning, ecology, sociology, and economics. Its aim is to reveal the laws of coordinated development between humans and their living environments, and its research value covers multiple dimensions including the improvement of human living quality, the promotion of social sustainable development, and the maintenance of ecological balance.

In academic research, it is necessary to distinguish between 'human settlements' and 'human settlement space', and the two have an inclusive relationship. Human settlement space refers to objective physical carriers such as residences and communities; human settlements, on the other hand, cover subjective experiences such as a sense of belonging and a sense of security as well as emotional connections on this basis, and are an organic whole formed by the interaction of spatial and

humanistic elements. The core difference between the two lies in the distinction between 'objective physical existence' and 'a comprehensive system combining subjectivity and objectivity'.

2.2. Evaluation Framework

2.2.1. Evaluation Model

Unlike current research on public spaces, research on community spatial quality has not yet formed a complete evaluation system or indicators. In the field of urban public space quality assessment, PPS provides a spatial quality assessment index system, which constructs an assessment and construction framework for high-quality public spaces from four dimensions: SOCIABILITY (including friendliness and interaction, which fosters interpersonal connections through a sense of community, etc.), USES & ACTIVITIES (emphasizing diverse functions, which activates value through retail, etc.), COMFORT & IMAGE (focusing on environmental quality, which shapes attractiveness through crime statistics, etc.), and ACCESS & LINKAGES (paying attention to traffic connectivity, which ensures accessibility based on traffic data, etc.)[2].

In Public Places Urban Spaces[3], the author proposes six dimensions for evaluating public space quality, namely the perceptual dimension (PERCEPTUAL, focusing on human perceptual experience), social dimension (SOCIAL, involving social attributes and interactions among people), visual dimension (VISUAL, centering on visual presentation and landscapes), functional dimension (FUNCTIONAL, emphasizing spatial functional layout), temporal dimension (TEMPORAL, considering changes over time and usage periods), and morphological dimension (MORPHOLOGICAL, relating to spatial morphological structure).

However, the value of different indicators varies and has different priorities due to human preferences in different geographical locations and periods. Previous indicators, due to differences in human preferences across regions and periods, as well as variations in social and research backgrounds, although applicable to public space research in Europe and America, do not focus on the quality of life in urban human settlement spaces and are not in line with the situation of large-scale communities in China, thus cannot be directly applied.

2.2.2. Indicator Construction

Based on the universal value orientation of Chinese residents and the in-depth cultural orientation in the Chinese social context, and with reference to the four indicators for assessing places proposed by PPS as well as the six indicators for urban spaces and public places, different indicators have been screened, and the following four evaluation indicators are finally established:

Indicator 1: Public Services. Communities undertake more public service functions to meet residents' diversified needs, which have a significant positive impact on residents' subjective life satisfaction and sense of gain[4]. Traditional content includes basic community public security, basic living facilities, community cultural and sports services, and people-benefiting services, etc. These directly affect residents' living costs and quality, serving as an important factor in maintaining living conditions and one of the considerations for measuring real estate value when purchasing property.

Indicator 2: Functionality. Human settlement spaces include activities such as human habitation, work, education and health, and cultural and entertainment, as well as physical structures that support these activities[5]. This indicator examines residents' needs for their environment, involving the operation of community functions and the improvement of community livability by meeting residents' needs for various activities. Demographic characteristics (such as gender and age) can affect the choice of value priorities[6], and different individuals have different needs for functional spaces such as education, work, medical care, and public areas.

Indicator 3: Linkage. The linkage indicator includes spatial relevance and interpersonal relevance. From spatial relevance, urban functional zoning improves the operational efficiency of cities, but it may lead to the compression of citizens' living spaces, the loss of vitality in communities, and the waste of urban resources[7]. In terms of interpersonal linkage, place identity and emotional attachment affect personal well-being and the development of community cohesion[8].

Indicator 4: Readability. Current urban development is facing the homogeneous dilemma of 'thousands of cities looking the same' and is in urgent need of building a new relatively overall order to realize the organic integration of traditional urban texture and modern urban needs, so that cities can not only carry forward national traditional genes but also highlight the spirit of the times and regional characteristics[9]. Within the framework of 'genius loci' (spirit of place)[10], enabling the form, material, and space of architecture to form a 'meaningful resonance' with people, the environment, and history is the underlying logic for building an overall urban order. Focusing on the aesthetic quality of community space configuration, relevant evaluation indicators can reflect the aesthetic quality of community space, as well as the status of the urban environment in terms of readability, imagery, way finding, and other aspects.

3. Case Background and Research Design

3.1. Development History of Tiantongyuan Community

Tiantongyuan Community is a typical example of super-large residential communities in China. It originated in the late 1990s during the period of housing system reform. Its actual population far exceeds the planned figure and international livability standards, showing the characteristics of high density and a large and diverse population structure.

Tiantongyuan was built in 1999. It is a large-scale community constructed by Shuntongtian Real Estate Development Group in accordance with national planning and also one of the first batch of key affordable housing projects in Beijing. With a planned area of approximately 770 hectares and a construction land area of 423 hectares[11]. The community adopts a grid layout, which was influenced by the Soviet Union and shows a strong sense of order[12].

The human settlement issues in Tiantongyuan are prominent. In 2018, the Beijing Municipal Government issued a relevant three-year action plan to promote community renewal in aspects such as education, health care for the elderly, culture and sports, living services, living environment, transportation, employment and entrepreneurship, and municipal facilities. In 2021, a new action plan was issued, proposing to build a spatial pattern of 'one axis, one belt and two corridors' and further deepen and improve public services, transportation, environment, and industries. Some of these measures have achieved results, but others have not achieved good results because they failed to accurately address residents' core needs and daily life pain points, leaving room for further optimization.

3.2. Research Design

This study adopts spatial mapping analysis (by analyzing bird's-eye views of selected blocks) and interview survey methods, and combines the information collected from community forums to study the quality of the community's human settlements based on the four selected indicators.

3.2.1. Spatial Analysis

'Reading the City from the Air' refers to overlooking the city from an aerial perspective, systematically observing and analyzing elements such as natural landforms, road networks, building

layouts, as well as landforms, structures, and boundaries, so as to construct a typological framework[13]. It reveals the characteristics of urban spatial structure and form, providing a basis for planning optimization and other purposes. With 'Reading the City from the Air' as the core method, this study grasps the spatial texture inside and outside the community (including building layouts, public areas, and surrounding road networks) by analyzing the 2D bird's-eye view map of Tiantongyuan. It evaluates the rationality of functional and public service indicators in combination with literature and practical experience, and conducts on-site verification to avoid information omissions. For the evaluation of spatial linkage, it monitors the passenger flow at major transportation stations around the community during morning and evening peak hours on weekdays and weekends, and conducts on-site visits to nearby functional spaces to clarify their usage status and spatial relationships.

3.2.2. Interview

The interview method uses interviews as the core data collection tool, and it is a research method that tracks and interprets from multiple perspectives such as the interviewee’s tone, facial expressions, and hesitation to explore their true attitudes[14].

The interviewees in this study are 40 residents selected from different locations in Tiantongyuan Community: 10 middle-aged and young male residents, 10 middle-aged and young female residents, 10 elderly male residents, and 10 elderly female residents, with interview codes Q1-Q40.

The study proceeds with logical questions and hypotheses, conducting semi-structured interviews with the above-mentioned interviewees in outdoor community venues.

It collects community data based on the four selected indicators, and at the same time uses open-ended questions to guide residents to express their feelings about the community’s human settlements, expected improvement directions, the community’s strengths and weaknesses, and other related issues.

4. Effectiveness Evaluation

4.1. Community Public Services

The community has adopted comprehensive measures in terms of safety assurance and emergency response: Each residential sub-district has set up gate posts with rotating guards to raise the access threshold for non-residents. Combined with evenly distributed property service points and volunteer teams, a regular response mechanism has been formed to quickly handle emergencies. In severe weather, property staff and volunteers work together to provide protection, effectively reducing accidents and losses, which reflects the effectiveness of the traditional 'defensive guarantee' model.

The independent website forum built by the community serves as a digital governance platform, which has reduced the cost for residents to express their needs and obtain information. It breaks through time and space constraints to achieve efficient communication, and some constructive suggestions have been quickly addressed after being forwarded, promoting the upgrading of the governance paradigm. However, during interviews to understand community management, 60% of the interviewees failed to participate due to 'inability to use' or 'unawareness' (95% of elderly residents, Q01-Q19; 30% of middle-aged and young residents, Q22, Q28, Q31, Q36-Q37, Q40). This exposes the neglect of the needs of different groups in digital governance, reflecting the disconnection between tool innovation and humanistic care, as well as the lack of balance between 'universality' and 'precision' in services.

The interviewed residents generally recognized the community’s continuous renovations in multiple fields. Although some renovations had limited effects due to space constraints, residents felt

that their needs and feelings were valued. Overall, community governance features the coexistence of traditional models and digital upgrading. However, there are shortcomings in coordination and inclusiveness between the two, which need further optimization to bridge group differences and improve efficiency.

4.2. Coverage of Functional Resources

As mentioned earlier, demographic characteristics directly affect the priority selection of community functional values: middle-aged and young groups pay more attention to education and employment functions, while elderly groups value a comfortable living environment more.

The community has responded to some basic needs through two policy-driven renovations resource supplementation, but there is still a gap in meeting deep-seated needs. Information from community forums shows that parents' demands for educational resources focus on the facilities for the higher education stage have not yet been satisfied, office spaces or innovative industrial spaces are significantly insufficient—this may lead to jobs-housing separation.

Leisure functions, with land allocation mainly targeting elderly residents, are obviously insufficient: the community has only one green space park on the east side, residents on the west side are forced to rely on secondary spaces within their sub-districts to meet their needs. There have been concentrated suggestions on the forum such as 'adding ecological green spaces on the west'. More prominently, elderly residents use public seats on the sidewalks at sub-district entrances as a 'strategic substitute' to meet their leisure needs. Interviews also show that there is a significant fragmentation issue in public spaces: a young female interviewee (Q38) stated that more than 80% of her leisure trips depend on spaces outside the community, such as driving 10 kilometers to Olympic Forest Park to meet her need for public green spaces, or going to downtown business districts to satisfy her shopping needs.

Such dependence on external spaces in the community is not only reflected in leisure scenarios, but also exacerbated by limitations in the commercial field. Although the community is within the radiation range of a shopping center, the shopping center has almost a monopoly, resulting in very limited choices for residents' offline consumption, which further strengthens the characteristic of 'community function spillover'.

4.3. Spatial and Neighborhood Linkage

Due to its remote location, residents of this community rely on public transport and private cars for travel on non-working days. It takes about 45 minutes to drive to the surrounding commercial space and over 90 minutes by public transport. Weak functional space integration increases residents' burden and urban transport pressure. Currently, the community has 4 subway stations and 51 bus stops, with 2 subway lines and 50 bus routes providing services. A comparison shows that Line 5's starting station "Tiantongyuan North Station" is the largest and most frequently used: passenger flow peaks during weekday morning and evening rushes (a train every two minutes), while weekend morning rush entries drop. This passenger flow difference reflects local job-housing separation and functional singularity. Over 90% of interviewed middle-aged and young residents cite prominent transportation issues, such as long commutes, difficulty getting shared transport in morning rush, and distance from popular commercial areas.

From the 'Neighborhood Linkage' aspect, there are obvious differences in the survey results between the middle-aged and young group to the elderly group. As to community collective activities, the community organizes relevant activities,, but 95% of middle-aged and young residents do not participate because 'no one invited, don't know how to participate', 'not interested' or have no time (Q21-Q31, Q33-Q40). This low participation is also reflected in neighborhood relations. 'I don't see

my roommates, and I don’t know any of my neighbors' — a young female interviewee said (Q40) , indicating that the community cohesion is relatively weak, the sense of belonging and security of the middle-aged and young group is generally at a medium level. Moreover, the differences between the two groups are more prominent as for friendships within the community and interaction frequency: 85% of the elderly know people in the community and often walk together or participate in other activities (Q01-Q09, Q11-Q15, Q17, Q19-Q20); 15% of young people said they know people in the community but basically never travel with them (Q25, Q31, Q38).

4.4. Spatial Image System

The problem of homogenization in community spaces is significant. Different residential complexes within the community use coatings with high color similarity to paint the exterior facades of residential buildings. The form and building height are uniformly standardized. Such regularized residential buildings result in a monotonous spatial form, with a lack of contrast and variation in spatial texture and scale. It fails to fulfill the macro-level role of space in the dissemination of community and urban culture, as well as in enhancing regional cultural cohesion.

On the micro-level, visually, the uniform exterior facades, forms, and heights erase positioning symbols, making it difficult for people to distinguish between buildings based on their appearance. The uniform texture and scale disrupt cognitive habits, preventing people from positioning themselves in space using distinctive features. Emotionally, the absence of exclusive symbols deprives the space of emotional attachment points, making it hard for residents to develop a 'sense of exclusivity' toward the space. The disappearance of boundary signals blurs the distinction between the inside and outside, undermining the sense of control and belonging to the domain. This eliminates the uniqueness of the space and the carrier of emotional connection. Therefore, such homogenization leads to a lack of recognizability and a sense of territory.

In addition, there is no supplementary way finding system within the residential complexes. There are no eye-catching signboards, distinctive landmarks, or other elements to provide additional visual positioning clues, nor is there any guidance design that integrates spatial characteristics (such as exclusive logos at building entrances). As a result, the identification difficulties caused by homogenization cannot be effectively alleviated. A young female respondent stated (Q38): "These buildings all look too similar. Now the name of the community has also been changed. For example, the community I live in used to be called 'South Zone' and was renamed 'Third Zone'. I already have poor direction recognition ability, and it’s even harder for me to distinguish directions now. So I only move around within our own community complex."

5. Conclusion

5.1. Research Findings

From the perspective of spatial allocation, the housing-job mismatch is a result of the unbalanced dual distribution of spatial resources between residential and industrial spaces, rather than a simple issue of geographical distance. The insufficiency of leisure spaces such as public spaces further exacerbates the compression of living space, forming an alienated situation where 'residential space is saturated while living service space is scarce'. At the governance level, the breakdown of the coordination mechanism among spatial planning, industrial cultivation, and population structure, the failure to implement policies to stimulate local employment, and the lagging of supporting industries in the surrounding areas have led to a mismatch between employment positions and the scale of resident population. This forces residents to commute over long distances, which not only generates social costs but also squeezes the time for social activities, solidifying a life pattern centered on

commuting and work. Such solidification stems from the mandatory shaping of urban spatial structure—i.e., the individual rational choices where families choose suburban housing and enterprises gather in core areas. When these choices are superimposed on a large scale, they result in systematic jobs-housing separation, which has become a typical 'fallacy of composition' and caused a loss in collective quality of life. Behind this lies the 'emphasis on scale expansion over functional coordination' path dependence of super-large communities. The extensive urban expansion absorbs population but ignores the spatial matching of residence, employment, and services, making the separation of housing and employment self-reinforced due to 'similar individual choices' and entrenched as a structural dilemma. The main reason for poor readability is that excessive emphasis was placed on rigid architectural indicators in the early stage, while regional culture and differences in people's needs were ignored.

Currently, Chinese cities are shifting from extensive expansion to connotative development, which is a reconstruction centered on spatial reproduction. Under the background of the 'bimodal' population structure and changes in major social contradictions, urban renewal needs to solve problems such as the singleness of residential area functions and spatial fragmentation, give rise to a new governance ecology with collaboration among the government, market, and society, provide spatial support for internal circulation, and promote high-quality urbanization.

Urban spatial planning should take dynamic coordination as the core optimization direction and promote positive interaction among 'spatial practice', 'spatial representation' and 'representational space'. The specific paths are as follows: Firstly, construct a diversified collaborative governance system by establishing a collaborative governance mechanism involving the government, enterprises, and residents, relying on collaborative systems to coordinate resources, implement various policies, ensure residents' right to participate, and promote steady improvement of space. Secondly, the subjects of community management and relevant government departments should improve functional settings according to population characteristics by equally adding public facilities and creating composite public spaces based on population size to alleviate the compression of living space and meet residents' diversified needs. Thirdly, the planning department is to optimize spatial allocation through job-housing balance by allocating residential and industrial land reasonably, adopting mixed layouts, and adding various types of jobs to promote coordinated development of industries and population, further optimizing the transportation network to improve commuting efficiency and reserving space for residents to participate in family and community activities, as well as strengthening community building to enhance residents' sense of belonging, reduce family pressure, and guide residents to make rational choices so as to promote the formation of diversified lifestyles. Fourthly, take steps to popularize the cognition of aesthetic education value at the social level by optimizing the visual system in combination with regional culture in the area, establishing a resident feedback mechanism to adapt to design, and carrying out multi-dimensional remedies.

5.2. Main Contributions and Limitations

Main Contributions: Theoretically, it breaks away from the distance-based attribution of job-housing separation, adopts an interdisciplinary and dialectical perspective, and uses the 'fallacy of composition' to analyze the contradictions between individuals and collectives, thereby enhancing the adaptability of Western economic theories to Chinese cities. Practically, taking Beijing's super-large community as a case study, it provides a problem list and factual basis for the governance of similar communities. Methodologically, it combines spatial layout with governance logic analysis and conducts multi-dimensional attribution analysis, offering a practical tool for exploring underlying causes.

Research Limitations: First, the persistent high summer temperatures in the local area during the

research period affected the objectivity and completeness of the data. Second, under the research norms of the urban design discipline, on one hand, residents' experiences and psychological perceptions were not included in the effective evaluation, which may reduce the objectivity and scientificity of the quality of life assessment; on the other hand, there is a lack of a systematic evaluation index system for human settlement space in this field, and individual cognitive differences can lead to diverse spatial conceptions, which impose certain limitations on related research.

5.3. Future Outlook

This study reveals the structural dilemmas such as jobs-housing mismatch and governance fragmentation in super-large suburban communities, providing the following insights for future research:

At the theoretical level, it is necessary to promote in-depth integration of urban planning, human settlement environment research, and multiple disciplines. This paper attempts to interpret urban planning phenomena from different perspectives, analyze the formation logic of human settlements dilemmas at their root, and provide a more systematic scientific basis for urban renewal practices.

At the methodological level, existing limitations should be addressed. The study period should be extended to obtain full-time data; sociological and psychological methods should be introduced to incorporate residents' subjective feelings into evaluations; and a systematic evaluation index system for human settlement space that takes into account individual cognitive differences should be established.

At the perspective level, human settlement environment governance should return to the core logic of being resident-centered. Attention should be paid to the real needs of all residents to prevent community governance from becoming a ' power game' for a minority group, and opinions from groups of different ages and occupations should be included. It is also necessary to break through traditional governance models and build a new governance pattern with collaborative participation of 'government-market-residents'.

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